Using gravity to move Armington

An empirical approach to the small initial trade share problem in general equilibrium models

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1. The small shares problem

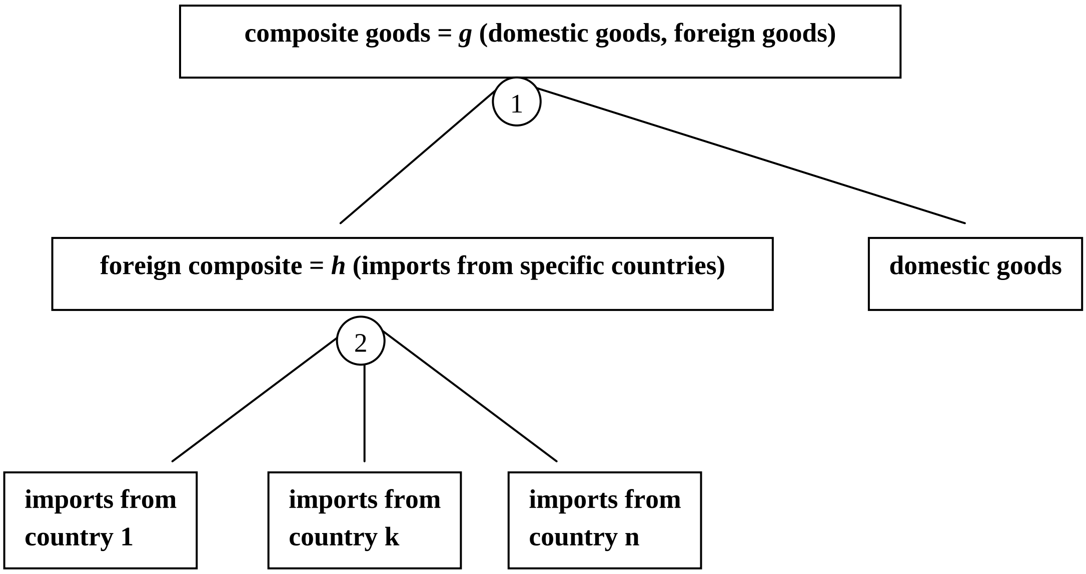
This paper addresses a well-known problem in applied trade policy models using an Armington-style specification of import demand. The 'small shares stay small' problem implies that even after significant reductions of import barriers these models do not predict sizeable changes in trade flows from importers whose initial import shares are small before liberalisation, but who might be competitive suppliers after liberalisation. To solve this problem, this paper proposes a marriage between an estimated gravity equation and an Armington import demand specification, which both come together in a CGE model.

The public and scientific debate on the expected impacts of trade liberalization, as for example aimed for in the current Doha round, is often based on ex-ante analyses of trade liberalization with general equilibrium models. The majority of these general equilibrium models is based on GTAP data and uses a similar theoretical structure. A key feature of this model structure is to model bilateral trade flows with an Armington specification.

This specification is a convenient way to make the model correspond with important stylized facts such as imperfect transmission of world price changes to domestic prices, incomplete specialization and two-way trade. Most current applied general equilibrium models use a two-level structure to model import demand. Import demand is derived from decisions regarding the sourcing of goods for intermediate use or for final consumption. In step one goods are either from domestic or foreign origin. In the second step the foreign goods are sourced from different countries. Figure 1 reproduces the approach taken in GTAPEM.

The characterizing feature of the Armington approach is to distinguish goods by origin, thus treating them as imperfectly substitutable[1]. Such an Armington approach to dealing with goods of different origin can be used with a variety of functional forms for aggregating domestic and foreign goods and for aggregating goods from different countries. The CES is the most commonly used functional form used for both these steps. It owes its popularity to its analytical tractability and to limited data requirements, only requiring estimates of one single substitution elasticity in addition to trade flow data. A drawback from using a CES functional form is the small shares problem.

Figure 1: Modeling of import demand in GTAPEM



The small shares problem arises in a CES-based Armington specification because producer and consumer 'incentive' prices are calculated as volume weighted shares of prices of domestic and imported goods. If trade volumes in the base period are close to zero, for example as a consequence of prohibitive trade barriers, such trade-weighted averages will not fully reflect the importance of liberalization of imports and reduction of domestic agricultural support. Hence, Armington models tend to understate the trade creation following significant liberalization efforts if initial trade flows are small. Stated simply, if there is no or little trade in the base period, there will likely be no or little trade impact of reducing tariffs - even if that reduction is very large.

To illustrate the small share problem consider the input demand function derived from the cost minimization problem subject to CES preferences and a budget constraint,

$$\frac{X_i}{X} = \alpha_i \left(\frac{P_i}{P} \right)^{-\sigma} \qquad (1)$$

[1] Distinguishing goods by origin implies that all suppliers, even small countries, have some degree of market power. The presence of market power results in strong terms of trade effects with Armington models (Brown 1987).

where X_i is the quantity of input i demanded, X is the quantity of output supplied, α_i is a share parameter and σ is the common and constant elasticity of substitution between inputs rendering the CES function its name. The price index for output X is given by

$$P = \left(\sum_i \alpha_i \, P_i^{1-\sigma} \right)^{\frac{1}{1-\sigma}} . \qquad (2)$$

Consider the case where (1) represents function h in figure 1, *i.e.* the aggregation of imports from different foreign sources. In that case X represents total imports and X_i represents the import from country i. Normalizing all prices to one, the share parameter α_i can be directly derived as the ratio of imports from i to the total amount of imports. Or in other words α_i reflects the relative importance of imports from country i compared to total imports.

Calibrating α_i on the trade flows in the base period, after which it remains unchanged during simulations, creates the small share problem. Consider the extreme case when there are no imports from country i in the base period, for example due to prohibitive trade barriers. In that case there will never be any imports from i, even if all trade barriers are removed, since α_i will be set to zero. If imports from i are very small in the base period α_i will be very small. In order to get any significant increases in the imports of i its price needs to drop by large amounts and/or the substitution elasticity has to be large.

The omnipresence of the CES-based Armington specifications in current applied general equilibrium models suggests that the impact of trade liberalization may be underestimated in many empirical applications. One may expect this to hold especially in cases with high initial market protection, like for example protection of agricultural markets in some OECD countries or protection of domestic markets in some developing markets with respect to other developing countries. Protection of agricultural markets in OECD countries and the impact of trade liberalization on developing countries feature prominently in the discussions of the Doha Development Agenda.

After discussing existing solutions to the small shares problem we outline the approach followed in this study. This approach is based on estimating gravity equations to predict changes in trade flows following a change in trade barriers. After outlining the methodological approach we present the result of the gravity equations, followed by simulation results. These first simulation results present the effect of full trade liberalization by OECD countries, with and without technology shifters to deal with small trade shares. We conclude by assessing the potential for the methodology developed in this study in future work.

2. Existing solutions to the small shares problem

To deal with the small shares problem an array of solutions has been proposed in the literature. These range from ad-hoc changes to model parameters to structural changes to the model structure. Given that the small shares problem arises from limited response for small or zero initial trade flows, obvious *ad hoc solutions* are replacing zero trade flows with small numbers and/or increasing the substitution elasticity between imported goods or aggregating regions or products. These ad hoc model adjustments do not yield sizeable responses, as is the experience in practice. Apart from not solving the problem, arbitrarily increasing the in substitution elasticity may result in technical difficulties when solving the model. More importantly, the desire to increase the response from a single source with a small or zero initial supply will raise the response of all suppliers. The CES function has only one substitution elasticity for all sources and the response of all sources of imports, including the large ones, will be increased.

