Shifting Armington Trade Preferences:

A re-examination of the Mercosur-EU negotiations

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1. Introduction

A decade has passed and a successful outcome to the Doha Development Round remains as uncertain as ever, leading some trade partners to seek out 'second best' bilateral preferential trade agreements (PTAs). The, European Union (EU), for example, has forged recent PTAs with South Korea, Columbia and Peru, whilst negotiations with Mercosur, which began in 1999, have floundered. In part, this was out of respect for the ongoing multilateral talks, but it also reflected a frustration related to the perceived intransigence of both sides to broker a deal. As a result, discussions were formally suspended in 2004, although a détente in relations would later bridge the way for a re-launch of the negotiations at the EU-Latin America and Caribbean Madrid summit in May 2010.

A review of the literature reveals various examples of computable general equilibrium (CGE) assessments of the EU-Mercosur negotiations (e.g., Diao et al., 2003; Philippidis and Sanjuán, 2007; Burrell, 2011). Indeed, with significant improvements in computational facility and access to the well known Global Trade Analysis Project (GTAP) database, deterministic neoclassical multi-region CGE models have become an accepted workhorse for assessing *ex-ante* trade led gains. The general consensus of this literature is that both the EU and Mercosur would witness real GDP gains (trade creation exceeds trade diversion), although the magnitude of these trade benefits is very much a function of the behavioural modifications within each study (i.e., economies of scale; trade led technology spillovers; non-tariff barrier estimates; capital accumulation etc.).

A common characteristic of multi-region CGE models is the treatment of import demands employing the Armington (1969) assumption. As a departure from the neoclassical paradigm, this structural feature permits the empirical observation of intra-industry trade (i.e., two-way trade in similar products), which at the level of aggregation inherent within the GTAP database, is considerable. In particular, characterising import demand by a 'convenient' functional form[1] (i.e., constant elasticity of substitution (CES)) captures horizontal product differentiation employing 'exogenous' considerations relating to region of origin; allows imperfect transmission between world and domestic prices; and offers analytical simplicity and computational tractability owing to its parsimonious structure.

Unfortunately, owing to the degree of parametric uncertainty, this behavioural structure often leaves CGE model results open to criticisms of disproportionate terms of trade effects when examining tariff liberalisation scenarios (Boadway and Treddenick, 1978; Brown, 1987).[2] A further well known results bias, which constitutes the focus of the present study, is the 'small share' problem (Morkre and Tarr, 1993). In particular, the Armington treatment understates trade creation when the benchmark data import share is 'small'. The policy implication is that tariff restricted competitive suppliers with small initial import shares do not witness the expected level of export growth in CGE liberalisation scenarios. There are a number of *ad hoc* solutions to the small share problem, although these only treat the symptoms whilst lacking any theoretical foundation. Furthermore, structural solutions (i.e., homogeneous product assumption, flexible functional forms) forgo the benefit of characterising intra-industry trade or place unreasonable parametric demands on a CGE model with global coverage.[3]

As a promising alternative, Kuiper and van Tongeren (2006) propose the gravity specification. More specifically, 'post-liberalisation' import trade patterns based on econometric tariff parameter estimates are subsequently employed in CGE models by

[1] The use of a convenient functions to specify import demands has implicit structural weaknesses (see Winters, 1984; Alston et al., 1990). Nonetheless, modellers accept these restrictions since the econometric information required to support a more flexible treatment is not available for disaggregated global CGE treatments.
[2] The relationship between the size of the Armington substitution elasticities and the terms of trade effect is particularly complex. Zhang (2006) provides a useful empirical discussion on this topic.
[3] A comprehensive discussion of these issues can be found in Komorovska et al (2007)

‘shifting’ the preference parameter in the Armington demand functions. Importantly, the gravity specification is theoretically consistent with a CES import demand structure (Anderson and van Wincoop, 2003, 2004), whilst its ability to decompose trade restrictiveness into economic (i.e., tariffs, export subsidies) and non-economic (i.e., remoteness, cultural barriers etc.) considerations, permits the modeller to discriminate between trade flows that remain small after liberalisation and those where competitive trade led growth may potentially arise. Surprisingly, whilst gravity models have enjoyed a renaissance in the literature, to the best of our knowledge, there are very few gravity studies (De Frahan and Vancauteren, 2006; Kuiper and van Tongeren, 2006; Raimondi and Olper, 2011) which attempt to estimate the trade restrictiveness of tariff barriers for a wide selection of agro-food sectors, whilst no known published studies extend this practise to disaggregated non agro-food sectors. Consequently, given the pervasiveness of the Armington assumption in global CGE assessments, the estimation and provision of publically available robust econometric estimates to correct this structural bias, constitutes a primary aim of this research.

Accordingly, this study builds on the seminal work of Kuiper and van Tongeren (2006) in three ways. Firstly, Kuiper and Van Tongeren (2006) and subsequently Komorovska et al. (2007) restrict their analysis to cross section data (release 6 of the GTAP database), while this study applies panel data to better control for country heterogeneity. Secondly, a typical feature of large trade data sets is the existence of zero values. In common with (*inter alia*) Komorovska et al. (2007), this study employs the Poisson estimator, but also explores more flexible variants of count models (Burger et al. 2009). Thirdly, in addition to the 20 agro-food sectors examined in the aforementioned CGE studies, the current paper considers all 56 tradable commodities in the GTAP database. To the best of our knowledge, this is the only panel gravity study which reconciles the methodological improvements of using zero-inflated models with a disaggregated sector analysis. A comparison with previous work reveals that the statistical significance of our sectoral gravity equations and the theoretical consistency of (*inter alia*), tariff and subsidy parameter estimates with a priori expectations is greatly improved.

In the second part of this study, estimated trade preference shifters are implemented into an agricultural variant of the GTAP CGE model to examine the revised pattern of trade gains from an EU-Mercosur PTA. Aside from its pertinence to global trade policy, EU-Mercosur trade relations also embody various ´small share' examples due to the EU's prohibitively high agro-food tariff regime. A comparison with a non-gravity baseline reveals important additional trade led gains in the Mercosur regions, with further increases in real economic growth of between 0.9% (Brazil) to 3.8% (Uruguay).

The rest of this paper is structured as follows: Section two analyses the gravity specification and the use of count models. Section three presents the results of the gravity specification for each of the sectors. Section four describes the CGE model, the policy scenarios, the gravity implementation and the CGE model results. Section five concludes.

2. The gravity specification

2.1 Model developments[4]

In its simplest form, the gravity model posits that trade between two countries is a positive function of GDP (i.e., economic 'mass') and a negative function of trade costs (i.e., distance). Empirical applications have extended this specification to encompass (*inter alia*) preferential trade (Kandogan, 2008; Martinez-Zarzoso et al., 2009; Foster et al., 2011; Hayakawa and Yamashita, 2011), contiguity (Bergstrand, 1985; Thoumi, 1989), common language and/or ex-colonial ties (e.g. Rose and van Wincoop, 2001), or even to cater for the effect of distance along different hemispheres as well as remoteness (Melitz, 2007). From an

[4] Chapter five of Feenstra (2004) provides a comprehensive review of the theoretical and empirical development of the gravity equation

econometric standpoint, earlier studies favoured the use of an Ordinary Least Squares (OLS) log-linear specification. Subsequent literature (Santos Silva and Tenreyro, 2006; 2011) demonstrates that this estimator does not adequately cater for zero value observations, whilst the expected value of the log-linearized error will in general depend on the covariates and therefore lead to problems of heteroskedasticity. This leads Santos Silva and Tenreyro (2006; 2011) to recommend the Poisson estimator, which belongs to the category of count models. This study further explores the potential of alternative count model specification, following closely the work by Burger et al. (2009).

2.2. Methodology: Count models

Trade observations are not pure count-, but rather non-negative continuous data. Notwtihstanding, the Poisson Maximum Likelihood estimator still provides consistent estimates (Woolridge, 2002; Burger et al., 2009), in which case it is referred to more precisely as the Poisson Pseudo-Maximum Likelihood (PML) estimator[5]. In the Poisson model, the occurrence of an event (i.e. the observed volume of trade between countries *i* and *j*) follows a Poisson distribution with density:

$$PProb = \Pr\left[X_{ij}\right] = \frac{e^{-\mu_{ij}}\ \mu_{ij}^{Xij}}{X_{ij}!} \quad X_{ij} = 0, 1 \ldots \tag{1}$$

where μ_{ij} is the rate parameter, which is a (exponential) function of the explanatory variables; the conditional mean of bilateral trade X_{ij} is $E[X_{ij}] = \mu_{ij}$ and the variance $Var[X_{ij}] = \mu_{ij}$. If the conditional variance exceeds the conditional mean, then there is over-dispersion, revealing the presence of unobserved heterogeneity caused by omitted variables (Burger et al., 2009). In this case, a Negative Binomial (NB) PML estimator is more advisable, as it relaxes the assumption of equi-dispersion. The NB model assumes that: $Var[X_{ij}] = \mu_{ij} + \alpha\ \mu_{ij}^2$, with α

[5] In the econometric literature the term Pseudo-Maximum Likelihood refers to estimating by Maximum Likelihood under the assumption that the specified density is not correct (Gourieoroux *et al.*, 1984).

being the dispersion parameter; if α equals zero the NB becomes a Poisson (Cameron and Trivedi, 1998).

