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The Global Trade Analysis Project (GTAP) Data Base: Version 11

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This paper describes the construction of the Global Trade Analysis Project (GTAP) Data Base, version 11. The Data Base reconciles different data sources at a global scale for analytical use and provides time series data on value flows, volumes, and various tax instruments. GTAP 11 offers a time series of 5 reference years (2004, 2007, 2011, 2014, and 2017), distinguishes 65 sectors in each of 141 countries and 19 aggregate regions—with extensive individual countries accounting for 99.1% of world Gross Domestic Product (GDP) and 96.4% of world population. The exhaustive nature of GTAP's economic activity coverage facilitates its use in economy-wide studies of global economic issues.

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1. Introduction

The Global Trade Analysis Project (GTAP) was established in 1992, during a very dynamic time for trade policy (van Tongeren et al., 2017). Nowadays, GTAP is also a key component of energy and environmental analysis at the global level. The purpose of GTAP is to lower the entry cost for those seeking to conduct quantitative analyses of international economic issues in an economy-wide framework. The centerpiece of GTAP is its database, which is constructed to represent the world economy for a given reference year and underlies most, if not all, Applied or Computable General Equilibrium models (Aguiar et al., 2019).

The GTAP Data Base describes the domestic transactions, global bilateral trade patterns, international transport margins and protection matrices that link individual countries and regions. For each country/region, the Data Base provides values of production, in addition to intermediate and final consumption of goods and ser-

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[b] This manuscript was updated on February 27, 2023 to add four erroneously excluded countries/regions to Table A.5.

vices measured in millions of current U.S. dollars. Many domestic policies are also captured by this database, including value-added taxes, producer subsidies and consumption taxes (Aguiar, Narayanan, and McDougall, 2016). The GTAP Data Base serves as a benchmark equilibrium for the standard GTAP model (Corong et al., 2017). The standard GTAP model is freely available, easy to modify and extend.[1] There are a variety of model extensions available on the GTAP website (www.gtap.org), under the technical paper series and in the Journal for Global Economic Analysis (www.jgea.org). For a growing list of economic models calibrated to GTAP data, please refer to the following link (https://www.gtap.agecon.purdue.edu/about/data_models.asp). These models go beyond the analysis of trade issues to examine environmental and other economic issues both national and global levels.

Compared to GTAP version 10 data, version 11 increases its geographic coverage to 141 individual countries and 19 aggregate regions to capture global economic activity—with individual countries accounting for 99.1% of world Gross Domestic Product (GDP) and 96.4% of world population.[2] Table A.1 reports new and updated countries in GTAP 11 for the latest reference year, i.e., 2017.

The sectoral coverage remains the same, as in GTAP version 10, with each country/region distinguishing 65 products and services in the standard GTAP data version (See Table A.4 for a complete list). In broad terms, GTAP classifies agriculture, food, resource extraction, manufacturing, and service activities to describe all economic sectors within each country.[3]

The GTAP Data Base relies on country-based Input Output Tables (IOTs) which contain inter-sectoral linkages within each country. Relative to GTAP version 10 (Aguiar et al., 2019), this latest version incorporates 20 new countries mainly from the Middle East and Central Africa. The latter have been made possible due to collaboration with African researchers and support from the United Nations Economic Commission for Africa (UNECA).

Figure 1 shows the country coverage of GTAP 11. Three shades of green are used to reflect existing countries in GTAP that are new or updated relative to previous version. Dark green indicates a new country in GTAP, which was previously part of a regional aggregate. The lightest shade of green represents existing countries with an updated IOT. In GTAP 11, there are 39 updated IOTs. The medium shade of

[1] For information about GTAP courses, please refer to https://www.gtap.agecon.purdue.edu/events/gtap-u/index.aspx.

[2] GTAP version 10 Data Base covers 121 countries and 20 composite regions with individual countries accounting for 98% of world GDP and 92% of world population.

[3] While several IOTs are very detailed and can be aggregated to represent the 65 sectors in GTAP, the majority of tables submitted by our data contributors are less than 65 sectors. Whenever necessary, we disaggregate sectors using a representative table, prior to the other adjustments. Corong (2020) provides information about the composition of the representative table.

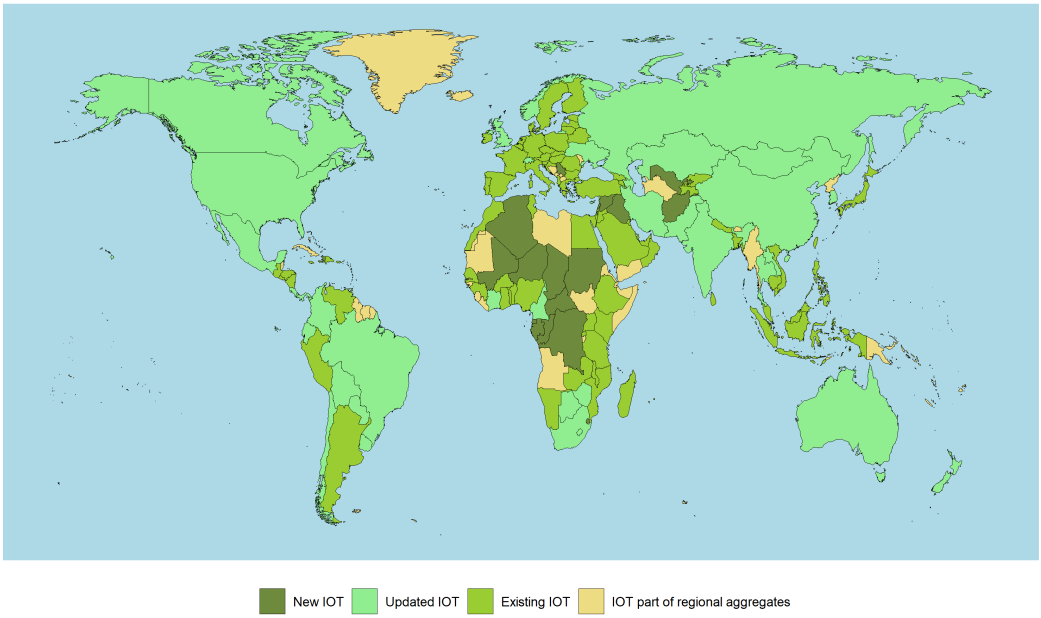

Figure 1. Regional coverage in GTAP 11.

Notes: Countries in green are part of GTAP 11. The darkest green indicates a country newly extracted from a composite region, based on newly available IOTs. The lightest green represents countries that have been updated for version 11. The medium shade of green is for existing countries with no IOT updates. Other countries (in beige) are represented in GTAP's 'Rest of' regions.

Source: GTAP 11 Data Base.

green is for all other existing countries, i.e., those without an updated IOT. Finally, countries in beige are part of a regional aggregate.

There are several new features of GTAP 11, summarized here, with additional details in Section 3. First, we target IOTs' agricultural production in all countries (Chepeliev, 2020b). Prior to GTAP 11, agricultural production was targeted for countries covered by the Organisation for Economic Co-operation and Development (OECD) Producer Support Estimates, but as Chepeliev (2020b) showed, using Food and Agriculture Organization of the United Nations (FAO) to complement OECD improves the global representation of agriculture. Adjusting agricultural production towards what is reported by OECD and FAO helps with the inclusion of agricultural domestic support in the case of the former and with intermediate use in the case of the latter.[4] Second, we use new sources for services trade data. Third, with regards to energy data, there are a number of updates summarized in Section 3, and detailed in (Chepeliev, 2022a). We update carbon dioxide (CO_2) emissions accounting and introduce changes to the processing of the energy data used in GTAP, thereby resulting in improved comparability in emissions when compared with other international sources as explained in Chepeliev (2022c). Fourth, we now explicitly include energy subsidies following the procedures in Chepeliev, McDougall, and van der Mensbrugghe (2018), providing a more consistent representation of energy prices and an additional policy instrument that improves energy and environmental policy simulations.

Finally, there are several data extensions/satellites that accompany the standard GTAP Data Base, which are generally updated soon after the public release. The additional satellite data are: (1) energy volumes and CO_2 emissions; (2) bilateral time-series trade data; (3) Non-CO_2 greenhouse gases (GHGs) (documented in Chepeliev (2020a)) and air pollution emissions (Chepeliev, 2021a), which also include estimates of process CO_2 emissions; and (4) food balance sheets (Chepeliev, 2022b), which allow for analysis of nutritional impacts of policies. These files can be aggregated when placed along the main data files in each distribution.