Another way around the small share problem is to increase initial shares by aggregating regions or products. An aggregation will increase initial trade flows and thus α_i. A less straightforward use of aggregation to get around the small shares problem is made in Cernat et al. (2003). When analyzing the EBA agreement with a partial equilibrium model they create an intermediate world market in which exports from LDCs to the EU and the rest of the world are aggregated and then directed to the EU. The current exports from LDCs to the rest of the world thus count towards the initial trade flow from a LDC to the EU, increasing the initial trade shares. The use of aggregation is limited by the amount of detail needed to address the issue of interest and thus does not pose a general answer to the small shares problem. For a more general answer we need to turn to structural approaches that change the way in which import demand is modeled.

Structural solutions to dealing with the small share problem can be grouped under two headings: homogeneous products or adjusting functional form. The first approach removes the distinction of goods by origin from the model for at least part of the commodities. This gets rid of the small share problem by eliminating the need for aggregation functions. The second approach maintains the distinction of goods by origin and replaces the CES function with another functional form. These alternative functional forms apply to all commodities in the model, not to a subset of goods as is generally the case in the first approach.

Treating goods as homogenous as opposed to distinguishing them by origin as in the Armington approach, results in a net trade model. A major drawback of treating goods as perfect substitutes is that there is no room for two-way trade flows, a stylized fact of international trade. Only net trade can be observed with countries being either net importers, self-sufficient or net exporters of a good, which in turn implies that information on bilateral trade flows is lost. Loss of bilateral trade from the model implies that there is no possibility to model bilateral trade policies, such as preferential trade regimes in which trade barriers differ across countries. Given the drawbacks of a net trade model in terms of two-way trade and bilateral trade flows applied general equilibrium models abandoning the Armington model tend to only do so for a limited set of agricultural (bulk) commodities.

An example is a study by Gohin *et al.* (2002) analyzing the impact of tariff reduction for France. They use a mixed model, including both imperfect and perfect substitutable goods. More specifically, in the case of wheat they allow for the possibility that foreign wheat is perfectly substitutable for domestic wheat. Their motivation for including the option of perfectly substitutable cereals in the model is that trade policies are prohibitive in the base period. Perfectly substitutable cereals are thus not imported in the base and with a standard CES aggregation function these would never be imported. Analyzing the impact of tariff reduction with imperfectly substitutable cereals (standard Armington assumption) they find nearly no effects on the French market. With perfect substitutable cereals they find substantial effects in cereals through a much stronger production response.

The second group of structural solutions maintains the Armington structure, as illustrated for GTAPEM in figure 1, while replacing the CES aggregation functions by another functional form. Witzke *et al.* (2005) deal with the small shares problem by introducing commitments in the CES function. These commitments assure that commodities with zero imports in the base period will still appear in the model (in contrast to the standard CES function where α_r would be zero, effectively removing the good from that region from the model). This specification furthermore allows imports from a specific source to become zero in a model simulation, something not allowed in a standard CES function. The modified CES is used for an illustrative analysis (using synthetic parameters) of a sugar market liberalization with the CAPRI model. The results show that Australia and New Zealand that do not export to the EU in the base period start producing in the liberalized regime. Such a result cannot be obtained with a standard CES aggregation function.

Hanslow (2001) adjusts the CES function in a different manner, replacing it with a CRESH function (Constant Ratio Elasticity of Substitution Homothetic). CRESH functions are a generalized form of the CES function put forward by Hanoch (1971). CRESH functions have an additional set of parameters determining the price elasticities of inputs. Raising these CRESH parameters for imports with small initial shares will raise their own and cross-price elasticities. This will elicit a stronger response to a reduction in trade barriers. As long as the price elasticities are governed by parameters, the strong response of prices of import flows that are small in the base period will persist. This may result in overcompensation of the small shares problem since initially small flows will maintain high responses even when they area no longer small. To prevent overcompensation Hanslow (2001) proposes to replace the CRESH parameters by a CRESH elasticity that is depending upon the associated input intensity. The CRESH and adaptive CRESH functions are illustrated with an analysis of services trade liberalization. The CRESH function was found to overcompensate, resulting in unrealistically large increases in initially small trade flows. The adaptive CRESH was found to offset but not overcompensate the small shares problem.

A number of studies (Robinson, Burfisher *et al.*, 1993; Weyerbrock, 1998) leaves the CES function altogether, instead opting for an AIDS function (Almost Ideal Demand System) . AIDS functions are flexible functions that can in principle accommodate arbitrary substitution and expenditure elasticities. To be incorporated in an applied general equilibrium model flexible functions need to be restrained to satisfy standard properties of demand system (symmetry, homogeneity, adding up and local concavity). An AIDS function allows expenditure shares to change when relative import prices changes, in contrast to the fixed proportions of expenditure shares in the CES function. These changes in expenditure shares may allow small initial flows to rise with trade liberalization. The main reason put forward in the literature for using an AIDS instead of a CES function are to reduce the terms of trade effects. Terms of trade effects result in Armington models from the market power each country has. These effects can be substantial, dominating efficiency gains from trade liberalization (Brown, 1987). By allowing differences in substitution and expenditure elasticities AIDS functions could allow initially small trade flows to expand with the removal of trade barriers. It remains unclear from the literature surveyed to what extent this works in practice.

We have discussed two types of structural solutions to the small share problem: (partially) abandoning the Armington assumption and changing the functional form of the import aggregation function. Abandoning the Armington assumption, *i.e.* moving to a net trade model, only makes sense for a limited number of homogenous goods. A partial shift to a net trade model thus does not provide a general solution to the small shares problem. By maintaining imperfect substitutability between imported and domestic goods we can account for bilateral trade policies. Given the proliferation of regional trade agreements the ability to distinguish bilateral trade flows increases the policy relevance of the model. Changing the functional form of the import aggregation function increases the number of parameters that needs to be estimated. Although this may be feasible for a specific subset of countries and trade flows for the functional forms discussed above, the attractiveness of GTAP lies with its global coverage in terms of countries and trade flows. We find lack of an empirical basis for parameters governing trade flows that are at the heart of the model a serious limitation of dealing with the small shares problem through changing the functional form.

3. Shifting Armington functions to reflect changes in trade flows

At the heart of the small shares problem is the idea that trade flows that are small in the base should not remain small with extensive trade liberalization. Researchers have thus been searching for ways of increasing trade flows that are initially small, as discussed above. A change in the composition of imports following a considerable change of trade barriers can be seen as a change of 'import technology' in the Armington specification.

Viewed as a technology change, the small shares problem can be rephrased as a problem of predicting the composition of trade flows following a change in trade barriers. As observed by Hanslow (2001:2) small trade flows that remain small are not a problem if these initially small flows are not due to trade barriers but the result of non-economic factors (like remoteness, language, cultural or political barriers). Only if trade barriers are the dominant cause of small trade flows, we expect the composition of trade flows to change following trade liberalization.

In order to asses the impact of trade liberalization on trade shares and changing the model structure to account for these changes we need to predict trade flows in relation to trade barriers posed by tariffs while accounting for non-economic factors that affect trade[2]. There is a well-established tradition in trade economics of disentangling different factors affecting trade flows through gravity equations. We employ recent advances in the literature on gravity models to obtain a prediction of trade flows in relation to trade barriers, while accounting for non-economic factors. These estimations are then used to shift the CES Armington import aggregation functions to reflect possible changes in import composition following trade policies. We then implement these shifts in a GTAP based model, GTAPEM (Huang et al., 2004), to assess the impact on the expected impact of trade liberalization.

