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This paper is from the
GTAP Annual Conference on Global Economic Analysis
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Global Value Chains and the Cost of Protection:
Insights from the New OECD Trade Model

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Abstract

This paper outlines the development of the OECD Trade Model. It describes the base model, GLOBE, and key points of departure. The major structural change is in the modelling of trade flows. Based on OECD data, the OECD Trade Model differentiates import and export markets by commodity, source, destination and four end users: intermediates, household, government and capital. A simulation is then conducted to illustrate the insights the new modelling structure provides, especially with respect to model trade along global value chains.

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***** This work should not be reported as representing the official views of the OECD or of its member countries. The opinions expressed and arguments employed are those of the authors.

I. INTRODUCTION

One of the dominate trends in international trade today is the rise of global value chains (GVCs). The term GVC is a generalisation of the trend of increasing fragmentation over the entire value-creating process along geographic lines. While firms have always engaged in fragmentation- including overseas - in an effort to minimise costs, the past ten years, for a number of reasons, has seen an acceleration in this trend. Understanding how this trend has the potential to affect economic outcomes across the board is essential for a policy development that can address this new trade reality.

To support this analysis, trade models need to incorporate these new trade, production and investment realities to provide the necessary insights. The possibility to better reflect GVC activity in a CGE framework is strongly influenced by the development of new databases, which make it possible to differentiate trade flows by end use. To depict GVCs it is not only necessary to trace bilateral flows of goods and services, i.e. by country of origin and by country of destination, but to distinguish trade flows by type of use, i.e. intermediate input, final consumption and capital goods. The information on use categories allows, for example, the derivation of value added by the origin of intermediate inputs, and thus an improved analysis of the effects of policy measures in a world of GVCs.

Walmsley et al. (2013) and ongoing work at the USITC (e.g. Koopman et al. 2012) both model GVCs based on augmented versions of the GTAP model that include additional modules like export processing zones and the allocation of bilateral trade flows directly to the end user. This allocation of bilateral trade flows by final uses can be based on several methods, usually applying the UN BEC (Broad Economic Categories) classification.[1]

Under a joint initiative with the WTO, the OECD has recently developed a database of indicators based on trade in value-added (TiVA) [2]. This database, and the underlying estimation procedures employed, gives the possibility to obtain more detail in end use categories. In addition, extensive work by the OECD in collecting services trade data allows for the extraction of this detailed information on services sectors as well.[3]

This paper describes the development of a new trade model at the OECD and its underlying data base. The OECD trade model is an augmented version of the Social Accounting Matrix (SAM) based

[1] See Walmsley et al. (2013) for a description of the various methods.

[2] More detail on the OECD TiVA database and its construction can be found http://www.oecd.org/industry/ind/measuringtradeinvalue-addedanoecd-wtojointinitiative.htm

[3] More information on services trade work at the OECD can be found here http://www.oecd.org/tad/services-trade/towardsaservicestraderestrictivenessindexstri.htm.

CGE model GLOBE developed by McDonald and Thierfelder (2013). The augmented model distinguishes traded commodities by end use, thus allowing for differentiated commodity markets by end use category. In addition, the model has been modified to analyse the effects of LCRs as quantitative measure (as described in more detail in Stone, Flaig and Van Tongeren 2014). The model is calibrated using the GTAP database (Narayanan et al., 2012). Trade flows are split by end use applying information obtained from the TiVA database of the OECD.

II. INCORPORATING END-USERS

Activities produce commodities distinguishing 4 end use categories: intermediate use, household consumption, government consumption and investment demand. After the distribution by end use category, the end-use commodities, e.g. intermediate inputs, are either exported or supplied to the domestic market, where exports and domestic supply are assumed imperfect substitutes. As exports are differentiated by use, commodities are imported by the destination country by its specific use and are finally used for the specific purpose. Consequently, end use commodity markets are fully separated and the model allows for separate price developments in the end use markets. The differentiation by end use allows the depiction of GVC activity in more detail e.g., intermediate good producers to specific country locations. Thus we can differentiate the effects of policies, such as tariff discrimination or local content requirements in government procurement, on specific parts of the value chain (i.e. intermediate versus final goods). Furthermore, it is possible to better represent participation in GVCs by allowing for different price responsiveness inside the GVC (e.g. inside an Asia-EU GVC for consumer electronics) relative to exports and imports that are not taking place as part of a GVC.

II.1. THE MODEL

General features

The OECD model develops a different structure of commodity markets and trade relationships, while following its parent model GLOBE in its other features. For a detailed description of the model equations refer to McDonald and Thierfelder (2013), this documentation limits detailed descriptions mainly to new features. The underlying approach for the multi-region modelling is the construction of a series of single country CGE models that are linked through trade relationships. As common in CGE models, the price system in the model is linear homogeneous, what directs the focus on relative and not on absolute price changes. Each region has its own numéraire, typically the Consumer Price Index (CPI), and a nominal exchange rate; an exchange rate index of reference regions serves as model numéraire. Thus, price effects inside a country are fed through the model as a change relative to the regional numéraire, and prices between regions change relative to the reference region. Finally, the OECD model contains a 'dummy' region to allow for inter-regional transactions where full bilateral information is not available, i.e., data on trade and transportation margins

As the focus of the model is on international trade relationships, the behavioural relationships of agents within a region are fairly standard. The model distinguishes activities which then produce commodities. Activities maximise profits and form output from primary inputs (i.e. land, natural resources, labour and capital), combined using Constant elasticity of Substitution (CES) technology, and intermediate inputs in fixed shares (Leontief technology). Households are assumed to maximise utility subject to a Stone-Geary utility function, which allows for the inclusion of a subsistence level of consumption[4]. All commodity and activity taxes are expressed as ad valorem tax rates and taxes are the only income source to the government. Government consumption is in fixed proportions to its income and government savings are defined as a residual. Closure rules for the government account allow for various fiscal specifications[5]. Total savings consist of savings from households, the internal balance on the government account and the external balance on the trade account. The external balance is defined as the difference between total exports and total imports in domestic currency units. While income to the capital account is defined by several savings sources, expenditures by the capital account are based solely on commodity demand for investment.

The model distinguishes various policy instruments as listed in Table 1, i.e. there are nine tax instruments of which eight are ad valorem rates and one is defined to the quantity of imports. In addition, the OECD model is augmented with a measure to capture LCRs as quantitative measure, as described later in this report.

