

Chapter 9

Processing of Input-Output Data

A Agricultural Production Targeting

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A.1 Background

In GTAP parlance, agricultural production targeting (APT) is a procedure applied to a country's I-O table before the main data construction phase. Except for its agricultural orientation, it is unrelated to the agricultural I-O data disaggregation. Rather, it arises from concerns that arose with the GTAP 5 Data Base, that in the data for European Union (EU) member countries, there were considerable inaccuracies in levels and international distribution of agricultural production, and, consequently, in the budgetary cost of assistance. This led to problems in the analysis of EU agricultural reform.

The investigation revealed that these inaccuracies largely reflected discrepancies between the representation of agriculture in the contributed I-O tables for EU member countries at the time (Leeuwen 2002) and EUROSTAT production data relied upon by EU stakeholders. These arose partly from differences in reference years (the I-O data being older), but more from basic data differences.

In response, a special version of the GTAP 5 Data Base was prepared for the exclusive use of GTAP Consortium members, in which the agricultural production levels in EU member countries were revised. The revisions were made not within the database construction procedure itself but as adjustments to the I-O tables entering into the procedure. In GTAP 6 Data Base, this targeting was incorporated for the first time into a public data release. Since then, Consortium members interested in agricultural policy analysis have pressed for the extension of the targeting to non-EU countries.

The EU tables processed in the initial application provided full GTAP sectoral detail, and the original implementation of the procedure relied on such provision. We now find ourselves

applying it to regions whose contributed tables require dis-aggregation. Rather than enhance the procedure to remove this limitation, we work around it by performing a partial run of the main GTAP data construction procedure, up to and including I-O table fitting, input the fitted tables into the production targeting procedure. The tables input into the production targeting procedure are therefore fully dis-aggregated, as well as cleaned and fitted. That they are fitted is not strictly necessary, but we hope that it may minimize the deviations from the production targets within the main build, discussed in sections A.2 and A.5 below. The tables output from the targeting procedure are then fed into a complete and final run of the main construction procedure.

A special release of GTAP 10 Data Base further expanded the set of countries that are subject to agricultural production targeting based on data from the Food and Agricultural Organization (Chepeliev 2020). Apart from expansion in country coverage, the FAO agricultural output data also eases the incorporation nutritional accounts in the GTAP Data Base, thereby reducing inconsistencies between GTAP and FAO agricultural accounting (Chepeliev 2022). The GTAP 11 Data Base extended this broader coverage to a standard public release, using data from EURO-STAT for EU countries and from Food and Agriculture Organization (FAO) of the United Nations 2022 for the remaining countries, a framework that GTAP 12 continues to follow.

The GTAP 12 Data Base targets agricultural production data from Food and Agriculture Organization (FAO) of the United Nations 2022 for all primary regions (i.e., those for which we have an IOT). The APT procedure is not applied to the composite regions in the GTAP Data Base. The input data for agricultural output targets for FAO-covered countries follows the procedures developed in Chepeliev 2020. The targeting covers twelve agricultural sectors (Table 9.1).

Table 9.1: Commodities Subject to Agricultural Production Targeting

Code	Description	Code	Description
PDR	Paddy rice	C.B	Sugar cane, sugar beet
WHT	Wheat	OCR	Crops n.e.c.
GRO	Cereal grains n.e.c.	CTL	Bovine cattle, sheep and goats, horses
OSD	Oil seeds	OAP	Animal products n.e.c.
V.F	Vegetables, fruit, nuts	WOL	Wool, silk-worm cocoons
PFB	Plant based fibers	RMK	Raw Milk

Note: n.e.c. stands for not elsewhere classified.

A.2 Overview

The purpose of the procedure is to adjust the I-O tables to match the agricultural production targets. But circumstances complicate the situation. The adjustment is done before the data base construction procedure, but parts of that procedure, especially I-O table fitting (Chapter 17) affect agricultural production levels in the I-O tables. In some cases, the agricultural production targets are incompatible with other data targets, more specifically, with export targets. And since the procedure was originally designed to deal with raw I-O tables that have not undergone the cleaning

procedures described in chapter 8, it contains safeguards against anomalous conditions that could abort processing.

