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European Integration and the Gains from Trade*

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Abstract

This chapter discusses whether and how 'new quantitative trade models' (NQTMs) can be fruitfully applied to quantify the welfare effects of trade liberalization, thus shedding light on the trade-related effects of further European integration. On the one hand, it argues that NQTMs have indeed the potential of being used to supplement traditional 'computable general equilibrium' (CGE) analysis thanks to their tight connection between theory and data, appealing micro-theoretical foundations, and enhanced attention to the estimation of structural parameters. On the other hand, further work is still needed in order to fully exploit such potential.

Keywords: Gains from trade, European integration, Quantitative trade models, Gravity equations, Structural estimation

J.E.L. Classification: F10, F15, F17

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1 Introduction

The aim of this chapter is to discuss whether and how an important class of theoretical models, which have been increasingly used to quantify the gains from trade in counterfactual scenarios, can be fruitfully applied to quantify the trade-related welfare effects of further European integration. For lack of a better name, these models will be called 'new quantitative trade models' (henceforth, simply NQTMs), with the understanding that, whereas the models themselves may not be all that new, the novelty resides in the recent formal comprehension of their common policy-relevant implications.

Since the beginning of the century, the field of international trade has become increasingly quantitative due to two major developments. First, thanks to the easier accessibility of individual datasets and to the higher computing power needed to process them, there has been a surge of empirical works studying *ex post* the implications of firms' and workers' heterogeneity for the sources, the patterns and the gains from trade. Second, thanks again to higher computing power, the calibration and the simulation of statistical models have been increasingly used to investigate *ex ante* the implications of trade policies in counterfactual scenarios for which data are necessarily unavailable.

The idea of using mathematical or statistical models to simulate the effects of counterfactual scenarios has a long tradition (Baldwin and Venables, 1995). In particular, 'Computable general equilibrium' (CGE) models remain a cornerstone of trade policy evaluation (Piermartini and Teh, 2005), having also contributed to the design of advanced softwares for their numerical solution such as GAMS or GEMPACK. To this tradition NQTMs contribute a tighter connection between theory and data thanks to more appealing micro-theoretical foundations and careful estimation of the structural parameters necessary for counterfactual analysis (Costinot and Rodriguez-Clare, 2014).

The trailblazer NQTM is arguably the statistical model proposed and structurally estimated by Eaton and Kortum (2002) to quantify the effects of trade liberalization and technological progress in 19 OECD countries. However, by assuming perfect competition, the Eaton-Kortum model does not speak directly to the parallel research line based on individual heterogeneity, of which the main theoretical reference is, instead, Melitz (2003). Introducing heterogeneous firms in the monopolistic competive model of Krugman (1980), the Melitz model provides a theoretical framework consistent with several stylized facts highlighted by the analysis of firm-level datasets, but its initial applications did not include counterfactual simulations. Early attempts at bridging the two lines of research can be found in Bernard, Eaton, Jensen and Kortum (2003) and Del Gatto, Mion and Ottaviano (2006). On the one side, Bernard, Eaton, Jensen and Kortum (2003) extend the Eaton-Kortum model by introducing heterogeneous firms under oligopostic price competition. The extended Eaton-Kortum model is consistent with fewer stylized facts than the Melitz model but has the merit of pushing the NQTM agenda one step further. On the other hand, Del Gatto, Mion and Ottaviano (2006), followed up by Corcos, Del Gatto, Mion and Ottaviano (2012), simulate counterfactual scenarios for European integration through a quantitative Melitz model as enriched by Melitz and Ottaviano (2008). Both Bernard, Eaton, Jensen and Kortum (2003) and Corcos, Del Gatto, Mion and Ottaviano (2012) are firmly grounded in the macroeconomic methodology of 'calibration, validation and simulation'. Calibration requires the values of the theoretical parameters to be set such that the model matches some key moments of the data. Validation requires the calibrated model to be able to match other moments of the data different from those used for calibrating. Simulation of counterfactual scenarios can be reasonably performed only if the calibrated model passes the validation checks.