Table 1 Policy Instruments

Policy instrument	Dimension	Type
Import tariff (tm)	By commodity, use, partner country and region	Ad valorem
Specific import tariff (tms)	By commodity, use, partner country and region	Quantitative
Export taxes (te)	By commodity, use, partner country and region	Ad valorem
Sales taxes (ts)	By commodity, use and region	Ad valorem
Value added tax (tv)	By commodity, on household consumption and region	Ad valorem
Indirect taxes on production (tx)	By producing sector and region	Ad valorem
Factor income tax (tyf)	By factor and region	Ad valorem
Income taxes of households (tyh)	By household and region	Ad valorem
Taxes on factor use (tf)	By producing sector, factor and region	Ad valorem
Local content requirement	By commodity, use, partner country and region	quantitative

Each of the tax rates is variable and equipped with four possibilities to vary the tax rate, allowing for additive and multiplicative, as well as endogenous and exogenous adjustments of the respective tax rate. The equation for import tariff rates ($TM_{w,c,r}$) shall serve as example: $tmb_{w,c,r}$ is the vector of

4. Thus, household consumption consists of two components: subsistence demand, consumed in fixed shares, and other consumption expenditure spent out of 'uncommitted' income. 'Uncommitted' income is income less taxes, saving and income spent on subsistence demand.
5. The default assumption for the government account is fixed tax rates, a flexible internal balance and fixed government expenditures, i.e., a fixed government share of final demand. Alternatively to the fixed government share of final demand, the volume of government demand or the quantity share could be fixed. Another setting could assume e.g., a fixed internal balance and leave either one of the tax rates or one of the fixed government expenditure parameters free to balance the government account.

import duties in the base, specified by partner country (w), commodity (c) and region (r). The parameter $\mathrm{dabtm_{w,c,r}}$ is a vector of absolute changes of the import tariff rate, which can be specified for specific commodities and partner regions. $\mathrm{TMADJ_r}$ is a region specific multiplicative variable with an initial value of 1 and $\mathrm{DTM_r}$ is the additive counterpart with an initial value of zero. The variables are either fixed at its initial values or can be solved for optimum values in the model, according to the closure rule employed. Finally, $\mathrm{tm01_{w,c,r}}$ is a partner region and commodity specific vector of zeroes and non-zeroes that manages additive adjustments.

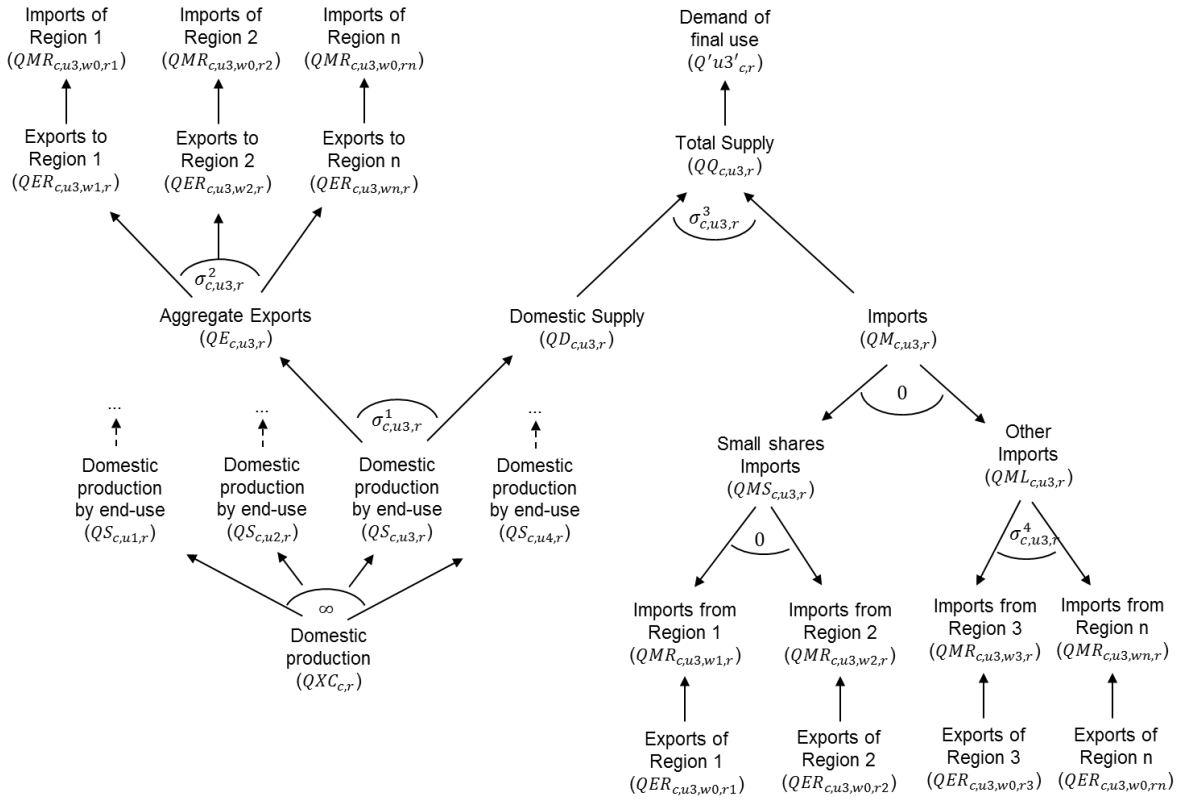
$$TM_{w,c,r} = \left(tmb_{w,c,r} + dabtm_{w,c,r}\right) * TMADJ_r + DTM_r * tm01_{w,c,r} \qquad \text{(Eq. 1)}$$

Commodity market structure by use category

Commodities are distinguished by use category (u) into commodities designed for intermediate consumption, for household consumption, government consumption and investment commodities. Figure 1 shows the structure of the commodity market. Domestic production ($QXC_{c,r}$) of commodity (c) in region (r) supplies the commodity in its 4 use categories ($QS_{c,u,r}$) (Equation 2), assuming perfect substitutability, displayed at the bottom of Figure 1. Hence, the production of a commodity in a specific use category is determined by its demand and production prices are equal.