In those cases containing an excess of zeros (compared to what the Poisson or NB predict) the Zero Inflated Poisson (ZIP) PML and Zero Inflated Negative Binomial (ZINB) PML is recommended.[6] Although ZIP and ZINB have been applied in a variety of fields including bio-diversity, medicine, manufacturing defects and economics, their application within the gravity literature (Burger *et al.*, 2009) is rare. The zero-inflated models acknowledge that zeros may arise subject to two regimes. In the first regime, the outcome is recorded as a 'false' zero, which reflects a situation where two partners never trade in a specific sector due to, for example, significant geographical and/or cultural distances, or simply because of errors in data recording. In the second regime, a Poisson process (or 'Negative Binomial') is assumed either in the case of a 'true' zero where trade could occur in the future subject to changing conditions (e.g., a reduction in transport costs; expansion of demand; trade liberalisation), or a non-zero trade observation.

In the context of zero observations, Burger et al. (2009) consider the ZIP and ZINB treatment to be superior to other rival specifications, such as the Hurdle Poisson or Heckman selection models. For example, comparing with the Hurdle Poisson, the inflated model is richer as it distinguishes between false zeros; true zeros; and non-zero values. Similarly, in contrast to the Heckman selection model, the inflated count models avoid (i) the restrictions imposed by the normality assumption; (ii) the need for an instrument in the second stage of the Heckman model where the amount of trade is predicted; and (iii) the bias induced by the log-transformation also in the second stage of the Heckman model.

2.3. Data and final model specification

[6] Further detail on the ZIP and ZINB models is available in Cameron and Trivedi (1998) and Greene (2002).

Data for 2001 and 2004 on bilateral trade flows, *ad-valorem* applied rates (import tariffs and export refunds) for 56 commodities (Table 1) and GDP for 95 regions are taken from releases 6 (Dimaranan, 2006) and 7 (Narayanan and Walmsley, 2008) of the GTAP database yielding 17892 observations for each sector. The population data needed to calculate *per capita* income is obtained from the World Bank (2011). Bilateral distance, contiguity, common official language, colonial linkages data, and the latitudes needed to calculate the variable *NoSo* are taken from CEPII (2011). A panel is better equipped to mitigate endogeneity problems usually referred in the literature in relation to PTAs (Martínez-Zarzoso et al., 2009) and tariff rates (Komorovska et al., 2007; Philippidis and Sanjuán, 2007).[7]

The final form of our gravity specification is presented in equation (2), where the sub-index *i* and *j* refer to the exporter and importer, respectively, whilst *t*, refers to the year:

$$E[X_{ijt}] = \mu_{ijt} = \exp\left(\begin{array}{l} \beta_0 + \beta_1 Mt_{ijt} + \beta_2 Xs_{ijt} + \beta_3 Dist_{ij} + \beta_4 NoSo_{ij} + \beta_5 \mathrm{Re}mote_{it} + \beta_6 Contig_{ij} \\ +\beta_7 Lang_{ij} + \beta_8 Col_{ij} + \beta_9 PTA_{ij} + \beta_{10} SqIncome_{ijt} + \beta_{11} Gdp_{ijt} \\ +\beta_{12} Y2004_t + \sum_{i=2}^{T} \theta_i F_i + \sum_{j=2}^{T} \theta_j F_j + \varepsilon_{ijt} \end{array} \right) \quad (2)$$

The gravity equation includes fixed effects for both time (*Y2004*) and country (exporter and importer) (F_i and F_j)[8]. The country fixed effects proxy the unobserved theoretical multilateral resistence terms posed by Anderson and van Wincoop (2003, 2004)[9], while both, country and year fixed effects control for correlation between omitted and observed variables (Greene, 2002). The distance variable (*Dist*) is complemented by contiguity (*Cont*), location by hemisphere (*NoSo*) and remoteness (*Remote*) variables. The *NoSo* may mitigate the negative impact of distance when trade between hemispheres is due to different factor

[7] Employing only a single year of data, the observation that 'large' agro-food net importers (i.e., the EU, USA) also impose high tariff barriers explains the perverse positive tariff coefficients found in previous empirical applications.
[8] In the final estimated model, however, some of the exporter fixed effects had to be dropped to avoid collinearity problems, in particular with export specific variables such as remoteness.
[9] Anderson and van Wincoop (2003, 2004) stress the importance of controlling for multilateral resistance terms arguing that trade between two regions depends on the bilateral barrier between them relative to the average trade barriers that both regions face with all their trading partners.

endowments and patterns of product specialization (Melitz, 2007), while *Remote* may also mitigate the distance effect due to the lack of large countries in the proximity with which to trade (Frankel, 1997). In terms of historical and cultural linkages, we include both common language (*Lang*) and colonial ties (*Col*) dummies, which are expected to have a non-negative effect. Additionally, membership of a PTA (*PTA*), the squared difference (*SqIncome*) (Linder hypothesis) and the product of GDPs (*Gdp*) in per capita GDPs are incorporated. [10] A positive *PTA* effect is expected, while a negative *SqIncome* impact would confirm the Linder hypothesis. Finally, bilateral import tariffs (*Mt*) and export subsidies (*Xs*) are inserted into the gravity regression. A full description of the explanatory variables is presented in Table 2.

The estimated coefficients represent the percentage change in the conditional mean of trade resulting from a unit variation in the explanatory variable (Cameron and Trivedi, 1998). If the explanatory variable is expressed in logs, the coefficient can be interpreted directly as an elasticity; whilst in the case of a dummy variable, the exponential minus one multiplied by 100 provides the percentage change in trade when the dummy changes from 0 to 1. Robust standard errors have been estimated using the White sandwich estimator of variance, and the econometric software STATA 8.0 has been applied in the estimation of all count models.

3. Gravity model results

Results of the estimation are presented in Table 3. In choosing between the four alternative models (Poisson, Negative Binomial, Zero Inflated Poisson and Zero Inflated Negative Binomial) for each of the 56 gravity models, two tests are conducted. The Vuong statistic (Vuong, 1989) is applied to compare the inflated versus the non-inflated versions (i.e., ZIP versus Poisson; and ZINB versus NB). Subsequently, the log-likelihood ratio (LR) statistic is used to test for the significance of the dispersion parameter (α). A significant

[10] The *Gdp* coefficient is restricted to a value of 1 according to the theoretical model derived by Anderson and van Wincoop (2003). From an estimation perspective, the use of the bilateral product of GDP and the difference in per capita income reduces collinearity problems that may emerge between individual GDP (or per capita GDP) with country fixed effects. The Linder hypothesis posits that countries with similar per capita incomes have a greater tendency to engage in mutual trade

dispersion parameter favours the NB versus the Poisson model, or the ZINB versus the ZIP model. Neither test is adequate for comparing the Poisson vs. ZIB, or NB vs. ZIP, in which case, the model with the lowest Akaike Information Criteria (AIC) is selected (not shown), whilst the statistical significance of tariff and export refund coefficients also has an important bearing on final model choice.

Focusing on tariff barriers (*Mt*), we observe that in almost all the regressions, *ad valorem* tariffs have the expected negative sign (Table 3). Comparing between the agro-food sectors where applied *ad valorem* tariff peaks are typically highest, plant fibres, livestock activities and dairy record the largest tariff coefficient estimates (i.e., the perceived sensitivity between tariff reductions and trade changes). For example, in the latter, trade rises by 1.931% in response to a 1% reduction in tariffs. In the non-food sectors, the sensitivity of trade to tariff rate changes is highest in the textiles and leather sectors; coal mining; refined petroleum and coal; and non ferrous metals. One sector ('ely') exhibits an unexpected positive but non-significant sign, whilst five more sectors show insignificant *ad valorem* tariffs coefficients ('osd', 'c_b', 'oil', 'gas', 'gdt').[11] In the data, raw sugar (c_b) is largely non-tradable, whilst the tariff coefficient on downstream tradable sugar (sgr) is significant. In the oilseeds sector, there is tariff escalation where protection of oilseeds imports by 'large' developed countries is typically low, whilst tariffs on oilseed products (i.e., 'vol', whose coefficient is found to be highly significant) are high.[12]

Turning to the export refund coefficients, a positive and significant coefficient (*Xs*) is found in five of the 14 agro-food markets which employ export refunds (Table 3). Unexpectedly, a negative but non-significant effect is found in the cattle meat (cmt), and beverages and tobacco (b_t) sectors. We suggest that the degree of insignificance of export subsidies (vis-à-vis import tariffs) is a consequence of the fact that export refunds are a

[11] Komorovska et al. (2007) also find insignificant tariff coefficients for oilseeds (osd) and raw sugar (c_b)
[12] Sarker and Jayasinghe (2007) also note that as the largest importer of oilseeds (soybean, rapeseed and sunflower) the EU market access has been tariff free since the Uruguay Round Agreement on Agriculture.

response to market conditions and therefore are not systematically employed year on year. In non-agro-food sectors, a positive and significant impact of export subsidies is found in 13 out of 20 sectors for which export subsidies are applied, while *a priori* an unexpected non-significant and negative impact is found only in one sector: transport equipment ('otn').