The GTAP extensions/satellites provide modified data to be used with specific models. Among others, these are the energy extension (GTAP-E documented in McDougall and Golub (2009)), land use and cover (GTAP-LULC documented in Baldos and Corong (2019)), international migration and remittances (GMIG documented in Walmsley, Winters, and Ahmed (2007); Aguiar (2020)), foreign income payment and receipts (GDYN documented in McDougall et al. (2012); Golub (2016)), electricity generation (GTAP-Power documented in Peters (2016); Chepeliev (2020c)), multi-region Input Output (MRIO described in Carrico, Corong, and van der Mensbrugghe (2020)) and domestic margins (Corong, 2018).[5]

[4] Agricultural production does not exactly match what is reported in OECD and FAO because the IOTs are then subject to the reconciliation of balanced trade.

[5] More information is also available from https://www.gtap.agecon.purdue.edu/

The release of GTAP 11 data will be announced on the GTAP website (i.e., www.gtap.org). Three formats will be distributed: (1) the new standard format to match the nomenclature of the new standard GTAP model (Corong et al., 2017); (2) General Algebraic Modeling System (GAMS) Data Exchange (GDX) containers for GAMS users—also using the conventions of the new standard format; and (3) the classic version (Hertel, 1997) for backward compatibility. The latter is aimed at providing flexibility for researchers as they convert to the new standard format. New database developments, however, such as the domestic margins model, will only be available in the new standard format.

The new format of the database is presented in Appendices 1 to 3 of Corong et al. (2017). These Appendices show the relationship between the classic and new nomenclature in side-by-side tables. Among other things, the new model allows for multi-product sectors, as well as multiple sectors producing the same commodity, e.g. electricity.

The next section provides a summary of the data reconciliation procedure used in the construction of the GTAP Data Base. Section 3 discusses the updates and new features of GTAP 11. Section 4 presents a numerical illustration of the Data Base. The final section concludes with a brief discussion on future developments.

Those interested in accessing previous versions of the GTAP Data Base are referred to the web site (https://www.gtap.agecon.purdue.edu/databases/default.asp) where versions 1 to 9 can be downloaded for free.[6] The most recent versions of the Data Base are free to contributors (both data contributors and consortium members). Others are charged a fee, the revenue from which goes to support ongoing development of the GTAP Data Base.

In addition, for this paper, a simulation archive containing numerical illustration of a Carbon Border Adjustment Mechanism (CBAM) policy experiment is provided in the supplementary materials. The archive is accompanied by a ReadMe file with replication instructions.

2. Data reconciliation

The GTAP Data Base makes use of international data to supplement IOTs and reflect more recent economic activities for each country/region in each of the five reference years. All IOTs representing various reference years are adjusted to each GTAP reference year and to a single currency using market exchange rates and unit (millions of U.S. dollars) using macroeconomic data we collect from the World Development Indicators (Wang and Aguiar, forthcoming). Thus, the first macroeconomic condition we impose is:

$$GDP = C + I + G + X - M \tag{1}$$

databases/Utilities/default.asp.

[6] Once version 11 is published, version 10 is sequestered from the public, only to become available when version 12 is released.

where GDP is Gross Domestic Product, C is Private consumption, I is Investment or Gross fixed capital formation, G is Government consumption, X is Exports of goods and services, and M is Imports of goods and services.

Since we target GDP and trade, we must adjust other GDP expenditure-side aggregates (private consumption, government consumption, and investment) in order to ensure that equation 1 is satisfied by the Data Base. Note that the level of trade, exports and imports, is initially sourced at the sectoral level and reconciled. We use reconciled bilateral trade data for merchandise and services in the GTAP Data Base because the initial trade data is not balanced, i.e., world exports differ from world imports (Economist, 2011), and because there are frequent discrepancies between countries' reported imports and what their partners report as exports (Gehlhar, 1997).

The second macroeconomic condition we ensure is that the savings-investment balance is equal to the trade balance:

$$S - I = X - M \tag{2}$$

where S is Savings and I is Investment net of depreciation. Depreciation is assumed to be 4% of capital stock for all countries. Capital stock is calibrated based on information from the Penn World Tables (Feenstra, Inklaar, and Timmer, 2015).

Because exports and imports are targeted in the GTAP Data Base construction, and investment adjusts to maintain GDP, the level of savings is computed as a residual. This is also the case in other GTAP data extensions such as the international labor migration extension (see GMIG, documented in Walmsley, Ahmed, and Parsons (2007); Aguiar (2020)) and one of the dynamic extensions (GDYN, documented in McDougall et al. (2012); Golub (2016)) where other elements of the external accounts are considered such as net remittances and net foreign payments, respectively. In both of these datasets, the level of savings is also computed as a residual. Note that this is not gross savings, but savings net of depreciation.[7]

One of the key features of GTAP is its treatment of protection data, which supersedes the tax information included in the contributed IOTs (McDougall, 2006). The protection data are composed of bilateral tariff information contributed by the International Trade Centre (ITC, 2021), agricultural domestic support from the OECD's Producer Support Estimates (OECD, 2021), and agricultural export subsidies based on World Trade Organization (WTO) notifications (WTO, 2021).

The next section highlights the updates and new features in data sources and methodologies of GTAP 11.

[7] Savings take a more prominent role in dynamic analyses. The level of the capital stock, depreciation, and savings can be adjusted by users where better data is available. As with other adjustments, we recommend the use of pre-simulations as explained in Malcolm (1998).

3. Updates and New features of GTAP 11

The GTAP Data Base makes use of international data to supplement IOTs and reflect more recent economic activities for each country/region in each of the five reference years. The sub-sections below highlight the novelties in data sources and methodologies. These are all reflected in the revised time series made available in GTAP 11, since we have rebuilt the historical benchmark data using these new methods and sources.

3.1 Country and Sector Coverage

Both the expansion and update of countries in the GTAP Data Base are made possible through IOTs contributed by members of the GTAP network. In version 11, 20 new and 39 updated national IOTs have been incorporated. The new countries extracted from previous regional aggregates are: Afghanistan, Algeria, Central African Republic, Chad, Comoros, the Congo Republic, the Democratic Republic of the Congo, Equatorial Guinea, Eswatini, Gabon, Haiti, Iraq, Lebanon, Mali, Niger, Palestine, Serbia, Sudan, Syria, and Uzbekistan. References to the IOTs used for each of these new and updated countries are available on the GTAP website[8] and listed in Table A.1. A complete listing of the countries/regions is available in the Appendix, Table A.5.[9]

Since GTAP version 10, we allocate IOTs to the closest reference year (i.e., 2004, 2007, 2011, 2014, 2017). This allocation is restricted to countries for which we have received IOTs for multiple years (see Table A.2). Table A.2 lists the countries for which we have two or more IOTs matching the closest reference year.[10] For the remaining countries, however, a single IOT must be matched against all reference years. This deficiency highlights the need for a continuing stream of new IOT contributions and the important role that other international data sources have in updating IOTs. We regularly improve the collection and allocation of IOTs as information becomes available to us via contributions from researchers in the GTAP network, who help us improve the quality of the GTAP time-series data with country-specific knowledge.

Individual countries not represented in GTAP are included in the 'Rest of' composite regions. In GTAP 11, many countries in the former *Rest of Central Africa* are now part of the database as separate countries prompting us to remove the previous *Rest of Central Africa* and *South Central Africa* regions that were available in GTAP version 10 (Aguiar et al., 2019) and define a new *Rest of South and Central*

[8] For new and updated country information included in version 11, please refer to https://www.gtap.agecon.purdue.edu/databases/v11/v11_doco.asp.

[9] For information on all countries available in GTAP, please refer to https://www.gtap.agecon.purdue.edu/databases/regions.asp?Version=11.131.

[10] All of these are listed in https://www.gtap.agecon.purdue.edu/databases/regions.aspx?Version=11.131.

Africa region composed of Angola and São Tomé and Príncipe.[11] In GTAP, composite regions are assigned an IOT estimated using neighboring countries' data based on similarity in GDP per capita, then adjusted using information we are able to collect from these countries as explained in Corong (2020). For Africa, there are five aggregate regions remaining: Rest of North Africa, Western Africa, Rest of South and Central Africa, Eastern Africa, and Rest of South African Customs Union.[12] We encourage the development of IOT statistics and look forward to increasing the number of individually-represented countries in the GTAP Data Base. For a summary of the history of GTAP data releases, please refer to Table A.3 in the Appendix.

