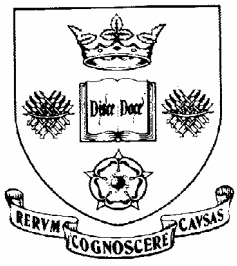
Sheffield Economic Research Paper Series

SERP Number: 2004009



Scott McDonald* and Yontem Sonmez

Augmenting the GTAP Database with Data on Inter-Regional Transactions

August 2004

* Corresponding author

Department of Economics
University of Sheffield
9 Mappin Street
Sheffield
S1 4DT
United Kingdom
www.shef.ac.uk/economics

Augmenting the GTAP Database with Data on Inter-Regional Transactions

Scott McDonald
and
Yontem Sonmez

Abstract

This paper reports the results of an exercise to augment the GTAP database with information from the income and current transfers components of the current account of the balance of payments. The exercise demonstrates that the process of augmenting the GTAP database is relatively straightforward. A simple simulation exercise using the augmented and non-augmented versions of the database demonstrates that the results from a trade liberalisation scenario are sufficiently large to provide a justification for the augmentation of the GTAP database over and above the case that could be argued based on national accounting conventions.

Keywords: Social Accounting Matrix, Trade Analysis, Computable General Equilibrium.

Correspondence Address:

Department of Economics, The University of Sheffield, 9 Mappin Street, Sheffield, S1 4DT, UK. tel: +44 114 2223407, email: s.mcdonald@sheffield.ac.uk or y.sonmez@sheffield.ac.uk

1. Introduction

The external accounts in the GTAP database record external transactions for goods and services – the 'External Account of Goods and Services' in the United Nations System of National Accounts (SNA) – and (implicitly) a series of 'balances' on the capital account. Strictly speaking however the 'balances' on the capital accounts are a combination of unaccounted for transactions on the current account – current transfers and primary incomes (the SNA's 'External account of primary income and current transfers') – and the capital account. In circumstances where the inter-regional transactions on the 'external account of primary income and current transfers' are substantial there is the potential for non-trivial distortions in the patterns of inter-regional economic relationships.

In this paper a method for augmenting the GTAP database using data on inter-regional transactions, which are readily available from published IMF sources, is developed and implemented. The data augmentation is implemented using a global social accounting matrix (SAM) representation of the GTAP database (see McDonald and Thierfelder, 2004), under the maintained assumption that the GTAP database contains a full accounting of the 'External account of goods and services'.

The first stage of the process is the elimination of the regional household account for each region, which is shown to be straightforward if data on government borrowings/savings are available. The main advantages of this approach are the specification of only three institutional accounts for each region – private household, government and capital account – and the identification of transactions between these institutions, i.e., net 'direct taxes' paid by the private household, and private household and government savings. In the second stage IMF data on inter-regional transactions are added to the database; the identified transactions include payments for factor services, household remittances and official transfers. The maintained assumption that there is a full accounting for the 'external account of goods and services' means that for each region the balance on the capital account (implicit) in the GTAP database requires adjustment using the net value of these additional transactions for that region, subject to the condition that the sum of these regional net values is zero. The final stage of the process is the development of a reduced form of the global SAM that restores the regional household accounts and is therefore consistent with the structure of version 5 of the GTAP database.

In order to illustrate the potential benefits from augmenting the GTAP database a simple policy experiment is implemented for two different regions using two variants of the database. The first region is a developing region where official transfers are a large component of government revenue, while the second region is a developed region where household income taxes are an important source of government revenue. The policy experiment is complete trade (import) liberalisation with a tax replacement scenario that holds the nominal value of government savings/borrowings constant. In the first version of the database the augmented SAMs are used while in the second variant of the database non-augmented SAMs are used. The results indicate that models estimated using this augmentation of the GTAP database may, under certain circumstances, produce substantially different results and hence may enhance the quality of the analysis.

The rest of the paper is organised as follows: The next section provides a brief overview of the external accounts of the System of National Accounts (SNA). In the third section a global SAM representation of the GTAP database is described, followed by a section that identifies the data and sources used to augment the global SAM and steps followed in the augmentation process. The fifth section reports the results of the simulations, and the final section contains some concluding comments about the strengths and weaknesses of the process adopted and some suggestions about ways forward.

2. The External Accounts of the System of National Accounts

The UN System of National Accounts (SNA), which is the international standard for the compilation of national accounts statistics, provides a comprehensive and detailed record of macroeconomic accounts, balance sheets and tables. The SNA includes information about the economic activities and the interaction of the economic agents and the sectors, about the productive assets of an economy and the wealth of its nationals. How the links between an economy and the rest of the world should be recorded are also included in the SNA; these are the external accounts of the SNA (see Chapter 14 of the SNA (UN, 1993)). Moreover there is a harmonisation and consistency between the UN SNA and the other international statistical standards, especially the balance of payments and government finance statistics of the International Monetary Fund (IMF). While the SNA was being revised, the IMF was also revising its Balance of Payments Manual; consequently, the definitions and the description of the concepts are often the same in the SNA and the Balance of Payments Manual of the IMF.

The balance of payments is a systematic representation of all economic transactions between residents and non-residents. The balance of payments is divided into three main sub-balances. These are

i) the Current Account;

ii) Capital and Financial Account; and

iii) Net Errors and Omissions.

The focus in this case is on the accounts dealing with goods and services, income and current transfers, i.e., the transactions and transfers that form the current account of the balance of payments (UN, 1993).

The current account balance is divided into four components: goods, services, income and current transfers. All transactions between resident and non-resident entities involving economic values and the offsets to current economic values provided are covered in the current account.

i) Classified under the "Goods" subtitle are general merchandise, goods for processing, repairs on goods, goods procured in ports by carriers and non-monetary gold.

ii) Classified under the "Services" subtitle are transportation, travel, communication services and construction services as well as the insurance and financial services; in addition, computer and information services, royalties and license fees, personal, cultural and recreational services, government services and other business services such as operational leasing services and merchanting are also classified under the title of services.