As expected, distance has a negative and significant impact on trade in almost every sector. The median parameter estimate is -0.762, which implies that in 50% of the sectors, trade increases by more than 0.762% when distance drops by 1%. Notwithstanding, when measuring distance North-South hemispheres a positive (although generally small) and significant effect is found in 18 sectors, whilst contrary to expectations, eight other sectors yield statistically significant negative effects, intensifying the already negative distance effect. In many sectors (27 in total) remoteness plays a significant positive role in explaining bilateral trade, with an associated median impact of 1.308. Nevertheless, a significant *negative* impact is also found in eight other sectors. Contiguity is also found to favour trade. In half of the sectors, the fact of sharing a border increases bilateral trade by 57.62%.

Turning to our historical explanatory factors, language is statistically significant in only 21 sectors, whilst colonial links are found to encourage greater bilateral trade in 39 sectors. In both cases, however, the median impact on trade is small (zero per cent in language, since positive and negative coefficients cancel each other out; 25.73 per cent for colonial ties). Membership of a preferential trade agreement (*PTA*) increases bilateral trade in most sectors (36), with particularly notable impacts in the three cereals sectors. On the other hand, in seven sectors, a statistically significant negative effect is recorded. Overall, the results indicate that the median impact on trade is 34.46%. Finally, Table 3 shows a significant Linder effect (*SqIncome*) in 12 sectors, four of which are in the agro-food industries.

4. CGE model and experiments

4.1 CGE model description and gravity implementation

The ‘standard’ comparative static GTAP model (Hertel, 1997) is demand driven, employing neo-classical optimisation to derive Hicksian consumer and intermediate demands. Regional utility is aggregated over non-homothetic private demands, public demands and savings (investment demand). Producers are perfectly competitive and exhibit constant returns to scale technology, with access to five factors of production. Both (skilled and unskilled) labour types and capital are fully mobile between sectors, whilst land (agriculture specific) and natural resources exhibit restricted mobility. Regional savings are collected by a fictitious ‘global bank’, which then assigns regional investments subject to a rate of return or a ‘fixed share rule. Once an endogenous/exogenous variable split is determined (‘closure’), exogenous policy shocks catalyse an interaction between economic agents, subject to a series of accounting identities and market clearing equations, which ensures a new (‘counterfactual’) general equilibrium solution. This study employs an agricultural variant of the standard GTAP model which shares a number of common features with the GTAP-AGR (Keeney and Hertel, 2005), whilst also explicitly incorporating EU common agricultural policy (CAP) mechanisms and an econometrically estimated land supply function by region.[13]

Since the standard GTAP model is typically represented in linear (percentage change) form, Armington import demands of commodity ‘i’, from origin ‘r’ to destination ‘s’ are typically represented as:

$$m_{i,r,s} = -a_{i,r,s} + mc_{i,s} - \sigma_i^M \left(p_{i,r,s} - a_{i,r,s} - pc_{i,s} \right) \quad (3)$$

$$pc_{i,s} = \sum_r MSHRS_{i,r,s} \left[p_{i,r,s} - a_{i,r,s} \right] \quad (4)$$

where $m_{i,r,s}$ are bilateral demands; $mc_{i,s}$ is the import composite from all origin countries; $p_{i,r,s}$ is the (post-tariff) commodity market price; $pc_{i,s}$ is the composite (or ‘weighted’) price of commodity ‘i’ across all origin countries; σ is the elasticity of substitution of commodity ‘i’

[13] The model is employed by the UK Ministry of Agriculture (DEFRA). Full documentation of the model extensions is available upon request.

between alternative origin routes. The composite import price of good ‘i’ in region ‘s’ is calculated as a weighted import share (MSHRS) index of individual import prices from origin ‘r’. Thus, in linearised form, the small share problem manifests itself by the size of the coefficient ‘MSHRS’ in equation (4). If ‘MSHRS’ were tiny for a particular route of origin ‘r’, significant (tariff induced) falls in ‘p’, coupled with a large trade elasticity (σ), will still only result in a small trade effect.[14]

From a modelling perspective it is not practical to directly substitute the GTAP import shares in the benchmark data with equivalent post-liberalisation gravity predictions (GSHRS) since this would disrupt the internal consistency of the GTAP database. Kuiper and van Tongeren (2006) view the necessary change in import composition as akin to a change in ‘import technology’. More specifically, an exogenous Hicks neutral technological shift variable for each bilateral route ($a_{i,r,s}$) shifts the Armington import demand curve to mimic the composition of import trade shares predicted by the gravity model. Thus, a positive shock to the technology shifter reduces the ‘effective’ bilateral import price (i.e., $p_{i,r,s} - a_{i,r,s}$) and increases the effective quantity imported (i.e., $m_{i,r,s} + a_{i,r,s}$). To determine the magnitude of these shocks, it is assumed that the percentage change in the effective import price is based on the following identity:

$$MSHRS_{i,r,s}\left[p_{i,r,s} - a_{i,r,s}\right] = GSHRS_{i,r,s}\, p_{i,r,s} \qquad (5)$$

where GSHRS is the predicted bilateral gravity import share from removal of all tariffs between the EU the Mercosur. Rearranging:

$$a_{i,r,s} = p_{i,r,s} - \frac{GSHRS_{i,r,s}}{MSHRS_{i,r,s}}\, p_{i,r,s} \qquad (6)$$

[14] Consider two MSHRS values of 0.99 (r=1) and 0.01 (r=2) in region ‘s’. Since $pc_{i,s} \approx p_{i,1,s}$, then under tariff liberalisation, $p_{i,2,s}$ would have to fall considerably more than $p_{i,1,s}$ to provoke any significant bilateral import demand response (i.e., the relative tariff along r=1 should be much higher than other import routes, whilst the σ parameter must also be highly responsive). Notwithstanding, even then, the percentage change in bilateral import *value* (-%ΔP x +%ΔM) may not increase significantly from such a small base.

Employing a first order linear price linkage assumption, the percentage change in the (post tariff) bilateral import price in destination 's' reflects the percentage change in its applied tariff and (if present) the export subsidy in origin 'r'.[15] For example, a greater applied tariff reduction for a specific bilateral route is expected (*a priori*) to raise the corresponding gravity predicted import share, accompanied by a notable percentage drop in the bilateral import price. Accordingly, the prescribed (positive) shock to the technological shifter would be of a larger magnitude.

4.2 Data aggregation, scenario design and closure

Employing version 7.1 of the GTAP data (2004 benchmark), our study includes all 20 GTAP agro-food sectors; textiles, light- and heavy-manufacturing, services and natural resources. For modelling purposes, the EU is split into four regions, although results are only presented for the bloc of 27. In addition, each of the four Mercosur members (Argentina, Brazil, Paraguay, Uruguay) are disaggregated; whilst residual trade flows are captured by the rest of the world (ROW) region.

In our long run 'baseline', tariff shocks extend the single market to 27 EU members, whilst all tariffs between the EU and Mercosur are removed. Moreover, the importance of agro-food markets in our analysis warrants an explicit characterisation of the CAP reforms (i.e., intervention price reductions, abolition of set-aside, abolition of dairy and sugar quotas, single farm payment, CAP budget, modulation increases). Given the degree of uncertainty surrounding the Doha talks, whilst also with a view to isolating the policy shocks of interest, multilateral liberalisation shocks were not considered. A further 'gravity' scenario mimics the trade policy shocks of the baseline, with the addition of exogenous shocks to the

[15] A reduction in an applied tariff (export subsidy) is expected to reduce (increase) the import price. Moreover, in those relevant cases where data are available, the size of the tariff reduction may also depend on the binding tariff overhang (in multilateral simulations) and sensitive product exceptions.

technological shift parameters.[16] The model closure follows traditional neoclassical assumptions of flexible wages and long-run (exogenous) natural rates of employment. The capital market is characterised by a long run 'steady-state' Baldwin closure (Francois, 1996),[17] whilst regional land supply is subject to an econometrically estimated supply function. Unless otherwise stated, the results report the additional impacts of gravity compared with the baseline.