Building on previous theoretical work by Arkolakis, Costinot and Rodriguez-Clare (2012), Costinot and Rodriguez-Clare (2014) provide the most accomplished attempt at fully bridging NQTMs and firm-level analysis so far. Arkolakis, Costinot and Rodriguez-Clare (2012) are often quoted for showing theoretically that firm heterogeneity is not that important when one is interested in evaluating aggregate gains from trade. Whether they actually do so is debated (Melitz and Redding, 2013). What they do show is, instead, that all models in a specific class share the same predicted 'gains from trade' (defined as welfare with trade relative to welfare with autarky), conditional on the changes in two aggregate statistics: the observed share of domestic expenditure and an estimate of the trade elasticity.[1] These models have four primitive assumptions in common: (a) Dixit-Stiglitz preferences; (b) one factor of production; (c) linear cost functions; (d) perfect or monopolistic competition. They also share three common macro-level restrictions: (A) trade is balanced; (B) aggregate profits are a constant share of aggregate revenues; (C) the import demand system exhibits constant elasticity of substitution (CES). As this set of assumptions is extremely restrictive, one would be forgiven for dismissing the finding by Arkolakis, Costinot and Rodriguez-Clare (2012) as some sort of 'impossibility theorem' with very limited practical relevance. What makes, instead, their finding important is that some of the most popular trade models do satisfy those restrictive assumptions, from the workhorse CGE model by Armington (1969) to the hallmark 'new trade theory' model by Krugman (1980), to the already cited NQTM by Eaton and Kortum (2002) and several variations of the model by Melitz (2003) though not necessarily its original version. In this respect, the main contribution of Arkolakis, Costinot and Rodriguez-Clare (2012) is indeed to theoretically define the class of NQTMs, paving the way to their subsequent empirical implementation by Costinot and Rodriguez-Clare (2014).

The next sections provide a streamlined presentation of some key insights highlighted by Costinot and Rodriguez-Clare (2014), to which the reader is referred for additional details. In particular, Sections 2 and 3 derive the key equations of the Armington model showing how a simple NQTM works. Section 4 uses the simple NQTM to evaluate the gains from trade for selected EU countries by comparing the status quo to counterfactual autarky. Apart from being a very peculiar counterfactual, the autarky example has also the limit of

[1] See Head and Mayer (2014) as well as Simonovska and Waugh (2014) for recent discussions of methodological issues related to the estimation of the trade elasticity.

not fully exploiting the structure of the model. Subsequent sections therefore present richer counterfactuals. Specifically, Section 5 uses the Armington model to quantify the damages EU countries would suffer from a counterfactual protectionist policy enacted by the US. Section 6 looks at a counterfactual worldwide protectionist policy to discuss how the predicted welfare changes vary going for the Armington model to richer NQTMs.

Section 7 concludes highlighting three main challenges for the use of NQTMs for policy analysis in Europe and beyond. First, the single most delicate choice for policy applications appears to be the one of market structure. As shown by Costinot and Rodriguez-Clare (2014), some cross-country predictions may change dramatically going from perfect to monopolistic competition. Second, current NQTMs do not allow for the 'dynamic' effects of policy intervention on economic growth, through more competition, innovation and adoption of new technologies. Third, the validation of calibrated models before simulating them has increasingly gone missing as recent works tend to favor the implementation of 'exactly identified' NQTMs. These are models in which the number of free parameters to be calibrated equals the number of observed moments of the data, and hence yield a trivially perfect fit. Can simulation based on tautology really help policy design?

2 A simple quantititative trade model

Following Costinot and Rodriguez-Clare (2014), the main components and the working of NQTMs can be usefully illustrated through a simple Armington model.

The economy consists of n countries, indexed $i = 1, ..., n$, with each country supplying its own distinct good. There are thus n goods, also indexed $i = 1, ..., n$, with country i being the only supplier of good i in fixed quantity Q_i, which corresponds to the country's endowment of the good.

