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Progress Report on
Public procurement data base extension and modelling modifications
for analysis purposes

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Summary

The objective of this project is to improve data and modelling representation of government procurement in a general equilibrium framework for analysis purposes.

In terms of data developments, government investment is now distinguished for the 57 GTAP Commodities. In order to determine the origin of imports by end use, we use economic concordances, replicating the approach taken in the recent MRIO literature.

The modified model adds a new nest to the production structure that would allow for different procurement regimes in a model that incorporates the origin of imports by agents' end use (i.e., for firms, private consumption, government consumption, and investment). We illustrate this framework by simulating the impact of local preference reduction in one of the newly introduced procurement regimes. Local preference was not estimated, but assumed to illustrate the use of the model.

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Introduction

Government consumption makes up a significant part of national economies, ranging from 6-26% of gross domestic product (GDP).¹ In addition, government procurement affects a substantial volume of world trade flows, amounting to \$1300 billion per year.² Given the size and the potential implications for trade, employment and prices, government procurement policies have become increasingly prominent in the multilateral negotiations starting with the 1978 Tokyo Round of GATT and leading up to the ratification of the WTO-Government Procurement Agreement (GPA) in 1996.³ At the core of these negotiations has been the idea of encouraging government procurement from the most efficient suppliers in order to enhance global welfare (Brulhart and Trionfetti, 2001).

Despite its importance in the overall trade reform picture, the analytical tools used to quantify the economic impact of discriminatory government procurement remain underdeveloped. The objective of this project is to improve the quantitative representation of government procurement in global trade policy analysis by enhancing data and modelling tools. In this paper, we document the data and modelling work completed to date, including an illustrative application.

Government procurement agreements involve multiple countries purchasing a wide range of goods and services supplied by many different regions. Therefore the effect of these agreements is best addressed in a multi-region, general equilibrium framework. Since most contemporary, global CGE models are based on the GTAP Data Base (Narayanan et al., 2012),

¹ Authors computation based on GTAP v8.1, reference year 2007.

² Public Procurement, Trade, European Commission: <http://ec.europa.eu/trade/policy/accessing-markets/public-procurement/>

³ The revised Agreement on Government Procurement entered into force on April 6, 2014.

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we have taken this framework as the starting point for our analysis. Despite its merits, the scope for global CGE modelling of any new issue, such as government procurement, is inevitably limited by data availability. For purposes of this project, current purchases by governments of each commodity and service must be identified separately in the data, otherwise, it becomes nearly impossible to estimate the likely impact of government procurement liberalization. In order to improve the representation of government procurement in the GTAP framework, the standard GTAP Data Base has been supplemented with data that allows for disaggregation of government investment, and identification of the country of origin of imports by intermediate and final use. We have also modified the standard GTAP model, according to the new data developments, in order to permit a preliminary analysis of changes to rules and regulations of government procurement, using this new information.

This paper discusses the extended data base and analytical framework in order to gain insight into the current state of play with government procurement at global scale.

Methodology

The GTAP framework is composed of a data base and a standard CGE model of the global economy. This data base (now entering its 9th series of public releases since its inception in 1992), along with dozens of variants of the standard model, are widely used for analyzing trade policies and their effects on the global markets. The regional structure of the GTAP Data Base derives from input-output (IO) tables and, as such, it fully characterizes the intermediate and final demands of each national economy. At present, the GTAP Data Base allows for just one aggregate sector for the production of public goods: 'OSG' = Other Services (Government). This

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sector includes the following UN International Standard Industry Classification (ISIC), revision 3 categories:

- 75 = Public administration and defense; compulsory social security
- 80 = Education
- 85 = Health and social work
- 90 = Sewage and refuse disposal, sanitation and similar activities
- 91 = Activities of membership organizations n.e.c.
- 99 = Extra-territorial organizations and bodies

The services produced by the OSG sector are destined for final consumption as well as an input to other activities. The IO structure underpinning the GTAP Data Base also includes a vector of final demands by government, along with a vector comprising final demand for investment goods. For the purpose of this project, we focus on the “Other Services (Government)” industry, which is closely related to final government consumption. Other Services (Government) includes public administration and defense, therefore it typically accounts for the bulk of government consumption expenditure (94 per cent in GTAP Standard Data Release 8 for reference year 2007).⁴ By focusing on the sector that produces the public goods, we capture the effects that changes on procurement policy have in the production of public goods that are used as an input of other industries and represents the main expenditure of final government consumption.⁵

⁴ The other 6 per cent varies across regions, but is defined over the other 56 GTAP commodities. For the world as a whole, other business services, recreation and other services, and other transport account for 1 per cent each.

⁵ We do not focus on government consumption because being a final demand, it does not appear as an input of other industries and the complete effects of a potential policy change would not be captured.

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In addition, in the standard GTAP Data Base, there is no information available on the origin of imports by use, as this has not been a point of emphasis in the GTAP Data Base construction to date and the data to support such sourcing of imports have not been available. For the purpose of this project, the absence of such sourcing information is problematic, as it holds the key to determining which countries will benefit from a liberalization of government procurement rules. Also, the GTAP Data Base does not distinguish public from private investment, and therefore, important share of government procurement⁶ — namely that associated with infrastructure development — is not available for analysis.

In order to identify the current availability of government investment data as well as information regarding government procurement, we undertook a survey of our global network of national Input-Output table contributors (Appendix B). The survey was designed to collect information regarding the availability of government investment and procurement data. We sent out a total of 44 questionnaires to IO Table contributors and the response rate was 45 percent. Summary responses to each of the seven questions can be found in Appendix B.

The responses to our survey confirm our hypothesis that little information related to government procurement is accessible to our typical IO contributor. Notable exceptions are Japan and Australia. The survey also revealed that foreign vs. domestic composition of uses and the origin and destination of imports and exports, respectively, are generally not available in the data from most national IO frameworks; therefore these splits need to continue to be estimated by GTAP staff. A notable exception is the information available in the EU tables.

⁶ According to the Organization for Economic Co-operation and Development (OECD), the estimated size of general government procurement is determined by the sum of intermediate consumption by governments, government's gross fixed capital formation, and social transfers in kind via market producers (OECD, 2013). Appendix A computes this statistic using the GTAP Data Base.

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In addition, we considered the WTO statistical reports from parties under the Government Procurement Agreement (GPA) to improve the domestic and import composition of the government sector in GTAP. After careful review, it was determined that GPA data only captured a limited component of government procurement. Due to this limited availability of source data in the IO tables, we have resorted to external data sources to estimate the sourcing of imports and distinguish public from private investment. The next section discusses the external data sources we use and the resulting modifications to the GTAP Data Base.

Data Base Developments

We estimate the sourcing of imports, based on multi-regional input output (MRIO) techniques.

In addition, we turn to external macroeconomic data sources to disaggregate private and public investment from GTAP's gross fixed capital formation (i.e., total investment). These are discussed next.

GTAP MRIO

This section discusses the methods used to generate a multi-regional input-output (MRIO) database from the GTAP Data Base, in order to be able to identify agent purchases of foreign goods by country of origin.

A multiregional input-output (MRIO) framework extends the traditional IO framework by distinguishing imports by country of origin as well as by end use. End uses may include both imported products used in the production of another product (also called intermediate use) as well as imports for final demands, including investment, government consumption and private demands. In the context of a global MRIO database, all countries have such dimensionality, which permits the emergence of complex source patterns in trade.

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An MRIO framework can be derived from the reconciliation of trade data with the cost structure data available in IO tables. In this interim report, we follow the procedures used in Johnson and Noguera (2012), Koopman et al. (2010), and Walmsley et al. (2014), building from the GTAP Data Base as explained in the following paragraphs.

The GTAP Data Base is compiled from IO tables and trade data, among other data sources, which are globally reconciled.⁷ Following Koopman et al. (2010) and Walmsley et al. (2014), we additionally draw on trade data external to the GTAP Data Base, from the UN COMTRADE Database. In doing so, we assimilate the cost structure of each country-agent pair with agent specific import demands, which are assembled from the disaggregated bilateral trade data in the UN COMTRADE Database. Given the differences in use for the disaggregated products, when these data have been aggregated, the resulting data base will show variation in sourcing by use category which reflects differences in product composition at the GTAP level of commodity aggregation.

In IO tables as well as the GTAP Data Base, commodity demands (i.e., input demands) are specified for intermediate uses (i.e., commodity production or output), the private household, investment, and the government. In addition, trade data from the GTAP Data Base or the UN COMTRADE Database, display country sourcing information for each commodity in bilateral datasets. However, neither trade database contains bilateral trade data with information specifying whether a bilaterally traded commodity is a product intended for intermediate use or for final consumption. Although the GTAP Database contains imports data on government ($VIGM(i,r)$), household ($VIPM(i,r)$), and industrial ($VIFM(i,j,r)$) use, these data do

⁷ For detailed explanation about the GTAP Data Base, please see Narayanan et al. (2012).

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not contain information on the source country. Further, the distribution of demand for imports of intermediate products across industries remains unknown in both the GTAP Data Base and the UN COMTRADE Database.

In order to enhance the information inherently available in disaggregate trade data, such as from the UN COMTRADE Database, the MRIO literature uses a concordance table to map between product categories and the Broad Economic Categories (BEC) and the end use categories of the System of National Accounts (SNA) framework: capital goods, intermediate goods, and consumption goods (Timmer 2012 and Walmsley et al. 2014).

At the most disaggregated level, there are 19 categories under the BEC classification system, as seen in Table 1. These 19 categories can be easily mapped to end use categories. For the purposes of this paper, we use a combination of concordances between BEC and the Harmonized System (HS), differing by year of HS, which are publicly available from the United Nations Statistics Division (UNSD).⁸ The UNSD also provides a reference for mapping from the BEC to end use categories of the System of National Accounts (SNA) framework: capital goods, intermediate goods, and consumption goods. In the present report, we follow Koopman et al. (2010) and Walmsley et al. (2014), and we distinguish only between intermediate and final uses.