Anderson and van Wincoop (2003) derive a gravity model from a general equilibrium model. This model differs from commonly used gravity models by including 'multilateral resistance' terms capturing the country *i*'s and country *j*'s resistance to trade with all regions. These variables measure bilateral trade barriers in relation to trade barriers with other trading partners. Earlier gravity models have omitted such multilateral resistance terms from the specification and this has two important implications: (i) biased estimates due to omitted variables and (ii) incorrect comparative static analysis. Including the multilateral resistance terms as done in Anderson and van Wincoop (2003) would remedy these limitations. However, these multilateral resistance terms are not observable[3]. We therefore follow their suggestion to use exporter and importer fixed effects as proxies of the multilateral resistance terms. Including these fixed effects also allows asymmetric trade flows with symmetric trade barriers, allowing a better fit with the data.

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[2] Note that the presence of non-economic factors warns against model adjustments increasing the responsiveness of all small trade flows. If non-economic factors are the main cause of small initial trade flows these should not increase following a reduction in trade barriers.

[3] In Anderson and van Wincoop (2003) the multilateral resistance terms are defined as price-indices that account for trade costs. They however state that since trade costs can also be non-pecuniary these indices cannot be simply interpreted as consumer price indices, rendering them unobservable.

Using exporter and importer fixed effects as multilateral resistance terms we estimate the following gravity equation:

$$X_{ijk} = \rho_i + \rho_j + \beta + \beta_d \ln D_{ij} + \beta_s \ln T_{ijk}^{spec} + \beta_a \ln T_{ijk}^{adv} + \beta_e \ln S_{ijk}^{exp} + \sum_{m=1}^{M} \beta_{ijm} G_{ijm} + \varepsilon_{ij} \qquad (3)$$

where

i	= the exporting country
j	= the importing country
k	= GTAP sector for which the estimation is run
X	= trade from country *i* to country *j*
D	= distance between country *i* and *j*
$T^{specific}$	= power of the specific tariff applied by country *j* on imports from *i*, measured in ad valorem equivalents
$T^{ad\ valorem}$	= power of the ad valorem tariff applied by country *j* on imports from *i*
S^{export}	= power of the export subsidy applied by country on exports to *j*
G_m	= bilateral dummies capturing cultural and political distance
ρ	= multilateral resistance terms (exporter and importer fixed effects)
β	= coefficients to be estimated
ε	= error term.

Inclusion of the multilateral resistance terms through fixed effects implies that the estimated gravity equation only includes bilateral variables, thus lacking country-specific variables like country GDP traditionally included in gravity models. To avoid problems with zeros, we use the power of tariffs and export subsidies. The estimated model is similar to the most recent version of the TradeSim model used by the ITC to predict trade flows for developing countries and countries in transition (ITC, 2005). The major difference is that we differentiate ad valorem tariffs, specific tariffs and export subsidies. The ITC uses a single tariff variable thus assuming that ad valorem and specific tariffs have the same impact on trade flows and apparently ignoring the presence of export subsidies.

The absence of country-specific variables apart from the multilateral resistance terms reduces the potential for inconsistency between the gravity model and GTAPEM. The estimated gravity model only shares the tariffs (and export subsidies) with GTAPEM and these are always consistent since the gravity model is used to predict trade flows following a change in tariffs to be analyzed by GTAPEM. All other variables in the gravity model do not appear in GTAPEM, while other variables in GTAPEM do not appear in the gravity model. Recent contributions to the literature thus allow us to specify a gravity equation with a solid theoretical basis that reduces inconsistencies with GTAPEM and incorporates zero trade flows essential for the small shares problem in the GTAPEM.

Gravity models are generally estimated using OLS after log-linearizing the equation. Santos Silva and Tenreyro (2005) argue that such an OLS estimation is (a) biased because it omits zero trade flows and (b) inconsistent because of heteroscedasticity. To deal with these issues they propose the Poisson Pseudo Maximum Likelihood Estimator (PPMLE). PPMLE offers a consistent and efficient estimation method which is easy to implement even for large datasets. In the context of this study is has one other major advantage. Being developed for count data it allows zero observations of the dependent variable. We can thus include the zero trade flows causing the small share problem in general equilibrium models.

After estimating equation (3) we can predict for each combination of exporting and importing countries the expected trade flow. Comparing predicted and observed trade flows gives the residuals for each bilateral trade flow. These residuals contain bilateral differences not captured by the (dummy) variables included in the estimation. The aim of the gravity model is to predict trade flows following a change in tariffs or export subsidies. If we ignore the residuals and base predicted trade flows only on the estimated coefficients countries with identical variables end up with identical trade flows. This may result in large shifts in trade flows with a negligible change in tariffs. To avoid such large shifts we compute a bilateral fixed effect for each country-pair as the ratio of the residual to the predicted trade flow. The simulated trade flow after a change in tariffs or export subsidies is then computed as the predicted trade flow adjusted for the bilateral fixed effect.

The aim of our study is to address the small shares problem in a general equilibrium context. Although the estimated gravity equation is derived from a general equilibrium model there is a clear issue of consistency between the model underlying the gravity equation and GTAPEM. In this study we take a pragmatic approach, using the gravity model only to quantify changes in 'import technology' following a change in trade barriers. The idea being that the CES functions used in GTAPEM do not capture large shifts in trade flows one would expect when trade barriers change considerably. We employ the gravity model to quantify the expected shift in the composition of imports. We only use the market shares of different countries, not the levels of the exports, to avoid imposing the assumptions underlying the gravity model on GTAPEM. The gravity model thus serves to predict technological change while the determination of actual trade flows is left to GTAPEM.

In order to implement the technological shift we need to consider the manner in which GTAPEM models import demand. The small shares problem is explained above using a CES function defined in levels. The crucial issue turned out to be that for trade flows that are initially small or zero the share parameter α_i becomes small or zero in the input demand function (1). Based on the predictions provided by the gravity model we could thus change the share parameter α to capture changes in trade flows induced by changes in trade barriers.

Implementing such a change in GTAPEM is less straightforward than it seems at first sight. GTAPEM is modeled not in terms of levels, but in percent changes. This has implications for the manner in which import demand is modeled. For a discussion on deriving the model in terms of percent changes see Hertel (1998:43-44). In the current case there are two equations of interest: the percent change of price for aggregate imports (DPRICEIMP),

$$pim_{is} = \sum_{r} MSHR_{irs}[pms_{irs} - ams_{irs}], \qquad (4)$$

and the percent change of regional demand for disaggregated imported commodities (IMPORTDEMAND),

$$qxs_{irs} = -ams_{irs} + qim_{is} - ESUBM_i[pms_{irs} - ams_{irs} - pim_{is}], \qquad (5)$$

where

- i = set of traded commodities
- r = set of countries of origin
- s = set of countries of destination
- pim = percent change in market price of import i in country of destination
- pms = percent change in domestic price in country s of imports from region r
- qxs = percent change in the exports from region r to region s

qim = percent change in the imports by region *s*
ams = import of *i* from region *r* augmenting technical change in *s*
MSHR = market shares (*i.e.* α in equation 1)
ESUBM = elasticity of substitution between imports (*i.e.* σ in equation 1).

Equation (5) is the expression of equation (1) in percent terms, with an added variable *ams* that captures import augmenting technical change. Note that the share parameter α_i does not appear if import demand is expressed in percent terms. The small shares problem appears in the model because the share parameter ($MSHR_{irs}$) determines the import price in (4). If a country *r* is not exporting to region *s* in the base data it will have a zero market share. If trade barriers between *r* and *s* are then removed this would result in a lower price of imports from *r* (pms_{irs}). This lower price is however not accounted for when the price of imports in region *s* (pim_{is}) is computed, since the lower price of region *r* is multiplied with a zero market share. In other words, the small shares problem appears in GTAPEM because lower prices in regions with initially zero or very little trade are not 'seen' by model when the price of imports is computed.