In the data base construction process, there are many steps that affect agricultural production levels in the I-O data, but the main step is the fitting of I-O tables to international data-sets. There are many factors that affect agricultural production levels, but three are dominant: the targeting of GDP, exports, and production taxes. GDP targeting is achieved in effect by re-scaling the whole I-O table, so it affects production levels for all commodities. Changes in exports entail corresponding changes in production levels. Changes in production tax rates imply changes in either input or output values; an increase in the production tax rate, for instance, can be achieved either by increasing the money value of output or by reducing the money values of the intermediate and factor inputs. In practice, it is achieved by a combination of the two, leaning toward output value changes for domestically-oriented sectors and input value changes for export-oriented sectors.

It would be futile to target production levels in the incoming I-O tables if these were then altered drastically by the GDP, export, and production tax targeting. We therefore anticipate these adjustments in the production level targeting: we adjust not the production levels only but GDP, exports, and production taxes also. The tables going into the FIT process should therefore require little adjustment in these variables; we may then hope that the FIT process will have little effect on agricultural production levels.

Even though agricultural production targeting is done outside and before the main data construction procedure, it uses the same macroeconomic and protection data as those used in the final GTAP 12 Data Base construction. Since GTAP 12 Data Base, the trade data used agricultural production targeting and the final data construction is slightly different due to adjustments for fossil fuel exports in the latter procedure.

The attempt to anticipate the FIT export adjustments exposes another problem. In some cases, the export and agricultural production targets are simply incompatible. We encounter both hard inconsistencies, where the export target exceeds the production target, and soft inconsistencies, where the export target is lower than the production target, but still leaves very little domestic product available to the domestic market. Since the trade data are central to the whole data reconciliation process, in these cases, it is the production targets, not the export targets, that must give way. Accordingly, in such cases, we adjust the production targets before applying them to the I-O data.

To operationalize the concept of soft inconsistency, we deem a soft inconsistency to exist if the production target is less than the export target plus one quarter of the initial level of domestic absorption. But it would be meaningless to use the absorption level from the initial table, since that table may have any scale. So before testing for inconsistencies, we scale the I-O tables to match the GDP target. Having identified the inconsistencies, we then adjust the inconsistent production targets to exports plus one quarter of initial domestic absorption. In other words, we permit the production targeting to remove no more than three quarters of initial domestic absorption.

The general outline of operations is therefore:

- Clean the I-O tables.
- Adjust the tables to match the GDP targets.
- Identify inconsistencies between export and production and export targets; adjust the production targets.
- Adjust the tables to match export, output subsidy, and agricultural production targets.

Table 9.2 summarises the inconsistency and adjustment statistics across all seven base years. The columns report the number of hard and soft inconsistencies, the share of country–sector pairs with an adjusted target (*Adj.*), the aggregate percentage change in targets after adjustment (Δ Tgt.), the net percentage change in aggregate production implied by APT relative to GDP-scaled I-O values (*Net Adj.*, positive indicating an upward revision), and the percentage gap between final-database production and the adjusted targets (*Net Dev.*).

Table 9.2: Export-production adjustments: Summary statistics by base year

Year	Hard	Soft	Adj.	Adj. (%)	Δ Tgt. (%)	Net Adj. (%)	Net Dev. (%)
2004	348	184	532	32.6	1.59	14.80	−4.34
2007	356	240	596	36.5	1.94	7.07	−2.97
2011	372	219	591	36.2	2.01	7.46	−2.88
2014	359	257	616	37.7	2.22	−2.67	−2.75
2017	354	273	627	38.4	2.61	−9.52	−0.50
2019	359	278	637	39.0	2.37	−6.93	−1.40
2023	371	287	658	40.3	2.36	−6.89	−1.51

Note: To ensure comparability across base years, statistics are computed over the common set of 136 countries that are targeted in every base year (up to 141 countries are targeted in any given year), yielding 1,632 country–sector pairs per year.