⁸ <http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1>

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Table 1. Disaggregate Broad Economic Categories (BEC)

BEC	BEC Description
111	Food and beverages - Primary - Mainly for industry
112	Food and beverages - Primary - Mainly for household consumption
121	Food and beverages - Processed - Mainly for industry
122	Food and beverages - Processed - Mainly for household consumption
21	Industrial supplies not elsewhere specified - Primary
22	Industrial supplies not elsewhere specified - Processed
31	Fuels and lubricants – Primary
321	Fuels and lubricants - Processed - Motor spirit
321	Fuels and lubricants - Processed - Motor spirit
322	Fuels and lubricants - Processed - Other
41	Capital goods (except transport equipment)
42	Capital goods - Parts and accessories
51	Transport equipment - Passenger motor cars
51	Transport equipment - Passenger motor cars
521	Transport equipment - Other - Industrial
522	Transport equipment - Other - Non-industrial
53	Transport equipment - Parts and accessories
61	Consumer goods not elsewhere specified - Durable
62	Consumer goods not elsewhere specified - Semi-durable
63	Consumer goods not elsewhere specified - Non-durable
7	Goods not elsewhere specified
7	Goods not elsewhere specified
7	Goods not elsewhere specified

In the following paragraphs, we describe in detail the characteristics of our data sources, namely the GTAP Data Base, the UN COMTRADE Database, as well as the BEC concordance. Then, we describe the methodology which we use to compile the MRIO from these data and mappings.

As aforementioned, we use the GTAP Data Base and the UN COMTRADE Database to build a GTAP-MRIO Data Base that is a GTAP Data Base where imports are distinguished by country of origin and use. In addition to the previously described UNSD HS-BEC and BEC-SNA

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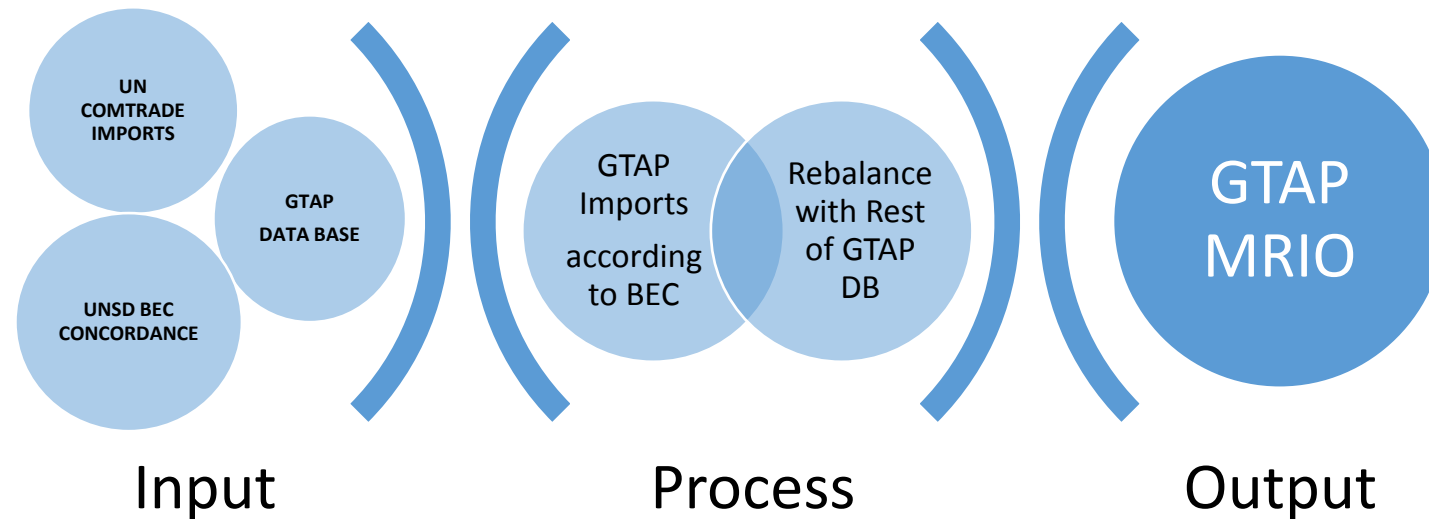
concordances, we also employ an HS-GTAP concordance from TASTE for GTAP. Figure 1 provides a simple all-encompassing flow chart of the steps taken to produce the GTAP-MRIO Data Base.

We build on the GTAP Data Base, Version 8 (the latest published version of GTAP), which consists of bilateral trade, private and government consumption, as well as industrial production data for the year 2007 (Narayanan et al., 2012). In Version 8, this exists for 129 regions across the standard 57 GTAP sectors.

From the UN COMTRADE Database, we acquire global bilateral imports data for the year 2007. The dataset consists of 163 reporting countries and 231 trading partner countries. The trade data is reported in US dollars for 5,111 unique tariff lines classified at the six digit level according to the HS 1996 nomenclature. We use the HS 1996 classification for broader correspondence with UNSD concordances between HS and BEC which cover years 1996, 2002, and 2007, as detailed below. Although there is overlap between the concordances, each contains HS-BEC mappings not contained in the others.

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Figure 1. Work flow of building a GTAP-MRIO Data Base



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We use two types of concordances from the United Nations Statistics Division (UNSD).

The first type is a concordance between the Harmonized System (HS) and the Broad Economic Categories (BEC). The UNSD has three of these concordances which map from the BEC, Revision 4, to HS 1996, 2002, and 2007, respectively. The concordances map at the six digit level of the HS. We map using a combination of these concordances until there are only thirty-three HS codes which do not map to a given BEC concordance. These thirty-three HS codes are mapped to the BEC by referencing the UNSD mappings of similar products at the six-digit level, the UN COMTRADE Commodity List Reference⁹, and the UNSD official publication on the BEC, “Classification by Broad Economic Categories” (UNSD, 2003). These mappings can be viewed in the Appendix, Table C1.

The second concordance from the UNSD maps the 19 BEC categories to the three SNA end use classes (i.e., capital goods, intermediate use, and final consumption). It should be noted that the concordance is only explicitly given for 17 of the BEC categories as a one-to-many mapping. For BEC categories “321” defined as “Motor Spirit” and “7” defined as “Goods not elsewhere specified”, the UNSD official publication on the BEC, “Classification by Broad Economic Categories” (UNSD, 2003) reports these goods may be a mix of the SNA end use classes and hence a many-to-many mapping. Specifically, category “321” is specified to be used for intermediate use and final consumption, whereas category “7” is specified for a general mix of end uses. Because at present we only consider two end use classes, intermediate use and final consumption, we map the SNA classification of capital goods to final consumption as well.

⁹ <http://comtrade.un.org/db/mr/rfCommoditiesList.aspx>

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See Table 2 for the mapping which we implemented between the BEC, SNA, and our dual end use categorization of intermediate and consumption goods.

Table 2. Mapping between the BEC, SNA, and End Use

No.	BEC	BEC Description	SNA	End Use
1	111	Food and beverages - Primary - Mainly for industry	Intermediate	Intermediate
2	112	Food and beverages - Primary - Mainly for household	Final	Final
3	121	Food and beverages - Processed - Mainly for industry	Intermediate	Intermediate
4	122	Food and beverages - Processed - Mainly for household	Final	Final
5	21	Industrial supplies not elsewhere specified - Primary	Intermediate	Intermediate
6	22	Industrial supplies not elsewhere specified - Processed	Intermediate	Intermediate
7	31	Fuels and lubricants - Primary	Intermediate	Intermediate
8	321	Fuels and lubricants - Processed - Motor spirit	Final	Final
	321	Fuels and lubricants - Processed - Motor spirit	Intermediate	Intermediate
9	322	Fuels and lubricants - Processed - Other	Intermediate	Intermediate
10	41	Capital goods (except transport equipment)	Capital goods	Final
11	42	Capital goods - Parts and accessories	Intermediate	Intermediate
12	51	Transport equipment - Passenger motor cars	Final	Final
	51	Transport equipment - Passenger motor cars	Capital goods	Final
13	521	Transport equipment - Other - Industrial	Capital goods	Final
14	522	Transport equipment - Other - Non-industrial	Final	Final
15	53	Transport equipment - Parts and accessories	Intermediate	Intermediate
16	61	Consumer goods not elsewhere specified - Durable	Final	Final
17	62	Consumer goods not elsewhere specified - Semi-durable	Final	Final
18	63	Consumer goods not elsewhere specified - Non-durable	Final	Final
19	7	Goods not elsewhere specified	Final	Final
	7	Goods not elsewhere specified	Intermediate	Intermediate
	7	Goods not elsewhere specified	Capital goods	Final

We use a concordance between HS and the standard GTAP sectors as obtained from TASTE for GTAP 8 (Horridge and Laborde 2010) and originally prepared by Guimbard et al. (2012). This concordance accounts for all 5,111 HS codes in our trade data from the UN COMTRADE Database, with the exception of the HS code “999999”, which is described as “Commodities not specified according to kind” according to UN COMTRADE Commodity List Reference. This code was mapped to Other Manufacturing (GTAP sector 47). This mapping was

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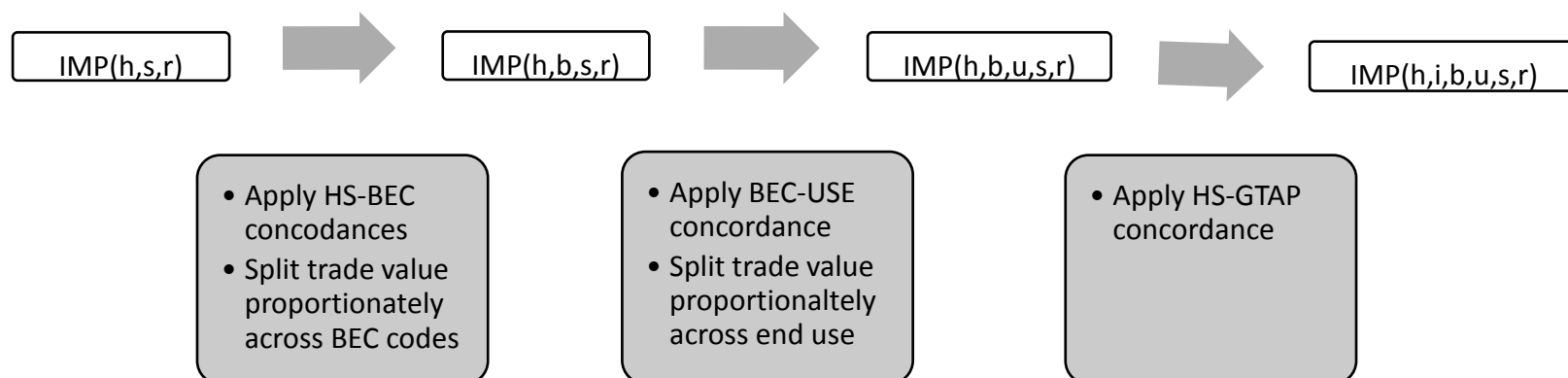
chosen on the account that the traded goods are mostly agricultural, processed agricultural, and manufactured goods. Hence, a plausible scenario is that an unidentified good may be an unidentified manufactured good.