These are the components of the external account that are currently captured by the trade accounts of the GTAP database.

Since a SAM, by definition, is concerned with current transactions, which for the external accounts are the components captured by the current account, it is the missing two components of the current account that are of particular interest here.

The income account consists of two main components which are "compensation of employees" and "investment income".

i) Compensation of employees covers wages, salaries and various other benefits in cash or in kind. Benefits of boarder, seasonal and other non-resident workers are also included in this category.

ii) Investment income, on the other hand, covers receipts and payments of income associated with holdings of external financial assets by residents and with liabilities to non-residents. The three sub-components of the investment income are the direct investment income, portfolio investment income and other investment income.

Entries with respect to the income account therefore relate to transactions that take place between the primary and secondary distribution of income accounts and external accounts or more simply, in terms of the structure of the global SAM reported below, the factor and external accounts.

The current transfers account consists of transactions between institutional accounts, particularly between households, enterprises and governments.

i) General government transfers consist of current international cooperation between different governments (aid) and payments of current taxes on income and wealth.

ii) Household transfers consist primarily of workers' remittances.

iii) Other current transfers consist of premiums - less service charges - and claims on non-life insurance.

These inter-institutional account transactions may be particularly important to some economies, e.g., development assistance (aid) may be an important part of government income as in Uganda, while workers' remittances may be an important component of household income as was especially the case for Botswana until the middle 1990s.

An important distinction is between current transfers from capital transfers since these can be easily confused. The latter, which are included in the capital and financial account in accordance with the SNA treatment of transfers accounts (IMF Balance of Payments Yearbook, 2002), relate primarily to transactions that involve changes of ownership of assets. A SAM is concerned with current transactions and hence details about transactions on the Capital and Financial Accounts are out with the accounting remit of a SAM. However there are circumstances where information about asset ownership might be expected to interact with the current account, namely the impact of changes in asset ownership on investment income.

3. A Global Social Accounting Matrix and the GTAP Database

The starting point for this extension to the GTAP database is the global SAM representation of the GTAP data developed by McDonald and Thierfelder (2004). The structure of the global SAM is illustrated by a representative SAM for one region, which is given in Table 1; the

structure of the SAM for each and every region is identical.[1] In general terms the SAM structure follows the conventions of the System of National Accounts for 1993 (UN, 1993), with adjustments in light of the limited data on intra-institutional accounts.

SAM Transactions

The SAM reports six groups of agents that demand commodities (reading across the rows of the commodity accounts); activities, private households, government, investment, global transport services and other regions. These transactions take place at sellers' prices, which in GTAP terms are market prices. However, associated with each purchase by an agent there is an additional payment to the government that represents sales taxes. The SAM demonstrates that for imported commodities sellers prices are the prices received by the exporting region plus the per unit transport costs plus the per unit tariff rates (reading down the columns of the commodity accounts), while for domestically produced commodities sellers prices are the (producer) prices received by domestic activities; note how export taxes are recorded. Domestic producer prices are derived from the production costs, which are made up of the costs of intermediate inputs valued at sellers' prices plus the sales taxes paid on intermediate inputs, plus the factor use and production taxes and payments to primary inputs.

All income initially accrues to the regional household before being distributed to the private household, government and the capital account. Regional income is made up of payments to factors, net of factor income taxes and depreciation, plus indirect taxes, which are made up of trade, sales, factor use and production taxes, and income taxes. The artifice of a regional household means that the private household does not pay income taxes nor does it save, and the government neither saves nor borrows, i.e., the implicit balance on the government budget is zero.

[1] For a general description of a SAM see King, 1985; Sadoulet and de Janvry, 1995; Pyatt and Round, 1977; Pyatt, 1991; and Reinert and Roland-Holst, 1997.

Table 1 Transactions in the Social Accounting Matrix for a Representative Region

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
		Imported Commod	Domestic Commod	Activities	Factors	Regional Household	Private Household	Trade Taxes	Import Taxes	Sales Taxes	Domestic Sales Tax	Factor Taxes	Production Taxes	Direct Taxes	Govt	Capital	Import Margins	Export Margins	Rest of World
1	Imported Commodities			Intermediate Inputs			Private demand								Government demand	Investment demand			
2	Domestic Commodities			Intermediate inputs			Private demand								Government demand	Investment demand		Exports of Transport Services	Exports of Goods and Services
3	Activities		Supply matrix																
4	Factors			Payments to Factors															
5	Regional Household				Distributed Factor Incomes			Import Duties and Export duties	Import Taxes	Sales Taxes	Domestic Sales Taxes	Factor Taxes	Use Taxes	Production Taxes	Income Taxes				
6	Private Household					Private Household income													
7	Trade Taxes	Import Duties	Export duties																
8	Import Sales Taxes			Sales Taxes - Imports			Sales Taxes - Imports								Sales Taxes - Imports	Sales Taxes - Imports			
9	Domestic Sales Tax			Sales Taxes - Domestic			Sales Taxes - Domestic								Sales Taxes - Domestic	Sales Taxes - Domestic			
10	Factor Taxes			Factor Use Taxes															
11	Production Taxes			Production Taxes															
12	Direct Taxes				Factor Income Taxes														
13	Government					Government income													
14	Capital				Depreciation	Savings												Trade balance	Trade balance
15	Import Margins	Transport margins on imports																	
16	Export Margins																Imports of transport services		
17	Rest of World	Imports of Goods and Services																	

Trade consists of two elements; expenditures on commodities and expenditures on transport margins. Exports are valued 'free on board' and after the payment of any export duties. Exports of transport services to the global transport pool are recorded separately. Imports of commodities are also valued fob, with transport services recorded separately. The sum of the two represents expenditure on imports inclusive of carriage, insurance and freight (cif). Consequently, there are two sets of trade balances. The first represents the trade balance with respect to each of the transport services, while the second is the trade balance with each and every region on goods and services that are valued fob.