$$QXC_{c,r} = \sum_u QS_{c,u,r} \qquad \text{(Eq. 2)}$$

Figure 1 Structure of commodity market by use category



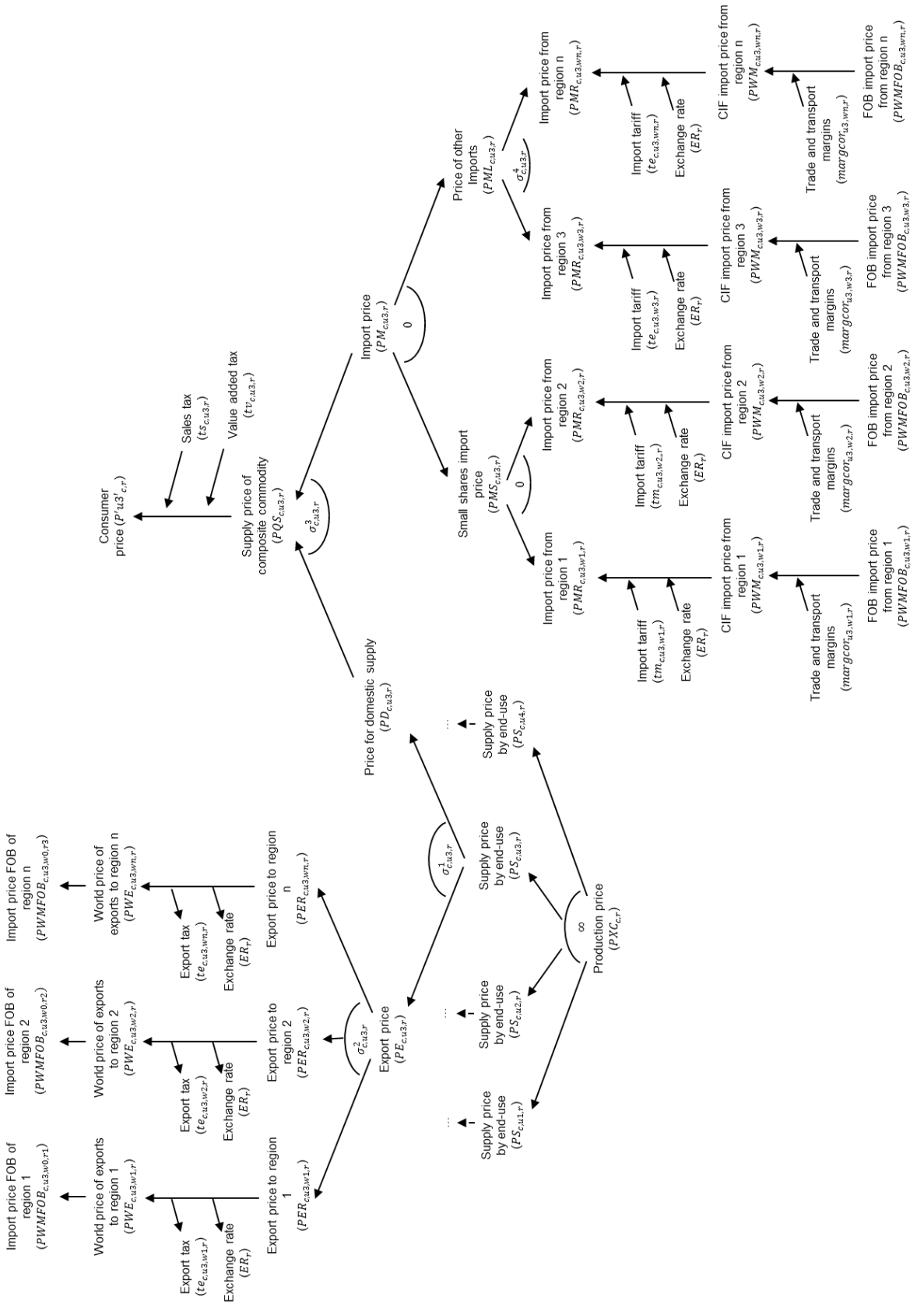
Domestically produced commodities are distributed to the domestic ($QD_{c,u,r}$) and the export market ($QE_{c,u,r}$) assuming imperfect transformability and for this purpose a two stage Constant Elasticity of Transformation (CET) function is applied. This feature allows firms to charge different prices on the domestic and export markets, depending on markets shares and price elasticities ($\sigma^1_{c,u,r}$). On the first level, commodity supply is distributed between the domestic market and the aggregated export market while on the second stage the aggregate export supply is distributed among the different export destination regions. The responsiveness to relative price changes on the second level is governed by the export elasticity ($\sigma^2_{c,u,r}$), which is commodity, use category and region specific and which gives the possibility to depict, e.g., global value chain characteristics. The distribution decision on both levels is based on relative prices: aggregate export supply is, on the first stage, determined by the relative price for the commodity on the domestic market and export market. The price of composite exports is determined by the export prices to different regions which also determine the allocation of exports on the second stage. The assumption of imperfect transformability can be switched off and then export supply is entirely determined by import demands.

Domestic demand is served from domestic supply and import supply ($QM_{c,u,r}$). Import supply is modelled as three-stage CES function assuming imperfect substitutability between domestically produced commodities and imported commodities. The composition of domestic and imported commodities is determined on the first stage by the relative price for the domestic commodity and aggregate import commodity. The second stage allows for a special treatment of imports whose volumes are small ($QMS_{c,u,r}$) and as a consequence are exposed to large relative price effects. The definition of a small import share can be freely chosen and by default import shares of less than 0.1% are considered small. On the second stage import commodities are aggregated in fixed shares from aggregate imports with small trade volumes and aggregate other imports ($QML_{c,u,r}$), i.e. from sources with import shares greater than 0.1%. Aggregate other imports is a CES-composite of imports from different regions ($QMR_{c,u,w,r}$) which are not considered small and are responsive to relative prices. At the third stage small volume share imports form aggregate small volume imports in fixed shares.

The price system, depicted in Figure 2, follows the quantitative structure and hence prices are differentiated by use category, too. In addition, the price system includes several tax instruments. Domestic export prices ($PER_{c,u,w,r}$) are valued in the domestic currency and include export taxes. The price of exports of region 0 to region 1, which is paid by the destination region ($PWE_{c,w1,u,r0}$), is expressed in the currency of the models reference region by use of the nominal exchange rate (ER_r) and net export taxes ($te_{c,u,w,r}$). This world price of exports is identical to the corresponding FOB import price ($PWMFOB_{c,u,w0,r1}$) for imports from region 0 to region 1.

The CIF price for imports by region ($PWM_{c,u,w,r}$) is valued including trade and transport margins ($margcor_{c,u,w,r}$). The domestic price for imports ($PMR_{c,u,w,r}$) is valued in the domestic currency by use of the nominal exchange rate and includes import tariffs ($tm_{c,u,w,r}$). At the top of a three stage CES-system the supply price of composite commodities ($PQS_{c,u,r}$) consists of the price of domestic supplies ($PD_{c,u,r}$) and the aggregate import price ($PM_{c,u,r}$). The consumer price for each use category ($P'u'_{c,r}$) finally includes sales taxes ($ts_{c,u,r}$) and value added taxes ($tv_{c,u,r}$).

Figure 2 Commodity price system by use category



II.2. DATA BASE

The OECD Model employs two databases, a series of Social Accounting Matrices (SAMs), which are linked through their trade accounts, which have been adjusted using the data underlying the OECD TiVA statistics.

OECD-SAM database

The OECD-SAM database derives from the GTAP V8 database (see Narayanan et al., 2012) and disaggregates imports based on use categories derived from the OECD sources. The database is in SAM format and developed from a SAM version[6] of the underlying GTAP database.

Imports (and by default exports) are differentiated by 4 use categories in the new database (thereafter 'OECD-SAM'): (1) intermediate use, (2) private consumption, (3) government consumption and (4) investment consumption. In addition, we differentiate tariffs, export taxes and sales taxes by use[7]. Accordingly, the commodity account is split to identify imported and domestic goods. This split is based on the new OECD data on use categories of imports and exports as opposed to the widely applied proportionality assumption[8].

The OECD-ICIO provides use information for all of the 44 GTAP agriculture and manufacturing sectors plus an additional 17 services sectors. The services data is mapped to attain the final 57 sectors available in the GTAP database. The 129 regions in GTAP are aggregated to match the 56 regions available in the OECD data. Two regions which are not included in the OECD data, Venezuela and Kazakhstan, are distinguished assuming proportionality in domestic and imported demand. Table 2 shows the structure of the OECD-SAM database distinguishing 58 regions, 57sectors and 4 use-categories.