The process of building the MRIO consists of processing trade data from the UN COMTRADE Database and using this data to rebalance the GTAP Data Base. Processing trade data refers to amplifying the information inherent in the trade data through the application of the UNSD HS-BEC and BEC-SNA concordances. We use this data to rebalance the GTAP Data Base, incorporating the additional information on end use specification inferred from the trade data.

Processing the trade data from the UN COMTRADE Database can be broken into two steps: the application of concordances and the reformatting of the trade data for compatibility with the GTAP Data Base. We apply the HS-BEC concordance by mapping bilateral imports data $IMP(h,s,r)$ indexed on HS line h , source country s , and importer r to BEC code b , giving us $IMP(h,b,s,r)$. Then we apply the BEC-SNA concordance, mapping to end use u . Finally, we implement the HS-GTAP concordance to map to GTAP sector i . This process is depicted in Figure 2 and further detailed below. Then as shown in Figure 3, the reformatting of the data prepares the trade data for rebalancing the GTAP Data Base.

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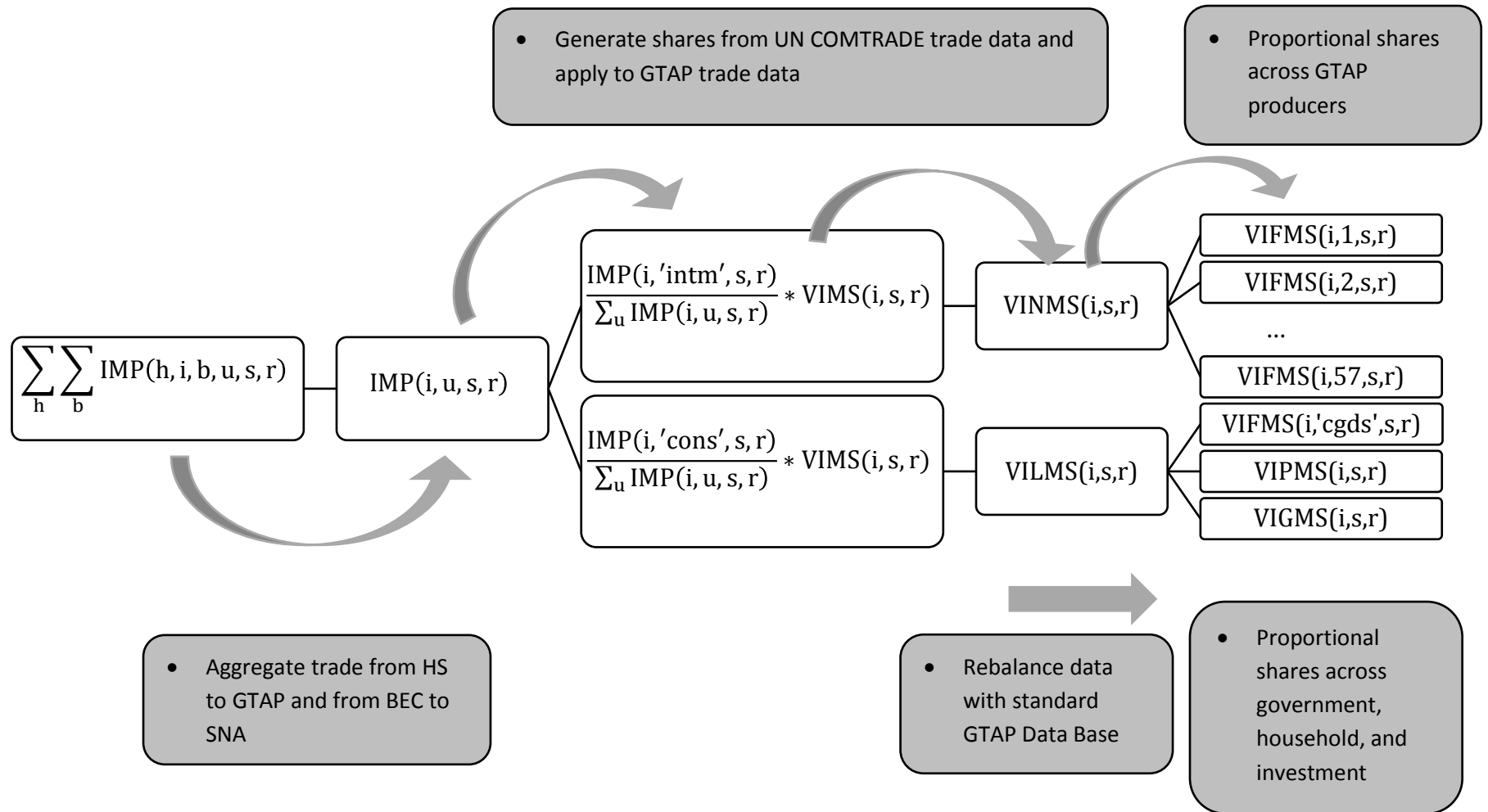
Figure 2. Application of the HS-BEC, BEC-SNA, and HS-GTAP concordances to the trade data from the UN COMTRADE Database



Note: $IMP(h,s,r)$ represents the imports trade data from the UNCOMTRADE Data base. This data is indexed on HS line h , source country s , and reporting country r . Index b represents BEC codes, introduced through the HS to BEC concordance. The index u represents the end USE categories included through the BEC to USE concordance. Finally, the index i represent the GTAP commodity, which is introduced through the HS to GTAP concordance.

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Figure 3. Reformatting the trade data from the UN COMTRADE Database and application to the GTAP Data Base



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We begin to apply the concordance of our trade data, which has 5,111 unique HS codes, to the 19 BEC categories, Table 3. As previously mentioned, the UNSD has three of these concordances which map from the BEC, Revision 4, to HS 1996, 2002, and 2007, respectively. First, we map using the UNSD HS-BEC concordance for HS 2007. This matches 4,476, for the remaining 635 codes, then we map use the HS-BEC concordance for HS 2002 to map 329 of these codes. For the remaining 306 codes, we use the HS-BEC concordance for HS 1996. At the end of this process, we have 33 HS codes which were not found in any of these three concordances. We, therefore hand map these, the mapping is presented in the Appendix, Table C1.

Table 3. Mapping between the HS and the BEC

	Total for matching	Matched	Not Matched
HS07-BEC	5,111	4,476	635
HS02-BEC	635	329	306
HS96-BEC	306	274	33
Hand¹⁰	33	33	0

We note that for the matched mappings from the HS-BEC concordance for HS 1996, there is only one case in which an HS code is mapped to multiple BEC codes. This occurs for the HS code “271000”, which is described as “petroleum oils and oils obtained from bituminous minerals, other than crude” according to UN COMTRADE Commodity List Reference. This is dually mapped to BEC codes “321”, which is described as “Motor Spirit”, and “322”, which is described as “Other Processed Fuels and lubricants”.¹¹ This dual mapping accounts for the fact

¹⁰ See Appendix Table C1.

¹¹ Across HS-BEC concordances, the HS category 271000, Petroleum oils, is the only case where the trade values are split between BEC categories. For example, in 2007, Germany reported imports at the HS line 271000 worth 2.732 billion USD from the Russian Federation. Thus, when the HS-BEC concordance is applied, 271000 maps to BEC categories 321 and 322, and a value of 1.366 billion was allocated to each of the HS-BEC mappings of 271000-321 and 271000-3222 of imports to Germany from the Russian Federation.

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that there are 274 matched HS-BEC mapping and 33 unmatched HS codes out of a total of 307 HS codes. To ensure that there is no double counting in the data, we assume that the value of trade at this HS line is split equally into the two corresponding BEC categories.

To implement the mapping between the BEC and the SNA, we use a concordance based on the UNSD official publication on the BEC, “Classification by Broad Economic Categories” (UNSD, 2003). This concordance shows a single direct mapping for 17 of the 19 BEC categories. For the remaining two BEC categories, the UNSD indicates that the mapping is composed of a mix of two end uses. Therefore, we must make simplifying assumptions due to the lack of better information. These two categories are discussed next.

For the BEC category “321” defined as “Motor Spirit”, we assume a proportional split of trade value between intermediate and consumption goods. That is to say that half of the trade value at a given HS category mapped to BEC category “321” would be allocated to intermediate use and the other half would be allocated to consumption goods.¹² BEC Category 321 maps to GTAP sector 32, Petroleum and Coke products. For Petroleum and Coke Products, 60% of the trade value, on average by country and partner region, comes from other BEC categories (not BEC 321) which uniquely map to the end use category intermediate use. The remaining percentage comes from BEC category 321, which is mapped between intermediate use and final consumption. That is, that on average, we allocate about 20 percent of the total trade

¹² We will continue with the same example about German imports at the HS line 271000, petroleum oils. BEC category 321 is a dual use product, meaning that it is used for both intermediate use as well as final consumption. When the BEC-USE concordance is applied, HS-BEC mapping of 271000-321, with a value of 1.366 billion, is now mapped to both intermediate and final USE categories such that each category is allocated a value of 683 million USD.

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value of Petroleum and Coke products to final consumption, across countries.¹³ For the BEC category “7” defined as “Goods not elsewhere specified”, we make an informed decision based on the BEC-SNA mapping shown in Table 2. We presume that two thirds of the trade value would be allocated to the consumption goods category while one third would be allocated to the intermediate goods category.

As described above, the HS-GTAP concordance is a one-to many mapping between the HS at the six digit level and the standard 57 GTAP sectors. Thus, the application of the concordance did not require any splitting of trade values. With the application of this concordance, we now are ready to aggregate the data into a matter compatible with the GTAP Data Base.

The process of reformatting the trade data, as depicted in Figure 2, begins with aggregation of the value of imports indexed on the HS line h , GTAP sectors i , the BEC code b , end use categories of intermediate and consumption goods u , source country s , and reporting country r ($IMP(h,i,b,u,s,r)$). We sum over all HS lines to aggregate to the GTAP commodities. Simultaneously, we sum over each Broad Economic Category to the two end use categories of intermediate and consumption goods, respectively. This gives us the value of imports indexed on GTAP commodities, end use categories of intermediate and consumption goods, source country s , and reporting country r ($IMP(i,u,s,r)$).

We then generate shares of intermediate imports and consumption imports from $IMP(i,u,s,r)$. We apply these shares to the value of imports in a given country from all regions (header $VIMS(i,s,r)$ in the GTAP Data Base). The resulting data represents the value of imports

¹³ This allocation is necessary because without splitting the BEC category 321 between end uses, no Petroleum and Coke would be designated for final consumer use which is not realistic.