The 65 sectors in GTAP are listed in Table A.4. For Food and Agricultural sectors, Table A.6 shows the concordance between the United Nations (UN) Central Product Classification (CPC) version 2.1 and relevant GTAP sectors. Tables A.7 and A.8 display the concordances between the UN International Standard Industry Classification (ISIC) revision 4 and the GTAP sectors for manufacturing and services, respectively.

3.2 Adjustments to IO tables

After an IOT is contributed, the table is first checked and then cleaned for any remaining minor issues.[13] Inventory changes, or changes in stocks, are removed from IOTs as these are incompatible with the GTAP model theory, which is medium-run in nature. Tables with less than 65 GTAP sectors are disaggregated using a representative table. The IOTs are then adjusted with supplementary data, for example macroeconomic accounts in millions of USD. Furthermore, some taxes (tariffs and export subsidies, for example) and value added are replaced with other internationally sourced data. Labor is split into five labor categories.

Starting with GTAP 11, we use the FAO data to target agricultural production for 193 countries, some of which are subsequently aggregated into regions (Chepeliev, 2020b). The following sub-sections explain other supplementary data.

3.2.1 Agricultural Factor shares

The value added shares for agricultural and resource commodities are adjusted and replaced. This allows us to report land and natural resources, since this information is not available from the contributed IOTs. For GTAP 11, Saeed, Hertel, and

[11] The standard country list used in GTAP is comprehensive covering more than 200 countries.

[12] To learn about the country composition of each of these, please go to: https://www.gtap.agecon.purdue.edu/databases/regions.asp?Version=11.131.

[13] For instance, the balance condition is checked during contribution based on a tolerance threshold. We do cost structure comparisons against an average table and the previous table, if it exists. The comparisons help us reveal mapping issues and/or structural changes. We also rely on regional experts to help us peer-review the contributed IOTs.

Fuglie (2020) compiled a revised set of value added cost shares obtained from the literature; they developed qualitative and quantitative comparisons, the latter of which was based on regression analysis to identify outliers that are excluded from GTAP.

3.2.2 Labor Splits

Initial versions of the GTAP Data Base only distinguished 3 primary factors, namely: land, capital and labor. Between GTAP versions 4 and 8, labor was disaggregated into skilled and unskilled categories based on econometric estimates by Liu et al. (1998). Since GTAP version 9, labor flows have been disaggregated into 5 occupation categories (agricultural/unskilled workers, service workers, clerks, technicians/associate professionals, and officials/managers) based on Weingarden and Tsigas (2010) who processed wage and occupation data from the International Labour Organization (ILO) to estimate imputed wages by occupation and industry using constrained optimization. For GTAP 11, we updated Weingarden and Tsigas (2010) by using recently available and more detailed industry and occupation wage (respectively, by ISIC rev.4 and the International Standard Classification of Occupations—ISCO-08) from the ILO, to estimate imputed wages for the 2017 reference year (Corong, Pattawee, and Tsigas, 2022).

3.2.3 Energy Data

An updated energy data treatment extends an approach first applied in the construction of the GTAP version 10 (McDougall and Chepeliev, 2021). Several important modifications are introduced to the new treatment of energy data, in part due to changes to the accounting of CO_2 emissions (Chepeliev, 2022a). First, in addition to relying on the extended International Energy Agency (IEA) energy balances, we also utilize more aggregate energy balances reported by the UN (UN, 2021) to represent countries not explicitly covered by the IEA. Second, for a more consistent representation of the bilateral energy trade flows, we rely on data from British Petroleum (BP, 2022) and the statistical office of the European Union (Eurostat, 2022). In combination with the UN-COMTRADE trade flows, these are then used to bilateralize the unilateral trade data from IEA. These updates result in a more consistent representation of trade between key energy exporters and importers, and allow us to address the widely-recognized weakness of UN-COMTRADE in capturing energy trade (Bellora, Cotterlaz, and Thie, 2022). Third, while refining the GTAP CO_2 emission estimates, we introduce blast furnace gas and other recovered gases into the energy database. Finally, we discard the energy flows associated with flaring from the GTAP energy database, to be consistent with the IEA energy balance accounting as well as with the definition of fossil fuel combustion emissions from the Intergovernmental Panel on Climate Change (IPCC) (Chepeliev, 2022c). This new treatment assures that flaring-related energy and emission flows are aligned with the corresponding estimates from international data sources.

In addition, fossil-fuel consumption subsidies based on estimates from the International Monetary Fund (IMF) and IEA data are now integrated in the standard database following an approach developed in Chepeliev, McDougall, and van der Mensbrugghe (2018).

3.2.4 CO_2 emissions

Since GTAP version 5 (Lee, 2002), CO_2 emissions from fossil fuel combustion have been provided as an extension account, based on the Tier 1 method of the 1996 IPCC Guidelines (IPCC/OECD/IEA, 1996). However, a number of concerns regarding discrepancies between GTAP CO_2 emissions data and other international data sources, such as The Emissions Database for Global Atmospheric Research (EDGAR) and IEA, have been raised over time (Chepeliev, 2022c). To address the discrepancies, we have updated the emissions accounting framework based on Tier 1 method of the 2006 IPCC Guidelines. The revised approach includes estimation of emission factors at a more granular commodity level. Two additional refinements include an updated accounting of emissions from blast furnaces and other recovered gases, as well as a more transparent treatment of CO_2 emissions from flaring. As shown in (Chepeliev, 2022c), the new treatment substantially reduces the discrepancies between GTAP and other international data sources both at the global and country levels.

3.2.5 Protection Data

GTAP 11 accounts for several types of protection instruments. For agricultural products, domestic support and export subsidies are taken into account. Additionally, import tariffs are included for all merchandise products (agricultural and non-agricultural).

Agricultural domestic support is based on the Producer Support Estimates (PSE) from the OECD (2021). These data are only available for OECD countries and select non-OECD countries. The PSE is composed of Market Price Support (MPS) and budgetary transfers. MPS is an estimate of indirect transfers to producers that includes the accumulated impact of various policies, domestic price support, and border measures such as tariffs. As in previous versions of GTAP, since one of key elements of the Data Base is a tariff dataset, the MPS component of the PSE is excluded, leaving us to only consider the transfers to agricultural producers as explained in Huang (2013). We use OECD's PSE data to update all five reference years. For European Union member countries, we rely on the contribution from the European Commission's Joint Research Centre (JRC) (Boulanger, Philippidis, and Jensen, 2018) to disaggregate domestic support for each European Union (EU) member country. For version 11, the 2017 reference year was added, while for 2004, 2007, 2011, and 2014, we rely on previously contributed data.

Agricultural export subsidies also rely on previous treatment and efforts by various GTAP researchers: for 2004 we use Elbehri and Narayanan (2010), for 2007

we use Laborde (2012), for 2011, 2014, and 2017 we benefit from the contributions of Kayode Ajewole and Jayson Beckman from U.S. Department of Agriculture (USDA), who collected notifications to the WTO (Beckman and Aguiar, 2018).

For tariff information, we consider applied *ad valorem* tariffs, including *ad valorem* equivalents of specific tariffs and import quotas. Tariff data for the four most recent reference years (2007, 2011, 2014, and 2017) at the 6 digit Harmonized System (HS6) level are provided by Mondher Mimouni and Xavier Pichot from the UN International Trace Centre.[14] For 2004 we use previously contributed data from Laborde (2010) based on ITC data. MacMAP (ITC, 2021) includes 3-year average of imports, which we use as weights to aggregate HS6 level tariffs to the GTAP sector level.

3.2.6 Merchandise Trade data

Merchandise trade data are based on the United Nations Commodity Trade (UN-COMTRADE) Statistics (UNSD, 2021) and the reconciliation has been updated for all reference years using a new consistent methodology at the HS6 level (Gehlhar, forthcoming). One of the objectives of the reconciliation is to ensure that there are no re-exports in GTAP. That is, only domestically-produced exports are recorded.