4.3 CGE Results

The GTAP version 7 data reveal that the EU imports €36,452 million from Mercosur (2004 prices), of which 40 per cent consists of highly protected agro-food trade (e.g., sugar, dairy, meat). Similarly, Mercosur imports €26,974 million from the EU, of which 98 per cent is non agro-food related. Comparing between both regions, the data suggests that Mercosur applied tariffs are between 10-20 per cent in non-food sectors, whilst corresponding EU applied tariffs are typically below 5 per cent. It is therefore not surprising that the baseline experiment shows improved agro-food production in Brazil (5.1%); Argentina (20.7%); Paraguay (14.0%) and Uruguay (10.7%); with a concomitant contraction in EU agro-food activity (-1.1%). Similarly, textiles, light- and heavy-manufacturing production in the EU rise 0.7%, 0.2% and 0.3%, with concurrent contractions in Mercosur's corresponding sectors. Owing to significant agro-food market access gains, real growth rises in Brazil (1.2%), Argentina (2.9%), Paraguay (3.7%) and Uruguay (3.2%), whilst the EU real growth estimate is muted (0.01%).[18]

Comparing with this baseline, EU agrofood (non agro-food) imports from Mercosur rise (fall) a further 29.5 per cent (7.3 per cent), resulting in an overall fall of 16.4 per cent (results

[16] Additional ancillary programs are written to calculate predicted trade flows under gravity for the regional/commodity aggregation of choice.
[17] Steady state implies that the rate of capital growth is just sufficient to replace depreciated capital.
[18] We do not show these results since other studies in the literature find a similar result (a useful review is given in section 2 of Burrell, 2011). The focus here is to examine the potential bias from additional gravity induced trade effects.

not shown). This leads to important EU import trade share changes, which are presented as percentages in Table 4 for the most affected sectors. The benchmark EU trade data for processed sugar show that Brazil and Paraguay have characteristically small shares (2.6% and 0.1%, respectively) on account of the EU's prohibitive tariff. In the baseline, these figures rise to 47.0% and 4.1%, respectively, whilst with gravity included, there is a further rise to 66.1% and 5.7%, respectively.[19] Comparing between the baseline and gravity scenarios, the intra-EU trade share falls 13.1 percentage points.

A similar effect is observed for processed rice, where EU imports from Uruguay account for only 0.4% in the benchmark. From this small base, the gravity scenario produces a further rise of 2.2 percentage points compared with the baseline, with much of this newly acquired market share diverted from the rest of the world (ROW). In dairy trade, this effect is even more striking. Benchmark EU import shares from Argentina, Brazil and Uruguay, account for 0.04%, 0.02% and 0.01%, respectively, whilst compared with the baseline the gravity scenario induces, a 21.6, 4.8 and 2.8 percentage point increases in the import shares for Argentina , Brazil and Uruguay, respectively). Accordingly, the intra-EU trade share falls a further 27.1 percentage points.

In red and white meat markets, the benchmark data shows that Brazil already registers a small but steady presence, accounting for 7.2% and 4.6%, respectively, of EU imports. In the baseline, Brazil amasses a majority stake of EU red meat imports (74.3%), whilst its white meat trade share grows to a respectable 14.1%. Brazilian red meat trade shares increase a further 8.3 percentage points for red meat and 2.5 percentage points for white meat in the gravity scenario. Consequently, there are concomitant reductions in Argentinean, Uruguayan and intra-EU red meat trade shares (-1.2, -1.0 and -6.4 percentage points, respectively), whilst

[19] The EU operates a prohibitive TRQ system of preferences for imports of sugar. As a large producer, Brazil is not afforded preferential treatment under the ACP scheme, although its trade share is steadily rising in the absence of the EU-Mercosur agreement owing to trade preference erosion due to the reduction of the EU's guaranteed prices under the auspices of the sugar reforms.

the intra-EU white meat share falls a further two percentage points. In Paraguay, although the percentage point increase (0.64) in red meat trade share is not as visible, in relative terms this represents a significant import trade share gain when we considered next to its benchmark value (0.04%).

In terms of Mercosur's import shares (Table 4 – right panel), non agro-food imports from the EU record further gains compared with the baseline scenario, on account of Mercosur's higher tariff protection. Perhaps surprisingly, the EU's agro-food trade share also rises because of significant applied tariff protection levied by Mercosur on the aggregate sectors 'beverages and tobacco' and 'other food' processing. With the addition of gravity effects, the largest increases in EU trade shares occur in textiles (8.1 percentage points), whilst agro-food, light and heavy manufacturing record percentage point increases of approximately 2.5. Overall, Mercosur imports from the EU rise a further 9.4 per cent, due to agro-food (small base) and non agro-food increases of 20.2 per cent and 9.1 per cent (results not shown).

Translating these additional trade led impacts into euro values, Table 5 shows an additional EU trade revenues decline of €10,328 million for agro-food products, with losses mainly accruing in dairy (€7,493 million), red meat (€3,405 million) and processed sugar (€1,422 million). This agro-food loss is compensated by gains in non agro-food trade (€10,279 million), which mainly accrues to heavy- (€5,222 million) and light-manufacturing (€2,508 million). As expected, the two largest Mercosur partners (Argentina and Brazil) enjoy the biggest agro-food trade revenue gains. With important trade balance improvements in red meat, dairy and sugar, Brazil realises an improvement in agro-food trade revenues of €5,558 million, whilst Argentina's corresponding statistic of €4,003 million is due to sizeable gains in its dairy sector. Paraguay realises its largest trade revenue gains in red meat (€169 million) and sugar (€143 million), whilst in Uruguay, there are important gains of €767 million.

Table 6 presents the impacts on resource reallocation, output and prices compared with the baseline. In the Mercosur regions, addition 'gravity' effects fuel further macro growth (particularly in Uruguay) and corresponding demand pull inflationary impacts on factor prices. Land prices rise a further 29.1 per cent and 14.6 per cent in Uruguay and Argentina, respectively, whilst in Brazil and Paraguay increases of between eight and ten per cent are estimated. Consequently, market prices in these regions rise, with a retail price index increase of up to seven per cent in Uruguay. With healthy expansions in sugar, meat, and dairy activities, agro-food output in all Mercosur regions rises between 3.3 per cent in Brazil (from a large base) and 9.3 per cent in Uruguay (due to a large expansion in its dairy sector). This further resource reallocation leads to contractions in textile and manufacturing activities, which in percentage terms, are particularly marked in Uruguay and Argentina. In the EU, red meat, sugar and dairy activities contract significantly (with repercussions in upstream sectors) resulting in a 2.1 per cent fall in EU agro-food output and a fall in the land price of 2.1 per cent. In the non agro-food sectors where the EU maintains a competitive trade advantage, additional gravity shocks result in a (slight) output rises (from large bases) in textiles, light- and heavy-manufacturing sectors.

Examining the welfare impacts (Table 5 – lower panel), per capita real incomes increase further in Uruguay (5.8 per cent), Paraguay (3.1 per cent), Argentina (2.6 per cent) and Brazil (1.0 per cent), whilst in the EU the change is negligible. In monetary (equivalent variation) terms, the gains in Mercosur are largely due to the terms of trade (ToT) improvement owing to real exchange rate increases.[20] In the EU, allocative efficiency gains of €7,062 million are largely explained by contractions in (subsidised) agro food activity. Moreover, additional EU trade facilitation gains (€5,053 million) are due to the technological Armington shifters,

[20] For a full discussion of EV welfare decomposition in GTAP, see McDougall (2003).

particularly in meat, sugar and dairy imports from Mercosur.[21] In Mercosur, trade facilitation gains (principally textile, light- and heavy-manufacturing imports) are smaller due to lower benchmark applied tariffs in the Mercosur regions.

5. Conclusions

This study employs a quantitative framework to re-assess the potential trade-led gains from an EU-Mercosur agreement. With the widespread usage of neoclassical multi-region computable general equilibrium (CGE) *ex-ante* trade liberalisation assessments, a key methodological focus examines the estimation and correction of well known trade creation bias on small import shares which arises from the Armington import specification. As a remedial measure, the study follows Kuiper and van Tongeren (2006). More specifically a gravity specification is employed to estimate the trade restrictiveness of tariff parameters on a sector-by-sector basis. The novelty of the research relates to use of count models with panel data, whilst the sectoral coverage of the study is extended to include all 56 tradable agro-food and non agro-food sectors. It is hoped that other modellers may also be able to employ these estimates to their own aggregations in an attempt to eliminate this important source of bias

Comparing with Kuiper and van Tongeren (2006), the econometric results show a promising improvement in the statistical significance and consistency of the (tariff) parameter estimates with respect to *a priori* expectations across all of the sectors considered. In the second phase of this research, a baseline EU-Mercosur tariff elimination scenario is run employing a modified variant of the GTAP CGE model, , which in consonance with other CGE studies, yields real GDP gains to the Mercosur regions and to a lesser extent, the EU. In a further experiment, gravity simulations are run to ascertain the impact of a full tariff liberalisation between the EU and Mercosur on their respective import trade shares, which are subsequently employed to calculate 'technological' preference shifters in the CGE Armington

[21] Given the 'technological improvement' in import composition, this registers as an additional real income gain via increases in imports (quantity effect) and a lower effective prices (price effect).

functions. Comparing with the baseline, traditionally small Mercosur exports enjoy notable EU market penetration. More specifically, owing to its high tariff barriers, EU imports of meat, dairy, sugar and rice from the Mercosur regions grows significantly, whilst the largest third country trade diversion effects occur on sugar trade.