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indexed on GTAP commodities, end use categories of intermediate and consumption goods, source country s , and reporting country r . This procedure returns two new 'BEC-informed' coefficients: one is the value of imports for intermediate use indexed by GTAP commodities, source country s , and reporting country r ($VINMS(i,s,r)$), and the second is the value of imports for final use indexed by GTAP commodities, source country s , and reporting country r ($VILMS(i,s,r)$).

In order to maintain the integrity of the GTAP Data Base, $VINMS(i,s,r)$ and $VILMS(i,s,r)$ must be balanced with the GTAP Data Base, as depicted in Figure 4. Following the methods of Walmsley et al. (2014), intermediate imports $VINMS(i,s,r)$ and imports for final consumption $VILMS(i,s,r)$ are constrained such that they sum to $VIMS(i,s,r)$, the total value of imports from the standard GTAP Data Base. In addition, $VINMS(i,s,r)$ is specified to equal the summation over GTAP producers of the intermediate imports in the standard GTAP Data Base, $\sum_j VIFM(i,j,r)$. Likewise, $VILMS(i,s,r)$ must be constrained to equal the sum of imports for final consumption, which is equal to the imports demanded by the government $VIGM(i,r)$, the private household $VIPM(i,r)$, and investment $VIFM(i,'cgds',r)$ in the standard GTAP Data Base.

The rebalancing takes place according to Walmsley et al. (2014), by entropy optimization as detailed in Walmsley and McDougall (2007) and McDougall (1999). By this method, the share of imports from country s to country r in industry i in $VINMS(i,s,r)$ is adjusted to satisfy the above constraints. Then, the entropy, a measure of difference, between these shares and the original shares of imports from country s to country r in industry i in $VINMS(i,s,r)$ is minimized. The same is done for $VILMS(i,s,r)$. In essence, the goal of the optimization is to

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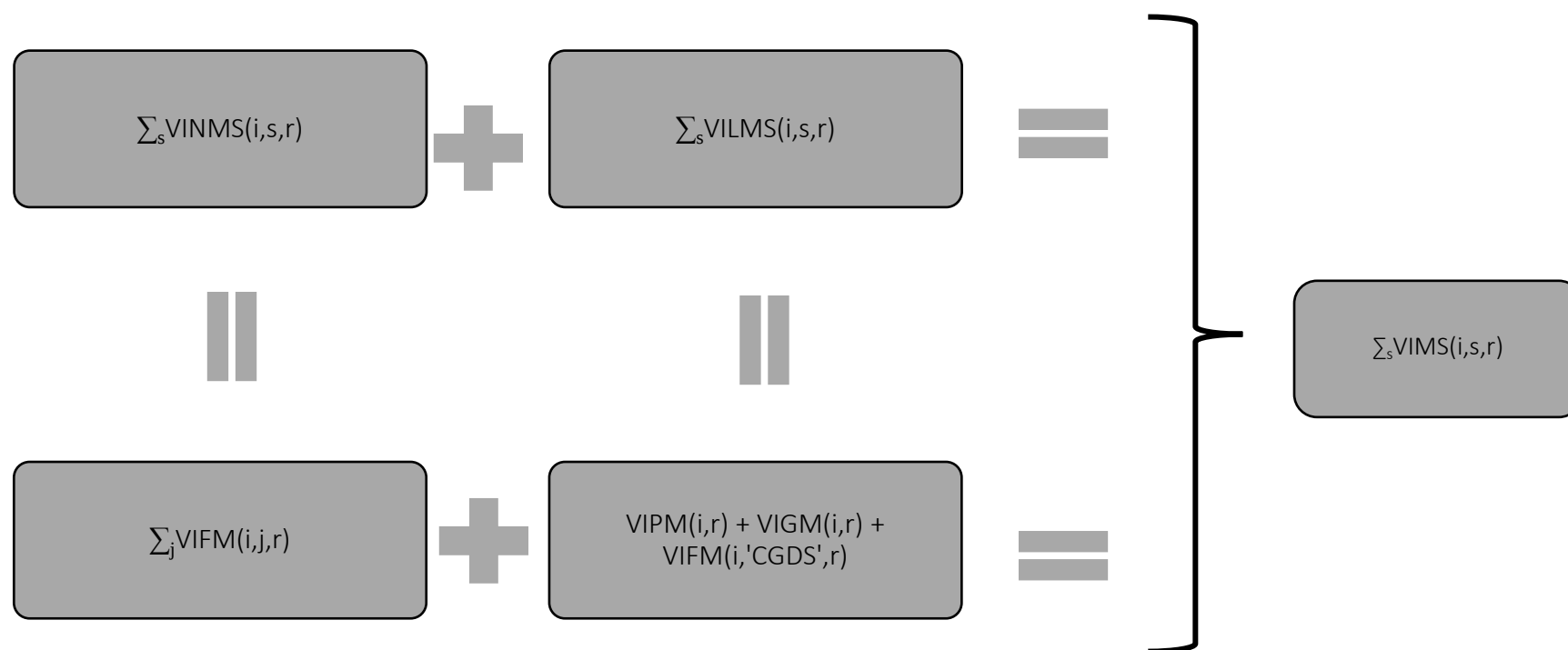
best preserve the original distribution across import source countries while conforming to the value of imports by agent and demanding country in the GTAP Data Base.

Now that the data are balanced with the rest of the GTAP Data Base, we must apportion $VINMS(i,s,r)$ and $VILMS(i,s,r)$ by specific agent, as in Figure 4. As neither the UN COMTRADE Database nor the GTAP Data Base contain explicit information on agent-specific import demands, we assume that demand for intermediate imports, $VINMS(i,s,r)$, is proportionate across GTAP producers, $VIFMS(i,j,s,r)$. Likewise, we consider that demand for imports of consumption goods, $VILMS(i,s,r)$, is proportionate across the government ($VIGMS(i,s,r)$), the private household ($VIPMS(i,s,r)$), and investment ($VIFMS(i,'cgds',s,r)$). This leaves us with a complete MRIO, in balance with the entire GTAP Data Base and, hence, finalized for analytic use.

Table 5 shows the world interrelations for an aggregation of regions and selected industries based on the GTAP MRIO data that we just developed. This aggregate global inter-industry matrix, shows the imported inputs needed by each region industries from the rest of the regions.

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Figure 4. Rebalancing the BEC-informed data with the standard GTAP Data Base



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Investment Decomposition

The GTAP Data Base reports Gross Fixed Capital Formation (GFCF) for 109 countries and 20 regions. In order to determine how much of this corresponds to government investment, we compute shares based on data from the OECD, the United Nations (UN) and EUROSTAT.

The OECD data presents GFCF data for four years (1995, 1999, 2003, and 2007) distinguished by institutional sectors (General Government, Households and non-profit institutions serving households, and Corporations) for 30 countries. “For government this typically means investment in transport infrastructure and public buildings such as schools and hospitals. For households, this generally equates to dwellings.” (OECD, 2010).

The OECD also presents GFCF data by asset group (but not by asset group and institution). The six assets the OECD presents are: Dwellings (excluding land); Other buildings and structures (roads, bridges, airfields, dams, etc.); Transport equipment (ships railway, aircraft, etc.); Other machinery and equipment (office machinery and hardware, etc.); Cultivated assets (managed forests, livestock raised for milk production, etc.); and intellectual property type fixed assets (mineral exploration, software and databases and literary and artistic originals, etc.).

The integrated economic accounts data from the United Nations identifies data for the total economy and the five institutional sectors of the SNA system, i.e., the non-financial corporations, financial corporations, general government, households, and non-profit institutions serving households. For 2007, the UN offers data for 62 countries see Appendix D. From EUROSTAT, we can obtain GFCF data for the total economy, government, business, and household sectors for EU 27 countries.

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In general, there is consistency among data sources in terms of the monetary value of public investment. Table 4 shows the 2007 public investment for EU countries. We rely on EUROSTAT for public investment data for EU countries. UN estimates and EUROSTAT data for public investment are generally within 5% of one another. The Czech Republic and Greece are exceptions. Outside of the European countries, we allow the OECD to take precedence over the UN source.

After these data sources are combined, we have investment data by household, corporations, and government for 64 countries.¹⁴ Since the GTAP construction process lists 244 countries, we map every single available country to the regional aggregates and compute investment-weighted splits to fill in missing observations. Appendix E shows public investment data for the 129 regions represented in GTAP. The product composition of public investment is available for GTAP 57 products, based on the structure as the original total investment in GTAP.

We will interact with the EC staff to examine the feasibility of using information that we have for a few countries (i.e., Australia, Japan, France, and Canada) in the rest of GTAP countries. For these countries we have obtained detailed information that will allow us to better comprehend the composition of government investment. The composition may not substantially differ from the information contained in GTAP, in which case a no action would be recommended. In case the composition is different, we would recommend that this information supplements GTAP and change the composition in GTAP to match that provided by the detailed information. Depending on the level of consistency among the detailed

¹⁴ The list of 64 countries include the 62 country data from the UN plus Australia and Canada data retrieved from the OECD, please see Appendix D for country availability by source.

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information, we could recommend that this be applied to the rest of GTAP regions or to the subset of developed economies.

Table 4. EU's 2007 Gross Fixed Capital Formation by institutional sector (in millions of USD)

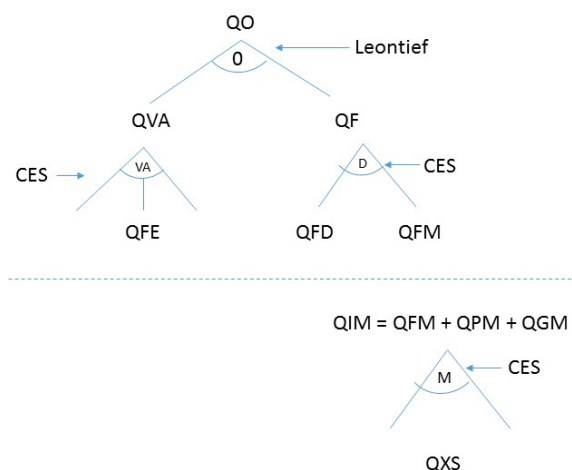
No.	Country Name	Corporate	Government	Household	Total
1	Austria	59,044	4,082	18,418	81,544
2	Belgium	69,445	8,145	35,766	113,355
3	Bulgaria	9,849	2,349	640	12,839
4	Croatia	11,181	2,395	2,870	16,446
5	Cyprus	1,984	702	2,469	5,155
6	Czech Republic	28,730	6,931	9,223	44,885
7	Denmark	42,355	5,943	20,511	68,809
8	Estonia	5,028	1,143	1,865	8,036
9	Finland	29,636	6,352	19,552	55,540
10	France	297,156	88,143	184,106	569,405
11	Germany	368,891	50,057	204,684	623,633
12	Greece	20,135	8,720	39,922	68,777
13	Hungary	18,305	5,121	7,040	30,466
14	Ireland	20,216	10,845	28,046	59,107
15	Italy	244,323	49,630	164,087	458,039
16	Latvia	7,481	1,805	1,533	10,818
17	Lithuania	8,205	2,224	1,600	12,029
18	Luxembourg	10,155	2,589	3,538	16,283
19	Malta	920	341	686	1,947
20	Netherlands	73,048	26,246	58,770	158,064
21	Poland	55,237	18,817	23,349	97,403
22	Portugal	32,281	6,316	13,314	51,912
23	Romania	38,064	9,593	3,455	51,113
24	Slovakia	16,664	1,648	4,772	23,084
25	Slovenia	8,782	2,156	3,234	14,172
26	Spain	246,581	58,731	140,429	445,741
27	Sweden	62,081	14,507	16,011	92,600
28	United Kingdom	281,886	54,143	168,756	504,785

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Model

The model used for this study, is a modified version of the standard GTAP model. The standard GTAP Model is a multi-region, multi-sector, computable general equilibrium model, with perfect competition and constant returns to scale (Hertel, 1997). In the standard GTAP model, output is a Leontief composite of each commodity input and factors of production (or value added), and each commodity is a constant elasticity of substitution (CES) composite of an imported and a domestically produced commodity, see Figure 5.