Gehlhar (2017) explains that since version 10, a unified and comprehensive approach has been applied consistently across time in order to obtain this key element of the GTAP Data Base for all reference years. This new approach is applied to the UN-COMTRADE dataset for 231 countries, where the main objective is to produce balanced trade, i.e., world exports line up with world imports for each commodity. Beside the discrepancies in countries' reporting, one of the challenges is the increasing presence of re-exports. Trade data for more than 50 countries with re-exports are estimated by deriving domestic exports and by converting total imports into retained imports.

The UN-COMTRADE dataset is available at the 6-digit level of the Harmonized System Classification. We use a concordance between the HS6 and GTAP sectors to aggregate the HS6 flows. For GTAP 11, this concordance was refined to address mapping issues raised in GTAP version 10.[15]

3.2.7 Services Trade Data

Prior to GTAP 11, trade in services data was based on unilateral services trade information from the IMF, which we had to bilateralize in-house (McDougall, 2002; McDougall and Hagemejer, 2006; Lejour, van Leeuwen, and McDougall, 2010). This data was bilateralized using the RAS method in versions 3, 4 and 5, then

[14] This is documented in https://www.macmap.org/en/about/methodology.

[15] The concordances used in GTAP are available in https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=5111.

improved by using additional sources such as OECD and Eurostat, versions 6 to 10. In GTAP 11, we take advantage of a recently developed dataset provided by the OECD and WTO called the Balanced Trade in Services (BaTiS) (Liberatore and Wettstein, 2021), which provides an initial bilateralization that does not need to be reconciled. The starting point for BaTiS is the trade in services dataset developed jointly by the WTO and the United Nations Conference on Trade and Development (WTO-UNCTAD). BaTiS provides time series data from 2005 to 2019 covering 200 economies and the services sector is classified into 12 service categories based on the 2010 extended balance of payments services (EBOPS) classification (Liberatore and Wettstein, 2021), see Table 1.[16]

Table 1. BaTiS services.

No.	Code	Description
1	SA	Manufacturing services on physical inputs owned by others
2	SB	Maintenance and repair services n.i.e.
3	SC	Transport
4	SD	Travel
5	SE	Construction
6	SF	Insurance and pension services
7	SG	Financial services
8	SH	Charges for the use of intellectual property n.i.e.
9	SI	Telecommunications, computer, and information services
10	SJ	Other business services
11	SK	Personal, cultural, and recreational services
12	SL	Government goods and services n.i.e.

Notes: n.i.e. Not included elsewhere

Using bilateral balanced data is convenient, however the sectoral coverage does not map perfectly to GTAP's 20 services sector. There are 4 services sectors that are not covered by BaTiS: electricity, gas distribution, water supply, and ownership of dwellings. As in previous versions, for these and other energy sectors including electricity and gas distribution, energy trade data is constructed using data from the International Energy Agency (IEA) as documented in (Chepeliev, 2022a). The two remaining sectors are assumed not to be traded.

In addition, there are two sectors provided in BaTiS that we do not consider: manufacturing services on physical inputs owned by others (SA) and the charges for the use of intellectual property n.i.e. (SH). For the latter (SH), we follow previous treatment that consider royalties to be an income flow rather than a trade flow. As such, this information is discarded because we consider it as a factor payment

[16] Since BaTiS is not available for 2004, the earliest reference year for GTAP, we select 2005 which is the closest year for all but two countries. We then apply GDP weights to obtain an estimate for 2004. For Serbia and Montenegro, the earliest available year in BaTiS is 2006.

(McDougall and Hagemejer, 2006). For the former, this is also discarded because it is not clear which manufacturing sectors are involved. Turning to SA, we note that it is defined as follows:

Covering the processing, assembly, labelling, packing, and other such processes undertaken by enterprises that do not own the physical inputs concerned.

Only the fee (the manufacturing service) charged by the enterprise undertaking the manufacturing service is included under this item.

But the breakdown by type of manufacturing services (i.e., whether it is assembly or packaging), is unknown, as well as the economic sectors from which it originates (i.e., motor vehicles or machinery).

The remaining sectors in BaTiS are sometimes too aggregated for GTAP. In order to disaggregate the sectors in BaTiS, we use another recently developed dataset that focuses on services trade. This is called the Trade in Service data by Mode of Supply (TiSMoS), which provides more detailed information, but is not bilateral (Wettstein et al., 2021). TiSMoS is a dataset produced by the WTO and funded by the Directorate-General for Trade of the European Commission (Wettstein et al., 2021).[17]

TiSMoS also uses the WTO-UNCTAD-ITC data set as a starting point for the measurement of resident to non-resident transactions. It is developed with the objective of providing another analytical dimension to the information available to the public—namely, the mode of supply dimension. The dataset covers 200 countries or regions for the period 2005-2017, which is classified by the four modes of supply per General Agreement on Trade in Services (GATS) definition: cross-border supply (mode 1), consumption abroad (mode 2), commercial presence (mode 3), and presence of natural persons (mode 4).

The sectoral coverage of TiSMoS is very detailed; it covers 55 sectors similar to the extended balance of payments services (EBOPS) classification in 4 different mode levels. We use TiSMoS to disaggregate BaTiS sectors considering the sum of all modes, except Mode 3. Table A.9 lists the BaTiS sectors that are disaggregated using TiSMoS. Table A.9 also includes the concordance between the disaggregated sector and GTAP. Traveler's expenditures (trvl) is not a sector in GTAP but is accounted for. As in previous versions, traveler's expenditures are allocated as trade among countries using private consumption information (McDougall and Hagemejer, 2006). This is a simplifying assumption due to the lack of better data, and the reason why the GTAP Data Base may sometimes report trade in water supply between distant countries.

In the following section we provide a numerical illustration of GTAP 11.

[17] Another possible data source is the International Trade in Services Statistics by the OECD, which is bilateral but with emphasis on OECD member countries.

4. Numerical illustration

In this section we provide an illustrative application of the GTAP 11 Data Base focusing on the potential implications of Carbon Border Adjustment Mechanism (CBAM) policy that was recently announced by the European Union (EU) (EC, 2021). Apart from addressing an important policy question that has received a lot of attention over the last two years (Böhringer et al., 2022), a CBAM application also allows us to exploit several key improvements introduced in the current version of the Data Base. First, the CBAM application heavily relies on the CO_2 emissions data, which has been revised and updated in GTAP 11 (Subsection 3.2.4). Second, the CBAM analysis benefits from the revised bilateral energy trade data, as discussed in the Subsection 3.2.3. Finally, unlike in the most recent CBAM studies that relied on the GTAP version 10 with a 2014 reference year (e.g. Chepeliev (2021b); UNCTAD (2021)), here we benefit from the newly introduced 2017 reference year with updated trade, production and consumption data inputs.[18] The CBAM is aimed at protecting domestic producers, avoiding carbon leakage and preventing the importation of additional carbon intensive products from countries with less stringent environmental regulations than in the EU (Chepeliev, 2021b).

To provide an assessment of the possible impacts of the EU's CBAM, we link the GTAP 11 Data Base to the GTAP-E computable general equilibrium (CGE) model (McDougall and Golub, 2009) in GTAP version 7 format. The latter is a static multi-region CGE model, which incorporates the carbon emissions accounting framework. For this illustrative simulation, the GTAP 11 Data Base is aggregated to 5 regions and 16 sectors (see Table A.10 for the regional aggregation and Table A.11 for the sectoral aggregation).

We first implement a pre-simulation that incorporates a carbon price in the EU at 83.5 Euros (EUR) per ton of CO_2, as was observed in the EU's Emission Trading System (ETS) during the first half of 2022 (EMBER, 2022). Applied carbon prices cover CO_2 emissions from the fossil fuel combustion by all emitting agents. We then use the updated database as a starting point to implement CBAM policies. In this way, we attempt to capture the observed evolution of the environmental policies in the EU. In addition, this implementation allows us to disentangle the implications of CBAM from the impacts of EU carbon pricing policies. The CBAM is implemented in a form of levy on the carbon content of imported commodities that enter the EU. The levy is defined based on the carbon prices applied by the EU (Chepeliev, 2021b). Within such implementation we consider direct emissions from fuel combustion (Scope 1) and indirect emissions from heat and electricity used in the production process of commodities covered by CBAM (Scope 2). According to the current EU CBAM proposal (EC, 2021), we do not cover other indirect emissions (Scope 3).