SAM Dimensions

The dimensions of the SAM are determined by accounts identified in the GTAP database, which has 57 sectors, 5 factors, 4 institutions and 78 regions. Hence the SAM has 114 commodity accounts (57 for imported and 57 for domestically produced commodities) and 57 activity accounts where production by each activity involves the use of up to 5 factors. Since each purchasing agent can be charged different purchase, or sales, tax rates for both imported and domestic commodities there are 114 accounts for sales taxes; each production activity can be charged factor specific taxes on factor use and an activity specific indirect/production tax, which requires another 6 accounts. Factors can also be charged a tax on factor incomes, which requires a single direct tax account.

Table 2 SAM Dimensions

Description	**Code**	**Base number**	**Multiples**	**Total**
Commodities	*c*	57	4	228
Activities	*a*	57	1	57
Factors	*f*	5	2	10
Regions	*k*	78	6	468
Margin Exports	*m*	3	1	3
Domestic Institutions and tax vectors	*i*	6	1	6
			Total	772

For trade relations, each region **can** import from and export to all other regions, hence there needs to be one account for each of 78 regions, and since all trade transactions can be taxed, import duties and export taxes, there needs to be 156 trade tax accounts. With three

types of transport margins associated with each trade transaction there needs to be three accounts for each region that a region **can** trade with to capture trade and transport costs (234 accounts); and three (3) accounts to capture exports by each region to the global trade and transport pool. Finally, there are four domestic institutional accounts: the regional household that gathers together all regional income, either from factor sales or taxes (indirect and direct). This income is dispersed to the other three domestic institutions, the private household, the government and the capital (savings and investment) account.

Consequently, the dimensions of the SAM can be defined in general terms by reference to the number of commodity accounts, *c*; activity accounts, *a*; factor accounts, *f*; domestic institutions and tax vectors, *i*; the number of trade and transport margin commodities, *m*; and the number of regions, *k*. These define the dimensions of the SAM as set out in Table 2.

The most immediately obvious points about the SAM are the large number of accounts and the relative scarcity of entries in the SAM. The large size of the SAM is primarily a consequence of the detailed treatment of trade relations in the database (471 out of 772 accounts excluding the separation of the accounts for domestic and imported commodities), with the major secondary reason being the series of commodity/user specific sales taxes on imports and domestic commodities.

The dimensions of the SAM indicate several very important features of the GTAP database.

- Information is concentrated in the trade accounts.
- The within regional information emphasises inter-industry and final demand transactions.
- The tax information relates overwhelmingly to indirect taxes on sales and purchases.
- The only detailed inter-regional transactions are those associated with commodity transactions, inclusive of trade and transport margins.
- There is very little information about domestic institutions other than for consumption.

It is these final two aspects of the database with which this exercise is concerned. Specifically, this extension to the database does two things: first, the regional household is eliminated to provide a richer specification of inter-institutional transactions within each region, and second, additional inter-regional transactions, other than commodity-based

transactions, are identified and quantified. For purposes of the illustrative examples reported later in the paper the reduced form of the SAM, i.e., the form with a regional household, is NOT used, but a brief description of how that reduced form can be generated is included in both the text and the associated GAMS code.[2]

SAM Augmentation

The augmented SAM for a representative region is presented in Table 3. The two most obvious differences between Tables 1 and 3 are the elimination of the regional household account and the inclusion of an additional account called globe. The inclusion of the 'globe' account is required because the data on inter-regional transactions/transfers does not provide a full accounting of the transactions between **each and every** region, but only defines the 'inflows' to and 'outflows' from **each** region (see below for further detail about the data). Hence the globe account is an accounting construct; the income to the globe account is the accumulation of all the outflows from **every** region and its expenditures are the inflows to **every** region – by definition these are equal. Notice however that the total value of recorded inflows and outflows for **each** region are not necessarily equal, with the net inflow/outflow being recorded - the 'balance on transfers' - as an income to the region's capital (savings) account. In essence, this approach is identical to that taken in the GTAP database for recording the export and import of trade and transport services for which full bi-lateral transaction data are absent; as such it is a pragmatic solution to a problem presented by suboptimal information.

[2] It may sound odd that the reduced form of the SAM has one more account than the extensive form, but the terminology derives from the fact that the reduced form can be derived from the information in the extensive form but the extensive form cannot be derived from the information in the reduced form.

Table 3 Transactions in an Augmented Social Accounting Matrix for a Representative Region

		1	2	3	4	6	7	8	9	10	11	12	13	14	15	16	17	18
		Imported Commod	Domestic Commod	Activities	Factors	Household	Trade Taxes	Import Taxes	Sales Domestic Sales Tax	Factor Taxes	Production Taxes	Direct Taxes	Govt	Capital	Import Margins	Export Margins	Rest of World	Globe
1	Imported Commodities			Intermediate Inputs		Private demand							Government demand	Investment demand				
2	Domestic Commodities			Intermediate inputs		Private demand							Government demand	Investment demand		Exports of Transport Services	Exports of Goods and Services	
3	Activities		Supply matrix															
4	Factors			Payments to Factors														Factor Payments from Globe
6	Household				Distributed Factor Incomes													Remittances from Globe
7	Trade Taxes	Import Duties	Export duties															
8	Import Sales Taxes			Sales Taxes - Imports		Sales Taxes - Imports							Sales Taxes - Imports	Sales Taxes - Imports				
9	Domestic Sales Tax			Sales Taxes - Domestic		Sales Taxes - Domestic							Sales Taxes - Domestic	Sales Taxes - Domestic				
10	Factor Taxes			Factor Use Taxes														
11	Production Taxes			Production Taxes														
12	Direct Taxes				Factor Income Taxes	Household Income Taxes												
13	Government						Import Duties and Export duties	Import Taxes	Sales Domestic Taxes	Sales Factor Taxes	Use Production Taxes	Income Taxes						Transfers from Globe
14	Capital				Depreciation	Household Savings							Government Savings			Trade balance	Trade balance	Balance on Transfers
15	Import Margins	Transport margins on imports																
16	Export Margins														Imports of transport services			
17	Rest of World	Imports of Goods and Services																
18	Globe				Factor Payments to Globe	Remittances to Globe							Transfers to Globe					