To address the small shares problem in GTAPEM one would at first sight thus want to replace the $MSHR_{irs}$ parameter with the market shares simulated by the gravity model. Although this parameter is initialized using the base year trade flows, introducing the small shares problem into GTAPEM, this parameter is updated when the model is being solved. The market share parameter in the final solution thus differs from the initial market shares, reflecting changes in trade flows.

Since the gravity model and GTAPEM are not necessarily consistent we do want to impose trade shares as simulated by the gravity model in GTAPEM. We therefore implement the change in import technology by shifting the import technology through the ams_{irs} parameter. This assures that changes in the price of countries with initially small or zero trade are included in the computation of the import price, without forcing the trade shares from the gravity model upon GTAPEM.

We base the determination of ams_{irs} on the small share problem in GTAPEM, namely that changes in prices of some trading partners are not 'seen' when the import price is computed. We therefore impose that the initial import price is based on the trade shares predicted by the gravity model. Based on equation (4) this requires each of the bilateral prices to satisfy

$$MSHR_{irs}[pms_{irs} - ams_{irs}] = GSHR_{irs}\, pms_{irs}\,, \qquad (6)$$

where $GHSR_{irs}$ is the share of imports from region *r* according to the gravity model. Rewriting results in an expression for ams_{irs}:

$$ams_{irs} = pms_{irs} - \frac{GSHR_{irs}}{MSHR_{irs}}\, pms_{irs}\,. \qquad (7)$$

From this expression we find that if the price of imports from region *r* is not changing, pms_{irs} will be zero (and $GSHR_{irs}$ will equal $MSHR_{irs}$ since the gravity equation reproduces the base trade flows in the absence of a change to trade barriers) so there is no change in the Armington aggregation of imports. An appealing feature of equation (7) is that if there is a large change in the price of imports from region *r* but initial trade flows from *r* are small or even zero because of non-economic factors, $GSHR_{irs}$ will not be affected by the change in trade barriers and remains equal to $MSHR_{irs}$. There will thus be no changes to the Armington function if small trade flows are due to non-economic factors.

The change of import prices can be approximated to the first order by setting the price change equal to the change in the power of the tariff. The level of the import price is given by

$$PMS_{irs} = P_i^{world} \cdot T_{irs}^{spc} \cdot T_{irs}^{adv} \cdot S_{irs}^{\exp}, \qquad (8)$$

where we adopt the convention that an export subsidy is measured as a negative tax, such that its power is less than one. Holding the world price P_i^{world} constant, the percent change can be approximated by

$$pms_{irs} = t_{irs}^{spc} + t_{irs}^{adv} + s_{irs}^{\exp}. \qquad (9)$$

Accounting for the small shares problem by shifting the Armington function thus requires one to compute the appropriate shift to the Armington function any time a change in tariffs and or export subsidies is being simulated.

4. Estimating trade shares in relation to trade barriers

We use a combination of trade, tariff and export subsidy data from the GTAP Version 6 database with geographical data made available by CEPII[4] to estimate the gravity model. Table 1 describes the variables used in the estimation. The geographical data of CEPII are bilateral and defined at country level. The GTAP data are based on both individual countries and aggregate regions covering several countries. In order to make the two datasets compatible we aggregated the bilateral data from CEPII to the GTAP region aggregation using country GDPs as weights[5]. This weighing results in geographical dummy variables varying between 0 and 1 for aggregated regions.

Table 1: Description of variables used in estimation

Name	*Description*
Trade flows[a)]	Trade flows measured in 2001 million US dollar
Trade barriers[a)]	
Specific tariff	Power of the applied specific tariff measured in ad valorem equivalents
Ad valorem tariff	Power of the ad valorem tariff
Export subsidy	Power of the export subsidy measured in ad valorem equivalents
Non-economic factors[b)]	
Distance	Distance between capitals (or main) cities
Shared border	Dummy is one if countries are contiguous
Common language	Dummy is one if countries have a common language (official language or a language spoken by at least 90 percent of the population)
Colonial relation	Dummy is one if countries have or have had a colonial link
Same hemisphere	Dummy is one if countries are located in the same hemisphere (north, tropical of south)

[a)] data from GTAP Version 6 database; [b)] data based on CEPII distance database.

[4] The data can be downloaded from http://www.cepii.org/anglaisgraph/bdd/distances.htm.
[5] We used the average 1999 -2002 GDP from the World Development Indicators, 2005.

Table 2: Gravity estimations primary agricultural sectors

	PDR	WHT	GRO	V_F	OSD	C_B	PFB	OCR	CTL	OAP	RMK	WOL
Trade barriers												
Specific tariff	-5.86***	-3.82***	1.27**	0.53**	0.81	-1.07***	-17.96**	0.19	-5.95***	1.72**	n.a.	19.24***
	(1.38)	(1.16)	(0.67)	(0.31)	(0.93)	(0.31)	(7.19)	(0.25)	(2.10)	(0.71)		(4.18)
Ad valorem tariff	-18.55***	-4.87***	4.27***	-0.63	0.42	0.67	-10.65***	0.39	2.93	-5.51***	n.a.	-16.82***
	(3.22)	(1.34)	(0.84)	(0.63)	(0.35)	(1.89)	(3.01)	(0.58)	(2.52)	(0.92)		(4.80)
Export subsidy	n.a.	12.77***	3.72***	0.70	n.a.	n.a.	n.a.	n.a.	6.63**	6.39	4.04**	n.a.
		(3.54)	(0.75)	(7.82)					(3.07)	(29.79)	(2.44)	
Non-economic factors												
Distance	-0.64***	-1.26***	-1.21***	-0.78***	-0.95***	-0.57***	-0.87***	-0.64***	-1.03***	-0.77***	-0.01	-0.62***
	(0.23)	(0.12)	(0.12)	(0.07)	(0.15)	(0.12)	(0.12)	(0.06)	(0.14)	(0.09)	(0.01)	(0.12)
Shared border	0.74**	0.36**	0.63***	0.60***	0.46**	0.76**	0.54***	0.37***	1.71***	1.16***	-0.02	0.95***
	(0.45)	(0.18)	(0.19)	(0.15)	(0.28)	(0.37)	(0.20)	(0.11)	(0.27)	(0.14)	(0.02)	(0.21)
Common language	-0.05	-0.14	-0.28	0.08	0.46**	0.70***	0.52**	0.01	0.84**	-0.16	-0.03	-0.81***
	(0.40)	(0.24)	(0.23)	(0.17)	(0.25)	(0.26)	(0.22)	(0.12)	(0.36)	(0.22)	(0.03)	(0.19)
Colonial relation	1.06**	1.21***	0.31	0.74***	-0.40	0.44	-0.04	0.58***	-0.09	0.24	-0.01	1.64***
	(0.49)	(0.28)	(0.33)	(0.20)	(0.25)	(0.35)	(0.31)	(0.14)	(0.36)	(0.17)	(0.02)	(0.31)
Same hemisphere	0.33	0.18	0.42**	0.82***	-0.33	0.00	0.13	0.19**	0.08	0.00	0.05***	0.33
	(0.43)	(0.22)	(0.24)	(0.13)	(0.26)	(0.27)	(0.18)	(0.10)	(0.31)	(0.15)	(0.01)	(0.24)
Pseudo R^2	0.76	0.86	0.85	0.82	0.84	0.52	0.79	0.80	0.89	0.80	0.53	0.83
N=	7477	7475	7472	7473	7473	7477	7477	7464	7480	7476	7482	7477
Percent of total trade	0.03	0.20	0.20	0.80	0.20	0.00	0.10	0.60	0.10	0.20	0.00	0.04
Percent of agricultural trade	0.45	2.91	2.91	11.65	2.91	0.01	1.46	8.74	1.46	2.91	0.04	0.62

Note: robust standard errors in parentheses; *** indicates significance at the 1% level, ** significance at the 5% level and * at the 1 % level; n.a. means not applicable. Results for the country-specific dummies are not reported.