Figure 5. Production structure in the standard GTAP model



Source: Based on Figure 2.6 in Hertel (1997)

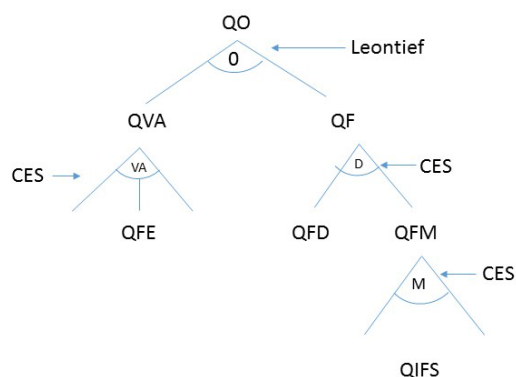
In Figure 5, QO represents quantity produced by industries, QVA represents the composite value added quantity purchased by industries, QFE is the quantity of individual factor endowments (e.g., Land, Labor, and Capital), QF is the quantity of intermediates purchased by industries, which is composed of domestic and imported intermediates. QIM are total imports composed of imports destined to intermediates (QFM), to private household (QPM), and to the government (QGM). Total imports are match with exports coming from other regions (QXS). Figure 5 describes that the sourcing decision for imports in the standard

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GTAP model is made at the aggregate level and not at the agent level. This was done mainly due to the original lack of detailed import sourcing data at the agent level (Walmsley, Hertel and Hummels, 2014).

The modified GTAP model presented here permits us to exploit the data developments described in the previous section. In the extended model, the sourcing of imports is determined at the agent level (i.e., for firms, private consumption, government consumption, private investment, and government investment), including source-specific commodity taxation on imports. This is achieved by incorporating a new nest level between the composite commodity and the source-specific varieties, see bottom of Figure 6, which represents the alternative production structure with industries' imports (QIFS) indexed by their country of origin.

Figure 6. Alternative production structure with origin of imports

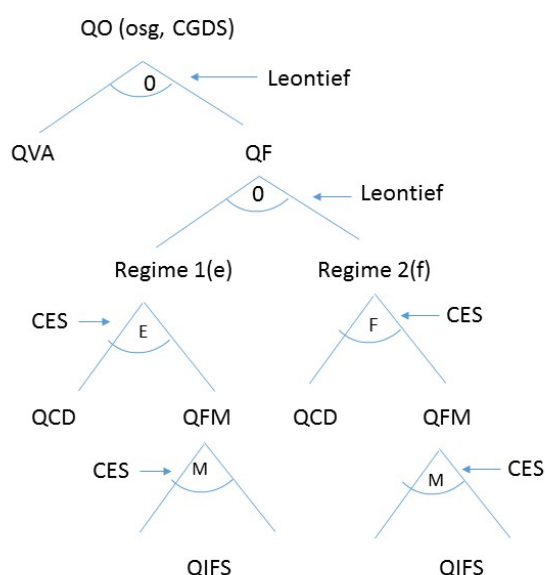


Source: Authors' illustration.

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In addition, the model is also modified to account for different government procurement regimes, see Figure 7.¹⁵ Note that the procurement regimes only affect the government related producing sectors in GTAP, these are the Other Services by Government (OSG) industry and the Government Capital Goods (CGDS) industry.¹⁶

Figure 7. Alternative production structure with origin of imports and procurement regimes



Source: Authors' illustration.

Two procurement policy regimes are considered, purchases exempt from procurement policy (see Regime 1(e) in Figure 7), and purchases subject to finite local preference (see Regime 2(f) in Figure 7). Purchases subject to finite local preference are those government purchases that can be subject to some kind of bias (e.g., home bias). Purchases exempt from procurement policy correspond to those purchases not subject to bias or could also be considered as competitive purchases or fully liberalized purchases.

¹⁵ In Figure 7, quantity of domestic intermediate products purchased by industries (formerly QFD) is renamed QCD.

¹⁶ Other Services (Government), sector OSG, is the main input of government final demand. We do not introduce procurement regimes in government's final demand because this is already captured in OSG.

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In order to introduce the procurement regime where some bias exist (Regime 2(f) in Figure 7), a new layer of taxes on intermediate inputs are considered. In the standard GTAP model, the variable *tfd* represents the percentage change in the power of the tax on intermediate usage of domestic product, and *tifs* is the percentage change in the corresponding power of the tax for imports. We divide these tax variables into *veridical*¹⁷ and *phantom* taxes¹⁸; the latter allow us to represent the finite local preference under public procurement policies. So, for instance, in standard GTAP, *tfd* is typically an exogenous variable, which links market prices with firms prices, see Equation 1.

Equation 1

$$pfd(i,j,r) = tfd(i,j,r) + pm(i,r)$$

where *pfd* is the price index for domestic purchases of product *i* by industry *j* in region *r*; *tfd* is the tax on domestic commodity *i* purchased by sector *j* in region *r*; and *pm* is the market price of commodity *i* in region *r*.

In the extended model, the corresponding regime-specific variable (*tfd*) is renamed *tcd* and is calculated from its veridical and phantom components, see Equation 2.

Equation 2

$$tcd(i,j,c,r) = tcdv(i,j,c,r) + tcdp(i,j,c,r)$$

where the new index '*c*' represents the policy regime; *tcd* is the tax on domestic commodity *i* purchased by sector *j* in region *r* (formerly *tfd*); *tcdv* is the veridical tax on domestic commodity *i* purchased by sector *j* in region *r*; and *tcdp* is the phantom tax on domestic commodity *i*

¹⁷ By *veridical* taxes, we mean taxes in the model that represent taxes in reality, by *phantom* taxes, taxes in the model used to mimic the effects of non-tax policy instruments.

¹⁸ Phantom taxes and subsidies are zero for inputs into all current production other than that of "other government services", and, for inputs into "other government services". It is also zero for purchases exempt from procurement policy (Regime 1(e) in Figure 3).

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purchased by sector j in region r .¹⁹ Similar to Equation 1, the new tax variable links the market price with firm price.²⁰

The phantom tax instrument allows us to incorporate local preference under the procurement regime 2(f) and it should not affect government revenue or industry costs, or lead to substitution between one composite commodity and another. This is achieved by imposing a requirement on phantom taxes revenue that the tax revenue associated with phantom taxes on any flow of domestic product and on the corresponding flow of imports should sum to zero. Therefore, local preference is represented as a tax on imports, which discourages imports purchases and an equal and opposite subsidy on domestic product, which encourages domestic purchases. As a consequence, between two corresponding components of $tcdp$ and $tcmp$ (phantom taxes on domestic product and on imports), there is only one degree of freedom, which is absorbed with a variable representing the power of local preference, see variable $tclp$ in Equation 3.

Equation 3

$$tclp(i,j,c,r) = tcmp(i,j,c,r) - tcdp(i,j,c,r)$$

The variable $tclp$ is exogenous. Therefore, the powers of the phantom tax on domestic product and imports are determined by the extent of local preference and the zero revenue condition. Shocking variable $tclp$ affects both phantom taxes, which affect the domestic and imported commodities through $tcdp$ and $tcmp$, respectively. Phantom taxes affect taxes on domestic and imported commodities. Equation 2 describes the case of taxes on domestic

¹⁹ Variables and coefficients indexed by regime have the letter 'C' in place of the standard GTAP 'F' for Firm. So, for instance, the regime-generic quantity of a composite intermediate input is qf , as in standard GTAP, and the corresponding regime-specific quantity is qc .

²⁰ In the model code, this is $pcd(i,j,c,r) = tcd(i,j,c,r) + pm(i,r)$

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commodities, tcd. Taxes on domestic commodities (tcd) subsequently affect the price linkage equations such as Equation 1 in the standard model and similarly in the updated equation for the modified model (see footnote 20).

Implementation of modifications

In dividing usage values between procurement regimes, we focus on production sectors that relate to the Government, “Other Services (Government)” industry (OSG) and government’s gross fixed capital formation. The GTAP Data Base indicates that, on average for the world, 65% of domestic government services (OSG) are sold to the final government use. For lack of better data, we assume that for each country, the share of final government consumption in total sales of domestically produced government services determines the initial share of purchases of inputs into “Other Services (Government)” *subject to local preference*. This means that on average for the world, 35 per cent is assumed to be procured competitively. For government investment, the initial value assigned to be subject to local preference is set to equal the share of public investment in total investment developed in the previous section (on average, 13 per cent).

GTAP has several levels of valuation, agent, market, or world prices. To accommodate the more complex structure of taxes on intermediate usage, for the data base we define a new level of valuation, in which prices for the new level include veridical but not phantom taxes. In data array and coefficient names, we use the symbol ‘V’ for veridical; so, for instance, corresponding to the standard GTAP intermediate usage of domestic product at market and agents’ prices (headers VDFM and VDFA, respectively), we now have the regime-specific VDCM,

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VDCA, and VDCV, the last of which represents value at veridical prices, to which phantom taxes or subsidies may be added or subtracted to obtain the value VDCA at agents' prices.