Preferences in country j are captured by a representative consumer with Dixit-Stiglitz utility function:

$$C_j = \left[\sum_{i=1}^{n} \left(\frac{C_{ij}}{\psi_{ij}} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where C_{ij} is country j's consumption of the good supplied by country i, $\psi_{ij} > 0$ is an inverse measure of the appeal of this good for country j, and $\sigma > 1$ is the constant elasticity of substitution (CES) between goods supplied by different countries. According to (1), utility can be interpreted as the level of consumption of an aggregate composite ('quantity index') of the various goods whose 'price index' is

$$P_j = \left[\sum_{i=1}^{n} \left(\psi_{ij} P_{ij} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \tag{2}$$

where P_{ij} is the price of good i in country j. Denoting aggregate expenditure by E_j, the price and quantity indices satisfy $P_jC_j = \sum_{i=1}^{n} P_{ij}C_{ij} = E_j$, which is the representative consumer's budget constraint. Utility (1) can then be equivalently rewritten as

$$C_j = \frac{E_j}{P_j} \tag{3}$$

which identifies real expenditure as a measure of country j's welfare.

External trade between countries is subject to trade costs, consisting of frictional and tariff barriers. Frictions are of the *iceberg* type: country i has to ship $\tau_{ij} \geq 1$ units of its good for one unit to reach country j. Tariff barriers are of the *ad-valorem* type with $t_{ij} \geq 0$ denoting the tariff imposed by country j on imports from country i. There are, instead, no trade costs for internal trade: $\tau_{jj} = \tau'_{jj} = 1$ and $t_{jj} = t'_{jj} = 0$.

Markets are perfectly competitive and perfect arbitrage implies that the price of a good at destination equals its price at the origin once trade costs are taken into account: $P_{ij} = (1 + t_{ij})\, \tau_{ij} P_{ii}$. This in turn implies that a country's income equals the country's good endowment times its domestic price: $Y_i = P_{ii}Q_i$. Hence, the price at destination satisfies

$$P_{ij} = \frac{\phi_{ij} Y_i}{Q_i} \tag{4}$$

where $\phi_{ij} \equiv (1 + t_{ij})\tau_{ij}$ denotes the trade costs from country i to country j.

Given (1), utility maximization under the representative consumer's budget constraint determines the value of country j's imports from country i inclusive of the associated tariff revenue

$$X_{ij} = \left(\frac{\psi_{ij} P_{ij}}{P_j} \right)^{1-\sigma} E_j \tag{5}$$

with $E_j = \sum_{i=1}^{n} X_{ij}$. By (2) and (5), the share of expenditure of country j on imports from country i evaluates to

$$\lambda_{ij} = \frac{X_{ij}}{E_j} = \left(\frac{\psi_{ij} P_{ij}}{P_j} \right)^{1-\sigma} = \frac{\left(\phi_{ij} Y_i\right)^{-\varepsilon} \left(Q_i/\psi_{ij}\right)^{\varepsilon}}{\sum_{i=1}^{n} \left(\phi_{ij} Y_i\right)^{-\varepsilon} \left(Q_i/\psi_{ij}\right)^{\varepsilon}} \tag{6}$$

where $\varepsilon \equiv \partial \left(X_{ij}/X_{jj}\right) / \partial \tau_{ij} = \sigma - 1$ denotes the 'trade elasticity': the elasticity of imports relative to domestic demand X_{ij}/X_{jj} with respect to bilateral trade costs ϕ_{ij} holding income levels constant. Given (6), equation (5) can be then restated as a standard 'gravity equation'

$$X_{ij} = \lambda_{ij} E_j = \frac{\left(\phi_{ij} Y_i\right)^{-\varepsilon} \left(Q_i/\psi_{ij}\right)^{\varepsilon}}{\sum_{i=1}^{n} \left(\phi_{ij} Y_i\right)^{-\varepsilon} \left(Q_i/\psi_{ij}\right)^{\varepsilon}} E_j \tag{7}$$

which expresses the bilateral trade flow from i to j as a function of characteristics of the country of origin (Y_i and Q_i), characteristics of the country of destination (E_j), and bilateral obstacles (ϕ_{ij} and ψ_{ij}).