Sectors:

PDR = Paddy rice; **WHT =** Wheat; **GRO =** Cereal grains nec; **V_F =** Vegetables, fruit, nuts; **OSD =** Oil seeds; **C_B =** Sugar cane, sugar beet; **PFB =** Plant-based fibers; **OCR =** Crops nec; **CTL =** Bovine cattle, sheep and goats, horses; **OAP =** Animal products nec; **RMK =** Raw milk; **WOL =** Wool, silk-worm cocoons

Table 3: Gravity estimations agro-food industry

	CMT	OMT	VOL	MIL	PCR	SGR	OFD	B_T
Trade barriers								
Specific tariff	0.43	0.60	2.02 ***	-0.34	-1.88 **	-0.68	-4.56 ***	0.62
	(0.41)	(0.50)	(0.47)	(0.40)	(0.73)	(0.50)	(1.17)	(0.66)
Ad valorem tariff	0.77	-0.61	-1.42	-2.99 ***	-3.43 **	-2.27 **	-4.07 ***	-0.51
	(1.03)	(0.66)	(1.12)	(0.71)	(2.00)	(0.90)	(0.73)	(0.65)
Export subsidy	0.68 ***	18.99 ***	n.a.	2.99 ***	2.39 ***	0.13	-1.88	4.10
	(0.25)	(3.92)		(0.54)	(0.83)	(0.35)	(3.80)	(26.57)
Non-economic factors								
Distance	-0.63 ***	-0.59 ***	-0.83 ***	-0.61 ***	-1.18 ***	-0.78 ***	-0.72 ***	-0.50 ***
	(0.14)	(0.09)	(0.11)	(0.07)	(0.14)	(0.13)	(0.04)	(0.09)
Shared border	0.48 **	0.82 ***	0.41 **	0.93 ***	0.26	1.04 ***	0.68 ***	0.79 ***
	(0.23)	(0.17)	(0.22)	(0.13)	(0.29)	(0.25)	(0.07)	(0.16)
Common official language	0.41	0.41 **	0.24	0.32 **	-0.05	0.77 ***	0.24 ***	0.30 **
	(0.26)	(0.16)	(0.18)	(0.15)	(0.25)	(0.23)	(0.08)	(0.14)
Colonial relation	0.57 **	0.33	0.85 ***	0.66 ***	0.83 **	-0.04	0.63 ***	0.62 ***
	(0.34)	(0.22)	(0.31)	(0.18)	(0.42)	(0.32)	(0.12)	(0.19)
Same hemisphere	0.63 **	0.36 **	0.31 **	0.49 ***	-0.82 ***	0.26	0.16 **	0.56 ***
	(0.27)	(0.17)	(0.16)	(0.15)	(0.27)	(0.20)	(0.09)	(0.15)
Pseudo R^2	0.83	0.85	0.77	0.86	0.78	0.70	0.85	0.83
N=	7479	7474	7476	7477	7477	7475	7461	7470
Percent of total trade	0.30	0.50	0.20	0.40	0.09	0.10	2.00	0.80
Percent of agricultural trade	4.37	7.28	2.91	5.82	1.33	1.46	29.12	11.65

Note: robust standard errors in parentheses; *** indicates significance at the 1% level, ** significance at the 5% level and * at the 1 % level; n.a. means not applicable. Results for the country-specific dummies are not reported.

Sectors:

CMT = Bovine meat products; **OMT =** Meat products nec; **VOL =** Vegetable oils and fats; **MIL =** Dairy products; **PCR =** Processed rice; **SGR =** Sugar; **OFD =** Food products nec; **B_T =** Beverages and tobacco products.

Given the role of the gravity estimations in this study, the variables of most interest are the barriers to trade posed by specific tariffs, ad valorem tariffs and exports subsidies. We expect tariffs to reduce trade and export subsidies to promote trade. We distinguish specific from ad valorem tariffs to allow a differential impact of these rather different types of trade barriers.

The estimates reveal that some but not all cases are consistent with the prior expectations. There are two sectors for which none of the trade barriers have a significant effect: oil seeds (osd), other crops (ocr) and beverages and tobacco (b_t). This may be due to the aggregation of rather diverse goods with distinctly different patterns of protection in a single sector.

Focusing on sectors where tariffs are found to significantly affect trade flows there are several instances where a positive impact of tariffs on trade flows is found: cereal grains (gro), vegetables, fruits and nuts (v_f), animal products (oap), wool (wol) and vegetable oils and fats (vol). A possible explanation is that the model, despite the country dummies, does not properly capture non-tariff barriers (NTBs) to trade.

If countries with better access to markets in terms of tariffs in fact have worse access due to NTBs, there could appear to be a positive relation between tariffs and trade levels. Another possible explanation is suggested by the finding that a positive coefficient mainly occurs with specific tariffs. Only in the case of cereal grains (gro) the ad valorem tariff has a positive and significant sign. The data indicate a correlation between large trade flows and specific tariffs. This suggests that specific tariffs, that are more complex and thus costly to implement than ad valorem tariffs, are mainly used to restrict imports from competitive countries with a large export potential.

Export subsidies (when used) have a positive and, in most cases, significant effect on trade. The only exception is an insignificant negative impact on food products (ofd) which may be caused by the aggregated character of this sector. Compared with the coefficients on tariffs export subsidies tend to have a stronger impact on trade flows. A very strong effect is found for wheat (wht) and meat products (omt). This suggests that elimination of export subsidies, as put forward in the current Doha negotiations, would have a considerable impact on these trade flows.

5. Some first simulation results

Using the estimates discussed above to define shifts of the ‘import technology’ (*ams*) we simulate a full removal of import tariffs and export subsidies by OECD countries with GTAPEM. The aggregation used is the same as in Tangermann (2005) to allow comparison of results (see Annex for the aggregations used).

We perform two distinct simulation experiments. The first is a standard removal of tariffs and export subsidies. The second simulation adds the 'import technology' effect as obtained from the gravity model. The shifters *ams* for each bilateral trade flow are calculated according to equation (7). We do not shock the essentially untradable goods: paddy rice (pdr), sugar cane and beet (c_b) and raw milk (rmk). In addition, intra-regional trade is also not shocked. [6]

The results reported here should be regarded as preliminary, and are certainly not (yet) meant to be used in applied policy research. There remain a couple of questions regarding the specification of the gravity model that warrant further research. Especially the apparent *positive* impact of tariffs on trade in livestock products, which follows from the omission of non-tariff barriers in the econometric specification, is an area that needs further research. Nevertheless, we chose to present the results of the simulations in order to see the workings and implications of the amended Armington specification.

With all those reservations in mind, table 4 can be used to interpret world price effects. The first column shows the input into the gravity equation. It gives the first-round effects of price changes calculated from the change in the power of distortions. It shows the average domestic prices 'seen' by importers behind the border, *i.e.* after tariffs and subsidies are taken into account.

The second column gives the effects of removing trade barriers (tariffs and export subsidies) by OECD countries only using the GTAPEM model. It shows the price effects after all behavioral responses have settled into a new global equilibrium. Since this includes changes to supply and demand, the equilibrium responses usually differ from the first-round effects. In some instances they are smaller in magnitude, but in some cases they exceed the first-order effect. The divergence is attributable to a host of factors, including elasticities of supply and demand, import content of the commodity, market shares and so on.