For this implementation, the CBAM is imposed on imported chemicals (chm),

[18] For this numerical illustration we are using an internal pre-release of GTAP 11.

non-metallic minerals (nmm) and metals (met). It should be noted that this is a simplified CBAM interpretation, since based on the EU's proposal (EC, 2021), a more granular (narrow) commodity coverage of the CBAM is considered, which would most likely result in a lower magnitude of impacts than presented here. In addition, in the current assessment, we cover CO_2 emissions from fossil fuel combustion only and do not consider non-combustion emissions from industrial processes, such as cement or fertilizer production. The latter would tend to reduce the magnitude of the CBAM impacts compared to the implementation currently discussed in the EU (EC, 2021).

Exploring the composition and emission intensity of exports to the EU, one notices a rather substantial variation across regions and commodities (Figure 2). On average, under the considered 83.5 EUR per ton of CO_2 carbon price, exporters to the EU would be facing an import tax ranging from 1.6 to 1.7% for imports of chemicals from the rest of high-income countries (HIC) and imports of metals from low-income countries (LIC), with 15-16% for non-metallic minerals and metals exported from lower-middle income countries. Exported non-metallic minerals, despite being emission-intensive commodities, correspond to a relatively low share in the GDP of exporting regions—in all cases below 0.05% (Figure 2b). Exports of chemicals and metals, on the other hand, play a much more substantial role in economies of the corresponding regions, with metals in lower- and upper-middle income countries being both emission-intensive and heavily-exported to the EU (Figure 2c). Though even in the case of the latter, the share of corresponding commodity exports to the EU is in a range of 0.2%. When decomposed across emission scopes, in most cases Scope 1 represents a higher share of emissions, especially for non-metallic minerals (Figure 2b).

When the corresponding CBAM shocks are imposed, simulation results suggest that CO_2 emissions from fossil fuel combustion outside the EU would decline by 0.14%. With increasing EU domestic production (substituting imports), EU-wide emissions grow by 0.4%, though when both trends are combined, global CO_2 emissions decrease by 0.1%. Thus the modeled EU CBAM proposal has relatively modest implications in terms of global mitigation potential. In terms of carbon leakage implications, we find that an implementation of the EU-wide carbon price of 83.5 EUR per ton of CO_2 leads to a leakage rate of around 20% and the CBAM reduces the leakage rate by around a quarter. It should be noted, however, that the CBAM considered here has substantially lower sectoral and emissions' scope coverage, when compared with economy-wide carbon prices. This explains the relatively modest impact of CBAM on leakage reduction.

The magnitude of changes in real income is also moderate, as EU countries see an increase in welfare of around 5 billion USD (+0.04%), while other regions experience an aggregate reduction in welfare of 8 billion USD (reductions across countries do not exceed 0.03%) (Figure 3a). Low-income countries tend to experience a minor increase in real income, benefiting from the CBAM implementation. This is because

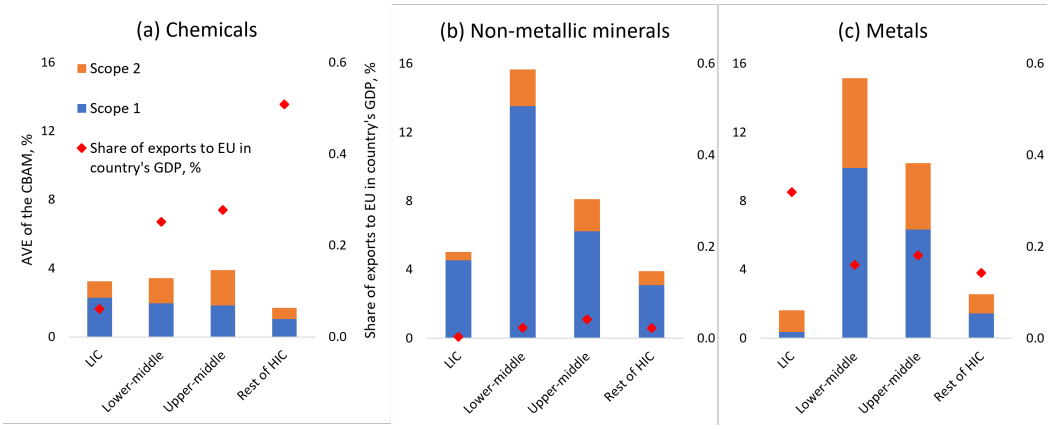

Figure 2. Ad valorem equivalent of the CBAM and share of exports to the EU across commodities and source regions.

Notes: Ad valorem equivalent of the CBAM for each commodity group and source region are indicated by the stacked bars and reported on the primary vertical axis. AVEs are further decomposed into components that correspond to Scope 1 and Scope 2 emissions. Values of the corresponding commodity exports to the EU measured as a percentage share of a country's GDP are plotted using red diamonds and are reported on the secondary vertical axis.

Source: Estimated by authors using GTAP 11 Data Base, pre-release 4.

these countries have a relatively low share of exports of CBAM-covered commodities directed towards the EU, and also the carbon intensity of commodities they export is relatively low (Figure 2). As a result, low-income countries experience almost no change in aggregate exports following the CBAM implementation (Figure 3b). Though this is not the case for other regions. Indeed, lower- and upper-middle income countries experience the largest magnitude of changes in absolute terms. In both cases, we observe a substantial reduction in exports to the EU: over 8 and 23 billion USD for lower- and upper-middle income countries, respectively—as these groups include large exporters of CBAM-covered commodities, like China (chemicals), India (iron and steel), Ukraine (iron and steel), etc.[19]

Reductions in exports of the CBAM-covered commodities to the EU are largely compensated by increasing exports of other commodities and redirection of the CBAM-covered exports to other destinations. As a result, in the case of upper-middle income countries, a 23 billion USD reduction in exports to the EU is compensated by a relatively smaller 17 billion USD increase in exports to other destinations (Figure 3b). Over half of this expansion is contributed by increasing exports of other manufactured goods to high-income countries (Figure 3c). Exports of other sectors, including services, are also expanding and positively contributing to the mitigation of trade effects of the CBAM (Figure 3c).

As expected, the EU reduces imports of CBAM-covered commodities and ex-

[19] Value changes are reported in constant 2017 USD.

pands their domestic production (Figure 3d). As imported intermediate inputs, such as metals for car manufacturing, become more expensive following the CBAM implementation, a reduction in the output of other manufactured goods, such as motor vehicles, transport equipment, machinery, etc. is observed in the EU (Figure 3d). These reductions are over-compensated by increasing output in the CBAM-covered sectors, with metals and chemicals benefiting the most in absolute terms (Figure 3d).

Overall, we find that the current EU CBAM proposal, if implemented, would have relatively limited implications on global emissions, trade and economic activity, which is consistent with earlier findings (e.g. Zhong and Pei (2022); UNCTAD (2021)). While at the macro level the mechanism would not likely provide substantial additional incentives for non-EU countries to engage into more active mitigation policies, producers of selected emission-intensive commodities in developing countries (that are large EU trading partners) might be impacted rather adversely and face the need to revise their production practices and trade patterns. Both macro and sectoral implications might be much more substantial if a broader commodity and emissions coverage of the CBAM is considered. Beyond the dimension of economic impacts, the EU CBAM could provide an important incentive toward advancement of the emissions' monitoring framework and pave the way toward broader implementation of environmental-friendly trade policies worldwide.