We set the new veridical value arrays for domestic and imported usage (VDCV and VICV) equal in aggregate to the old agents' value arrays VDFA and VIFA (that is, summing over regimes, from new VDCV we recover old VDFA, and likewise for VICV and VIFA). The new agents' values arrays VDCA and VICA incorporate phantom taxes and subsidies, which we set so that:

- Phantom taxes and subsidies are zero for inputs into all current production other than that of "other government services", and, for inputs into "other government services" and gross fixed capital formation, are zero for purchases exempt from procurement policy.
- For remaining purchases, that is, for the portion of inputs into "other government services" and gross fixed capital formation subject to local preference, we assume a hypothetical scenario where there is a 20 percent margin of local preference in the European Union, and 50 per cent elsewhere.
- The total value of phantom taxes and subsidies on corresponding domestic product and import flows are equal in and opposite in sign.

This set up allows us to explore the conjecture that local preference is substantial in most jurisdictions, but lower in the European Union than elsewhere.

Illustrative application

For purposes of illustration we aggregate the global economy into four regions and six sectors. The regional aggregates are: the EU, the USA, Japan (JPN), and rest of the world

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(ROW). The sector aggregates are composed of agriculture, forestry, and fishing (PRIM), Other Manufactures (OMF), equipment (EQU), construction (CONS), and services (SERV). In this case, services sector includes other services by the government (i.e., GTAP code OSG). This highly aggregated data base is for model testing and will be updated soon.

The illustrative scenario consists of simulating the reduction of local preference in the United States and Japan, so that, from an initial power of 1.5, the tax on imported government purchases covered under the GPA, it falls to the same level as in the European Union which is 1.2. In the rest of the world, the power of local preference remains 1.5. This means that only the US and Japan liberalize their purchasing under this scenario.

Simulation results

Table 5 reports the initial imports at market prices (in millions of USD). Table 6 shows the percentage change due to the policy simulation. As expected, the reduction of local preference in the services and investment sectors increases imports from EU into the US and Japan by considerable amounts (mostly double digit percentage change, in Table 6). At the same time, the portion of the US and Japanese services and investment sectors not subject to preferential regimes, have a minor decrease in imports from EU. These are preliminary results to the hypothetical scenario. Both model and scenarios need to be further refined for a complete analysis.

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Table 5. Import demand by services and investment, market prices (in millions of USD)

	EU				JPN				USA				ROW			
Supply\Demand	Serv-e	Serv-f	CGDS-e	CGDS-f	Serv-e	Serv-f	CGDS-e	CGDS-f	Serv-e	Serv-f	CGDS-e	CGDS-f	Serv-e	Serv-f	CGDS-e	CGDS-f
EU-PRIM	11,969	1,695	822	92	46	4	12	2	286	32	3	0	1,737	260	257	44
EU-OMF	207,746	52,805	12,522	1,457	2,912	1,259	257	41	23,843	5,133	1,625	241	68,167	13,968	13,035	2,939
EU-EQU	111,291	31,060	285,394	39,085	886	386	8,668	1,393	15,351	2,347	49,998	7,403	58,143	11,452	203,752	33,392
EU-CONS	3,859	1,149	9,624	1,171	1,593	182	232	37	851	98	109	16	2,598	802	9,995	1,908
EU-SERV	290,506	24,851	24,211	3,500	16,739	810	238	38	89,090	6,695	2,247	333	142,075	11,980	11,327	1,994
JPN- PRIM	12	3	1	0	0	0	0	0	22	1	0	0	183	3	13	2
JPN-OMF	2,442	947	234	24	0	0	0	0	4,173	1,101	153	23	13,404	4,029	1,421	279
JPN-EQU	6,838	2,146	21,335	2,638	0	0	0	0	11,305	1,228	37,534	5,558	25,449	3,495	79,814	12,148
JPN-CONS	1,211	376	1,672	177	0	0	0	0	313	36	40	6	861	213	2,291	433
JPN-SERV	7,522	468	345	49	0	0	0	0	6,667	537	157	23	13,088	897	849	134
USA- PRIM	2,124	135	6	1	249	9	10	2	0	0	0	0	4,868	339	610	76
USA-OMF	15,927	4,016	1,131	132	3,788	1,269	136	22	0	0	0	0	54,049	9,330	5,624	989
USA-EQU	12,797	6,160	30,387	3,854	1,105	420	8,995	1,446	0	0	0	0	38,469	7,326	109,935	17,052
USA-CONS	342	94	1,201	142	725	83	106	17	0	0	0	0	468	158	1,399	244
USA-SERV	48,933	4,737	3,648	537	16,207	1,093	275	44	0	0	0	0	67,423	6,893	4,063	713
ROW- PRIM	49,311	2,090	493	59	29,674	512	219	35	10,408	463	39	6	58,743	1,170	1,433	275
ROW-OMF	85,993	14,500	8,418	945	17,391	3,824	1,495	240	70,445	11,200	11,053	1,637	184,120	24,130	25,045	5,263
ROW-EQU	37,269	11,747	107,359	13,525	3,258	1,638	36,496	5,866	70,183	5,767	156,033	23,105	83,249	12,414	250,400	39,947
ROW-CONS	2,024	551	6,307	737	4,309	493	628	101	994	115	127	19	1,960	616	6,888	1,343
ROW-SERV	162,910	13,465	11,052	1,586	23,933	1,346	269	43	110,603	8,818	1,175	174	144,889	11,472	9,538	1,572

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Table 6. Percentage change in imports after local preference reduction

	EU				JPN				USA				ROW			
Supply\Demand	Serv-e	Serv-f	CGDS-e	CGDS-f	Serv-e	Serv-f	CGDS-e	CGDS-f	Serv-e	Serv-f	CGDS-e	CGDS-f	Serv-e	Serv-f	CGDS-e	CGDS-f
EU- PRIM	0%	0%	1%	1%	-1%	64%	-8%	86%	-3%	69%	-5%	121%	-1%	-1%	-1%	-1%
EU-OMF	0%	0%	1%	1%	-3%	73%	-6%	63%	-2%	63%	-4%	63%	-1%	-1%	0%	0%
EU-EQU	0%	-1%	1%	1%	-4%	70%	-8%	61%	-3%	84%	-5%	51%	-2%	-2%	-1%	-1%
EU-CONS	0%	0%	1%	1%	-2%	42%	-6%	43%	-2%	50%	-4%	47%	0%	0%	1%	1%
EU-SERV	0%	0%	1%	1%	-1%	50%	-5%	45%	-1%	49%	-3%	49%	0%	0%	1%	1%
JPN- PRIM	11%	11%	13%	12%					7%	88%	5%	145%	10%	9%	9%	10%
JPN-OMF	5%	5%	6%	6%					3%	71%	1%	71%	4%	4%	5%	5%
JPN-EQU	7%	7%	8%	8%					4%	97%	2%	62%	6%	5%	6%	6%
JPN-CONS	3%	3%	5%	5%					2%	55%	0%	52%	3%	3%	4%	4%
JPN-SERV	3%	3%	4%	4%					1%	53%	0%	53%	2%	2%	3%	3%
USA- PRIM	9%	9%	11%	11%	7%	78%	0%	102%					8%	7%	8%	8%
USA-OMF	5%	5%	6%	6%	1%	81%	-2%	71%					4%	4%	5%	5%
USA-EQU	6%	5%	7%	7%	1%	80%	-2%	70%					4%	4%	5%	5%
USA-CONS	3%	3%	4%	4%	1%	46%	-3%	48%					3%	3%	4%	4%
USA-SERV	2%	2%	3%	3%	0%	53%	-4%	48%					2%	2%	3%	3%
ROW- PRIM	0%	1%	2%	2%	-1%	65%	-8%	87%	-3%	70%	-5%	122%	0%	-1%	0%	0%
ROW-OMF	1%	1%	2%	2%	-2%	74%	-6%	64%	-2%	64%	-3%	63%	0%	0%	1%	1%
ROW-EQU	0%	0%	2%	2%	-4%	71%	-7%	62%	-2%	85%	-4%	52%	-1%	-1%	0%	0%
ROW-CONS	0%	0%	1%	1%	-2%	42%	-6%	44%	-2%	50%	-3%	48%	0%	0%	1%	1%
ROW-SERV	1%	1%	2%	2%	-1%	50%	-5%	46%	-1%	50%	-2%	49%	0%	0%	1%	1%

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Future directions

This paper presents the analytical data base, designed to improve the public procurement representation in the GTAP framework. From the beginning, it was recognized that improving the data was key to our final objective. Surveying our IO contributors served as confirmation that this is a non-trivial pursuit.

The composition of government investment needs to be improved. We will rely on selected IO tables that will help us improve the composition of government investment. The tables that we have available for this are France, Japan, Canada, and Australia.

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Appendix A: Estimates of the size of government procurement

According to the Organization for Economic Co-operation and Development (OECD, 2013), the estimated size of general government procurement (GP) is determined as:

$$GP = ICG + GGFCF + STIK$$

- where ICG is the sum of intermediate consumption by governments,
- GGFCF is the government's gross fixed capital formation (i.e., government investment), and
- STIK are the social transfers in kind via market producers.

Table A1 presents the components of this indicator using GTAP data for 129 GTAP regions/countries in 2007. For the intermediate consumption by governments, we take GTAP's intermediate use of products by the public sector, which is capture by sector 'osg: Other services (Government)', which accounts for the production account of public administration, defense, health and education.²¹ Government's gross fixed capital formation has been developed as part of this project and social transfers in kind (STIK) is data not separately distinguished in the GTAP Data Base.

Table A1. Government Procurement Indicator for 2007

Region/Country Name	Intermediate Government Consumption	Government Investment	Government Procurement (in millions USD)	Government Procurement (% of GDP)
Australia	54,557	20,396	74,953	8.75%
New Zealand	11,080	2,779	13,859	10.02%
Rest of Oceania	3,063	645	3,708	11.65%
China	268,022	158,431	426,453	12.21%
Hong Kong	4,632	5,326	9,958	4.81%
Japan	392,500	139,794	532,294	12.16%
Korea	80,978	50,441	131,419	12.53%
Mongolia	470	189	659	16.77%
Taiwan	15,703	10,411	26,114	6.63%
Rest of East Asia	3,165	1,523	4,688	14.22%
Cambodia	324	215	539	6.45%
Indonesia	18,454	13,355	31,809	7.36%
Lao People's Democratic Republic	134	187	321	7.48%
Malaysia	2,281	4,649	6,930	3.71%

²¹ We use header NVFA in the GTAP Data Base and exclude factor payments (e.g., payments to capital or labor).