The third column shows the price effects if the import technology shift (*ams*) is also included in the simulation. This effect reinforces the downward effect on import prices for all but one sector, most visibly in rice, sugar and meat products. The drop of average import prices indicate that on average the import technology shock in the model is indeed import augmenting: it reduces the effective price of imports, and it enhances global trade volumes. The exception is coarse grains (gro) where the model with an import technology shift results in a higher price than the standard model. This effect is caused by the counterintuitive gravity estimation results for coarse grains, with a positive impact of tariffs on trade flows (table 2).

The import price effects translate into trade effects, which are given in table 5. In the cases of sugar (processed) rice, wheat, oilseeds and Non-ruminant meat, the technology shift induces trade volumes to expand considerably beyond the standard trade effects. In other cases, where simulated price effects are smaller, the added effect of the import demand shift is smaller, yet clearly visible. An interesting case is processed rice, with a more than twofold increase in trade volumes already under standard assumptions. Our alternative specification adds an extra 10 percent points to global trade volumes.

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[6] A note for GEMPACK users: the large size of the model (26 regions, 20 commodities) in combination with the large size and large number of the shocks (full liberalisation) makes the model difficult to solve numerically. We needed 320 Euler steps to reach a solution. Furthermore, we chose to remove the sugar and milk quota restrictions that are part of the standard GTAPEM specification. We did this to prevent further numerical problems. The model was solved with GEMAPCK 9.0, using Euler's method with no extrapolation.

Table 4: World average import price

	Percent change from base	*1st order effect change in tariffs and export subsidies*	*GE solution, tariffs and export subsidies*	*GE solution incl. import techno -logy change*
		(1)	(2)	(3)
1	Paddy rice (pdr)	-27	-21	-22
2	Vegetable, fruits and nuts, pulses (v_f)	-5	-6	-8
3	Sugar can/beet (c_b)	-6	-10	-14
4	Plant fiber and other crops (pfoc)	-2	-3	-7
5	Wheat (wht)	-11	-4	-14
6	Coarse grains(gro)	-24	-10	-8
7	Oilseeds (osd)	-10	0	-2
8	Bovine cattle, sheep and goats, horses (ctl)	-2	-3	-5
9	Raw milk (rmk)	0	0	-1
10	Pigs, poultry, eggs etc (oap)	-1	-2	-5
11	Dairy products (mil)	-1	-5	-5
12	Processed rice (pcr)	-24	-10	-23
13	Sugar (sgr)	-21	-16	-27
14	Ruminant meat (cmt)	-11	-16	-18
15	Non-ruminant meat (omt)	-9	-10	-15
16	Vegetable oils and fats (vol)	-2	-6	-13
17	Other food (ofod)	-3	-5	-10
18	Manufacturing, fisheries, forestry, coal, oil, gas, Mineral (Mnfcs)	0	0	0
19	Textiles, wearing apparel, leather (twlthr)	0	0	0
20	Services (Svces)	0	0	0

Note: calculated as trade weighted percent change of domestic price of imports

Table 5: Global trade effects by commodity (excluding intra-EU trade)

		Base value, million US$ 2001	Effect of tariffs and export subsidies, % change from base		Effect including import technology change, % change from base	
			(value)	*(volume)*	*(value)*	*(volume)*
1	Paddy rice (pdr)	1960	381	402	354	376
2	Vegetable, fruits and nuts, pulses (v_f)	32740	12	18	12	20
3	Sugar can/beet (c_b)	44	6	15	6	20
4	Plant fiber and other crops (pfoc)	40979	1	3	1	8
5	Wheat (wht)	13568	6	10	7	21
6	Coarse grains(gro)	12213	9	19	12	21
7	Oilseeds (osd)	15805	2	2	3	6
8	Bovine cattle, sheep and goats, horses (ctl)	4478	2	5	3	9
9	Raw milk (rmk)	164	-8	-7	-8	-7
10	Pigs, poultry, eggs etc (oap)	11379	0	2	0	5
11	Dairy products (mil)	14256	52	57	42	47
12	Processed rice (pcr)	5220	126	136	126	149
13	Sugar (sgr)	7483	73	90	74	101
14	Ruminant meat (cmt)	15863	97	113	94	112
15	Non-ruminant meat (omt)	17889	52	62	59	75
16	Vegetable oils and fats (vol)	12432	23	29	12	24
17	Other food (ofod)	132480	5	10	6	16
18	Manufacturing, fisheries, forestry, coal, oil, gas, Mineral (Mnfcs)	3633692	0	0	0	0
19	Textiles, wearing apparel, leather (twlthr)	367826	0	0	0	0
20	Services (Svces)	1022077	0	0	0	0
Total		5362547	1	--	1	--

Figure 1 provides further insights into the effects of our import specification by showing world agricultural market shares. In most cases the technology shift results in a (sometimes strong) increase in market share while under the standard Armington assumptions a decrease in market share is observed. Australia & New Zealand (ANZL) provides the most extreme illustration of this effect, with a base market share of 1.2 percent, a small decline in market share to 1.1 percent under the standard model and a strong increase in market share to 7.2 percent with the import technology shift. For Brazil a similar strong difference is found, a small decline from 1.1 to 1.0 percent in the standard model, while its market increases to 6.1 percent with technology shifts. A similar, albeit less strong effect occurs in eight other regions (United States, China, India, Indonesia, Thailand, Sub-Sahara Africa, net food importing developing countries and ROW).

Figure 1: World market shares of agricultural trade (%)