One important consequence is that the interpretation of the trade balances for commodities and margin services needs refining. In the GTAP database the implicit trade balances are defined in terms of trade in goods and services – using standard cif and fob valuations for imports and exports respectively – without reference to other current and capital account transactions by regions. Consequently, the trade balances in Table 1 do not relate directly to the definitions of current account balances in the national accounts because a number of components of the current account have been omitted.[3]

4. Using IMF Data to Augment the GTAP Database

In line with the principles underlying the System of Nation Accounts (SNA) (UN, 1993) (see above) only transactions and transfers that are part of the current account of the balance of payments were considered since these are the accounts dealing with goods and services, income and current transfers. Moreover, since transactions in goods and services are already covered by the GTAP data on trade, the focus of attention here is on the income and current transfers components of the current account.

Table 4 Components of Income and Current Transfers

		Credit IMF Code	**Debit IMF Code**
Income	Compensation of Employees	2310	3310
	Investment Income	2320	3320
Current Transfers	General Government	2380	3380
	Workers Remittances	2391	3391
	Other Current Transfers	2392	3392

Data Sources

In addition to the GTAP database, data from IMF Balance of Payment (BOP) Statistics, IMF Government Finance Statistics and IMF Gross Domestic Product (GDP) Statistics for the years 1996, 1997 and 1998 were used.

[3] How of if these data omission have been absorbed into the intra-regional transactions data is not known. However, it is assumed below that they have absorbed into the intra-regional NOT intra-regional data, which leaves unaddressed any issues relating to potential distortions of the intra-regional transactions data.

The income section of the current account in the IMF BOP statistics provides the data on "compensation of employees" and "investment income", and the current transfers section provides the data on "general government transfers", "workers' remittances" and "other current transfers". The code numbers for credits and debits used in the IMF's BOP statistics are reported in Table 4 to facilitate replication. The data on "government surpluses/deficits" are from IMF Government Finance Statistics Yearbook 2001 while the data on "gross domestic product" is from the IMF World Economic Outlook database.[4]

The data on "government surpluses/deficits" were collected in national currencies, which using the reported exchange rates, were converted into US dollars, although the actual estimates used in the SAM augmentation process were expressed as shares of the gross domestic product. The data in the IMF BOP Balance of Payments, on the other hand, were in US dollars so no modifications are necessary rather than scaling. The IMF data are reported for individual countries, which require aggregation to form estimates for the GTAP regions. Therefore, the BOP data on individual IMF countries are mapped onto the GTAP regions and aggregated using a simple GAMS aggregation programme. The mappings are reported in Appendix Table A1.

SAM Augmentation

Given the principles underlying the SNA and the existing data in the GTAP database the process of augmenting the SAM is relatively straightforward and only requires two substantive decisions; first, to which of the SAM accounts should each component of the income and current transfers of the current account be allocated, and second how can the internal balance, i.e., the governments savings or deficit, be estimated so as to reverse the reduced form of the GTAP data based SAM.

Table 5 defines the SAM accounts to which each unallocated component of the current account is allocated. These are relatively unarguable given the accounts, except for the components of income for which two new accounts were created – overseas labour and overseas capital. This is an artifice adopted to avoid a difficult allocation problem that cannot be readily resolved using the IMF data; namely the GTAP database includes two types of labour – skilled and unskilled – while there is only one class of employees in the IMF data, and similarly land capital as well as physical capital could also be a source of investment income. Clearly, this aspect of the augmentation process would benefit from greater

[4] From website (http://www.imf.org/external/pubs/ft/weo/2003/02/data/dbcselm.cfm?G=0&Error=1)

information relating to current account; in the meantime the decision is left to the discretion of the modeller how to allocate overseas labour and capital between the factor accounts in the model. Moreover, it does not create a problem for balancing the SAM because there is only one non-government domestic institution that receives distributed factor incomes.

Table 5 Allocation of Income and Current Transfers to SAM Accounts

		SAM Account
Income	Compensation of Employees	Overseas Labour
	Investment Income	Overseas Capital
Current Transfers	General Government	Government
	Workers Remittances	Household
	Other current Transfers	Household

More difficult however is the issue of how to generate the extended form of the SAM. In essence, the problem is one of estimating *n* unknowns from (*n* - 3) equations for each regions in the GTAP data; hence, it requires three pieces of exogenous information for each regions to determine three of the unknowns and mathematically, it does matter which of the unknowns is fixed exogenously. In this case, one set of exogenous information is used to determine the internal balances for each region and two assumptions are made. The assumptions are that the household receives no transfer income from the government and that all distributed factor incomes accrue to the household in each region and; both have implications for the estimate of household income tax payments. The first assumption means that household income tax payments are defined as net of government transfers to the household, while the second means that household income tax payments are defined gross of any government factor incomes. While the former assumption is probably acceptable the latter is more questionable, since it has ramifications beyond the domestic institutional accounts and into the functional distribution of income.[5]

The data for the exogenous information were obtained from the IMF data base in terms of the IMF estimates of aggregate GDP and aggregate government surplus/deficit; these were combined to provide estimates of the government surplus/deficit as a share of GDP, both for

[5] One specific issue arises from the absence of an account for incorporated business enterprises; the implicit presumption in this case is that an incorporated business enterprise account has been merged with the household account and that doing so does not introduce a substantive distortion into the functional distribution of income.