Similar to an Input-Output Table, a SAM is a transaction matrix in which each cell records transaction values between two specific agents identified by the row and column accounts, where income is depicted in rows and expenditures in the columns, e.g. private import consumption is displayed as expenditure of the household account and income to the commodity account. The focus of an IO-Table lies on the transactions concerning domestic production, its formation and use. The SAM approach goes beyond this and aims to incorporate all transactions in an economy at a given point in time, especially transactions between households, government and primary factors. The SAM methodology represents a complete characterisation of the current account transactions of an economy as a circular system, and is completely embedded in the UN System of National Accounts

[6] Details on the SAM format provide McDonald and Thierfelder (2013) as well as Pyatt (1991) and Drud et al., (1986).

[7] Currently tax and tariff rates remain the same across users but future development of the model will include differentiation of these accounts.

[8] While the proportionality assumption was applied in the development of the OECD-ICIO, it was combined with additional detailed country and sector specific information which rendered the final statistics more robust.

(http://unstats.un.org/unsd/nationalaccount/docs/SNA2008.pdf). Thus it is possible to follow income flows through the system and identify interrelationships between production, factors, government and households. As income of an account must equal expenditures, row and column totals must be identical. In the context of a global SAM, this translates to the trade relationships, where each export value of one region must have an identical counterpart in imports to another region or regions.

The first two rows of Table 2 show the use of commodities by the four use categories, distinguishing imported and domestic commodities. The producing units, so-called activities, use domestic and imported commodities as intermediate inputs, households, the government and the capital account use commodities for private, government and investment consumption, respectively. Exports are displayed as purchases of the rest of the world account from domestic commodities only, there are no direct re-exports. The consumption values of imports, in the first column, include bilateral imports from the rest of the world account and in addition bilateral trade and transport margins, bilateral import tariffs and sales taxes, each distinguishing the respective use category. The total value of domestic commodity supply includes the domestic supply at producer price, supplied by the activity account, sales taxes and export taxes, each distinguishing the respective use category, too. Activities purchase intermediate inputs, and primary inputs and pay taxes on production and factor use.

Table 2 Structure of the OECD-SAM

	IMPORT COMMODITY	DOMESTIC COMMODITY	ACTIVITY	FACTORS	TARIFFS	EXPORT TAX	MARGINS	REST OF WORLD	HOUSHOLDS	SALES TAX	OTHER TAXES	GOVERNMENT	KAPITAL
IMPORT COMMODITY	0	0	Imported Intermediate Inputs	0	0	0	0	0	Private Import Consumption	0	0	Government Import Consumption	Investment Import Consumption
DOMESTIC COMMODITY	0	0	Domestic Intermediate Inputs	0	0	0	0	Exports of Commodities	Private Domestic Consumption	0	0	Government Domestic Consumption	Investment Domestic Consumption
ACTIVITY	0	Domestic Supply	0	0	0	0	0	0	0	0	0	0	0
FACTORS	0	0	Expenditure on Primary Inputs	0	0	0	0	0	0	0	0	0	0
TARIFFS	Bilateral Import Tariffs by Use Category	0	0	0	0	0	0	0	0	0	0	0	0
EXPORT TAX	0	Bilateral Export Taxes by Use Category	0	0	0	0	0	0	0	0	0	0	0
MARGINS	Trade and Transport Margins by Use	0	0	0	0	0	0	0	0	0	0	0	0
REST OF WORLD	Bilateral Imports by Use Category	0	0	0	0	0	Imports of Trade and Transport Margins	0	0	0	0	0	0
HOUSEHOLDS	0	0	0	Distribution of Factor Incomes	0	0	0	0	0	0	0	0	0
SALES TAX	Sales Taxes on Imports by Use Category	Domestic Sales Taxes by Use Category	0	0	0	0	0	0	0	0	0	0	0
OTHER TAXES	0	0	Taxes on production and Factor Use	0	0	0	0	0	Direct/ Income tax	0	0	0	0
GOVERNMENT	0	0	0	0	Tariff Income	Export Tax Income	0	0	0	Sales Tax Income	Other Tax Income	0	0
KAPITAL	0	0	0	Depreciation/ Allowances	0	0	0	Foreign Savings	Household Savings	0	0	Government Savings	0

Aggregation[9]

The database differentiates 58 countries and regions, plus one artificial region – globe – which serves for distribution of flows between regions where bilateral information is not available, i.e., trade and transport margins. Regions and sectors are aggregated in this study as displayed in Table 3

Table 3 Data aggregation: Regions, sectors and factors

Region	Commodity/Sector	Factors
Argentine	Agriculture	Skilled labour
Brazil	Coal, oil, gas, mining	Unskilled labour
China	Food	Capital
European Union	Textiles	Land
India	Motor vehicles	Natural resources
Indonesia	Electronic equipment	
Russia	Other Manufacturing	
United States	Water transport	
Rest of G20[10]	Other transport	
Rest of the OECD[11]	Utilities	
Venezuela	Construction	
Kazakhstan	Insurance	
Rest of the World	Other services	
GLOBE region		

[9] The aggregation used in this paper is in support of a separate project and easily changed.
[10] Australia, Japan, Korea, Canada, Mexico, Saudi Arabia, Turkey, South Africa.
[11] New Zealand, Chile, Switzerland, Norway, Israel.

III. SIMULATION

To illustrate the new model structure, we undertake an experiment where we eliminate import tariffs on electronics commodities. As discussed in more detail below, the electronics industry is one that is heavily reliant on value chains. Thus, this experiment allows us to contrast the outcomes under the two modelling structures, highlighting the GVC effects. Results are reported for three different scenarios:

- The first scenario employs the Globe model, thus, there is no differentiation of commodities by use category.
- The second scenario applies the same experiment to the OECD model structure as described above.
- The third scenario performs sensitivity analysis for different assumptions regarding substitution elasticities along a GVC.

Given that thus far the main distinction between the two models is in the creation of additional commodity markets, we do not expect to see large deviations in their macro outcomes. Rather, we expect that the new model structure will highlight differences in sector level results and more detailed trade results.

What difference does the new structure make?

In this section we discuss the results of the first two scenarios: the elimination of import tariffs on electronics commodities in the GLOBE and OECD models. As shown in Table 4, the results at the macro level are very much the same. Differences across GDP outcomes are essentially non-existent while those for total trade values are quite small. This is not surprising as we maintained most of the basic structure of GLOBE and the tariff cuts apply to all use categories.