The share of adjusted targets has grown gradually across base years, rising from around 33 percent in 2004 to 40 percent in 2023. This gradual increase is driven primarily by a rising number of soft inconsistencies, from 184 in 2004 to 287 in 2023, while hard inconsistencies have remained broadly stable at 348–372 per year. For the 2019 base year, 637 targets are adjusted in total (359 hard and 278 soft), representing 39 percent of the 1,632 possible country–sector combinations; for 2023, the figures are 658 adjusted targets (371 hard and 287 soft), or 40 percent. In all years, the aggregate target increases by between 1.6 and 2.6 percent after adjustment. Although individual adjustments can be severe, overall the targets are well maintained.

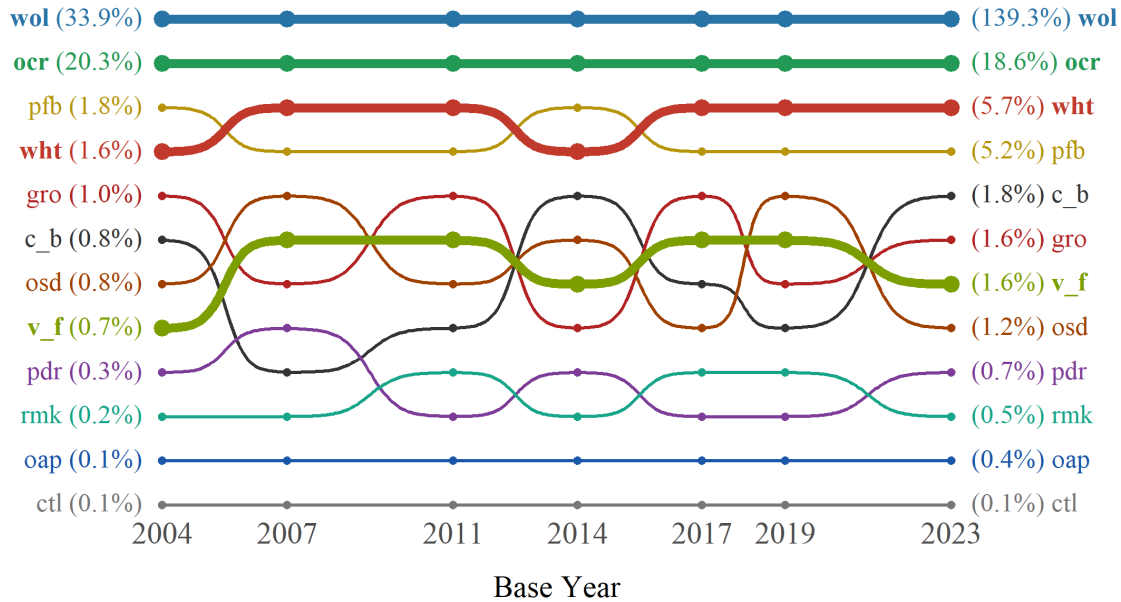
The aggregate statistics in Table 9.2 mask substantial heterogeneity across the twelve targeted sectors. For each base year, sectors are ranked by the aggregate percentage change in production targets, computed as

$$\Delta_{s,t} = \left(\frac{\sum_c \text{adjTgt}_{c,s,t}}{\sum_c \text{initTgt}_{c,s,t}} - 1 \right) \times 100,$$

where the summation runs over the 136 countries targeted in every base year, and $\text{adjTgt}_{c,s,t}$ and $\text{initTgt}_{c,s,t}$ denote, respectively, the adjusted and initial production targets for country c , sector s , and base year t ; rank 1 is assigned to the sector recording the largest aggregate upward revision. Figure 9.1 traces the evolution of these rankings across all seven base years.