1997 and for the three year average of 1996 to 1998. However, since the IMF data is not available in an aggregated form for the GTAP regions, all the data were collected for all countries in the IMF database and these countries were mapped onto the GTAP regions and aggregated using a simple GAMS aggregation programme (see Appendix Table A1 for the mappings).[6]

Inter Regional Transactions/Transfers

Because full bilateral details on inter-regional transactions/transfers are not reported in the balance of payments statistics the solution adopted in the GTAP database for trade and transport margin services was adapted to the allocation of inter-regional transactions; a new region – called GLOBE – was added to the database. Globe was defined as the recipient of all transaction/transfer expenditures and the source of all transaction/transfer incomes, which, in the absence of transaction costs, means that Globe's balance on income and current transfer transactions would be zero by definition. However, if the credit and debit data reported in the balance of payments statistics are used without adjustment Globe's balance on income and current transfer transactions would not be zero; to overcome this the expenditures (debits) reported in the trade statistics were assumed to be correct and the incomes (credits) were adjusted to balance Globe's accounts under the assumption that the reported credits were proportionately accurate across regions, hence the total payments by each category of expenditure (income) to Globe were equal to the total payments made by Globe under each category.

Components of Income

Investment income (II) debits (IIout) by all regions (kk) in a period (t) were paid to the overseas capital account (fOcapital) in the Globe's trade account (wwglo) for all regions, i.e.,

```
SAMG("wwglo","fOscapital",kk)  = IIout(kk,t) ;
```

And investment income credits (IIin) for all regions in a period (*t*) were paid to the overseas capital account by the Globe's trade account for all regions as regions and time specific shares (IIinSh1) of the total investment income debits by all regions, i.e.,

```
SAMG("fOscapital","wwglo",kk) = (IIinSh1(kk,t)*SUM(kkp,Iiout(kkp,t)));
```

where the shares were defined as the ratios of investment income credits in the global total of investment credits.

[6] This mapping was used for all the IMF data.

Similarly, compensation of employees (CE) debits (CEout) by all regions (kk) in a period (t) were paid to the overseas labour account (fOsLab) in the Globe's trade account (wwglo) for all regions, i.e.,

```
SAMG("wwglo","fOsLab",kk)  = CEout(kk,) ;
```

And compensation of employees credits (CEin) for all regions in a period were paid to the overseas labour account by the Globe's trade account for all regions as region and time specific shares (CEinSh1) of the total compensation of employees debits by all regions, i.e.,

```
SAMG("fOsLab","wwglo",kk) = (CEinSh1(kk,t) * SUM(kkp,CEout(kkp,t))) ;
```

where the shares were defined as the ratios of compensation of employees credits in the global total of compensation of employees credits.

Components of Current Transfers

Remittances by households consist of worker remittances (WRout) and Other Current Transfers (OCTout) debits by all regions (kk) in a period (t) that were paid to the household account (hhous) in the Globe's trade account (wwglo) for all regions, i.e.,

```
SAMG("wwglo","hhous",kk)  = WRout(kk,t) + OCTout(kk,t) ;
```

And remittances to households of worker remittances (WRin) and Other Current Transfers (OCTin) were paid to the household account by the Globe's trade account for all regions as region and time specific shares (WRinSh1 and OCTinSh1) of the total worker remittances and Other Current Transfer debits by all regions, i.e.,

```
SAMG("hhous","wwglo",kk) = (WRinSh1(kk,t) * SUM(kkp,WRout(kkp,t)))
                         + (OCTinSh1(kk,t) * SUM(kkp,OCTout(kkp,t))) ;
```

where the shares were defined as the ratios of worker remittances and Other Current Transfer credits in the global total of worker remittances and Other Current Transfer credits.

And finally, for current transfers by governments (GT) debits (GTout) by all regions (kk) in a period (t) were paid to the government account (ggvot) in the Globe's trade account (wwglo) for all regions, i.e.,

```
SAMG("wwglo","ggovt",kk)  = GTout(kk,t) ;
```

And current transfer credits by governments (GTin) were paid to the government account by the Globe's trade account for all regions as region and time specific shares (GTinSh1) of the current transfers by government credits by all regions, i.e.,

```
SAMG("ggovt","wwglo",kk) = (GTinSh1(kk,t) * SUM(kkp,GTout(kkp,t))) ;
```

where the shares were defined as the ratios of current transfer credits by government in the global total of current transfer credits by government.

Given these transactions between the Globe account and each region, it is straightforward to compute the transactions balance, with Globe (TRANSTRADBAL(kk)), on the income and current transfer components of the current account for each region as the difference between credits and debits, i.e.,

```
TRANSTRADBAL(kk)   = SUM(ff,SAMG("wwglo",ff,kk))
                       + SAMG("wwglo","hhous",kk)
                       + SAMG("wwglo","ggovt",kk)
                         - SUM(ff,SAMG(ff,"wwglo",kk))
                         - SAMG("hhous","wwglo",kk)
                         - SAMG("ggovt","wwglo",kk) ;
```

such that the sum of the transactions balance is defined as equal to zero.

This approach has the distinct advantage of leaving the other trade balances, i.e., those between regions with respect to imports and exports of commodities valued fob and between the imports and exports of trade and transport margin services, unaffected. This means that the sum of these trade balances for each region should equal the sum of the balances on the current account for goods and services. Hence, the data augmentation specifically addresses the omission of two components of the current account and thereby provides a more precise accounting for the contribution of other regions to the funds used for investment in each region.

Internal Balance

The estimation of the internal balance (government savings/deficit) is straightforward. Given an exogenous estimate of the magnitudes of the internal balances relative to GDPs (GSAVSh2) for each region (kk), the level of the internal balance (GSAVGTAP) – government (ggovt) savings (kkap) - can be estimated as those ratios times the levels of GDP calculated from the GTAP database (GTAPGDP), i.e.,

```
SAMG("kkap","ggovt",kk) = GSAVGTAP(kk) = GSAVSh2(kk) * GTAPGDP(kk);
```

This leaves only household savings unaccounted for in each region.