Table 4 Selected Macro Results

	Argentina	Brazil	Indonesia	India	Russia	USA	Venezuela	Kazakhstan	China	G20	OECD	EU	ROW
							GDP						
GLOBE	0.000	-0.004	0.002	-0.002	0.001	0.000	0.004	0.001	0.006	0.001	0.000	0.000	0.000
OECD	*0.000*	*-0.003*	*0.002*	*-0.002*	*0.000*	*0.000*	*0.003*	*0.001*	*0.005*	*0.001*	*0.000*	*0.000*	*0.000*
Difference	*0.000*	*-0.001*	*0.000*	*0.000*	*0.001*	*0.000*	*0.001*	*0.000*	*0.001*	*0.000*	*0.000*	*0.000*	*0.000*
							IMPORTS						
GLOBE	0.136	0.258	0.269	0.055	0.080	0.038	0.116	0.051	0.430	0.118	0.014	0.012	0.161
OECD	0.118	0.218	0.278	0.050	0.076	0.040	0.109	0.047	0.401	0.122	0.012	0.010	0.133
Difference	*0.018*	*0.040*	*-0.010*	*0.005*	*0.004*	*-0.002*	*0.008*	*0.004*	*0.029*	*-0.003*	*0.002*	*0.002*	*0.028*
							EXPORTS						
GLOBE	0.151	0.395	0.158	0.089	0.072	-0.001	0.073	0.027	0.400	0.066	0.009	0.016	0.189
OECD	0.123	0.361	0.189	0.071	0.079	-0.007	0.071	0.029	0.388	0.074	0.014	0.016	0.152
Difference	*0.029*	*0.034*	*-0.031*	*0.019*	*-0.007*	*0.006*	*0.002*	*-0.002*	*0.012*	*-0.007*	*-0.005*	*0.000*	*0.038*

Source: Authors' calculations. Aggregation details are presented in table 3.

As expected, the differences in the two models can be seen in the more detailed outcomes at the sector level. Table 5 presents the results for changes in the electronics sector in both models, with the additional information on the change in intermediates and household outcomes available with the OECD model. The new nesting structure provides information concerning the different uses (intermediates, households, government and capital) of imports and exports and different outcomes among trading partners. We report only the results for households and intermediates here.

Table 5 Changes in Electronics Sector

	Argentina	Brazil	Indonesia	India	Russia	USA	Venezuela	Kazakhstan	China	G20	OECD	EU	ROW
							Production						
Intermediates	-4.97	-4.14	7.86	-1.45	-4.67	-0.46	-0.28	-0.70	0.82	0.76	-0.46	-0.82	0.95
Households	-0.22	0.29	2.08	0.22	-2.05	-0.01	-0.32	-0.07	2.23	0.38	-0.03	-0.21	1.03
GLOBE	-4.51	-2.21	5.30	-1.65	-6.43	-0.49	-1.81	-0.80	1.54	0.29	-0.53	-0.73	1.19
							Imports						
Intermediates	5.30	7.83	3.73	2.15	3.42	0.60	0.05	1.13	1.69	0.76	0.10	0.10	1.01
Households	10.31	14.30	0.99	4.48	7.26	0.75	5.37	1.89	4.16	1.50	0.56	1.15	2.61
GLOBE	3.16	10.83	0.78	2.23	2.26	0.59	2.56	1.27	1.64	1.04	0.24	0.43	1.32
							Exports						
Intermediates	-3.16	-4.69	9.74	0.59	0.19	-0.65	0.84	2.20	1.78	1.80	-0.63	-0.92	1.32
Households	-0.55	-3.84	3.46	2.83	1.17	0.75	2.42	1.97	3.12	0.71	0.46	-0.47	2.16
GLOBE	-1.58	-3.51	6.63	0.66	0.40	-0.44	1.19	1.43	2.36	0.99	-0.61	-0.63	1.60

Source: Authors' calculations. Aggregation details are presented in table 3.

First, it should be noted that orders of magnitude of response are dependent on the initial level of the tariff. Most of the developed economies have close to zero tariffs on electronics goods trade and thus price responses are muted.[12] The largest responses are those with the largest tariff declines, i.e., Argentine, Brazil, Venezuela and Russia. It is therefore interesting that while Chinese tariffs are relatively low (especially with respect to Argentina and Brazil), they still experience quite a strong trade response.

The change in production reported in the GLOBE model can be quite different to those reported in the OECD model. For example, the OECD model reports increases in both household (0.38%) and intermediate (0.76%) production for the G20 region that is greater than what GLOBE reports for all electronic production (0.29%). This is due to the fact that the OECD model can account for the different markets among users. For example, in the G20 region the majority of trade in electronics is in intermediate goods (63% of exports), while for textiles, households make up the largest share of end uses (67% of exports). In GLOBE, the electronics sector outcomes are driven by average effects across all user groups. Thus, relative price changes are small due to the fact that, on average, the bulk of G20 trade is with economies that already have low tariffs. This leads to small changes in domestic demand. This is reflected in the minor difference in the change in exports and imports, thus small changes in domestic production of electronics.

The results for the OECD model are a bit different. The largest market for G20 exports of intermediates is China, but a sizable amount (23%) goes to the ROW. Here, the relative price changes are larger, thus we see exports of intermediates increase by almost 2%. Imports of intermediate come from regions with lower tariffs and thus we see smaller increases. This combination leads to a greater increase in the production of intermediates in G20 economies, than was seen in the GLOBE results. The same mechanics are at play in the household results where the majority of exports go to the US but most of the imports come from China and other G20 economies where relative price changes are greater, leading to smaller production gains for households.

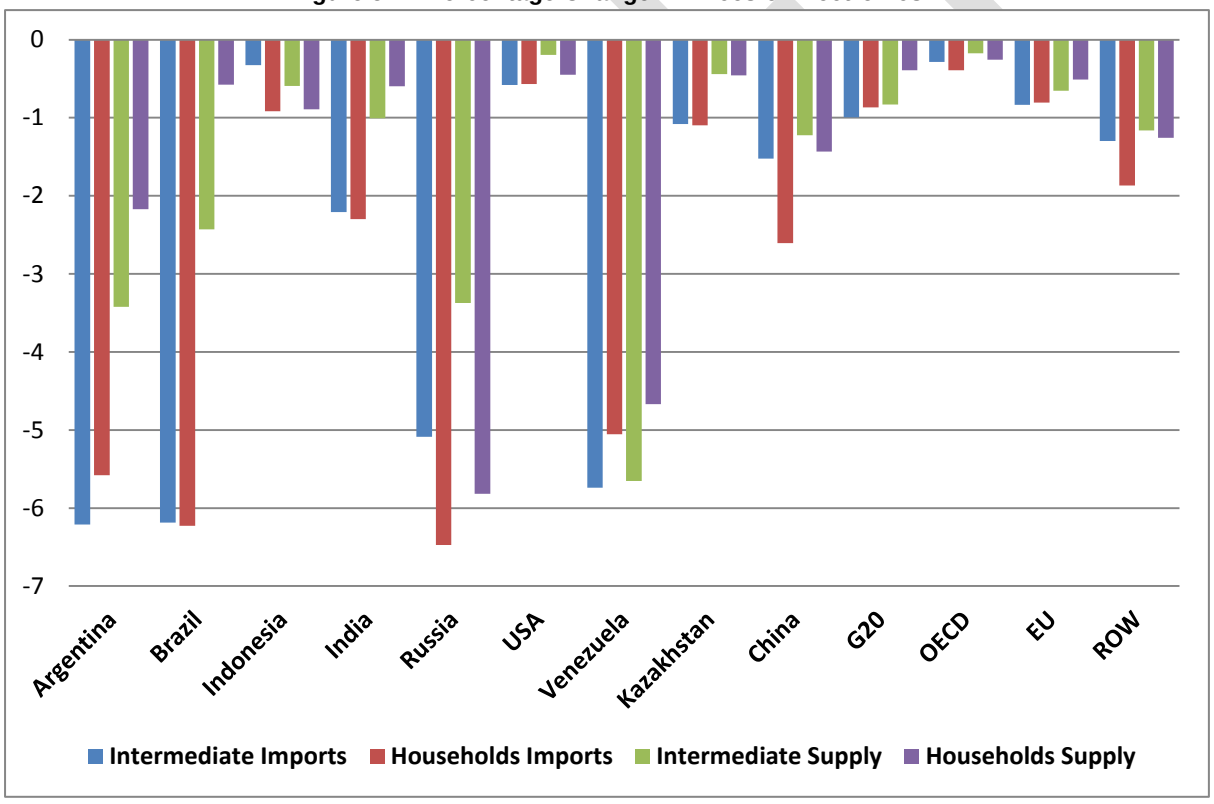
Another example can be seen in Brazilian trade. We see from the GLOBE results that production in electronics in Brazil has gone down as imports increase and exports decline. However, the OECD