As a caveat of this research, the size of the additional gravity induced gains are exaggerated due to the assumption of full liberalisation, although if/when the agreement draws to its conclusion it will be possible to calculate gravity shifters consistent with the final agreed tariff offers on sensitive product lines. Moreover, the CGE generated welfare gains in our baseline are understated, particularly for the EU, since we do not account for the removal of non-tariff barriers in services sectors nor imperfect competition. Notwithstanding, the incremental welfare gains on commodity trade owing to gravity induced technology shifters should be largely considered as an independent 'additive' component to the existing CGE model drivers. That is, the magnitude of marginal trade impacts owing to gravity predictions should remain relatively unaffected.

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6. References

Alston, J.M., Carter, C.A., Green, R. and Pick, D. (1990). Whither Armington Trade Models?, *American Journal of Agricultural Economics*, 72, pp455-467.

Armington P. (1969) A theory of demand for products distinguished by place of production. *IMF Staff Papers*, 16, 159-176.

Arnon A. and Weinblatt J. (1998). Linder's hypothesis revisited: income similarity effects for low income countries. *Applied Economic Letters* 5, 607-611.

Boadway, R. and Treddenick, J.M. (1978) A General Equilibrium Computation of the Effects of the Canadian Tariff Structure, *Canadian Journal of Economics*, 11 (3), 424-446.

Brown, D.K. (1987) Tariffs, the Terms of Trade and National Product Differentiation, *Journal of Policy Modelling*, 9 (3), 503-526.

Burger, M., van Oort, F., G.J. Linders, 2009. On the specification of the gravity model of trade: zeros, excess zeros and zero-inflated estimation, *Spatial Economic Analysis*, 4(2), 167-190.

Burrell, A. (ed) (2011) Potentuial EU-Mercosur Free Trade Agreement: Impact Assessment, JRC referente reports, IPTS, European Commission.

De Frahan, B. and Vancauteren, M. (2006) Harmonisation of food regulations and trade in the single market: evidence from disaggregated data, *European Review of Agricultural Economics*, 33(3), pp337-360.

Diao, X., E. Diaz-Bonilla and S. Robinson (2003), 'Scenarios for Trade Integration in the Americas', *Economie Internationale*, 94-95, 33-52.

Feenstra, R.C. (2004). *Advanced International Trade: Theory and Evidence*, Princeton University Press.

Foster N., Poeschl J. and Stehrer R. (2011). The impact of Preferential Trade Agreements on the margins of international trade. *Economic Systems*, 35, 84-97.

Francois, J.F., B. McDonald and H. Nordstrom (1996), 'Liberalisation and Capital Accumulation in the GTAP Model', Technical paper 7, GTAP technical paper series http://www.gtap.agecon.purdue.edu/resources/download/40.pdf

Frankel J. (1997). Regional tading blocs in the world economic system. Institute for International Economics, Washington D.C.

Gourieroux C., Monfort A. and Trognon A. (1984). Pseudo Maximum Likelihood Methods: Applications to Poisson models. *Econometrica* 52, 701-720.

Hallack J.C. (2010). A product-quality view of the Linder hypothesis. *The Review of Economics and Statistics* 92(3), 453-466.

Hayakawa K. and Yamashita N. (2011). The role of preferential trade agreements (PTAs) in facilitating global production networks. *Journal of World Trade*, 45(6), 1181-1207.

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

Kandogan Y. (2008). Consistent estimates of regional blocs' trade effects. *Review of International Economics*, 16(2), 301-314.

Keeney, R. and Hertel, T.W. (2005) GTAP-AGR: A framework for assessing the implications of multilateral changes in agricultural policies. GTAP technical paper 24, Purdue University, https://www.gtap.agecon.purdue.edu/resources/download/2310.pdf

Kirkpatrick, C. and George, C. (2009). Trade Sustainability Impact Assessment of the association agreement under negotiation between the European Community and Mercosur. Final Report (March 2009) carried out for the European Commission http://www.sia-trade.org/mercosur

Komorovska, J., Kuiper M. and van Tongeren F. (2006) Sharing Gravity: Gravity Estimates of Trade Shares in Agri-Food. Tenth Annual Conference on global Economic Analysis, Purdue University, West Lafayette, 7-9 June, 2007.

Martínez-Zarzoso I., Felicitas N.L.D. and Horsewood N. (2009). Are regional trading agreements beneficial? Static and dynamic panel gravity models. *North American Journal of Economics and Finance* 20(1), 46-65.

McDougall, R. (2003) A New Regional Household Demand System for GTAP, GTAP technical paper 20, Purdue University,

https://www.gtap.agecon.purdue.edu/resources(res_display.asp?RecordID=942

Melitz J. (2007). North, South and distance in the gravity model. *European Economic Review* 51, 971-991.

Morkre, M.E. and Tarr, D.G. (1993) Reforming Hungarian Agricultural Trade Policy - A Quantitative Evaluation, *World Bank Discussion Paper*, Sept '93, WPS 1185.

Santos Silva J.M.C. and Tenreyro S. (2006). The log of gravity. *The Review of Economics and Statistics* 88, 641-658.

Santos Silva J.M.C. and Tenreyro S. (2011). Further simulation evidence on the performance of the Poisson pseudo-maximum likelihood estimator. *Economics Letters* 112, 220-222.

Wang, C., Wei, Y. and Liu, X. (2010). Determinants of bilateral trade flows in OECD countries: Evidence from gravity panel data models, *The World Economy*, 33(7), 894-915.

Winters, L.A. (1984) Separability and the Specification of Foreign Trade Functions, Journal of International Economics, 17, pp239-263.

Woolridge J.M. (2002). Econometric Analysis of Cross Section and Panel Data. Boston, MIT Press.

Table 1: Description of the 56 sectors and accompanying codes

Sector code	Full description	Sector code	Full description
pdr	Paddy rice	**lea**	Leather products
wht	Wheat	**lum**	Wood products
gro	Other cereal grains	**ppp**	Paper products, publishing
v_f	Vegetables, fruits and nuts	**p_c**	Petroleum, coal products
osd	Oilseeds	**crp**	Chemical, rubbwer, plastic products
c_b	Raw sugar	**nmm**	Other mineral products
pfb	Plant based fibers	**i_s**	Ferrous metals
ocr	Other Crops	**nfm**	Non ferrous metals
ctl	Cattle	**fmp**	Metal products
oap	Other animal products	**mvh**	Motor vehicles and parts
rmk	Raw milk	**otn**	Other transport equipment
wol	Wool and silk-worm cocoons	**ele**	Electronic equipment
frs	Forestry	**ome**	Other machinery and equipment
fsh	Fishing	**omf**	Other manufacturing activity
coa	Coal	**ely**	Electricity
oil	Oil	**gdt**	Gas manufacture and distribution
gas	Gas	**wtr**	Water
omn	Other minerals	**cns**	Construction
cmt	Bovine meat	**trd**	Trade
omt	Other meat products	**otp**	Other transport
vol	Vegetable oils and fats	**wtp**	Water transport
mil	Dairy products	**atp**	Air transport
pcr	Processed rice	**cmn**	Communication
sgr	Sugar	**ofi**	Financial services
ofd	Other food products	**isr**	Insurance
b_t	Beverages and tobacco products	**obs**	Other business services
tex	Textiles	**ros**	Recreational and other services
wap	Wearing apparel	**osg**	Public administration, defense, education, health