Rebalancing the SAM

Completing the augmented SAM is now simply a matter of completing the accounting identities. Total investment expenditures (INVEST) are unaffected by the data augmentation

process, as is the value of depreciation (kkap,ff), so total savings are known and the missing component – household (hhous) savings (kkap) – can be computed as a residual, i.e.,

```
SAMG("kkap","hhous",kk)  = INVEST(kk)
                         - SUM(ff,SAMG("kkap",ff,kk))
                         - GSAVGTAP(kk)
                         - SUM(ww,COMTRADBAL(ww,kk))
                         - SUM(vsttmarg,MARGTRADBAL(vsttmarg,kk))
                         - SAMG("kkap","wwglo",kk) ;
```

This closes the capital account.

Household incomes for each region (kk) are defined as distributed factor incomes (DISTFACTY) plus remittances from the rest of the world (hhous,kkap). Since factor incomes (f,total) are known – domestic payments to factors plus factor payments from the rest of the world, all other factor expenditures are known – factor income taxes (fftax,ff), depreciation (kkap,ff) and factor payments to the rest of the world (wwglo,ff), distributed factor incomes can be computed as

```
DISTFACTY(ff,kk)          = SAMG(ff,"ttotal",kk)
                            - SUM(fftax,SAMG(fftax,ff,kk))
                            - SAMG("kkap",ff,kk)
                            - SAMG("wwglo",ff,kk) ;
```

which means that household income can be computed as

```
YHGTAP(kk) = (SUM(ff,DISTFACTY(ff,kk)) + SAMG("hhous","wwglo",kk)) ;
```

Since all items of household expenditure other than (net) household income taxes (ddirtax,hhous) are also known, tax payments can be computed as a residual, i.e.,

```
SAMG("ddirtax","hhous",kk)  = YHGTAP(kk)
                              - SUM(mcc,SAMG(mcc,"hhous",kk))
                              - SUM(dcc,SAMG(dcc,"hhous",kk))
                              - SUM(smmtax,SAMG(smmtax,"hhous",kk))
                              - SUM(sddtax,SAMG(sddtax,"hhous",kk))
                              - SAMG("kkap","hhous",kk)
                              - SAMG("wwglo","hhous",kk)  ;
```

where mcc and dcc are the sets of imported and domestic commodities respectively, smmtax and sddtax the sets of purchase taxes on imported and domestic commodities respectively, and the remaining items are household savings (kkap,hhous) and household remittances to the rest of the world (wwglo,hhous). This closes the household account.

All that remains is to close the government account. Provided there have been no errors elsewhere this simply requires that the tax incomes that accrued to the regional household in the global GTAP SAM are reallocated as incomes to the government account and that an entry is made so that household income tax revenues are paid to the government account. The satisfaction of the SAM requirement for completeness and consistency is sufficient to ensure that the government accounts are all correctly balanced.

Reduced Form Augmented SAM

The creation of reduced form augmented global SAM is straightforward. Payments to and from the household and government accounts for a region are aggregated and treated as payments to and from the regional households. Distributed factor incomes are reclassified as payments to the regional households. Household income taxes and savings and government savings are set equal to zero, and all the remaining tax revenues are treated as incomes to the regional households. Payments by the regional households to the private household, government and capital accounts are then defined as residual entries that balance those accounts. Since this process involves the (irreversible) elimination of information from the SAM, the resultant SAM is a reduced form by definition.

5. Simulations Using the Augmented Data

The simulations using the augmented SAM are carried out in a single country CGE model that uses only the data for two regions; by using a simple single country model it is easier to see how the simulation results are influenced by the data augmentation. The countries chosen are Uganda and Australia because they illustrate different aspects of the augmentation effects; in the case of Uganda it is the high dependence of the government on transfers as an income source, while in Australia it is the low dependence of the government on import duties as a revenue source.

The policy experiment in both cases is (broadly) the same; a scenario in which trade liberalised, via a 100 percent reduction in import duties, with tax replacement achieved via direct (income) taxes on the household. The SAMs used to calibrate the models have 10 sectors, 3 factors and one Rest of the World (trade) account (see Appendix Table A2 for a list

of the accounts). The model closure rules were standard: for the trade account the small country assumption was chosen with flexible exchange rates; for the investment/capital account the household savings rate was fixed; the internal balance was fixed and the direct/income tax rate on the household was variable; and the CPI was the numéraire. Models for both regions were run under the assumption of full employment of the three factors with full inter-sectoral factor mobility, and in addition, for Uganda, the models were also run with the assumption of a perfectly elastic supply of labour at a fixed wage rate.[7]

Two SAMs were generated for each region. In the first, the augmented SAMs for each regions, i.e., with all the additional inter-regional transfers data, were used, while for the second set of SAMs the inter-regional transfers data were omitted BUT the estimated internal balances for each region were included. The intention was to limit the differences between the SAMs used to calibrate the models, hence the base case SAMs do contain more inter-institutional information than in the GTAP database. The models for both regions were run using identical elasticities. The reasoning for these decisions was simple; to minimise the extent to which differences in the results were due to factors other than the additional inter-regional transfers data. The results are presented in Table 6; they are deliberately limited.

The results for Australia suggest that augmenting the database with additional information on inter-regional flows makes little or no difference to the simulation results. The only effects that are appreciably different are those relating to investment, and even those differ by only a small amount. Such results are relatively unsurprising; the inter-regional flows are not a substantive factor in the operation of the Australian economy and income taxes form a large part of government income.

[7] Full documentation of the models are available form the authors.