[12] We have maintained the GTAP bilateral tariff structure thus the same tariff rate is applied across uses. The OECD has developed a database of tariffs applicable to intermediate versus final goods users. A future version of the database will include this differentiated tariff structure.

model shows that the big declines in production are coming from intermediates and that despite an increase in imports, total supply (domestic production plus imports) actually shrinks. Production for households, on the other hand, actually increases, and together with a larger increase in imports, increases total supply. This affects relative trading partners as well, given that most of Brazil's intermediate imports come from China while a large share of their household imports come from Rest of the G20.

The figure 5 shows the differences by focusing on price changes from the OECD mode. The percentage change of household imports is larger for most economies but this is off a smaller base as the trade in intermediate electronics dominates this market. For example, household imports to China increase more than twice as much as those to intermediate uses. This accrues from the much smaller base household trade accounts in China, but it also can be traced to the different sources of supply to the two markets. Household trade tends to come from areas which have slightly higher than average tariffs (such as ROW) and thus household import prices experience greater relative declines (Figure 5).

Figure 5 Percentage Change in Prices of Electronics



Source: Authors' calculations

We can also track information by trading partners within the end-use categories. For example, 21% of Chinese intermediate exports of electronics go to the US and 27% to the EU. For household end-use, 42% of Chinese exports go to the US but only 15% to the EU. For the US 0.2% of intermediate exports of electronics go to Venezuela while over 14% of exports to households go to this country. These different trade patterns are reflected in the outcomes of the experiment for the OECD model. Table 6 shows the results for bilateral trade for electronics commodities.

We can see the different patterns in trade changes across the two use markets. For example, the US increases its intermediate exports to Indonesia by 3.6% but only increase exports to households by 0.65%. China, on the other hand, increases its intermediate exports to the EU by 2.8% but increases exports to households by almost twice that amount. For their part, Argentina and Brazil reduce exports to Venezuela and increase their presence in the Chinese and G20 markets. Overall we see larger changes in the household use where non-low tariff trading countries tend to have larger market shares. The new model structure allows for a more detailed tracking of relative price changes which is then reflected in an ability to show the benefits of one group of end-users versus another.

Table 6 Percentage Change in Bilateral Exports of Electronics in OECD Model

	Intermediates												
	Argentina	**Brazil**	**Indonesia**	**India**	**Russia**	**USA**	**Venezuela**	**Kazakhstan**	**China**	**G20**	**OECD**	**EU**	**ROW**
Argentina		-12.02	15.96	5.30	5.30	4.96	5.30	5.30	12.36	5.04	8.36	6.39	9.41
Brazil	-12.71		14.27	3.84	7.83	6.96	7.83	7.83	11.34	5.04	7.17	6.23	8.59
Indonesia	3.73	3.73		1.60	3.73	3.62	3.73	3.73	4.97	4.08	3.21	3.29	3.36
India	2.15	4.26	16.77		0.56	-0.20	2.15	2.15	2.08	2.95	1.48	3.71	1.73
Russia	3.42	3.42	15.72	-6.02		-3.40	3.42	3.42	1.43	6.36	-1.03	4.17	5.93
USA	0.60	0.60	3.16	-1.37	0.60		0.60	0.60	1.20	-0.16	-1.03	-0.45	0.92
Venezuela	-11.66	-12.83	0.05	0.05	0.05	2.15		0.05	6.62	5.25	0.20	1.62	2.40
Kazakhstan	1.13	1.13	7.96	1.13	-3.31	-0.71	1.13		2.05	1.58	0.06	1.32	2.26
China	1.69	1.69	20.32	1.69	1.69	-1.16	1.69	1.69		3.57	-0.25	0.48	0.65
G20	0.76	0.76	4.38	0.76	0.76	-1.40	0.76	0.76	1.28	0.33	-0.74	-0.68	2.03
OECD	0.10	-1.18	9.71	0.44	0.10	-0.09	0.10	0.10	1.14	0.65	1.63	-0.63	2.22
EU	0.10	0.10	8.93	-2.00	0.10	-0.65	0.10	0.10	2.80	2.23	-2.03	-1.94	1.82
ROW	1.01	1.01	4.30	6.10	1.01	-0.16	1.01	1.01	0.81	0.43	2.65	1.56	1.64
	Households												
Argentina		-3.85	16.21	10.31	10.31	8.79	10.31	10.31	17.77	-0.91	13.34	9.47	15.78
Brazil	14.30		14.30			9.78	14.30	14.30	15.55	3.29	14.30	11.75	13.84
Indonesia	0.99	0.99		-0.25	0.99	0.65	0.99	0.99	3.09	1.33	0.47	0.99	0.20
India		4.48	13.69			0.50	4.48	4.48	3.93	4.97	2.51	4.93	5.23
Russia			10.03	7.26		-5.00	7.26	7.26	0.86	4.35	7.26	11.45	3.07
USA	0.75	0.75	-0.40	-0.46	0.75		0.75	0.75	2.17	-0.38	0.75	0.20	0.85
Venezuela	-3.81	-4.36	5.37	5.37	5.37	6.30		5.37	12.18	9.79	4.48	6.43	6.35
Kazakhstan	1.89	1.89	4.48	1.89	-1.30	-0.61	1.89		3.28	1.91	0.36	2.08	2.15
China	4.16	4.16	14.60	4.16	4.16	-2.62	4.16	4.16		4.76	0.33	1.00	0.66
G20	1.50	1.50	1.66	1.50	1.50	-1.02	1.50	1.50	2.24	1.19	0.20	0.37	1.35
OECD	0.56	0.56	1.74	0.56	0.56	-0.38	0.56	0.56	2.01	0.34	-0.51	-0.27	1.62
EU	1.15	1.15	5.78	1.15	1.15	-0.17	1.15	1.15	5.04	2.55	-1.45	-0.96	2.45
ROW	2.61	2.61	1.74	9.53	2.61	0.34	2.61	2.61	2.62	1.16	4.63	3.92	4.95

Source: Authors' calculations. Aggregation details are presented in table 3.