The figure reveals a striking degree of persistence in the cross-sectoral ranking structure. Raw wool (*wol*) occupies rank 1 in every base year, reflecting the systematic tendency for initial FAO-based production targets to fall short of recorded export volumes in major wool-exporting countries. Other crops (*ocr*) consistently ranks second, driven primarily by a recurrent hard inconsistency in Australia where export values substantially exceed the initial production target. Wheat (*wht*) and vegetables, fruit and nuts (*v_f*) also remain near the top of the ranking throughout the sample, consistent with the soft inconsistencies documented in section A.3. At the other extreme, cattle (*ctl*) and other animal products (*oap*) rank last in all seven years, indicating that export-production pressures in these sectors are either rare or of modest aggregate magnitude. The stability of this ranking structure across seven independently constructed base years suggests that the patterns reflect systematic structural features, particularly the divergence between FAO output estimates and national trade statistics in specific commodity-exporting countries, rather than idiosyncratic year-specific anomalies.

Figure 9.1: Sector rankings by aggregate percentage adjustment to production targets, 2004–2023



We discuss the handling of export-production inconsistencies further in section A.3, and the production adjustments themselves in section A.4. Finally, in section A.5, we see how well the production targets are maintained in the database construction program. In the discussion that follows we focus primarily on the 2023 reference year of the GTAP 12 Data Base.

A.3 Export-Production Inconsistencies

For the 2019 reference year, a prominent example of a hard inconsistency is Australia's other crops (ocr) sector, where the initial production target falls far short of export levels and is accordingly adjusted substantially upward. A notable soft inconsistency in 2019 is Iraq's vegetables, fruit and nuts (v_f) sector: while the production target exceeds exports, it covers only a small fraction of domestic demand, and the target is accordingly raised by a large amount.

For the 2023 reference year, the same patterns recur. Australia's other crops (ocr) again presents a hard inconsistency, as exports substantially exceed the initial production target, requiring a large upward revision. Iraq's v_f sector is again a prominent soft inconsistency: the production target, while above export levels, leaves inadequate domestic supply and is revised considerably upward. Saudi Arabia's wheat (wht) sector also exhibits a soft inconsistency, where the initial production target falls far short of domestic demand requirements and is raised several-fold.

Table 9.3 reports some of the notable adjustments for the 2023 base year. Here, we select the items for which changes or differences are more significant than others, where the criterion for "most significant" takes into account both the absolute magnitude of the item and the relative magnitude of the change or difference. We see that adjustments are more prevalent among non-EU countries, and particularly for the commodities other crops (ocr), raw wool (wol), vegetable, fruit and nuts (v_f), and wheat (wht).

Table 9.3: Production target adjustments for 2023: Selected cases (US\$ million)

GTAP Region	Sector	Domestic Absorption	Exports	Initial Production Target	Adjusted Production Target
aus	ocr	13110	791	17	4068
nld	ocr	3070	9986	1196	10753
irq	v_f	33407	120	1735	8472
pak	wol	9682	1	35	2422
can	ocr	4250	1386	183	2449
nld	v_f	1316	14566	7273	14895
irq	gro	8046	205	247	2217
ind	ocr	103188	4211	19973	30008
irq	wht	19534	22	1511	4905
ken	osd	6285	7	115	1578
isr	ocr	1001	120	0	370
nld	osd	156	679	4	718
col	ocr	3856	5093	2252	6057
sau	wht	13236	4	770	3313
bra	wol	4567	9	51	1151
are	ocr	11	471	0	474
are	v_f	260	1976	356	2041
irq	pdr	2614	0	8	654
irq	ocr	5457	8	170	1372
hti	v_f	3297	1	37	825

A.4 Production Adjustments

Table 9.4 shows the effects of the production adjustments for the 2023 base year. We compare the production level after GDP scaling (third column) to the adjusted production targets (fifth column). We also report the production levels obtained without the export and production subsidy adjustments being applied (fourth column).