Table 6 Simulation Results

	Uganda					**Australia**		
Variable	Base Level	Inter Regional Transfers		Inter Regional Transfers		Base Level	Inter Regional Transfers	
		Without	With	Without	With		Without	With
	$ '00 m	Full employment		Unemployment		$ '00 m	Full employment	
		% Change		% Change			% Change	
Macroeconomic Results								
GDP Value Added	67.39	1.15	1.14	4.01	4.04	3,736.12	0.83	0.83
Exchange Rate	1.00	4.67	4.39	4.79	4.67	1.00	1.63	1.59
Investment Value	10.20	1.32	-0.88	3.42	2.56	861.91	-0.03	0.18
Government Income	6.52	1.00	0.93	1.12	1.09	720.95	0.54	0.54
PPI	1.00	0.08	0.08	0.19	0.19	1.00	0.23	0.23
Investment Volume	1.00	2.64	0.50	4.41	3.58	1.00	0.32	0.54
Income Tax Adjustment	1.00	20.98	-75.00	17.21	-72.51	1.00	8.50	8.38
Export Tax Revenue	0.01	26.69	24.47	24.22	23.26	-7.56	4.26	4.11
Income Tax Revenue	-1.03	22.41	-74.70	21.95	-71.39	345.34	9.43	9.32
Household								
Disposable Income	55.07	-0.39	0.04	2.72	2.93	2,404.39	-0.06	-0.07
Factor Prices								
Land	1.00	1.21	1.33	2.59	2.66	1.00	2.14	2.08
Labour	1.00	1.17	1.20	0.00	0.00	1.00	0.80	0.80
Capital	1.00	1.18	1.10	2.79	2.77	1.00	0.86	0.86

Source: Authors' calculations

The results for Uganda are more pronounced, not only are the impacts relatively larger they are also characterised by greater diversity between those in the models with and without inter-regional transfers. The most striking results are those for the tax rate changes. In part these reflect the low yield on income tax, indeed households are net recipients, and in part the high dependence of the Ugandan government's income on inter-regional transfers. With the exception of GDP and the investment variables the unemployment closure makes little difference to the macroeconomic results, although the unemployment closure clearly has substantial effects on factor prices.

6. Concluding Comments

This exercise has demonstrated several things. First, that by using data that are readily available in IMF publications, it is relatively simple to augment the GTAP database so as to provide an arguably better representation of the external accounts for regions in the GTAP database. The extent to which this is judged to be a better representation clearly depends upon the views held about the necessary assumptions used in the augmentation process. And second, it has been shown that the augmented database is likely to produce non-trivial differences in the estimated impacts of policy experiments; even if this was not the case the exercise is arguably worthwhile if only to protect GTAP based analyses from being criticised for the treatment of the external accounts of regions.

The augmentation process does raise a number of concerns.

i) The assumption that the accounting for trade in goods and services within the GTAP database was completely accurate seems innocuous, but it requires assuming that the effects of the other (missing) components of the external account have been absorbed in the intra-regional accounts, by making the implicit presumption that all the adjustment takes place through the capital account. It thereby avoids addressing a potentially fundamental concern as to whether the previous treatment caused distortions in the GTAP database.

ii) The assumption that the incorporated business enterprises could be collapsed into the private household account is often made. But it does require an assumption that such a collapsing of the database has no

impact upon the functional distribution of income, e.g., for a model with fixed savings for non government domestic institutions it requires the implicit presumption that the enterprise and household savings rates are the same, while for a tax replacement policy where income taxes are variable the proportion changes in the private household and enterprise tax rates must be identical.

iii) The imbalance between credits and debits in the IMF data are to be expected and it is arguable how they should be handled. One strong argument is that the data should be collected for each region and then in the final balancing process for the global database the external accounts should be reconciled by imposing the constraint that the global sums of the value of credits and debits for each category of the external account should equal zero. This was not the option chosen here.

On the other had the exercise does have merits.

i) It demonstrates that the process is relatively straightforward, and that there may be non trivial benefits.

ii) It highlights the extent to which (a) governments are running surpluses/deficits on their internal balance; (b) governments rely on income taxes for revenue, (c) governments are net recipients of transfers, (d) households incomes are affected by remittances, and (e) factor incomes are generated domestically or in other regions.

iii) It raises the issue of the appropriate choice of institutional accounts, this has ramifications for both how the functional distribution of income is represented within the GTAP database and the range of model closure conditions that can be realised using the GTAP database.

The exercise also stimulates some suggestions abut future developments. These are made in no order of priority.

i) These results generated here suggest that there would the potential for non trivial improvements in the GTAP database if the income and

current transfer components of the current account were incorporated into the GTAP database. Ideally, this would be done prior to final balancing as this would allow for an, arguably, better treatment of the differences between credit and debit totals in the IMF data. Further into the future a full bilateral mapping of intra-institutional transactions would be desirable but the use of a 'globe' account would represent an important first step.

ii) Dropping the Regional Household artefact from the GTAP database would have major advantages. First, it would make it easier to reconcile the intra-regional data with the national accounts of regions. Second, provide additional information on inter-institutional within regions. And third, it would ease the augmentation of the GTAP database with additional external account data by providing more detail on inter-regional intra-institutional transactions. All these benefits would be achievable without needing to change the GTAP model since the adjustment of the resulting extensive form of database to a reduced form with a regional household for each region would require trivial adjustments to the model's calibration code.

iii) Extending the institutional accounts to include an account for incorporated business enterprises would also have some benefits. First, it would make it easier to reconcile the intra-regional data with the national accounts of regions. And second, it would provide a more detailed picture of the functional distribution of income. Again there would be no need to change the GTAP model.

References

McDonald, S. and Thierfelder, K., (2004). 'Deriving a Global Social Accounting Matrix from GTAP version 5 Data', *Sheffield Economics Research Paper 2004002*.