Table 2: Variable descriptions in the gravity equation

Variable	Description
X_{ijt}	Value of imports into country *j* from country *i* at world prices in year t
Mt_{ijt}	Power of the import tariff rate ($AdvRate_{ijt}$) applied by importer *j* on imports from *i* in year *t*, measured in *ad-valorem* equivalents, in logs: $$Mt_{ijt} = ln\left(1 + \frac{AdvRate_{ijt}}{100}\right)$$
Xs_{ijt}	Power of the export subsidy rate ($XSubRate_{ijt}$) applied by country *i* on exports to country *j* in year *t*, in logs: $$Xs_{ijt} = ln\left(1 + \frac{XSubRate_{ijt}}{100}\right)$$
$Dist_{ij}$	Great circle distance between the capitals of country *i* and *j,* in logs
$NoSo_{ij}$	Difference in latitudes between countries *i* and *j*, in logs: $ln(latitude_i – latitude_j)$
$Remote_{it}$	Indicator of remoteness of country *i* in year *t*, calculated as a GDP weighted average of distance to the rest of countries/regions: $$Remote_{it} = ln\left(\sum_{j}^{T(i)} \frac{GDP_{jt}}{GDP_{Wt} - GDP_{it}} \times Dist_{ij}\right)$$ where $Dist_{ij}$ is the distance between *i* and *j* (defined as above), GDP_{Wt} is the world GDP in year *t*, and *T(i)* is the number of (possible) destination countries of exports from *i* which is 95 when *i* is a composite region, and 94 when *i* is an individual country.
$Contig_{ij}$	Dummy variable that values 1 when countries *i* and *j* share a border, and 0 otherwise
$Lang_{ij}$	Dummy variable that values 1 when countries *i* and *j* share the same official language, and 0 otherwise;
Col_{ijt}	Dummy variable that values 1 when countries *i* and *j* have or have had a colonial linkage
PTA_{ij}	Dummy variable that values 1 when countries *i* and *j* have belonged to the same Preferential Trade Area, at least from 2001. PTA includes EU, NAFTA, Mercosur (Southern Cone Common Market), Andean Pact, Caricom (Caribbean Community and Common Market) and CACM (Central American Common Market)
$Sqincome_{ijt}$	Square of the difference in per capita income in countries *i* and *j*, in logs: $ln((GDPpc_{it} – GDPpc_{jt})^2)$ with GDPpc measured in US$ per habitant (in nominal terms)
Gdp_{ijt}	Product of GDP in country *i* and country *j* in year *t*, in logs: $ln(GDP_{it} \times GDP_{jt})$, with GDP measured in million US $ (in nominal terms)
$Y2004_t$	Dummy variable that values 1 when the year *t* is 2004
F_i (F_j)	Fixed effects for exporter (importer) country *i* (*j*). $F_i(F_j)$ are dummy variables, that value 1 when the exporter (importer) is *i* (*j*), and 0 otherwise

Table 3. Estimated parameters of the gravity equation

Sector code		Mt	Xs	Dist	NoSo	Remote	Contig	Lang	Col	PTA	Sqincome	Constant	MODEL	LR [e]	Vuong Test [f]
pdr	**coef**	-0.201	.	-0.553	-0.002	5.867	0.340	-0.023	0.479	1.072	0.044	-71.159	NB	1987.0	0.630
	p-value	0.047	.	0.000	0.962	0.001	0.009	0.785	0.000	0.000	0.001	0.000		0.000	0.264
wht	**coef**	-0.855	3.788	-1.568	0.018	3.553	0.109	-0.058	0.931	1.514	-0.015	-43.101	ZIP	34126.9	2.280
	p-value	0.000	0.000	0.000	0.012	0.000	0.000	0.010	0.000	0.000	0.000	0.000		0.000	0.011
gro	**coef**	-0.810	2.755	-1.810	0.058	3.531	0.192	0.245	0.343	0.895	0.002	-47.076	ZINB	n.a.	n.a.
	p-value	0.013	0.004	0.000	0.160	0.185	0.250	0.111	0.186	0.000	0.904	0.044		n.a.	n.a.
v_f	**coef**	-0.949	2.675	-1.056	0.130	3.001	0.948	-0.040	0.391	0.310	0.004	-38.361	NB	1.398	0.210
	p-value	0.000	0.014	0.000	0.000	0.013	0.000	0.588	0.000	0.011	0.651	0.000		0.237	0.419
osd	**coef**	-0.082	.	-1.316	-0.196	7.218	0.722	0.674	0.252	0.207	0.041	-80.992	ZINB	n.a.	n.a.
	p-value	0.887	.	0.000	0.000	0.029	0.000	0.000	0.307	0.418	0.109	0.005		n.a.	n.a.
c_b	**coef**	-1.011	.	-1.576	0.532	-9.995	2.164	0.593	0.550	-0.053	0.107	48.516	NB	23.6	-0.500
	p-value	0.126	.	0.000	0.043	0.441	0.033	0.118	0.446	0.962	0.110	0.000		0.000	0.691
pfb	**coef**	-4.937	0.662	-0.494	-0.010	5.009	0.486	-0.126	0.195	0.430	0.039	-75.040	NB	11333.9	0.700
	p-value	0.000	0.850	0.000	0.722	0.000	0.000	0.085	0.095	0.003	0.000	0.000		0.000	0.243
ocr	**coef**	-0.341	.	-0.928	0.083	2.483	0.259	-0.125	0.140	-0.153	0.005	-35.950	ZIP	14.1	2.060
	p-value	0.050	.	0.000	0.002	0.092	0.003	0.139	0.204	0.103	0.549	0.005		0.000	0.020
ctl	**coef**	-1.010	2.403	-1.644	0.039	2.379	1.249	-0.201	0.621	-0.346	-0.058	-34.002	ZINB	11987.4	-2.780
	p-value	0.025	0.044	0.000	0.332	0.275	0.000	0.073	0.001	0.029	0.000	0.075		0.000	0.997
oap	**coef**	-1.068	.	-0.528	-0.068	2.213	0.882	0.002	0.223	0.676	0.051	-36.158	NB	14475.3	-2.490
	p-value	0.000	.	0.000	0.019	0.081	0.000	0.968	0.004	0.000	0.000	0.001		0.000	0.994
rmk	**coef**	.	0.438	-0.497	0.015	-16.857	0.441	0.009	0.175	0.520	0.001	90.021	POISSON	0.001	-0.600
	p-value	.	0.352	0.004	0.835	0.049	0.107	0.973	0.537	0.189	0.992	0.000		1.000	0.727
wol	**coef**	-8.859	.	-0.716	0.128	-12.139	0.374	0.096	0.447	0.196	-0.026	86.943	POISSON	0.000	n.a.
	p-value	0.000	.	0.000	0.001	0.000	0.027	0.396	0.051	0.344	0.052	0.000		1.000	n.a.
cmt	**coef**	-0.415	-0.016	-1.265	0.026	2.092	0.665	0.060	0.802	0.752	0.007	-32.895	ZINB	46177.8	1.220
	p-value	0.013	0.946	0.000	0.397	0.173	0.000	0.516	0.000	0.000	0.563	0.015		0.000	0.110
omt	**coef**	-0.832	0.733	-1.071	-0.011	5.502	0.772	0.294	0.497	0.695	-0.017	-63.297	NB	n.a.	n.a.
	p-value	0.004	0.756	0.000	0.735	0.006	0.000	0.001	0.000	0.000	0.151	0.000		n.a.	n.a.
vol	**coef**	-0.718	2.098	-0.579	0.012	6.900	0.496	0.174	0.190	0.144	0.007	-75.774	NB	71683.7	2.810
	p-value	0.000	0.122	0.000	0.438	0.000	0.000	0.001	0.002	0.088	0.133	0.000		0.000	0.002
mil	**coef**	-1.931	0.080	-1.069	0.016	-0.567	0.417	0.376	0.639	0.680	-0.025	-33.53	POISSON	39228.5	0.210
	p-value	0.000	0.381	0.000	0.001	0.027	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.410
pcr	**coef**	-0.297	0.182	-0.443	-0.043	3.056	0.389	0.005	0.233	0.603	0.012	-45.064	NB	7707.0	-1.800
	p-value	0.000	0.383	0.000	0.102	0.000	0.000	0.930	0.001	0.000	0.056	0.000		0.000	0.960