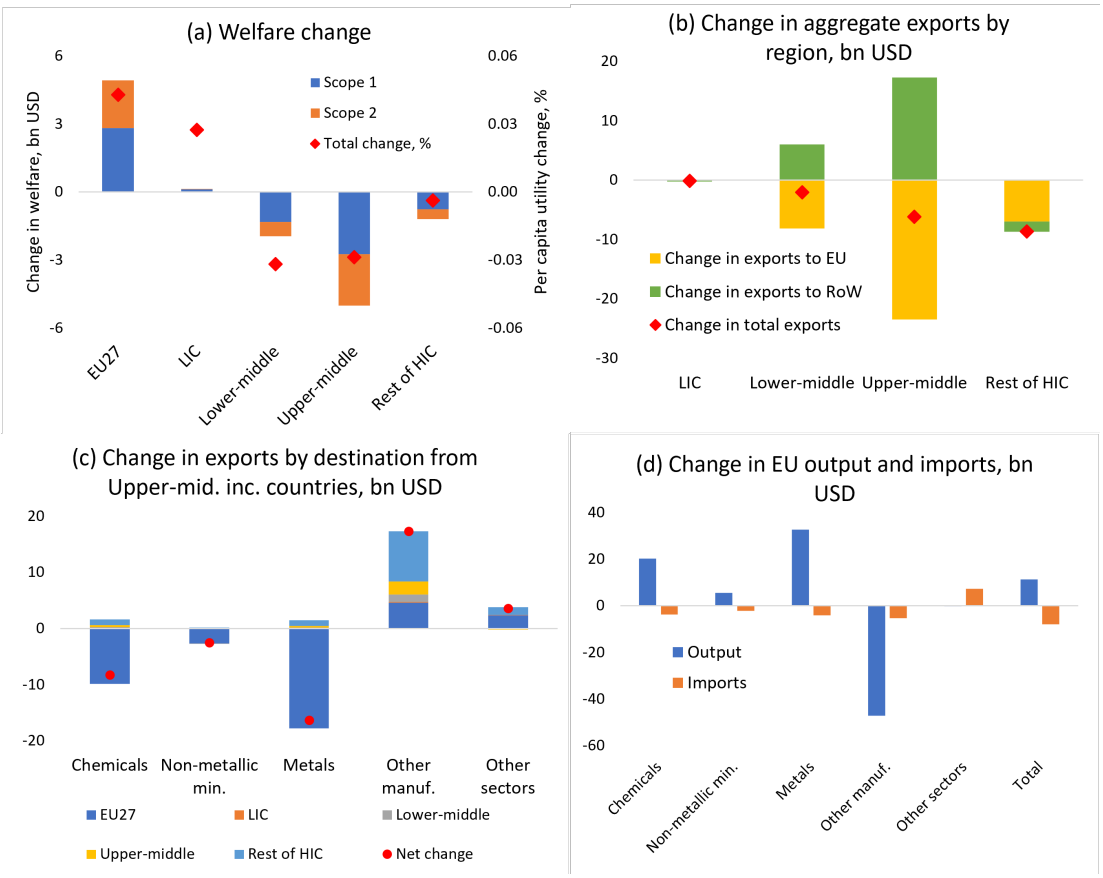

Figure 3. Economic impacts of the EU CBAM.

Notes: Panel (a) reports changes in welfare in billion USD decomposed across emission scopes. These are reported using stacked bars on the primary vertical axis. Changes in per capita utility are reported in percent using red diamonds and are plotted on the secondary vertical axis of the panel (a). Panel (b) reports changes in total exports by regions decomposed into changes in exports to the EU and changes in exports to other destinations, including within-regional trade. Red diamonds report changes in total exports (all destinations combined). Panel (c) provides a decomposition of export changes by destination regions and commodities for the case of upper-middle income countries. ”Other sectors” reported on the figure include an aggregation of all sectors except ”chm”, ”nmm”, ”met” and ”xmf”. Finally, panel (d) reports changes in output and imports by EU countries. Value changes are reported in constant 2017 USD.

Source: Estimated by authors using GTAP 11 Data Base, pre-release 4, and GTAP-E model.

5. Summary and future developments

The geographical coverage of the GTAP 11 Data Base has increased to 160 regions—141 individual countries and 19 composite regions—with the addition of 20 new countries mostly from the Middle East and Africa. Its construction relies on contributed datasets from a large network of individuals, GTAP Board member agencies, and institutions from around the world. Increasing the representation of countries and sectors in GTAP depends on data availability. Also, in order to improve the time-series dimension of the Data Base, continuous development and contribution of IOTs are critical in order to capture structural changes over time. For historical reference years (i.e., 2004, 2007, 2011 and 2014), we rebuild the GTAP Data Base with the latest methodologies and updated inputs. For example, the 2014 reference year available in both GTAP Data Base version 10 and 11 will show differences owing to new sources for services trade data, different treatment to energy data, or perhaps the IOT was updated for GTAP 11.

Further improvements of the GTAP Data Base are also influenced by the quality and availability of international data sources. Our objective is to reconcile available information, with the primary aim of improving initial country data to meet the requirements of global economic modeling. The snapshot of the world economy that we have constructed can and should be extended to better meet the needs of research and policy objectives. Greater emphasis can be placed on a particular country, to then perform sub-regional modelling or reflect more recent trends.

In GTAP 11, the services trade data now rely on new sources (Wettstein et al., 2021). If these data sources are not maintained, we would need to rely on a different source for GTAP 12. These and other similar instances highlight the particular importance of consistent maintenance and regular updates of the key data sources developed by statistical agencies and other agencies around the world.

One of the key features of the GTAP Data Base includes reconciliation and merging multiple datasets in an attempt to provide a more consistent representation of global economic flows. In this regard, we are constantly exploring new datasets that can be used to complement current procedures. Similar to our targeting of agricultural production, we are considering the use of statistics by the UN Industrial Development Organization to target the production of manufactured goods in GTAP 12, to provide a better representation of output across these sectors of the economy.

To complement GTAP 11, several data extensions will be updated for subsequent release after the public release of GTAP 11. In terms of extensions, it is worth noting the release of the version of GTAP with explicit domestic margins (Corong, 2018). There is also the energy environmental extension (GTAP-E documented in McDougall and Golub (2009)), that tracks CO_2 emissions, the international migration and remittances data extension (GMig documented in Walmsley, Winters, and Ahmed (2007)), the land use and cover extensions (GTAP-AEZ documented in Baldos and Corong (2019)), the foreign income payment and receipt data

extension (GDYN documented in Golub (2016)), the disaggregation of the electricity sector (GTAP-POWER documented in Peters (2016); Chepeliev (2020c)) and the MRIO described in Carrico, Corong, and van der Mensbrugghe (2020). Among the extensions, we expect to release the bilateral time series trade data (Gehlhar, forthcoming), food balance sheets (Chepeliev, 2022b), and the non-CO_2 emissions (Chepeliev, 2020a) and air pollution datasets (Chepeliev, 2021a).

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Appendix.

Table A.1. New and updated national country IOTs in GTAP 11.

Country	IO Year(s)	Country	IO Year(s)
Afghanistan*	2017	Korea	2015
Algeria*	2015	Laos	2017
Australia	2015, 2018	Lebanon*	2010
Azerbaijan	2016	Mali	2017
Bolivia	2014	Mexico	2013
Botswana	2016	Mongolia	2016
Brazil	2010, 2015	Mozambique	2015
Cameroon	2017	New Zealand	2013
Canada	2014	Niger*	2019
Central African Republic*	2017	Norway	2017
Chad*	2016	Pakistan	2017
Chile	2016	Palestine*	2011
China	2017	Panama	2016
Colombia	2014	Paraguay	2014
Comoros*	2017	Philippines	2018
Congo*	2016	Russian Federation	2016
Congo, D. R.*	2013	Serbia*	2015
Costa Rica	2017	South Africa	2017
Côte d'Ivoire	2015	Sudan*	2012
Cyprus	2010	Switzerland	2014
Ecuador	2019	Syrian Arab Republic*	2007
Equatorial Guinea*	2017	Thailand	2010, 2015
Eswatini*	2017	Ukraine	2015
Gabon*	2017	United Kingdom	2013
Haiti*	2012	United States of America	2012
India	2015	Uruguay	2016
Indonesia	2017	Uzbekistan*	2018
Iran	2012	Vietnam	2016
Iraq*	2011	Zimbabwe	2017
Kazakhstan	2017		

Notes: * New country.

Source: GTAP 11 Data Base. Documentation for each table available from:
www.gtap.agecon.purdue.edu/databases/v11/v11_doco.aspx

Table A.2. IOT allocations in GTAP 11.