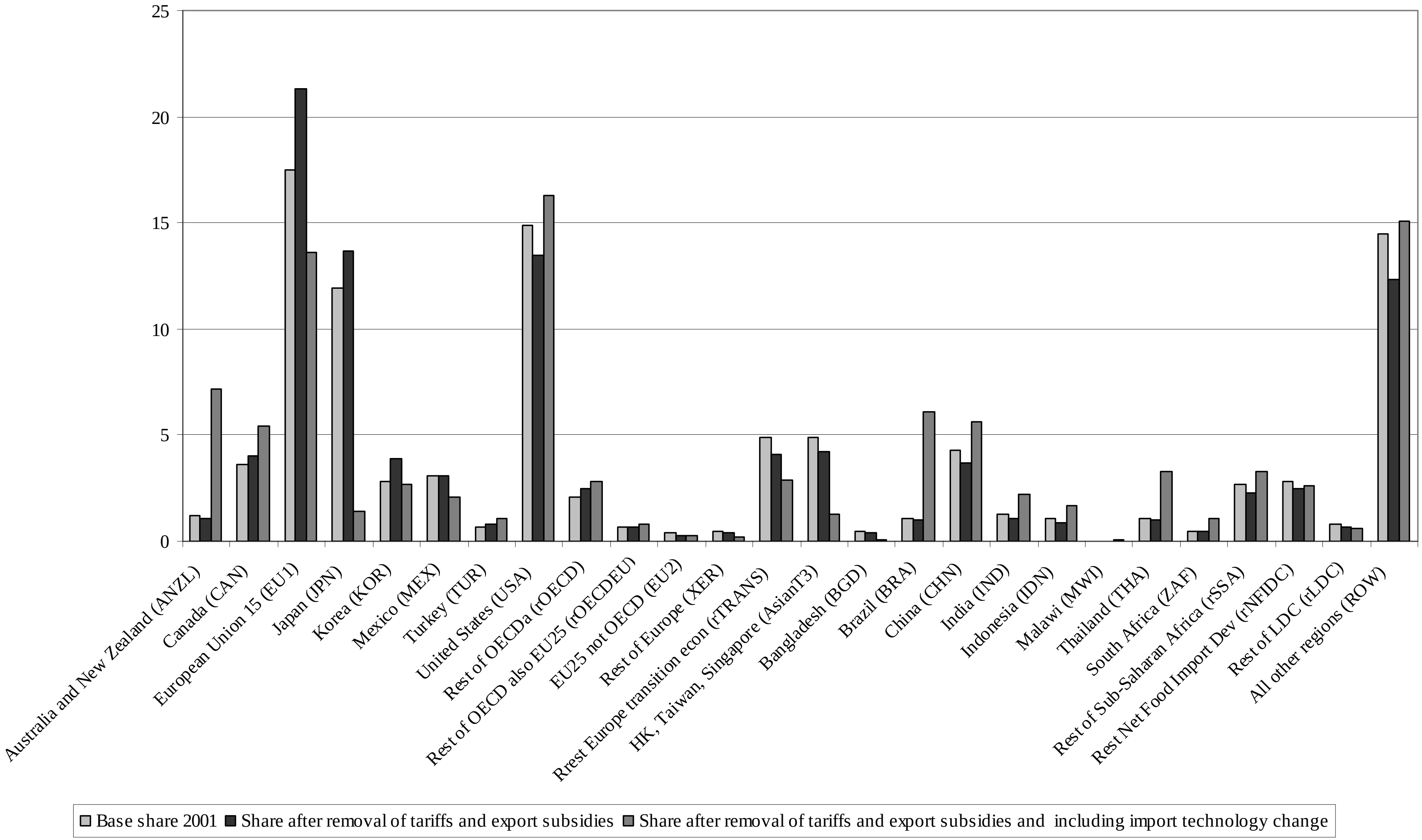
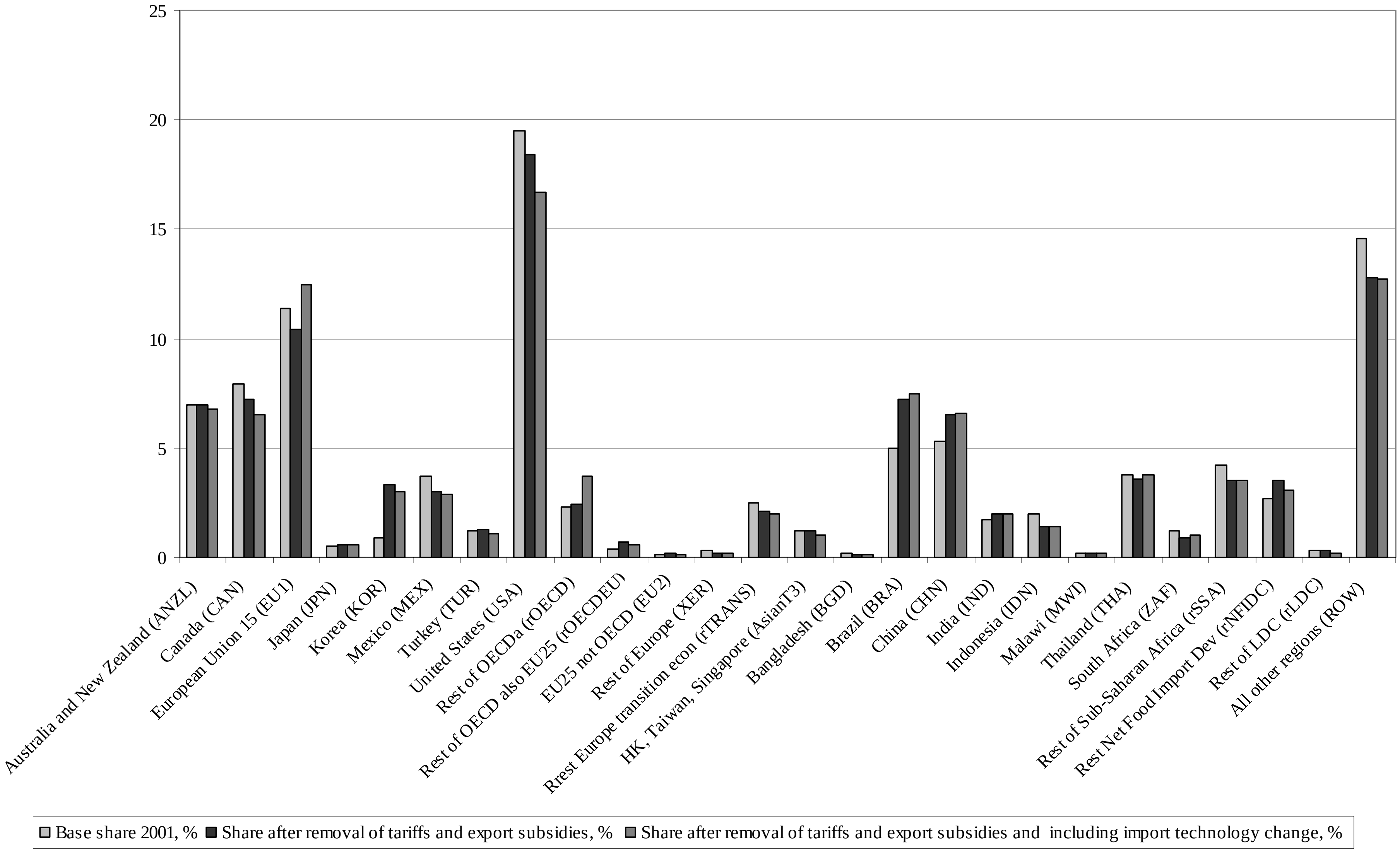


Figure 2: Exporter share in total OECD agri-food imports (excluding intra-EU trade) (%)



If some regions increase their market share with the technology shift, the market share of other regions must decrease. There are three regions where the standard model results in an increase in market share whereas the model with technology shift results in a (strong) decrease in market share: European Union, Japan and Korea. In the case of Japan, for example, the standard model results in an increased market share from 11.9 in the base to 13.7 with liberalization, whereas with technology shift its market share drops to only 1.4 percent.

Comparing the direction of change with respect to the base market shares the results of the standard Armington model and the model with technology shifts thus differ qualitatively. The standard model results in an increased market share of regions with an initially large market share. The model with technology shifts result in a redirection of trade from regions whose exports are fuelled by policy arrangements that encourage production by curbing imports, to regions jumping into the gaps and increasing their exports.

Although for halve the regions the two model specifications result in opposite trends in market shares for the other halve the same trend is observed. There are eight regions where the both model specifications result in a decreased market share: Mexico; rest of OECD also EU25; EU25 not OECD; rest of Europe; European transition economies; HK, Taiwan and Singapore; Bangladesh; rest of developing countries. For the remaining five regions, Canada, Turkey, rest of OECD, Malawi and South Africa both model specifications result in an increase in market share when the OECD liberalizes. In all cases the model with technology shift results in a much stronger change (upward or downward) in market shares. Finally, Malawi provides a nice illustration of the small trade share problem. It has an almost zero market share of 0.03% in the base which even decline to 0.02% in the standard model, as can be expected given the small trade share problem. In contrast, the model with technology shift results in a market share of 0.15 percent after liberalization of OECD markets. While still small, this represents a fivefold increase of Malawi's share of world agricultural markets.

Figure 2 presents the market shares in OECD imports of different exporters. Again the two model specifications show different results, although differences are less strong than for world market shares. The strongest difference is for the European Union (EU15) where the standard model results in a decreased market share form 11.4 to 10.4, whereas with a technology shift an increase to 12.5 percent of OECD imports results. The opposite pattern was observed for the word markets in Figure 1. With technology shifts The EU 15 thus looses global market share while increasing its market share on OECD countries. With the standard Armington assumptions the opposite is found, an increase in global market share and a decreased share of OECD markets.