Sensitivity Analysis: Trying to get at GVCs[13]

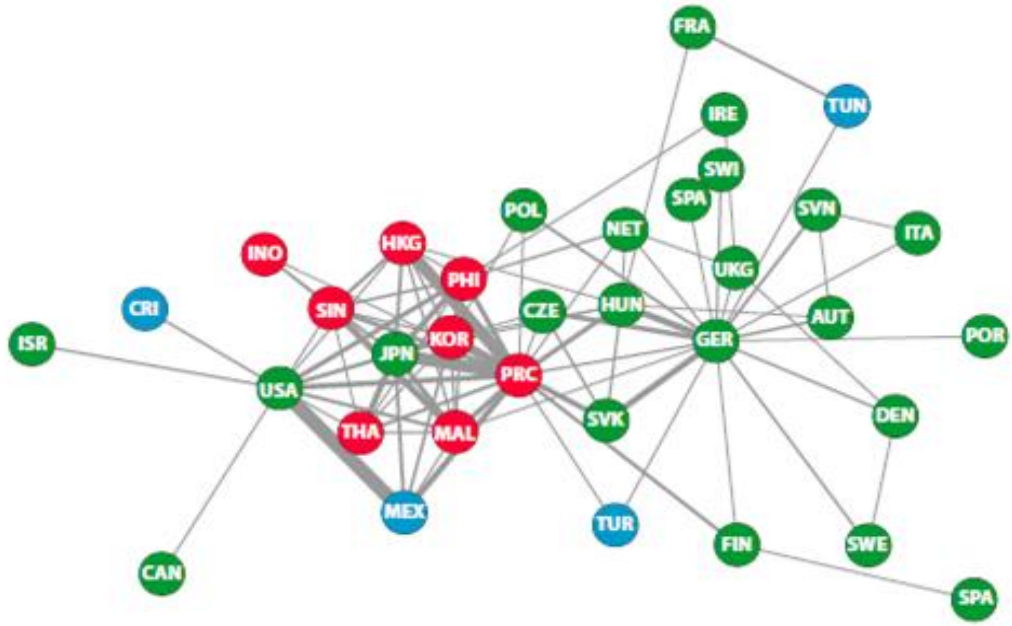
The electronics industry is dominated by global value chains. This is due to the high modulatory of its products, which allows for the fragmentation of the production process. Thus, design, logistics and various parts of the production process are executed by different firms located throughout the (OECD 2013). Figure 6 depicts a network analysis of the electronics industry based on vertical trade. It shows the existence of three hubs: Asia, Europe and North America. The figure illustrates not only the strong inter-Asia linkages but also the strong relationships between Asia and the North America hub (especially the United States). While the Europe hub (Germany, the Czech Republic, the Slovak

[13] This part of the paper is provided to highlight potential areas of analysis with the new model structure rather than a discussion of completed work.

Republic and Hungary) is important, it does not have as strong ties to Asia as the North American hub.

Based on this analysis of the electronics industry, we have adjusted the price responsiveness in the model to reflect the stronger ties among countries in the hub given the current aggregation and rerun the tariff experiment. We did this by lowering the trade elasticities by 70% for Asia (i.e. China and Indonesia) and North America (i.e. the US).[14] Thus this final set of results reflects the stronger ties of countries along the electronics network that are less price responsive ('GVC scenario'). We then compare the changes in trade outcomes. Within electronics trade, the US accounts for approximately 13% of intermediate electronics imports and 9% of exports. For households, it accounts for 18% of imports and only 7% of exports. China accounts for only 2% of electronics imports to households yet over 14% of exports to household use markets.

Figure 6. Vertical Trade in the Electronics Sector (2008-2009)



Source: Ferrarini (2010) as quoted in OECD (2013).

By lowering the trade elasticities between those countries particularly active in a GVC, we hope to begin to capture the unique trading relationships along these networks. The difference in the percentage change in trade, as a result of the GVC scenario, is shown in Table 7. As expected, we see smaller changes in the electronics exports of China and Indonesia, and we see a smaller decline in US exports while US exports of electronics to households remained largely unchanged. In fact, there is less change in both intermediate and household trade across the board (either smaller losses or smaller gains). We see also that relative prices for imports have much smaller changes across the board although the more inelastic trade was only introduced on key players. This outcome shows the model's ability to more accurately capture the influence certain players can have in international

[14] We ran a number of country groupings and found the results consistent. We report this first grouping as it is the most precise with the current aggregation.

markets. The decline in exports to household by Argentina was reversed to a small increase. We observe smaller differences in the percentage change in imports between the two scenarios for countries outside the GVC network, with Argentina and Brazil see the largest differences.

Table 7 Differences in Electronics Trade Outcomes under GVC assumption

	Argentina	Brazil	Indonesia	India	Russia	USA	Venezuela	Kazakhstan	China	G20	OECD	EU	ROW
							Exports						
Intermediates	-3.16	-4.69	9.74	0.59	0.19	-0.65	0.84	2.20	1.78	1.80	-0.63	-0.92	1.32
Intermediates GVC	-2.50	-3.67	8.14	0.33	0.10	-0.53	0.72	1.83	1.45	1.45	-0.49	-0.74	1.14
Difference	*0.67*	*1.01*	*-1.60*	*-0.27*	*-0.09*	*0.13*	*-0.12*	*-0.38*	*-0.33*	*-0.35*	*0.15*	*0.18*	*-0.17*
Households	-0.55	-3.84	3.46	2.83	1.17	0.75	2.42	1.97	3.12	0.71	0.46	-0.47	2.16
Households GVC	0.10	-2.33	2.89	2.23	1.17	0.72	2.12	1.74	2.70	0.66	0.43	-0.27	1.87
Difference	*0.65*	*1.51*	*-0.57*	*-0.61*	*0.00*	*-0.03*	*-0.30*	*-0.22*	*-0.42*	*-0.06*	*-0.03*	*0.21*	*-0.29*
							Imports						
Intermediates	5.30	7.83	3.73	2.15	3.42	0.60	0.05	1.13	1.69	0.76	0.10	0.10	1.01
Intermediates GVC	5.04	7.51	3.12	2.12	3.41	0.47	0.04	1.12	1.46	0.77	0.10	0.11	1.00
Difference	*-0.27*	*-0.32*	*-0.61*	*-0.02*	*-0.01*	*-0.14*	*0.00*	*-0.01*	*-0.23*	*0.01*	*0.00*	*0.01*	*-0.01*
Households	10.31	14.30	0.99	4.48	7.26	0.75	5.37	1.89	4.16	1.50	0.56	1.15	2.61
Households GVC	9.31	12.86	0.93	4.38	7.28	0.70	5.05	1.87	3.47	1.49	0.57	1.09	2.59
Difference	*-1.00*	*-1.44*	*-0.07*	*-0.10*	*0.02*	*-0.05*	*-0.31*	*-0.02*	*-0.68*	*-0.01*	*0.01*	*-0.06*	*-0.02*

Source: Authors' calculations. Aggregation details are presented in table 3.