Countries — Reference Years	2004	2007	2011	2014	2017
Australia	2005	2010	2010	2015	2018
Azerbaijan	2001	2001	2016	2016	2016
Bolivia	2004	2004	2014	2014	2014
Botswana	1994	2016	2016	2016	2016
Brazil	2005	2005	2010	2015	2015
Cameroon	2003	2003	2017	2017	2017
Canada	2003	2011	2011	2014	2014
Chile	2003	2003	2016	2016	2016
China	2002	2007	2010	2012	2017
Colombia	2003	2007	2007	2014	2014
Costa Rica	2002	2011	2011	2017	2017
Ecuador	2001	2007	2013	2013	2019
India	2003	2007	2007	2015	2015
Indonesia	2004	2004	2017	2017	2017
Iran	2001	2012	2012	2012	2012
Japan	2005	2005	2011	2011	2011
Kazakhstan	2004	2004	2015	2015	2017
Korea	2003	2007	2010	2014	2015
Laos	2002	2002	2017	2017	2017
Mexico	2003	2003	2013	2013	2013
Mongolia	2005	2005	2016	2016	2016
Mozambique	2007	2007	2015	2015	2015
New Zealand	2007	2007	2013	2013	2013
Norway	2004	2007	2011	2014	2017
Pakistan	2002	2011	2011	2011	2017
Panama	2016	2016	2016	2016	2016
Paraguay	2009	2009	2014	2014	2014
Philippines	2000	2006	2006	2018	2018
Russian Federation	2003	2003	2016	2016	2016
South Africa	2005	2005	2017	2017	2017
Sri Lanka	2000	2000	2011	2011	2011
Switzerland	2005	2008	2011	2014	2014
Thailand	2005	2005	2010	2015	2015
Turkey	2002	2002	2012	2012	2012
Uganda	2002	2007	2007	2007	2007
Ukraine	2004	2007	2013	2015	2017
United States	2002	2012	2012	2012	2012
United Kingdom	2010	2010	2010	2013	2013
Uruguay	1997	2016	2016	2016	2016
Vietnam	2003	2005	2016	2016	2016
Zimbabwe	1991	2017	2017	2017	2017

Table A.3. A summary of GTAP data releases.

Version	Release Year	Regions	Sectors	Reference year(s)
1	1993	15	37	1990
2	1994	24	37	1992
3	1996	30	37	1992
4	1998	45	50	1995
5	2001	66	57	1997
6	2005	87	57	2001
7	2008	113	57	2004
8	2012	129	57	2004, 2007
9	2015	140	57	2004, 2007, 2011
10	2019	141	65	2004, 2007, 2011, 2014
11	2022	160	65	2004, 2007, 2011, 2014, 2017

Table A.4. GTAP sector classification (GSEC3).

No.	Code	Description	No.	Code	Description
1	pdr	Paddy rice	34	bph	Basic pharmaceutical products
2	wht	Wheat	35	rpp	Rubber and plastic products
3	gro	Cereal grains, not elsewhere classified (n.e.c.)	36	nmm	Mineral products n.e.c.
4	v_f	Vegetables, fruit, nuts	37	i_s	Ferrous metals
5	osd	Oil seeds	38	nfm	Metals n.e.c.
6	c_b	Sugar cane, sugar beet	39	fmp	Metal products
7	pfb	Plant-based fibers	40	ele	Computer, electronic and optical products
8	ocr	Crops n.e.c.	41	eeq	Electrical equipment
9	ctl	Cattle, sheep, goats, horses	42	ome	Machinery and equipment n.e.c.
10	oap	Animal products n.e.c.	43	mvh	Motor vehicles and parts
11	rmk	Raw milk	44	otn	Transport equipment n.e.c.
12	wol	Wool, silk-worm cocoons	45	omf	Manufactures n.e.c.
13	frs	Forestry	46	ely	Electricity
14	fsh	Fishing	47	gdt	Gas manufacture, distribution
15	coa	Coal	48	wtr	Water
16	oil	Oil	49	cns	Construction
17	gas	Gas	50	trd	Trade
18	oxt	Other extraction (formerly omn Minerals n.e.c.)	51	afs	Accommodation, Food and service activities
19	cmt	Meat: cattle, sheep, goats, horse	52	otp	Transport n.e.c.
20	omt	Meat products n.e.c.	53	wtp	Sea transport
21	vol	Vegetable oils and fats	54	atp	Air transport
22	mil	Dairy products	55	whs	Warehousing and support activities
23	pcr	Processed rice	56	cmn	Communication
24	sgr	Sugar	57	ofi	Financial services n.e.c.
25	ofd	Food products n.e.c.	58	ins	Insurance (formerly isr)
26	b_t	Beverages and tobacco products	59	rsa	Real estate activities
27	tex	Textiles	60	obs	Business services n.e.c.
28	wap	Wearing apparel	61	ros	Recreation and other services
29	lea	Leather products	62	osg	Public administration and defense
30	lum	Wood products	63	edu	Education
31	ppp	Paper products, publishing	64	hht	Human health and social work activities
32	p_c	Petroleum, coal products	65	dwe	Dwellings
33	chm	Chemical products			

Table A.5. The 160 countries/regions in GTAP 11.

No.	Code	Name	No.	Code	Name
1	aus	Australia	49	xca	Rest of Central America
2	nzl	New Zealand	50	dom	Dominican Republic
3	xoc	Rest of Oceania	51	hti	Haiti
4	chn	China	52	jam	Jamaica
5	hkg	Hong Kong	53	pri	Puerto Rico
6	jpn	Japan	54	tto	Trinidad and Tobago
7	kor	Korea	55	xcb	Caribbean
8	mng	Mongolia	56	aut	Austria
9	twn	Taiwan	57	bel	Belgium
10	xea	Rest of East Asia	58	bgr	Bulgaria
11	brn	Brunei Darussalam	59	hrv	Croatia
12	khm	Cambodia	60	cyp	Cyprus
13	idn	Indonesia	61	cze	Czech Republic
14	lao	Lao People's Democratic Republic	62	dnk	Denmark
15	mys	Malaysia	63	est	Estonia
16	phl	Philippines	64	fin	Finland
17	sgp	Singapore	65	fra	France
18	tha	Thailand	66	deu	Germany
19	vnm	Viet Nam	67	grc	Greece
20	xse	Rest of Southeast Asia	68	hun	Hungary
21	afg	Afghanistan	69	irl	Ireland
22	bgd	Bangladesh	70	ita	Italy
23	ind	India	71	lva	Latvia
24	npl	Nepal	72	ltu	Lithuania
25	pak	Pakistan	73	lux	Luxembourg
26	lka	Sri Lanka	74	mlt	Malta
27	xsa	Rest of South Asia	75	nld	Netherlands
28	can	Canada	76	pol	Poland
29	usa	United States of America	77	prt	Portugal
30	mex	Mexico	78	rou	Romania
31	xna	Rest of North America	79	svk	Slovakia
32	arg	Argentina	80	svn	Slovenia
33	bol	Bolivia	81	esp	Spain
34	bra	Brazil	82	swe	Sweden
35	chl	Chile	83	gbr	United Kingdom
36	col	Colombia	84	che	Switzerland
37	ecu	Ecuador	85	nor	Norway
38	pry	Paraguay	86	xef	Rest of EFTA
39	per	Peru	87	alb	Albania
40	ury	Uruguay	88	srb	Serbia
41	ven	Venezuela	89	blr	Belarus
42	xsm	Rest of South America	90	rus	Russian Federation
43	cri	Costa Rica	91	ukr	Ukraine
44	gtm	Guatemala	92	xee	Rest of Eastern Europe
45	hnd	Honduras	93	xer	Rest of Europe
46	nic	Nicaragua	94	kaz	Kazakhstan
47	pan	Panama	95	kgz	Kyrgyztan
48	slv	El Salvador	96	tjk	Tajikistan

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No.	Code	Name	No.	Code	Name
97	uzb	Uzbekistan	129	ner	Niger
98	xsu	Rest of Former Soviet Union	130	nga	Nigeria
99	arm	Armenia	131	sen	Senegal
100	aze	Azerbaijan	132	tgo	Togo
101	geo	Georgia	133	xwf	Rest of Western Africa
102	bhr	Bahrain	134	caf	Central African Republic
103	irn	Iran, Islamic Republic	135	tcd	Chad
104	irq	Iraq	136	cog	Congo
105	isr	Israel	137	cod	Democratic Republic of the Congo
106	jor	Jordan	138	gnq	Equatorial Guinea
107	kwt	Kuwait	139	gab	Gabon
108	lbn	Lebanon	140	xac	Rest of South and Central Africa
109	omn	Oman	141	com	Comoros
110	pse	State of Palestine	142	eth	Ethiopia
111	qat	Qatar	143	ken	Kenya
112	sau	Saudi Arabia	144	mdg	Madagascar
113	syr	Syria	145	mwi	Malawi
114	tur	Türkiye	146	mus	Mauritius
115	are	United Arab Emirates	147	moz	Mozambique
116	xws	Rest of Western Asia	148	rwa	Rwanda
117	dza	Algeria	149	sdn	Sudan
118	egy	Egypt	150	tza	Tanzania
119	mar	Morocco	151	uga	Uganda
120	tun	Tunisia	152	zmb	Zambia
121	xnf	Rest of North Africa	153	zwe	Zimbabwe
122	ben	Benin	154	xec	Rest of Eastern Africa
123	bfa	Burkina Faso	155	bwa	Botswana
124	cmr	Cameroon	156	swz	Eswatini
125	civ	Cote d'Ivoire	157	nam	Namibia
126	gha	Ghana	158	zaf	South Africa
127	gin	Guinea	159	xsc	Rest of South African Customs Union
128	mli	Mali	160	xtw	Rest of the World

Table A.6. Food and Agricultural Sectors Concordances against CPC ver. 2.1.