Table 9.4: Production adjustments for 2023: Selected cases (US\$ million)

GTAP Region	Sector	Scaled	Without Production Adjustments	With Production Adjustments
chn	v_f	254961	752915	752915
chn	gro	272625	116080	116080
chn	osd	212768	79988	79988
chn	wht	161857	55524	55524
chn	pdr	200346	83016	83016
ind	ocr	104043	19973	30008
ind	pdr	59007	116802	116802
bra	oap	12226	43241	43241
bgd	pdr	50965	17025	17025
rus	oap	8463	34443	34443
chn	wol	34057	4988	8647
irq	v_f	33570	1735	8472
usa	wht	47194	13046	16682
tur	ctl	6081	26872	26872
sdn	ctl	76	6864	6864
fra	v_f	8950	31808	31808
vnm	pdr	40584	14212	14212
rus	v_f	48566	21024	21024
pak	pfb	118	5986	5986
ind	ctl	33995	67449	67449

The results for the 2023 base year show that the largest adjustments are concentrated in China, India, the United States, Russia, and Brazil. China accounts for the most significant cases: vegetables, fruit and nuts (v_f) are adjusted sharply upward, with the FAO target substantially exceeding the GDP-scaled I-O value, while grain crops (gro), oilseeds (osd), wheat (wht), and paddy rice (pdr) are all revised downward, as GDP-scaled values exceed their respective FAO targets. A striking feature of the historical series is the reversal in the direction of the net production adjustment. In the earlier base years, FAO targets were on average above the GDP-scaled I-O values, so agricultural production was adjusted upward: by 14.8 percent in 2004, and by approximately

7 percent in both 2007 and 2011. From 2014 onward, the pattern reversed, with FAO targets generally falling below the GDP-scaled values: production was adjusted downward by 2.7 percent in 2014, 9.5 percent in 2017, 6.9 percent in 2019, and 6.9 percent in 2023. This trend reflects the combination of rising nominal GDP (which scales up the I-O tables) and moderated growth in FAO agricultural output estimates in recent years.

A.5 Deviations from Targets in the Main Data Base Construction Program

As noted above, the production adjustment is performed before the main data construction program. The adjusted targets are attained quite accurately within the adjustment program itself, but nothing in the main program guarantees that they will be maintained through the regular I-O processing. In table 9.5 therefore, we examine the largest deviations between the production targets and the final data.

Table 9.5: Deviations from production targets for 2023: Selected cases (US\$ million)

GTAP Region	Sector	Target	Final
arg	oap	8155	21041
vnm	oap	16365	8991
nga	v_f	70758	54510
vnm	pdr	14212	9079
arg	ctl	25455	19566
ken	rmk	4569	2367
are	v_f	2041	4044
vnm	osd	1703	559
ind	wht	40202	33567
are	ctl	1274	2794
dza	v_f	21935	17378
arg	osd	12545	9215
are	ocr	474	1413
ukr	v_f	7820	5373
jpn	v_f	25948	21383
tur	ctl	26872	22450
gin	ocr	176	728
can	ctl	16517	20304
sdn	ctl	6864	4796
gha	v_f	17769	21557

Overall, deviations from the target are not extreme. Key deviations in 2023 are in Argentina, Vietnam, Nigeria, Kenya, and the United Arab Emirates. In terms of commodities, the

sectors with the largest deviations include other animal products (oap), vegetables, fruit and nuts (v_f), cattle (ctl), paddy rice (pdr), and raw milk (rmk). A notable case is Argentina's other animal products (oap) sector, where the final production in the database substantially exceeds the production target. Vietnam's other animal products (oap) and paddy rice (pdr) also show large deviations, as does Nigeria's v_f sector. Bearing in mind that the differences presented are those considered most serious, we may say that the targets are well maintained. The net deviation, overall agricultural production for targeted countries relative to the production targets, has been consistently negative (i.e., the final data fall slightly below the targets) and has generally improved over the sample: from -4.3 percent in 2004 to -3.0 percent in 2007, -2.9 percent in 2011, -2.8 percent in 2014, and -0.5 percent in 2017, before widening slightly to -1.4 percent in 2019 and -1.5 percent in 2023.

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