Looking at changes in the bilateral trade relationships under the GVC scenario (Table 8), we see that the majority of trade flow changes are smaller than in the original experiment. We also see that households experience larger differences than intermediates in the GVC scenario. For example, Indonesia and the US, two of the three GVC economies singled out, experience no real difference in intermediate trade between the two scenarios (3.16% versus 3.13%), yet the difference in household exports between the two is the largest of any changes (-0.4% versus -0.1%). US imports most of its household electronics from China (over 40%) but with the GVC structure, Russia sees the largest increase in household electronics trade with China (although this is off a very small base).

Table 8 Changes in Bilateral Exports of Electronics under GVC scenario

Intermediates													
	Argentina	Brazil	Indonesia	India	Russia	USA	Venezuela	Kazakhstan	China	G20	OECD	EU	ROW
Argentina		-9.35	13.25	4.37	4.37	4.13	4.37	4.37	9.86	4.29	6.74	5.21	7.68
Brazil	-10.10		11.95	3.11	6.37	5.63	6.37	6.37	9.07	4.27	5.82	5.06	7.04
Indonesia	3.01	3.01		1.12	3.01	2.81	3.01	3.01	3.96	3.25	2.53	2.55	2.78
India	1.77	2.96	13.51		-0.23	-0.13	1.77	1.77	1.73	2.37	1.19	2.85	1.51
Russia	2.82	2.82	12.84	-4.68		-2.50	2.82	2.82	1.34	5.08	-0.64	3.31	4.82
USA	0.53	0.53	3.13	-1.24	0.53		0.53	0.53	0.99	-0.08	-0.81	-0.41	0.82
Venezuela	-9.49	-10.23	0.04	0.04	0.04	1.72		0.04	5.24	4.17	0.25	1.30	2.07
Kazakhstan	0.91	0.91	6.88	0.91	-3.18	-0.50	0.91		1.73	1.34	0.11	1.04	1.93
China	1.40	1.40	16.11	1.40	1.40	-0.91	1.40	1.40	1.40	2.81	-0.17	0.35	0.64
G20	0.61	0.61	4.04	0.61	0.61	-1.15	0.61	0.61	1.02	0.27	-0.62	-0.60	1.64
OECD	0.08	-1.23	8.15	0.17	0.08	-0.09	0.08	0.08	0.97	0.56	1.26	-0.52	1.84
EU	0.10	0.10	7.55	-1.71	0.10	-0.53	0.10	0.10	2.24	1.77	-1.57	-1.53	1.52
ROW	0.87	0.87	4.05	4.50	0.87	-0.12	0.87	0.87	0.74	0.42	2.06	1.19	1.41
	Households												
Argentina		-2.58	12.99	8.46	8.46	7.16	8.46	8.46	14.24	-0.16	10.61	7.75	12.63
Brazil	11.40		11.40			7.72	11.40	11.40	12.39	2.91	11.40	9.29	10.99
Indonesia	0.95	0.95		-0.14	0.95	0.52	0.95	0.95	2.69	1.14	0.39	0.85	0.36
India		3.73	10.70			0.46	3.73	3.73	3.39	3.99	2.02	3.93	4.27
Russia			8.89	6.66		-2.96	6.66	6.66	1.91	4.41	6.66	9.79	3.51
USA	0.73	0.73	-0.12	-0.35	0.73		0.73	0.73	1.93	-0.22	0.73	0.19	0.81
Venezuela	-2.13	-2.66	4.95	4.95	4.95	5.62		4.95	10.41	8.39	4.24	5.80	5.86
Kazakhstan	1.60	1.60	3.69	1.60	-0.62	-0.44	1.60		2.85	1.61	0.32	1.70	1.88
China	3.44	3.44	11.45	3.44	3.44	-1.88	3.44	3.44		3.89	0.41	0.98	0.84
G20	1.33	1.33	1.47	1.33	1.33	-0.81	1.33	1.33	2.00	0.99	0.15	0.33	1.20
OECD	0.53	0.53	1.52	0.53	0.53	-0.34	0.53	0.53	1.79	0.32	-0.42	-0.18	1.39
EU	1.03	1.03	4.66	1.03	1.03	-0.12	1.03	1.03	4.17	2.07	-1.09	-0.65	2.08
ROW	2.28	2.28	1.67	7.39	2.28	0.37	2.28	2.28	2.42	1.10	3.67	3.18	4.08

Source: Authors' calculations. Aggregation details are presented in table 3.

IV. CONCLUSIONS AND NEXT STEPS

This paper outlines a new model structure, incorporating information on trade by end-use in addition to the usual source and destination across commodities. We show how this new model structure improves the ability to track more detailed information on particular markets from changes in trade policy. We do this by implementing a complete tariff liberalisation on electronic goods. While overall macro results do not change, we illustrate the importance the different effects on the household versus intermediates markets. This has important policy implications for several reasons. First, we know that tariffs are higher on intermediate goods so any change in policy will likely have a stronger effect in these markets. We also know that trade in intermediate goods is vital to the efficient operations of GVCs, a key driver of global trade. Finally, we know that NTMs often target trade in intermediates, thus a more precise account of these markets will likewise provide more targeted policy advice.

In future we intend to introduce the data which differentiates tariffs into the model. We also intend to better reflect GVC trade through the different trading partner-market-use dimensions. We have briefly illustrated here the potential this differentiate can add to policy analysis. But much more can be done along these lines.

REFERENCES

Drud, A., W. Grais and G. Pyatt (1986), 'Macroeconomic Modelling Based on Social-Accounting Principles', Journal of Policy Modeling, Vol 8, pp 111-145.

Koopman, R., Z. Wang, and S. J. Wei (2012), Tracing Value-added and Double Counting in Gross Exports, NBER Working Paper No. 18579,http://www.nber.org/papers/w18579.pdf.

McDonald, S. and K.E. Thierfelder (2013), Globe v1: A SAM Based Global CGE Model using GTAP Data, Model documentation. Available at: http://www.cgemod.org.uk/

Narayanan, B., Aguiar, A. and R. McDougall (eds.), (2012). Global Trade, Assistance, and Production: The GTAP 8 Data Base, Center for Global Trade Analysis, Purdue University.

OECD (2013), *Interconnected Economies: Benefiting from Global Value Chains*, OECD Publishing, DOI:10.1787/9789264189560-en.

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

Stone, S. , D. Flaig and F. Van Tongeren (2014), "Modelling Local Content Requirements: Quantitative Restrictions in a CGE Model", 2014 GTAP Conference, Dakar, Senegal.

Walmsley, T., Hertel, T. and D. Hummels (2013). Developing a GTAP-Based Multi-Region, Input-Output Framework for Supply Chain Analysis. Purdue University, 9 September 2013.Pyatt, G. (1987), 'A SAM Approach to Modelling', Journal of Policy Modeling, Vol 10, pp 327-352.