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Region/Country Name	Intermediate Government Consumption	Government Investment	Government Procurement (in millions USD)	Government Procurement (% of GDP)
Philippines	5,978	2,710	8,688	6.03%
Singapore	19,298	16,179	35,477	20.07%
Thailand	5,227	7,866	13,093	5.30%
Viet Nam	2,687	3,567	6,254	9.14%
Rest of Southeast Asia	993	518	1,511	5.28%
Bangladesh	2,272	2,277	4,549	6.65%
India	15,781	60,729	76,510	6.21%
Nepal	479	294	773	7.52%
Pakistan	7,811	4,284	12,095	8.45%
Sri Lanka	2,094	1,109	3,203	9.90%
Rest of South Asia	628	500	1,128	9.39%
Canada	149,216	43,362	192,578	13.52%
United States of America	1,440,599	346,375	1,786,974	12.71%
Mexico	25,753	21,189	46,942	4.58%
Rest of North America	2,202	276	2,478	30.22%
Argentina	16,531	7,533	24,064	9.23%
Bolivia	1,012	1,131	2,143	16.33%
Brazil	116,387	29,148	145,535	10.65%
Chile	7,819	3,776	11,595	7.06%
Colombia	15,926	5,297	21,223	10.23%
Ecuador	1,456	1,226	2,682	5.86%
Paraguay	432	265	697	5.70%
Peru	4,616	2,826	7,442	6.92%
Uruguay	1,553	536	2,089	8.72%
Venezuela	7,699	6,849	14,548	6.41%
Rest of South America	680	213	893	15.08%
Costa Rica	899	746	1,645	6.26%
Guatemala	1,119	1,137	2,256	6.61%
Honduras	597	344	941	7.59%
Nicaragua	365	271	636	11.33%
Panama	858	813	1,671	8.44%
El Salvador	493	1,202	1,695	8.32%
Rest of Central America	100	36	136	10.66%
Caribbean	24,320	1,738	26,058	9.88%
Austria	24,471	4,082	28,553	7.67%
Belgium	40,095	8,145	48,240	10.52%
Cyprus	1,882	702	2,584	12.05%
Czech Republic	13,432	6,931	20,363	11.69%
Denmark	28,484	5,943	34,427	11.08%
Estonia	1,843	1,143	2,986	13.96%
Finland	20,887	6,352	27,239	11.05%
France	176,959	88,143	265,102	10.05%
Germany	215,333	50,057	265,390	7.97%
Greece	17,118	8,720	25,838	8.34%

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Region/Country Name	Intermediate Government Consumption	Government Investment	Government Procurement (in millions USD)	Government Procurement (% of GDP)
Hungary	6,110	5,121	11,231	8.09%
Ireland	14,288	10,845	25,133	9.68%
Italy	161,166	49,629	210,795	9.96%
Latvia	2,106	1,805	3,911	13.60%
Lithuania	2,670	2,224	4,894	12.51%
Luxembourg	3,300	2,589	5,889	11.48%
Malta	589	341	930	12.49%
Netherlands	73,723	26,246	99,969	12.84%
Poland	23,189	18,817	42,006	9.88%
Portugal	16,525	6,316	22,841	9.89%
Slovakia	5,561	1,648	7,209	8.56%
Slovenia	4,334	2,156	6,490	13.72%
Spain	79,164	58,731	137,895	9.57%
Sweden	42,543	14,507	57,050	12.33%
United Kingdom	302,645	54,143	356,788	12.75%
Switzerland	28,412	8,977	37,389	8.61%
Norway	23,969	12,410	36,379	9.39%
Rest of EFTA	1,833	851	2,684	10.82%
Albania	114	400	514	4.75%
Bulgaria	4,609	2,349	6,958	16.52%
Belarus	3,863	2,586	6,449	14.24%
Croatia	204	2,395	2,599	4.44%
Romania	11,731	9,593	21,324	12.60%
Russian Federation	89,888	47,511	137,399	10.57%
Ukraine	12,580	5,663	18,243	12.78%
Rest of Eastern Europe	544	157	701	15.92%
Rest of Europe	4,974	2,901	7,875	8.57%
Kazakhstan	8,679	5,839	14,518	13.85%
Kyrgyzstan	386	116	502	13.21%
Rest of Former Soviet Union	3,220	1,057	4,277	11.06%
Armenia	597	424	1,021	11.10%
Azerbaijan	1,469	1,660	3,129	9.47%
Georgia	934	645	1,579	15.52%
Bahrain	357	1,258	1,615	8.74%
Slovak Republic	9,139	5,684	14,823	5.18%
Israel	23,475	3,039	26,514	15.88%
Kuwait	1,653	5,020	6,673	5.82%
Oman	1,097	2,916	4,013	9.58%
Qatar	1,494	7,405	8,899	11.02%
Saudi Arabia	5,756	21,717	27,473	7.15%
Turkey	8,807	31,669	40,476	6.25%
United Arab Emirates	2,000	14,504	16,504	7.95%
Rest of Western Asia	9,063	6,164	15,227	11.43%
Egypt	13,015	4,742	17,757	13.61%

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Region/Country Name	Intermediate Government Consumption	Government Investment	Government Procurement (in millions USD)	Government Procurement (% of GDP)
Morocco	23,118	2,288	25,406	33.77%
Tunisia	1,528	1,474	3,002	8.43%
Rest of North Africa	5,434	8,357	13,791	6.63%
Cameroon	948	434	1,382	6.68%
Cote d'Ivoire	696	740	1,436	7.26%
Ghana	1,824	2,006	3,830	15.55%
Nigeria	84	68	152	3.61%
Senegal	305	455	760	6.70%
Rest of Western Africa	1,034	1,850	2,884	15.08%
Central Africa	2,372	1,594	3,966	9.59%
South Central Africa	3,607	1,881	5,488	7.93%
Ethiopia	951	570	1,521	7.93%
Kenya	5,223	656	5,879	21.64%
Madagascar	166	405	571	7.78%
Malawi	108	111	219	6.11%
Mauritius	225	220	445	5.92%
Mozambique	439	145	584	7.28%
Tanzania	933	628	1,561	9.28%
Uganda	889	289	1,178	9.91%
Zambia	449	348	797	6.91%
Zimbabwe	113	145	258	5.82%
Rest of Eastern Africa	515	1,679	2,194	3.98%
Botswana	1,247	561	1,808	14.60%
Namibia	577	363	940	10.67%
South Africa	27,861	9,376	37,237	13.01%
Rest of South African Customs Union	294	86	380	8.39%
Rest of the World	7	3	10	8.00%

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Appendix B: The GTAP IO Table Survey Questionnaire

Questions	Answers
1. What countries' I-O table (or SAM) have you worked with? Which of these have been contributed to the GTAP Data Base?	The first question of the survey is designed to identify the contributors and the IO tables they have worked on and contributed to GTAP. While there are several contributors for Latin and Asian countries, there are fewer contributors for African countries, and a single respondent for the EU countries. ²²
2. In the IO sources upon which you have drawn, are you able to locate data on public (vs. private) investments?	75% of respondents indicated that they were not able to locate private from public investment data. The exception to this are the IO tables from Japan, Australia, and Taiwan where contributors were able to identify a verifiable source.
3. Are you aware of other sources of data on government procurement in the countries which you have contributed? If yes, please list them here.	Australia publishes tender results in AusTender, all the other contributors said that they are not aware of any other source of government procurement data. ²³ Other respondents for Thailand, Latin America, and the Middle East indicated their awareness of government data being available.
4. Does your IO table display foreign vs. domestic composition of inputs used within each industry/activity?	60% of respondents answered that their IO table does not display foreign vs. domestic composition of inputs. Only one of the remaining 40% responded that this distinction is available through the pro-rate computation that GTAP recommends when a table's imports is a vector in the matrix. All of the EU tables, however, do make this distinction.
5. Does the IO table indicate the origin and destination of your country's imports and exports?	All respondents, except for Taiwanese table contributor, say that the IO tables do not indicate the origin of imports or the destination of exports. Also, the EU tables provide extra-EU and intra-EU information for imports and exports.
6. Does the original IO table distinguish between imports for intermediate use and those for final demand?	Question six received the largest number of positive answers. 50% of respondents indicate that the original IO tables distinguished import use between intermediate and final demand. The geographic distribution of the response includes countries in Asia (Mongolia, Thailand, and Taiwan) and Latin America (Mexico, Brazil, and Ecuador). None of the African IO table contributors were able to indicate such distinction of the use of imports.
7. Do you know if your country restricts government purchases of	The last question on the IO survey was designed to inquire further into the extent to which government procurement affects imported goods. 65% of the respondents indicated that they

²² The EU contributor is new, but currently working on the next EU contribution.

²³ The contributor for the Thai table, as well as Martin Cicowiez for Latin American countries, mention that basic government data is available but is not always well systematized.

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Questions	Answers
imported goods? If yes, please indicate the study or data source.	were not aware of any restrictions. 20% confirmed that there are no restrictions (Philippines, Thailand, New Zealand, and Australia). For Brazil, on the other hand, certain government programs do give preference to domestic suppliers. Some Middle Eastern countries (Bahrain, Oman, Kuwait, United Arab Emirates, Qatar, and Saudi Arabia) have a system of government procurement that gives a ten percent price advantage to local producers.