In equilibrium expenditure equals income plus tariff revenue

$$E_j = Y_j + T_j \tag{8}$$

with

$$T_j = \sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} X_{ij} \tag{9}$$

and

$$Y_i = \sum_{j=1}^{n} \frac{1}{1+t_{ij}} X_{ij} \tag{10}$$

where $X_{ij}/(1+t_{ij})$ is the tax base. By (6) the share of tariff revenue in country j's expenditure can be expressed as

$$\pi_j = \frac{T_j}{E_j} = \sum_{i=1}^{n} \frac{t_{ij}}{1+t_{ij}} \lambda_{ij} \tag{11}$$

which allows one to use (8) to state country j's total expenditure as a function of its income

$$E_j = \frac{Y_j}{1-\pi_j} \tag{12}$$

Plugged together with (7) into (10), (12) implies that good i's market clears as long as

$$Y_i = \sum_{j=1}^{n} \frac{1}{1+t_{ij}} \frac{\left(\phi_{ij} Y_i\right)^{-\varepsilon} \left(Q_i/\psi_{ij}\right)^{\varepsilon}}{\sum_{i=1}^{n} \left(\phi_{ij} Y_i\right)^{-\varepsilon} \left(Q_i/\psi_{ij}\right)^{\varepsilon}} \frac{Y_j}{1-\pi_j} \tag{13}$$

holds. After using (11) and (6) to substitute π_j with an expression in which income levels are the only endogenous variables, for $i = 1, ..., n$ (13) generates a system of n equations in n unknowns that can be solved for the equilibrium income levels $Y = \{Y_i\}$. However, as by Walras' Law, one of those equations is redundant, income levels can be determined only up to a constant pinned down by the choice of the numeràire good. Having determined the equilibrium income levels, the corresponding bilateral prices and price indices $P = \{P_{ij}\}$ can be recovered from (4) and (2) respectively. With the price information at hand, trade flows $X = \{X_{ij}\}$ and expenditures $E = \{E_i\}$ can then be obtained from (5) and $E_j = \sum_{i=1}^{n} X_{ij}$. This provides also information required to compute expenditure shares $\lambda = \{\lambda_{ij}\}$ from (6) and tax revenue shares $\pi = \{\pi_i\}$ from (11). Finally, knowing prices and expenditures, welfare $C = \{C_i\}$ can be measured from (3). This concludes the description of the model and its equilibrium solution.

3 Welfare effects of trade integration

How does trade integration affect national welfare? To answer this question one has to assess what happens to C when trade costs change from actual levels

$\phi = \{\phi_{ij}\}$ to counterfactual levels $\phi' = \{\phi'_{ij}\}$. The main insights of Arkolakis, Costinot and Rodriguez-Clare (2012) is that changes in the real expenditure of a country j can be readily computed using only few statistics: the trade elasticity (ε) and the changes in the country's shares of expenditure across goods (from $\lambda = \{\lambda_{ij}\}$ to $\lambda' = \{\lambda'_{ij}\}$).

To see this, one needs first to derive three preliminary results on the effects of an infinitesimal change in trade costs. First, given (2), partially differentiating P_j with respect to P_{ij} yields

$$\frac{\partial P_j}{\partial P_{ij}} = \left[\sum_{i=1}^{n} \left(\psi_{ij} P_{ij}\right)^{1-\sigma}\right]^{\frac{\sigma}{1-\sigma}} \left(\psi_{ij}\right)^{1-\sigma} \left(P_{ij}\right)^{-\sigma} = \left(\frac{\psi_{ij} P_{ij}}{P_j}\right)^{1-\sigma} \frac{P_j}{P_{ij}}$$

which, by (5), can be rewritten as

$$\frac{\partial P_j}{\partial P_{ij}} = \frac{X_{ij}}{E_j} \frac{P_j}{P_{ij}}$$

implying the total differential

$$d \ln P_j = \sum_{i=0}^{n} \lambda_{ij} d \ln P_{ij} \tag{14}$$

This change in country j's price index can be further broken down into changes of domestic and import prices as