Sector code		Mt	Xs	Dist	NoSo	Remote	Contig	Lang	Col	PTA	Sqincome	Constant	MODEL	LR [e]	Vuong Test [f]
sgr	**coef**	-0.521	0.533	-1.305	0.126	1.466	0.533	0.260	0.156	-0.407	0.027	-39.592	NB	37917.8	-0.530
	p-value	0.000	0.149	0.000	0.000	0.309	0.000	0.000	0.143	0.006	0.010	0.951		0.000	0.702
ofd	**coef**	-0.736	2.725	-0.724	0.027	1.315	0.627	0.117	0.310	0.695	0.020	-25.461	NB	156273.8	0.500
	p-value	0.000	0.016	0.000	0.000	0.002	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.308
b_t	**coef**	-0.825	-9.560	-1.012	0.173	2.963	0.234	0.281	0.621	0.187	-0.035	-40.232	POISSON	101452.1	-0.740
	p-value	0.010	0.567	0.000	0.000	0.158	0.095	0.002	0.000	0.225	0.008	0.029		0.000	0.769
frs	**coef**	-0.917	.	-0.487	0.044	3.823	0.805	0.025	0.349	0.233	0.023	-50.224	NB	10388.060	1.390
	p-value	0.000	.	0.000	0.003	0.000	0.000	0.611	0.000	0.046	0.000	0.000		0.000	0.082
fsh	**coef**	-1.068	.	-1.427	-0.073	9.164	0.453	0.204	0.331	0.313	0.009	-95.772	**POISSON**	7599.920	n.a.
	p-value	0.000	.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.020	0.000		0.000	n.a.
coa	**coef**	-8.909	7.582	-2.299	0.232	1.300	0.679	-0.320	0.703	-1.413	0.030	-26.840	**POISSON**	33912.442	1.560
	p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.307		0.000	0.059
oil	**coef**	-0.994	1.876	-2.182	0.002	1.135	0.009	0.459	0.914	0.868	-0.022	-30.550	ZINB	723212.120	2.670
	p-value	0.272	0.199	0.000	0.956	0.659	0.959	0.000	0.000	0.000	0.203	0.175		0.000	0.004
gas	**coef**	-8.701	0.524	-0.823	-0.196	-10.502	1.253	0.090	0.582	0.575	0.009	56.213	NB	216126.020	-1.420
	p-value	0.061	0.001	0.000	0.000	0.000	0.000	0.554	0.003	0.018	0.627	.		0.000	0.922
omn	**coef**	-6.433	6.003	-0.860	0.131	-6.735	0.787	0.110	1.196	-0.336	0.048	41.850	ZIP	191451.040	3.780
	p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.000
tex	**coef**	-1.866	2.628	-1.129	0.049	4.368	0.280	0.335	0.078	0.329	0.132	-52.164	**POISSON**	187455.530	0.980
	p-value	0.008	0.000	0.000	0.002	0.001	0.000	0.000	0.520	0.000	0.000	0.000		0.000	0.164
wap	**coef**	-1.381	1.836	-1.216	0.095	2.465	0.502	0.422	0.198	-0.128	0.146	-34.094	**POISSON**	155778.470	1.030
	p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.152
lea	**coef**	-2.639	4.789	-0.635	-0.096	1.463	0.458	0.209	0.397	0.277	0.113	-27.967	**POISSON**	105557.600	0.530
	p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	0.297
lum	**coef**	-0.972	1.264	-0.674	0.002	2.599	0.864	0.100	0.182	0.582	0.044	-36.721	NB	114741.310	n.a.
	p-value	0.000	0.009	0.000	0.850	0.000	0.000	0.000	0.000	0.000	0.000	0.000		0.000	n.a.
ppp	**coef**	-0.890	2.828	-0.797	0.063	1.711	0.683	0.173	0.232	0.698	-0.012	-28.151	NB	98226.006	-1.250
	p-value	0.008	0.049	0.000	0.000	0.164	0.000	0.000	0.000	0.000	0.021	0.009		0.000	0.894
p_c	**coef**	-2.417	3.296	-2.026	0.048	-1.813	1.052	0.079	0.422	-0.524	0.039	3.509	ZINB	234.794	n.a.
	p-value	0.002	0.126	0.000	0.288	0.636	0.000	0.550	0.006	0.017	0.070	0.917		0.000	n.a.
crp	**coef**	-1.525	1.653	-0.738	0.032	3.199	0.308	0.026	0.194	0.463	-0.033	-40.615	NB	574431.880	-0.350
	p-value	0.000	0.002	0.000	0.000	0.000	0.000	0.160	0.000	0.000	0.000	0.000		0.000	0.636
nmm	**coef**	-1.094	2.038	-0.812	-0.019	2.230	0.647	0.035	0.242	0.226	0.006	-32.531	NB	77011.662	-0.530
	p-value	0.000	0.045	0.000	0.005	0.000	0.000	0.125	0.000	0.000	0.021	0.000		0.000	0.701
i_s	**coef**	-0.786	3.457	-0.939	0.022	5.263	0.494	0.159	0.345	0.509	0.008	-58.922	NB	175053.690	-0.620
	p-value	0.001	0.026	0.000	0.011	0.000	0.000	0.000	0.000	0.000	0.016	0.000		0.000	0.731

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Sector code		Mt	Xs	Dist	NoSo	Remote	Contig	Lang	Col	PTA	Sqincome	Constant	MODEL	LR [e]	Vuong Test [f]
nfm	**coef**	-8.910	11.086	-0.879	0.020	3.819	0.286	0.129	0.442	0.800	0.059	-49.231	ZIP	329344.760	6.300
	p-value	0.000	0.049	0.000	0.512	0.013	0.002	0.224	0.003	0.000	0.000	0.000		0.000	0.000
fmp	**coef**	-1.649	3.817	-1.620	-0.051	2.734	0.673	0.541	1.085	0.003	-0.034	-34.267	ZINB	76.488	2.580
	p-value	0.014	0.539	0.000	0.034	0.107	0.000	0.000	0.000	0.985	0.001	0.022		0.000	0.005
mvh	**coef**	-0.636	3.402	-0.785	-0.031	4.520	0.457	0.123	0.208	0.779	-0.013	-53.357	NB	89.574	-0.670
	p-value	0.000	0.105	0.000	0.057	0.000	0.000	0.006	0.035	0.000	0.051	0.000		0.000	0.750
otn	**coef**	-0.504	-0.364	-0.383	0.009	2.521	0.524	-0.088	0.458	0.038	-0.043	-38.434	NB	405444.810	-0.240
	p-value	0.024	0.671	0.000	0.562	0.013	0.000	0.084	0.000	0.712	0.000	0.000		0.000	0.596
ele	**coef**	-0.978	2.911	-0.598	0.041	4.463	0.184	0.055	0.158	0.435	0.014	-52.539	NB	594653.070	-1.430
	p-value	0.007	0.000	0.000	0.145	0.000	0.025	0.318	0.020	0.000	0.076	0.000		0.000	0.924
ome	**coef**	-1.453	3.633	-1.084	-0.043	3.976	0.313	0.224	0.375	-0.062	-0.013	-47.551	NB	84.374	n.a.
	p-value	0.006	0.310	0.000	0.007	0.000	0.000	0.000	0.000	0.493	0.083	0.000		0.000	n.a.
omf	**coef**	-0.446	1.784	-0.955	-0.018	0.776	0.636	0.467	1.137	-0.185	0.029	-23.532	ZINB	214377.990	1.450
	p-value	0.038	0.400	0.000	0.290	0.414	0.000	0.000	0.000	0.010	0.000	0.005		0.000	0.074
ely	**coef**	2.161	.	-0.618	-0.036	6.925	1.958	0.057	-0.011	-0.001	-0.010	-77.989	NB	n.a	n.a.
	p-value	0.203	.	0.000	0.323	0.003	0.000	0.538	0.943	0.996	0.470	0.000		n.a	n.a.
gdt	**coef**	-1.418	.	-0.004	-0.073	-7.706	-0.131	0.527	-0.389	0.122	-0.022	18.150	**POISSON**	2884.790	-1.530
	p-value	0.792	.	0.985	0.411	0.090	0.731	0.055	0.446	0.747	0.383	.		0.000	0.937
wtr	**coef**	.	.	-0.163	0.004	-1.699	0.283	0.056	0.226	0.363	0.034	-10.390	POISSON	0.000	1.210
	p-value	.	.	0.000	0.850	0.197	0.002	0.345	0.018	0.000	0.000	0.366		1.000	0.113
cns	**coef**	.	.	-0.029	-0.027	1.834	0.240	0.091	0.032	0.398	-0.012	-37.121	NB	6914.372	-0.020
	p-value	.	.	0.247	0.101	0.165	0.001	0.121	0.676	0.000	0.103	0.001		0.000	0.509
trd	**coef**	.	.	-0.203	0.082	3.956	0.386	0.196	0.065	0.365	0.002	-51.768	NB	82585.976	1.090
	p-value	.	.	0.000	0.002	0.000	0.032	0.038	0.561	0.000	0.782	0.000		0.000	0.138
otp	**coef**	.	.	-0.014	-0.016	1.589	0.152	-0.077	0.042	0.348	-0.012	-32.113	NB	72517.956	0.750
	p-value	.	.	0.528	0.293	0.117	0.034	0.131	0.643	0.000	0.041	0.000		0.000	0.228
wtp	**coef**	.	.	-0.048	-0.015	0.002	0.297	-0.052	0.196	0.143	0.012	-22.201	ZINB	36922.3	1.850
	p-value	.	.	0.016	0.202	0.997	0.000	0.147	0.001	0.010	0.003	0.000		0.000	0.032
atp	**coef**	.	.	-0.074	-0.001	-3.092	0.321	-0.020	0.170	0.116	0.007	5.688	ZINB	47619.378	2.040
	p-value	.	.	0.000	0.908	0.000	0.000	0.442	0.001	0.015	0.018	0.132		0.000	0.021
cmn	**coef**	.	.	-0.148	-0.005	-2.880	0.274	-0.009	0.202	0.187	0.020	4.745	ZINB	16874.982	9.570
	p-value	.	.	0.000	0.690	0.000	0.000	0.766	0.000	0.000	0.000	0.269		0.000	0.000
ofi	**coef**	.	.	-0.131	-0.019	1.119	0.468	-0.038	0.073	0.057	0.001	-33.139	ZINB	n.a	2.070
	p-value	.	.	0.000	0.171	0.110	0.000	0.329	0.273	0.368	0.776	0.000		n.a	0.019

Sector code		Mt	Xs	Dist	NoSo	Remote	Contig	Lang	Col	PTA	Sqincome	Constant	MODEL	LR [d]	Vuong Test
isr	**coef**	.	.	-0.124	0.003	-5.980	0.219	0.024	0.165	0.232	0.015	29.944	ZINB	n.a	1.860
	p-value	.	.	0.000	0.820	0.000	0.003	0.452	0.017	0.000	0.001	0.000		n.a	0.032
obs	**coef**	.	.	-0.036	-0.007	-1.536	0.200	-0.003	0.135	0.490	-0.030	-4.633	NB	153907.590	1.090
	p-value	.	.	0.057	0.683	0.169	0.004	0.954	0.113	0.000	0.000	0.636		0.000	0.137
ros	**coef**	.	.	-0.075	0.005	3.805	0.140	0.003	0.270	0.569	-0.013	-52.564	NB	29189.122	1.060
	p-value	.	.	0.001	0.770	0.003	0.087	0.953	0.005	0.000	0.025	0.000		0.000	0.144
osg	**coef**	.	.	-0.081	0.018	1.724	0.221	-0.050	0.130	0.282	-0.016	-33.833	NB	28237.708	1.520
	p-value	.	.	0.001	0.322	0.210	0.007	0.291	0.160	0.003	0.042	0.005		0.000	0.064
Impact on Trade	**Median [c]**	-0.917	0.894	-0.762	0.000	1.308	57.62%	0.00%	25.73%	34.46%	0.000				

[a] Results for the year, country-specific fixed effects, and explanatory variables in the state of zero inflated probability, are not reported for space saving reasons.