Hertel, T.W., (1997). *Global Trade Analysis: Modeling and Applications*. Cambridge: Cambridge University Press.

King, B.B., (1985). 'What is a SAM?', in Pyatt, G. and Round, J.I. (ed), Social Accounting Matrices: A Basis for Planning. Washington: World Bank.

Pyatt, G. and Round, J.I., (1977). 'Social Accounting Matrices for Development Planning', Review of Income and Wealth, Vol 23, pp 339-364.

Pyatt, G., (1991). 'Fundamentals of Social Accounting', Economic Systems Research, Vol 3, pp 315-341.

Reinert, K.A. and Roland-Holst, D.W., (1977). 'Social Accounting Matrices' in Francois, J.F. and Reinert, K.A., (eds) *Applied Methods for Trade Policy Analysis: A Handbook*. Cambridge University Press: Cambridge

Sadoulet, E. and de Janvry, A., (1995). *Quantitative Development Policy Analysis*. John Hopkins University Press: Baltimore. Chap 10.

UN, (1993). *System of National Accounts*. UN: New York.

Appendix

Table A1 Mapping of (IMF) Countries to GTAP Regions

Countries (3 digit codes)	GTAP Region	Countries (3 digit codes)	GTAP Region	Countries (3 digit codes)	GTAP Region	Countries (3 digit codes)	GTAP Region	Countries (3 digit codes)	GTAP Region
abw	xcm	com	xss	hnd	xcm	mkd	xrw	sgp	sgp
afg	xrw	cpv	xss	hrv	xrw	mli	xss	slb	xrw
ago	xsf	cri	xcm	hti	xcm	mlt	xrw	sle	xss
aia	xcm	cub	xcm	hun	hun	mmr	xrw	slv	xcm
alb	xrw	cym	xcm	idn	idn	mng	xrw	smr	xrw
and	xrw	cyp	xrw	ind	ind	mnp	usa	som	xss
ant	xcm	cze	xce	irl	irl	moz	moz	stp	xss
are	xme	deu	deu	irn	xme	mrt	xss	sur	xsm
arg	arg	dji	xss	irq	xme	mtq	fra	svk	xce
arm	xsu	dma	xcm	isl	xef	mus	xsf	svn	xce
asm	usa	dnk	dnk	isr	xme	mwi	mwi	swe	swe
atg	xcm	dom	xcm	ita	ita	mys	mys	swz	xsc
aus	aus	dza	xnf	jam	xcm	myt	xss	syc	xss
aut	aut	ecu	xap	jor	xme	nam	xsc	syr	xme
aze	xsu	egy	xnf	jpn	jpn	ncl	xrw	tcd	xss
bdi	xss	eri	xss	kaz	xsu	ner	xss	tgo	xss
bel	bel	esp	esp	ken	xss	nga	xss	tha	tha
ben	xss	est	xsu	kgz	xsu	nic	xcm	tjk	xsu
bfa	xss	eth	xss	khm	xrw	nld	nld	tkm	xsu
bgd	bgd	fin	fin	kir	xrw	nor	xef	ton	xrw
bgr	xce	fji	xrw	kna	xcm	npl	xsa	tto	xcm
bhr	xme	fra	fra	kor	kor	nru	xrw	tun	xnf
bhs	xcm	fro	xrw	kwt	xme	nzl	nzl	tur	tur
bih	xrw	fsm	xrw	lao	xrw	omn	xme	tuv	xrw
blr	xsu	gab	xss	lbn	xme	pak	xsa	twn	twn
blz	xcm	gbr	gbr	lbr	xss	pan	xcm	tza	tza
bmu	xrw	geo	xsu	lby	xnf	per	per	uga	uga
bol	xap	gha	xss	lca	xcm	phl	phl	ukr	xsu

bra	bra	gib	xrw	lie	xef	png	xrw	ury	ury
brb	xcm	gin	xss	lka	lka	pol	pol	usa	usa
brn	xrw	glp	xrw	lso	xsc	prk	xrw	uzb	xsu
btn	xsa	gmb	xss	ltu	xsu	prt	prt	vct	xcm
bwa	bwa	gnb	xss	lux	lux	pry	xsm	ven	ven
caf	xss	gnq	xss	lva	xsu	pyf	xrw	vgb	xcm
can	can	grc	grc	mac	xrw	qat	xme	vnm	vnm
che	che	grd	xcm	mar	mar	reu	fra	vut	xrw
chl	chl	grl	xrw	mco	xrw	rom	xce	wsm	xrw
chn	chn	gtm	xcm	mda	xsu	rus	xsu	yem	xme
civ	xss	guf	fra	mdg	xss	rwa	xss	yug	xrw
cmr	xss	gum	usa	mdv	xsa	sau	xme	zaf	xsc
cog	xss	guy	xsm	mex	mex	sdn	xss	zar	xss
col	col	hkg	hkg	mhl	xrw	sen	xss	zmb	zmb
								zwe	zwe

Table A2 Social Accounting Matrix Accounts for the Models

Commodity Accounts	
cagric	Agriculture
cmine	Fuels & Minerals
cfood	Food Products
ctex	Textiles
chman	Heavy Manufacturing
clman	Light Manufacturing
cutil	Utilities
ccns	Construction
ctrad	Trade
cserv	Services
Activity Accounts	
aagric	Agriculture
amine	Fuels & Minerals
afood	Food Products
atex	Textiles
ahman	Heavy Manufacturing
alman	Light Manufacturing
autil	Utilities
acns	Construction
atrad	Trade
aserv	Services
Factor Accounts	
fLand	Land
fLab	Lab
fCap	Capital
Household Accounts	
HOUS	Household
Government and Tax Accounts	

imptax	Import duties
exptax	Export duties
saltax	Sales taxes
prodtax	Production Taxes
dirtax	Direct Taxes
govt	Government
Capital Account	
KAP	Capital
Trade Account	
row	Rest of the World