The import technology shift does not change estimates of global welfare change by very much. It increases global welfare from US$ 48 billion by a mere US$ 1.6 billion (measured in 2001 prices), see table 6. The import shift affects the welfare calculation in much the same way as a technological change. Since it is an import augmenting shift of demand it lowers the effective prices that importers use to determine their importing decisions. We therefore observe both a price effect and a volume effect that is taken into account in the welfare estimate provided here. Consequently the largest positive welfare effects from our import specification are observed in regions that have large import volumes. Their terms of trade improve as imports become cheaper. For exporting regions the welfare effects are smaller, as their increased export volumes are sold at a lower price and their terms of trade deteriorate. On balance the positive effect from import technology change just outweighs the negative terms of trade effects, and we obtain a net positive, but small, effect on global welfare.

Table 6: Welfare effects (million US$ 2001)

	Standard tariffs and export subsidy effect	*Import technology effect*	*Total welfare change*
Australia and New Zealand (ANZL)	2096	-252	1845
Canada (CAN)	753	-618	136
European Union 15 (EU1)	6782	1396	8178
Japan (JPN)	18197	1254	19451
Korea (KOR)	5767	-347	5421
Mexico (MEX)	-108	621	513
Turkey (TUR)	599	-53	546
United States (USA)	2714	-936	1778
Rest of OECDa (rOECD)	1429	541	1970
Rest of OECD also EU25 (rOECDEU)	728	-114	614
EU25 not OECD (EU2)	284	-33	251
Rest of Europe (XER)	20	-16	4
Rrest Europe transition econ (rTRANS)	-74	-70	-144
HK, Taiwan, Singapore (AsianT3)	355	-125	230
Bangladesh (BGD)	-47	-1	-48
Brazil (BRA)	3921	248	4169
China (CHN)	792	147	939
India (IND)	490	30	520
Indonesia (IDN)	-86	18	-68
Malawi (MWI)	57	-2	55
Thailand (THA)	833	150	983
South Africa (ZAF)	107	69	175
Rest of Sub-Saharan Africa (rSSA)	87	-10	76
Rest Net Food Import Dev (rNFIDC)	830	-245	585
Rest of LDC (rLDC)	-16	-5	-21
All other regions (ROW)	1328	-38	1290
WORLD	47836	1611	49447

Note: calculated from Hicksian equivalent variation, EV

6. Conclusions

This paper presents an approach to tackle the so called "small shares stay small" problem that haunts Armington-style trade models. These models tend to understate the trade creation following significant liberalization efforts if initial trade flows are small. Stated simply, if there is no or little trade in the base period, there will likely be no or little trade impact of reducing tariffs - even if that reduction is very large.

A review of existing approaches to address this problem leads us to the formulation of an alternative that combines the Armington formulation with an econometrically estimated gravity model. The empirically founded specification is precisely where we view our contribution to the literature. Previous approaches have to rely on some assumptions regarding the parameterization of alternative functional specifications, or they abandon the advantages of a bilateral trade model in favor of a net trade specification.

We estimate a theoretically consistent gravity model along the lines of the recent literature in that area. This model includes trade barriers as explanatory factors as well as multilateral and bilateral factors, including non-economic factors, to explain bilateral trade flows in agricultural products. The model is estimated using the Poisson Pseudo Maximum Likelihood Estimator, which is a consistent and efficient method for our task and allows the inclusion of observation with zero values.

The gravity equation is then used to estimate the trade shares that would prevail after a lowering of OECD trade barriers. These estimated shares are subsequently used to calculate an import augmenting shifter for the Armington functions in the global general equilibrium model GTAPEM, such that the trade shares of the GTAPEM model are consistent with the shares obtained from the gravity model. This shock feeds together with reductions of tariffs and subsidies into simulation experiments.

The gravity model seems to perform well for most of the commodities included, but it performs less for livestock products. The econometric estimations reveal that other factors than tariffs and subsidies affect trade livestock products. Since NTBs are not included as explanatory variable, the estimations therefore falsely attribute a positive effect of traditional trade barriers on trade volumes. We nevertheless chose to retain these effects in the numerical simulations with GTAPEM, such that we can fully explore their consequences in a general equilibrium context.

Results from the GTAPEM simulations are encouraging. We simulate a full removal of tariffs and export subsidies by OECD countries only, leaving policies of other regions untouched. The standard model results in an increased market share of regions with an initially large market share resulting from protective policies. The model with technology shifts result in a redirection of trade from regions whose exports are fuelled by policy arrangements that encourage production by curbing imports, to regions jumping into the gaps and increasing their exports. The results also illustrate the small trade share problem. In the standard model Malawi maintains its zero share of global trade, whereas the model with technology shift Malawi obtains 0.1 percent of global trade after liberalization of OECD markets.

We are still a distance away from including the proposed alternative specification in applied policy research. Further work on the gravity estimations is clearly needed, especially regarding NTBs in livestock products. Nevertheless, we find the results obtained thus far sufficiently encouraging to warrant further work along the lines proposed here. We see the following advantages of our specification over alternatives: (1) its empirical underpinning, (2) the possibility to run the gravity model and GTAPEM independently from each other, hence avoiding the need to re-specify the import specification of GTAPEM, and, (3) the possibility to decompose the results such that the effects of adding our new specification can be made fully transparent.

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Annex: Region and sector aggregations

Table A1: Regional aggregation

No.	*Code*	*Description*	*GTAP V6 regions*
1	ANZL	Australia and New Zealand	aus nzl
2	CAN	Canada	can
3	EU1	European Union 15	aut bel dnk fin fra deu gbr grc irl ita lux nld prt esp swe
4	JPN	Japan	jpn
5	KOR	Korea	kor
6	MEX	Mexico	mex
7	TUR	Turkey	tur
8	USA	United States	usa
9	rOECD	Rest of OECDa	che xef
10	rOECDEU	Rest of OECD also EU25	cze hun pol svk
11	EU2	EU25 not OECD	cyp mlt svn est lva ltu
12	XER	rest of Europe	xer
13	rTRANS	rest Europe transition econ	alb bgr hrv rom rus xsu
14	AsianT3	HK, Taiwan, Singapore	hkg twn sgp
15	BGD	Bangladesh	bgd
16	BRA	Brazil	bra
17	CHN	China	chn
18	IND	India	ind
19	IDN	Indonesia	idn
20	MWI	Malawi	mwi
21	THA	Thailand	tha
22	ZAF	South Africa	zaf
23	rSSA	rest of Sub-Saharan Africa	xsc moz tza zmb zwe xsd mdg uga xss
24	rNFIDC	rest Net Food Import Dev	lka per ven xfa mar tun bwa
25	rLDC	rest of LDC	xse xsa
26	ROW	All other regions	xoc xea mys phl vnm xna col xap arg chl ury xsm xca xcb xme xnf

Table A2: Sector aggregation

No.	*Code*	*Description*	*old sectors*
1	pdr	Paddy rice	pdr
2	v_f	Vegetables, fruits, nuts	v_f
3	c_b	Sugar cane, sugar beet	c_b
4	pfoc	Plant fiber, other crops	pfb ocr
5	wht	Wheat	wht
6	gro	Cereal grains nec	gro
7	osd	Oilseeds	osd
8	ctl	Cattle, sheep, goats, horses	ctl
9	rmk	Raw milk	rmk
10	oap	Animal products nec	oap
11	mil	Dairy products	mil
12	pcr	Processed rice	pcr
13	sgr	Sugar	sgr
14	cmt	Meat, ruminants	cmt
15	omt	Meat, non-ruminants	omt
16	vol	Vegetable oils and fats	vol
17	ofod	Other food	wol ofd b_t
18	Mnfcs	Manufactures	frs fsh coa oil gas omn lum ppp p_c crp nmm i_s nfm fmp mvh otn ele ome omf
19	twlthr	Textiles, wearing app, leather	tex wap lea
20	Svces	Services and activities NES	ely gdt wtr cns trd otp wtp atp cmn ofi isr obs ros osg dwe