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Appendix C: Table C1. Hand Mapping between the HS and the BEC

HS	BEC
120792	111
120919	21
121292	111
230640	22
230810	21
230890	21
253040	21
262090	21
410122	21
410130	21
410422	22
410520	22
410620	22
430120	21
480251	22
480253	22
480522	22
480570	22
480580	22
482351	22
510530	22
846110	41
850810	41
850890	42
854214	42
854219	42
854240	42
900990	42
902111	61
902119	62
911210	22
930590	7
999999	7

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Appendix D: Table D1. 2007 Government Gross Fixed Capital Formation Country Availability by source

No.	Country Name	UN	OECD	EUROSTAT
1	Armenia	1	0	0
2	Australia	0	1	0
3	Austria	1	1	1
4	Azerbaijan	1	0	0
5	Belarus	1	0	0
6	Belgium	1	1	1
7	Bolivia	1	0	0
8	Brazil	1	0	0
9	Bulgaria	1	0	1
10	Burkina Faso	1	0	0
11	Canada	0	1	0
12	Chile	1	0	0
13	China	1	0	0
14	Colombia	1	0	0
15	Croatia	1	0	0
16	Cyprus	1	0	1
17	Czech Republic	1	1	1
18	Denmark	1	1	1
19	Egypt, Arab Rep.	1	0	0
20	Estonia	1	0	1
21	Finland	1	1	1
22	France	1	1	1
23	Germany	1	1	1
24	Greece	1	1	1
25	Guatemala	1	0	0
26	Guinea	1	0	0
27	Honduras	1	0	0
28	Hungary	1	1	1
29	India	1	0	0
30	Iran, Islamic Rep.	1	0	0
31	Ireland	1	1	1
32	Israel	1	0	0
33	Italy	1	1	1
34	Japan	1	1	0
35	Kazakhstan	1	0	0
36	Korea, Rep.	1	1	0
37	Kyrgyz Republic	1	0	0

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No.	Country Name	UN	OECD	EUROSTAT
38	Latvia	1	0	1
39	Lithuania	1	0	1
40	Luxembourg	1	0	1
41	Malta	1	0	1
42	Mexico	1	0	0
43	Moldova	1	0	0
44	Morocco	1	0	0
45	Netherlands	1	1	1
46	Netherlands Antilles	1	0	0
47	Nicaragua	1	0	0
48	Niger	1	0	0
49	Norway	1	1	1
50	Poland	1	1	1
51	Portugal	1	1	1
52	Romania	1	0	1
53	Saudi Arabia	1	0	0
54	Serbia	1	0	0
55	Slovak Republic	1	1	1
56	Slovenia	1	0	1
57	South Africa	1	0	0
58	Spain	1	1	1
59	Sweden	1	1	1
60	Switzerland	1	1	1
61	Tunisia	1	0	0
62	Ukraine	1	0	0
63	United Kingdom	1	1	1
64	United States	1	1	0
	Total	62	25	29

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Appendix E: Table E1. 2007 Gross Fixed Capital Formation by institutional sector, in millions of USD

Gross Fixed Capital Formation, in millions of USD					
No.	Region/Country name	Corporate	Government	Household	Total
1	Australia	110,167	20,396	102,004	232,568
2	New Zealand	15,011	2,779	13,899	31,689
3	Rest of Oceania	3,481	645	3,211	7,337
4	China	959,748	158,432	305,052	1,423,233
5	Hong Kong	28,229	5,326	8,003	41,557
6	Japan	696,601	139,795	173,190	1,009,586
7	Korea	197,143	50,441	48,473	296,057
8	Mongolia	1,002	189	284	1,475
9	Taiwan	55,183	10,411	15,644	81,238
10	Rest of East Asia	8,071	1,523	2,288	11,881
11	Cambodia	992	215	498	1,705
12	Indonesia	61,519	13,355	30,898	105,772
13	Lao People's Democratic Republic	860	187	432	1,479
14	Malaysia	21,417	4,649	10,756	36,822
15	Philippines	12,485	2,710	6,270	21,465
16	Singapore	16,876	16,179	8,842	41,897
17	Thailand	36,234	7,866	18,198	62,298
18	Viet Nam	16,433	3,567	8,253	28,253
19	Rest of Southeast Asia	2,387	518	1,199	4,105
20	Bangladesh	9,342	2,277	5,595	17,213
21	India	226,794	60,728	136,746	424,268
22	Nepal	1,208	295	724	2,226
23	Pakistan	17,574	4,284	10,525	32,383
24	Sri Lanka	4,551	1,109	2,726	8,386
25	Rest of South Asia	2,051	500	1,228	3,779
26	Canada	178,784	43,362	107,350	329,496
27	United States of America	1,361,660	346,376	977,542	2,685,577
28	Mexico	131,709	21,189	66,154	219,053
29	Rest of North America	1,132	276	768	2,176
30	Argentina	39,047	7,533	15,286	61,866
31	Bolivia	969	1,131	195	2,295
32	Brazil	152,870	29,148	60,223	242,241
33	Chile	20,614	3,776	8,512	32,903
34	Colombia	29,168	5,297	10,786	45,250
35	Ecuador	6,355	1,226	2,488	10,069
36	Paraguay	1,372	265	537	2,174
37	Peru	14,648	2,826	5,734	23,208
38	Uruguay	2,779	536	1,088	4,402

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Gross Fixed Capital Formation, in millions of USD

No.	Region/Country name	Corporate	Government	Household	Total
39	Venezuela	35,502	6,849	13,898	56,249
40	Rest of South America	1,105	213	432	1,750
41	Costa Rica	3,360	746	1,082	5,188
42	Guatemala	3,487	1,137	1,829	6,453
43	Honduras	3,474	344	226	4,044
44	Nicaragua	1,034	271	474	1,779
45	Panama	3,663	813	1,179	5,655
46	El Salvador	1,253	1,202	657	3,112
47	Rest of Central America	163	36	52	251
48	Caribbean	41,468	1,738	3,108	46,314
49	Austria	59,044	4,082	18,418	81,544
50	Belgium	69,445	8,145	35,766	113,355
51	Cyprus	1,984	702	2,469	5,155
52	Czech Republic	28,730	6,931	9,223	44,885
53	Denmark	42,355	5,943	20,511	68,809
54	Estonia	5,028	1,143	1,865	8,036
55	Finland	29,636	6,352	19,552	55,540
56	France	297,156	88,143	184,106	569,405
57	Germany	368,891	50,057	204,684	623,633
58	Greece	20,135	8,720	39,922	68,777
59	Hungary	18,305	5,121	7,040	30,466
60	Ireland	20,216	10,845	28,046	59,107
61	Italy	244,323	49,630	164,087	458,039
62	Latvia	7,481	1,805	1,533	10,818
63	Lithuania	8,205	2,224	1,600	12,029
64	Luxembourg	10,155	2,589	3,538	16,283
65	Malta	920	341	686	1,947
66	Netherlands	73,048	26,246	58,770	158,064
67	Poland	55,237	18,817	23,349	97,403
68	Portugal	32,281	6,316	13,314	51,912
69	Slovakia	16,664	1,648	4,772	23,084
70	Slovenia	8,782	2,156	3,234	14,172
71	Spain	246,581	58,731	140,429	445,741
72	Sweden	62,081	14,507	16,011	92,600
73	United Kingdom	281,886	54,143	168,756	504,785
74	Switzerland	66,620	8,977	21,634	97,231
75	Norway	54,591	12,411	21,980	88,982
76	Rest of EFTA	3,985	851	2,213	7,049
77	Albania	1,854	400	1,028	3,282
78	Bulgaria	9,849	2,349	640	12,839

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Gross Fixed Capital Formation, in millions of USD					
No.	Region/Country name	Corporate	Government	Household	Total
79	Belarus	10,691	2,586	2,866	16,143
80	Croatia	11,181	2,395	2,870	16,446
81	Romania	38,064	9,593	3,455	51,113
82	Russian Federation	191,027	47,511	49,227	287,765
83	Ukraine	33,964	5,663	3,169	42,796
84	Rest of Eastern Europe	1,524	157	97	1,778
85	Rest of Europe	16,038	2,901	5,803	24,742
86	Kazakhstan	23,912	5,839	4,372	34,123
87	Kyrgyzstan	619	116	101	837
88	Rest of Former Soviet Union	4,358	1,057	794	6,209
89	Armenia	2,052	424	933	3,409
90	Azerbaijan	5,186	1,660	664	7,510
91	Georgia	2,141	645	114	2,901
92	Bahrain	4,178	1,259	223	5,659
93	Slovak Republic	46,133	5,684	26,694	78,511
94	Israel	28,416	3,039	425	31,880
95	Kuwait	16,665	5,020	890	22,576
96	Oman	9,680	2,916	517	13,113
97	Qatar	24,581	7,405	1,312	33,298
98	Saudi Arabia	53,901	21,717	717	76,335
99	Turkey	105,128	31,669	5,612	142,409
100	United Arab Emirates	48,146	14,504	2,570	65,219
101	Rest of Western Asia	20,461	6,164	1,092	27,717
102	Egypt	18,700	4,742	4,877	28,319
103	Morocco	14,601	2,288	8,303	25,191
104	Tunisia	4,574	1,474	2,638	8,686
105	Rest of North Africa	37,117	8,357	15,431	60,906
106	Cameroon	2,001	434	1,005	3,440
107	Cote d'Ivoire	772	740	405	1,917
108	Ghana	2,093	2,006	1,097	5,196
109	Nigeria	5,943	5,698	3,114	14,755
110	Senegal	2,094	455	1,052	3,600
111	Rest of Western Africa	2,225	1,850	1,238	5,313
112	Central Africa	7,342	1,594	3,688	12,623
113	South Central Africa	8,665	1,881	4,352	14,898
114	Ethiopia	2,627	570	1,320	4,517
115	Kenya	3,021	656	1,517	5,194
116	Madagascar	1,868	405	938	3,211
117	Malawi	513	111	257	881
118	Mauritius	1,014	220	509	1,744

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Gross Fixed Capital Formation, in millions of USD

No.	Region/Country name	Corporate	Government	Household	Total
119	Mozambique	670	145	336	1,152
120	Tanzania	2,892	628	1,453	4,973
121	Uganda	1,331	289	669	2,289
122	Zambia	1,605	348	806	2,759
123	Zimbabwe	667	145	335	1,146
124	Rest of Eastern Africa	7,423	1,678	4,677	13,779
125	Botswana	2,373	561	496	3,430
126	Namibia	1,535	363	321	2,218
127	South Africa	39,677	9,376	8,289	57,342
128	Rest of South African Customs Union	364	86	76	526
129	Rest of the World	15	3	13	31

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Glossary of Technical Terms

BEC-SNA	Concordance for trade data under the Broad Economic Categories by the end use specified by the System of National Accounts (SNA).
CGE	Computable General Equilibrium type of model.
HS-BEC	Concordance for trade data between the Harmonized System (HS) classification and the Broad Economic Categories (BEC). This is available for three different years (1996, 2002, and 2007).
IMP	Value of imports for the construction of GTAP-MRIO
MRIO	A multiregional input-output (MRIO) framework extends the traditional IO framework by distinguishing imports by country of origin as well as by end use. End uses may include both imported products used in the production of another product (also called intermediate use) as well as imports for final demands, including investment, government consumption and private demands.
VIFM	Data coefficient in the GTAP Data Base that accounts for firms' imports in region r, valued at market prices.
VIGM	Data coefficient in the GTAP Data Base that accounts for government's imports in region r, valued at market prices.
VILMS	Newly created coefficient for GTAP MRIO construction. Corresponds to a portion of VIMS that goes into final uses.
VIMS	Data coefficient in the GTAP Data Base that accounts for total imports i from region s to r, valued at market prices for GTAP commodities and regions.
VINMS	Newly created coefficient for GTAP MRIO construction. Corresponds to a portion of VIMS that goes into intermediate uses.
VIPM	Data coefficient in the GTAP Data Base that accounts for private households' imports in region r, valued at market prices.