[b] n.a indicates that one of the models involved in the comparison test failed to converge.

[c] Median (across sectors) of percentage change in expected value of bilateral trade following 1% change in the explanatory variable or elasticity (in continuous variables); and the median of the sectorial percentage change in expected value of bilateral trade when the dummy variable equals 1: $100 * \left[\exp(\beta_j) - 1\right]$. Non-significant (at 10%) coefficients are replaced by zero in the computation.

[d] The Log-likelihood ratio tests for the significance of the dispersion parameter. It compares either of the pairs NB vs. Poisson, or ZINB vs. ZIP, depending on the reported variant in the column 'MODEL'. When the LR statistic is not available due to convergence problems, the confidence interval is used instead as a guideline to verify if the dispersion parameter is greater than zero. The dispersion parameter (respective confidence intervals) for 'gro', 'osd', 'omt', 'ofi' and 'isr' are: 0.838 (0.707, 0.994), 0.799 (0.661, 0.965), 2.446 (2.404, 2.489), 0.381 (0.287, 0.505) and 0.225 (0.152, 0.331) . In sector 'ely', the dispersion parameter was neither available.

[e] The Vuong statistic. The test compares either of the pairs ZIP vs. Poisson, or ZINB vs. NB, depending on the reported variant in the column 'MODEL'

Table 4: Import trade shares for the benchmark data, baseline and gravity scenarios (calculated at c.i.f. prices)

	European Union import shares (%) (including intra-EU trade)					
	EU	Argentina	Brazil	Paraguay	Uruguay	ROW
Benchmark:						
Red meat	73.84	4.22	7.16	0.04	1.08	13.67
White meat	88.69	0.57	4.60	0.00	0.07	6.07
Dairy	94.65	0.04	0.02	0.00	0.01	5.28
Processed rice	56.32	0.01	0.11	0.00	0.39	43.17
Processed sugar	57.97	0.02	2.61	0.13	0.00	39.27
Baseline:						
Red meat	20.06	1.79	74.33	1.41	2.02	0.39
White meat	80.70	2.63	14.07	0.00	0.30	2.29
Dairy	93.77	2.56	0.48	0.07	0.52	2.60
Processed rice	51.78	0.00	0.10	0.00	11.98	36.14
Processed sugar	36.70	0.04	47.05	4.08	0.00	12.13
Gravity:						
Red meat	13.62	0.57	82.62	2.05	0.98	0.16
White meat	78.65	2.64	16.56	0.00	0.33	1.83
Dairy	66.68	24.16	5.28	0.00	3.31	0.56
Processed rice	50.94	0.00	0.09	0.00	14.19	34.78
Processed sugar	23.61	0.02	66.09	5.73	0.00	4.55

	Mercosur import shares (%) (including intra-Mercosur trade)		
	EU	Mercosur	ROW
Benchmark:			
Agro-food	14.18	60.36	25.46
Textiles	14.45	23.94	61.61
Light manufacturing	29.73	26.80	43.47
Heavy manufacturing	27.77	15.21	57.02
Baseline:			
Agro-food	21.45	53.76	24.79
Textiles	35.84	16.48	47.68
Light manufacturing	49.67	18.32	32.02
Heavy manufacturing	44.36	11.52	44.11
Gravity:			
Agro-food	24.04	50.42	25.54
Textiles	43.98	13.21	42.82
Light manufacturing	51.95	16.62	31.43
Heavy manufacturing	46.54	10.40	43.07

Table 5: Impacts on trade balances and regional welfare (€ millions, 2004 prices)

Trade balance impacts:	Benchmark (2004) trade balance					Gravity scenario vs. Baseline trade balance change				
	EU	Argentina	Brazil	Paraguay	Uruguay	EU	Argentina	Brazil	Paraguay	Uruguay
Red meat	-1,707	811	1,674	98	489	-3,405	-362	3,478	169	-254
White meat	1,404	195	3,419	1	19	-272	-39	281	-1	3
Dairy	3,812	393	3	-7	133	-7,493	6,071	1,383	-16	767
Processed sugar	-878	51	2,260	17	-15	-1,422	-11	1,517	143	-3
Textiles	-42,132	-273	111	-52	98	689	-92	-226	-16	-58
Light manufacturing	32,683	-935	13,707	-262	-4	2,508	-884	-1,584	-40	-139
Heavy manufacturing	22,429	-4,204	-5,380	-1,768	-1,166	5,222	-1,357	-2,477	-93	-150
Agro-food	-28,975	13,057	20,476	1,292	775	-10,328	4,003	5,558	250	462
Non agro-food	-16,817	-3,046	6,656	-676	-1,197	10,279	-3,340	-5,141	-213	-512
Total	-45,792	10,011	27,132	616	-422	-49	663	417	37	-50

Regional welfare analysis compared with the baseline:	EU	Argentina	Brazil	Paraguay	Uruguay	ROW
Per capita utility (%)	0.1	2.6	1.0	3.1	5.8	0.0
Equivalent variation	8,925	2,893	4,752	200	617	4,716
Allocative efficiency	7,062	526	932	33	123	1,056
Terms of trade	-3,738	1,174	1,451	90	231	669
Trade facilitation	5,053	66	236	3	11	0
Endowment effect	547	1,126	2,133	75	252	2,991

Table 6: Percentage changes in outputs and market prices compared with the baseline.

	Employment and output					Market price				
	EU	Argentina	Brazil	Paraguay	Uruguay	EU	Argentina	Brazil	Paraguay	Uruguay
Land	0.0	7.3	2.7	2.3	2.9	-1.0	14.6	8.4	9.5	29.1
Unskilled labour	0.0	0.0	0.0	0.0	0.0	-0.2	7.7	2.4	5.1	11.7
Skilled labour	0.0	0.0	0.0	0.0	0.0	-0.1	6.4	2.3	3.0	9.8
Capital	0.0	3.7	1.9	3.1	7.0	-0.1	3.4	1.1	1.5	4.0
Raw sugar	-13.2	13.0	12.8	32.8	14.7	-2.0	9.4	4.7	13.5	7.6
Raw milk	-6.1	216.7	16.1	0.5	164.7	-2.1	28.2	5.6	4.5	35.9
Cattle & Sheep	-8.8	3.1	11.5	13.3	-24.2	-0.2	9.1	5.4	6.4	6.3
Pigs & Poultry	0.3	-4.8	4.4	13.0	-15.8	-1.3	6.0	4.4	6.6	6.3
Red Meat	-22.4	-12.5	12.4	18.1	-31.1	-0.3	7.2	3.8	4.1	6.2
White meat	-0.2	-5.3	2.2	2.3	-2.8	-0.6	5.4	3.2	4.0	6.2
Dairy	-7.6	228.3	25.3	-12.5	176.8	-1.7	14.1	2.8	3.2	18.1
Processed sugar	-21.3	14.7	21.3	34.1	14.7	-0.7	6.9	2.5	7.7	4.7
Textiles	0.4	-4.6	-1.2	-0.6	-14.7	-0.2	2.3	1.1	2.4	3.9
Light manufacturing	0.2	-4.3	-2.0	-0.7	-12.5	-0.1	3.2	1.3	2.0	4.2
Heavy manufacturing	0.3	-4.5	-1.7	-2.2	-6.0	-0.1	2.6	0.9	1.9	2.6
Agro-food	-2.1	7.6	3.3	4.7	9.3	-0.8	7.6	3.3	4.7	9.3
Non agro-food	0.1	-0.1	0.0	0.1	0.4	-0.1	3.9	1.3	2.1	5.5
Real growth	0.1	1.7	0.9	1.9	3.8					
Retail price index						-0.2	5.1	1.7	3.4	7.2
Factor price index						-0.1	5.4	1.8	3.7	7.8