Code	Description	CPC version 2.1
pdr	Paddy rice	0113
wht	Wheat	0111
gro	Cereal grains not elsewhere classified (n.e.c.)	0112, 0114-0119
v_f	Vegetables, fruit, nuts	012, 013, 015, 017
osd	Oilseeds and oleaginous fruits	014
c_b	Sugar crops (cane, beet)	018
pfb	Plant-based fibers	0192
ocr	Crops nec	016, 0191, 0193-0197, 0199
ctl	Bovine animals, horses and other equines	0211-0213, 0299
oap	Other animals and animal products nec	0214, 0215, 0219, 023, 024, 0291-0293, 0295, 0296
rmk	Raw milk	022
wol	Wool, silk-worm cocoons	0294
frs	Forestry and logging products	03
cmt	Bovine meat products	21111, 21112, 21115-21119, 2113, 2115
omt	Meat products nec	21113, 21114, 2112, 2114, 2116-2119
vol	Vegetable oils and fats	215-219
mil	Dairy products and egg products	22
pcr	Processed rice	2316
sgr	Sugar and molasses	235
ofd	Food products nec	212-214, 2311-2314, 2317, 2318, 232-234, 236-239
b_t	Beverages and tobacco products	24, 25

Notes: For convenience, we use '-' to indicate all elements in between; for example, Cereal grains n.e.c. (gro) is composed of CPC products: 0112, 0114, 0115, 0116, 0117, 0118, and 0119.

Source: GTAP 11 Data Base.

Table A.7. Manufacturing Sectors Concordances against ISIC rev. 4.

Code	Description	ISIC revision 4
fsh	Fishing	03, 017
coa	Coal	05
oil	Oil	061, 091 (part)
gas	Gas	062, 091 (part)
oxt	Other extraction (formerly omn Minerals n.e.c.)	07, 08, 099
tex	Textiles	13
wap	Wearing apparel	14
lea	Leather products	15
lum	Wood products	16
ppp	Paper products, printing	17, 18
p_c	Petroleum, coal products	19
chm	Chemical products	20
bph	Basic pharmaceutical products	21
rpp	Rubber and plastic products	22
nmm	Mineral products n.e.c.	23
i_s	Ferrous metals	241, 2431
nfm	Metals n.e.c.	242, 2432
fmp	Metal products	25
ele	Computer, electronic and optical products	26
eeq	Electrical equipment	27
ome	Machinery and equipment n.e.c.	28
mvh	Motor vehicles and parts	29
otn	Transport equipment n.e.c.	30
omf	Manufactures n.e.c.	31, 32, 33

Notes: The oil and gas sectors are assigned part of ISIC code 091, "Support activities for petroleum and natural gas extraction", because more detailed ISIC codes are not available.

Source: GTAP 11 Data Base.

Table A.8. Services Sectors Concordances against ISIC rev. 4.

Code	Description	ISIC revision 4
ely	Electricity; steam and air conditioning supply	351, 353
gdt	Gas manufacture, distribution	352
wtr	Water supply; sewerage, waste management and remediation activities	36-39
cns	Construction	41-43
trd	Wholesale and retail trade; repair of motor vehicles and motorcycles	45-47
afs	Accommodation and food service activities	55, 56
otp	Land transport and transport via pipelines	49
wtp	Water transport	50
atp	Air transport	51
whs	Warehousing and support activities	52
cmn	Information and communication	53, 58-63
ofi	Financial services nec	64, 661, 663
ins	Insurance (formerly isr)	65, 662
rsa	Real estate activities	68
obs	Other business services	69-82 (M and N)
ros	Recreational and other services	90-98 (R, S, and T)
osg	Public administration and defense; compulsory social security; and activities of extraterritorial organizations and bodies	84, 99
edu	Education	85
hht	Human health and social work activities	86-88 (Q)
dwe	Dwellings	not available

Notes: For convenience, we use '-' to indicate all elements in between; for example, Water supply (wtr) is composed of ISIC codes: 36, 37, 38, and 39.

Source: GTAP 11 Data Base.

Table A.9. BaTiS sectors subject to disaggregation using TisMoS

Code	BaTiS	Code	TiSMoS	GTAP
SC	Transport	SC11, SC12	Sea transport (passenger and freight)	wtp
		SC21, SC22	Air transport (passenger and freight)	atp
		SC31, SC32	Other transport (passenger and freight)	otp
		SC13, SC23, SC33	Transport, Other	whs
		SC4	Postal and courier services	cmn
SD	Travel	SDA	Business travel	trvl*
		SDB1	Health-related travel	hht
		SDB2	Education-related travel	edu
		SDB3	Other personal travel	afs
SJ	Other	SJ1	Research and development services	obs
	business	SJ2	Professional and management consulting	obs
	services	SJ31	Architectural and engineering services	obs
		SJ32	Waste treatment and de-pollution, agricultural and mining services	obs
		SJ33	Operating leasing services	rsa
		SJ34	Trade-related services	trd
		SJ35	Other business services n.i.e.	obs
SK	Personal,	SK1	Audio-visual and related services	ros
	cultural, and	SK21	Health services (personal)	hht
	recreational	SK22	Education services (personal)	edu
	services	SK23	Heritage and recreational services	ros
		SK24	Other personal services	ros

Notes: trvl is not a sector in GTAP, but is a code assigned for the special treatment of traveler's expenditures.

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Table A.10. Regional Aggregation.

Code	Description	Composition
EU27	European Union	aut, bel, bgr, hrv, cyp, cze, dnk, est, fin, fra, deu, grc, hun, irl, ita, lva, ltu, lux, mlt, nld, pol, prt, rou, svk, svn, esp, swe
LI	Low-income countries	afg, syr, xws, bfa, gin, mli, ner, tgo, xwf, caf, tcd, cod, eth, mdg, mwi, moz, rwa, sdn, uga, zmb, xec
LMI	Lower-middle income	mng, xea, khm, idn, lao, phl, vnm, xse, bgd, ind, npl, pak, lka, bol, hnd, nic, slv, hti, ukr, xee, kgz, tjk, uzb, irn, lbn, pse, dza, egy, mar, tun, ben, cmr, civ, gha, nga, sen, cog, xac, com, ken, tza, zwe, swz, xsc
UMI	Upper-middle income	xoc, chn, mys, tha, xsa, mex, arg, bra, col, ecu, pry, per, ven, xsm, cri, gtm, xca, dom, jam, xcb, alb, srb, blr, rus, xer, kaz, xsu, arm, aze, geo, irq, jor, tur, xnf, xnf, gnq, gab, mus, bwa, nam, zaf
RHI	Rest of High-income	aus, nzl, hkg, jpn, kor, twn, brn, sgp, can, usa, xna, chl, ury, pan, pri, tto, gbr, che, nor, xef, bh=r, isr, kwt, omn, qat, sau, are, xtw

Table A.11. Sector Aggregation.

Code	Description	Composition
AGR	Agricultural products	pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol, frs, fsh, pcr, sgr
Coal	Coal mining	coa
Oil	Crude Oil	oil
Gas	Natural gas extraction and distribution	gas, gdt
PFD	Processed food	cmt, omt, vol, mil, ofd, b_t
XMF	Other manufacturing	tex, wap, lea, lum, ppp, fmp, ele, eeq, ome, mvh, otn, omf
oxt	Mining	oxt
Oil_pcts	Petroleum products	p_c
Electricity	Electricity	ely
CHM	Chemicals (incl. rubber and plastic)	chm, bph, rpp
nmm	Non-metallic minerals	nmm
MET	Metals	i_s, nfm
cns	Construction	cns
TRD	Trade	trd, afs, whs
TRN	Transportation	otp, atp, wtp
XSV	Other services	wtr, cmn, ofi, ins, rsa, obs, ros, osg, edu, hht, dwe