$$d \ln P_j = \lambda_{jj} d \ln P_{jj} + (1 - \lambda_{jj})\, d \ln P_j^M \tag{15}$$

where

$$P_j^M = \left[\sum_{i \neq j} \left(\psi_{ij} P_{ij}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

is the component of P_j associated with imports, and

$$d \ln P_j^M = \frac{1}{1 - \lambda_{jj}} \sum_{i \neq j} \lambda_{ij} d \ln P_{ij}$$

is its variation. Second, (6) and (5) imply

$$\frac{\lambda_{jj}}{1 - \lambda_{jj}} = \left(\frac{\psi_{jj} P_{jj}}{\psi_{ij} P_j^M}\right)^{1-\sigma} = \left(\frac{\psi_{jj}}{\psi_{ij}}\right)^{1-\sigma} \left(\frac{P_{jj}}{P_j^M}\right)^{1-\sigma}$$

which can be totally differentiated to obtain

$$d \ln P_j^M = d \ln P_{jj} + \frac{1}{1-\sigma} \left[d \ln (1 - \lambda_{jj}) - d \ln \lambda_{jj}\right] \tag{16}$$

Third, the fact that expenditure shares sum up to one requires

$$\lambda_{jj} + (1 - \lambda_{jj}) = 1$$

the total diffentiation of which leads to

$$(1 - \lambda_{jj})\, d\ln(1 - \lambda_{jj}) = -\lambda_{jj} d\ln \lambda_{jj} \tag{17}$$

Then, plugging (16) and (17) into (15) gives

$$d\ln P_j = d\ln P_{jj} - \frac{1}{1-\sigma} d\ln \lambda_{jj} \tag{18}$$

so that the change in country j's real expenditure $C_j = E_j/P_j$ can be written as

$$d\ln C_j = d\ln E_j - d\ln P_j = d\ln E_j - d\ln P_{jj} - \frac{1}{1-\sigma} d\ln \lambda_{jj} \tag{19}$$

This expression can be further simplified recalling that there are no internal trade costs ($\tau_{jj} = \tau'_{jj} = 1$ and $t_{jj} = t'_{jj} = 0$) and trade must balance ($Y_j = (1 - \pi_j)E_j$). Under these conditions, (4) implies $P_{jj}Q_j = Y_j = (1 - \pi_j)E_j$ and thus $d\ln E_j - d\ln P_{jj} = -d\ln(1 - \pi_j)$ since Q_j is a fixed endowment. Given $\varepsilon = \sigma - 1$, (19) finally becomes

$$d\ln C_j = -d\ln(1 - \pi_j) - \frac{1}{\varepsilon} d\ln \lambda_{jj} \tag{20}$$

which shows that the welfare change $d\ln C_j$ is driven by the changes in the expenditure share of tariff revenue π_j and in the expenditure share on the domestic good λ_{jj}.

Expression (20) holds only for infinitesimal changes in trade costs, which tend to be of little practical relevance. Nevertheless, it can be readily integrated to characterize the welfare effects of discrete changes. This yields

$$\widehat{C}_j = \frac{1 - \pi_j}{1 - \pi'_j} \left(\widehat{\lambda}_{jj}\right)^{-\frac{1}{\varepsilon}} \tag{21}$$

where the share of tariff revenues in the actual and counterfactual equilibria are given by

$$\pi_j = \sum_{i=1}^{n} \frac{t_{ij}}{1 + t_{ij}} \lambda_{ij} \text{ and } \pi'_j = \sum_{i=1}^{n} \frac{t'_{ij}}{1 + t'_{ij}} \lambda_{ij} \widehat{\lambda}_{ij}$$

Hence, the welfare consequences of any arbitrary change in trade costs can indeed be computed based only on few sufficient statistics: the trade elasticity and the change in the shares of expenditure across goods.

However, knowing that only few sufficient statistics are needed to compute the welfare effects of trade integration would be of little use unless we had a consistent way of identifying the values of those statistics in the counterfactual scenario. This is clearly not much of a problem for the trade elasticity ε, which, given utility (1), is constant by assumption. It may look more of a problem for the counterfactual expenditure shares $\lambda' = \left\{\lambda'_{ij}\right\}$. Luckily the structure of the model lends a hand.

Consider (6). As ψ_{ij} is constant, taking log changes gives

$$d\ln\lambda_{ij} = d\ln\left(P_{ij}\right)^{1-\sigma} - d\ln\left(P_j\right)^{1-\sigma}$$

which, by (14), can be rewritten as

$$d\ln\lambda_{ij} = d\ln\left(P_{ij}\right)^{1-\sigma} - \sum_{i=0}^{n}\lambda_{ij}d\ln\left(P_{ij}\right)^{1-\sigma} \tag{22}$$

As Q_i is also constant, (4) implies

$$d\ln\left(P_{ij}\right)^{1-\sigma} = d\ln\left(\phi_{ij}Y_i\right)^{1-\sigma}$$

which allows one to restate (22) as

$$d\ln\lambda_{ij} = d\ln\left(\phi_{ij}Y_i\right)^{1-\sigma} - \sum_{i=0}^{n}\lambda_{ij}d\ln\left(\phi_{ij}Y_i\right)^{1-\sigma}$$

for infinitesimal changes, or, by integration, as

$$\widehat{\lambda}_{ij} = \frac{\left(\widehat{\phi}_{ij}\widehat{Y}_i\right)^{-\varepsilon}}{\sum_{l=0}^{n}\lambda_{lj}\left(\widehat{\phi}_{ij}\widehat{Y}_l\right)^{-\varepsilon}} \tag{23}$$

for discrete changes given $\varepsilon = \sigma - 1$.

In the counterfactual equilibrium, (6), (12) and (10) further imply

$$Y'_j = \sum_{i=1}^{n}\frac{1}{1+t'_{ij}}\lambda'_{ij}\frac{Y'_i}{1-\pi'_i}$$

which can be rewritten as

$$\widehat{Y}_jY_j = \sum_{i=1}^{n}\frac{1}{1+t'_{ij}}\widehat{\lambda}_{ij}\lambda_{ij}\widehat{Y}_i\frac{Y_i}{1-\pi'_i}$$

so that using (23) to substitute for $\widehat{\lambda}_{ij}$ yields

$$\widehat{Y}_jY_j = \sum_{i=1}^{n}\frac{1}{1+t'_{ij}}\frac{\lambda_{ij}\left(\widehat{\phi}_{ij}\widehat{Y}_i\right)^{-\varepsilon}}{\sum_{l=0}^{n}\lambda_{lj}\left(\widehat{\phi}_{lj}\widehat{Y}_l\right)^{-\varepsilon}}\frac{\widehat{Y}_iY_i}{1-\pi'_i} \tag{24}$$

The share of tariff revenues in the counterfactual equilibrium is itself given by

$$\pi'_i = \sum_{i=1}^{n}\frac{t'_{ij}}{1+t'_{ij}}\lambda'_{ij} = \sum_{i=1}^{n}\frac{t'_{ij}}{1+t'_{ij}}\widehat{\lambda}_{ij}\lambda_{ij}$$

which, by (23), becomes

$$\pi'_i = \sum_{i=1}^{n} \frac{t'_{ij}}{1+t'_{ij}} \frac{\lambda_{ij}\left(\widehat{\phi}_{ij}\widehat{Y}_i\right)^{-\varepsilon}}{\sum_{l=0}^{n}\lambda_{lj}\left(\widehat{\phi}_{ij}\widehat{Y}_l\right)^{-\varepsilon}} \tag{25}$$

After using (25) to substitute for π'_i, (24) generates a system of n equations in n unknown income changes that can be solved for the counterfactual $\widehat{Y} = \left\{\widehat{Y}_i\right\}$ (up to a normalization due the choice of the numeràire good). As the system does not depend directly on the utility parameters $\psi = \{\psi_{ij}\}$ and the endowments $Q = \{Q_i\}$, changes in factor income levels $\widehat{Y} = \left\{\widehat{Y}_i\right\}$ can be determined using only the initial expenditure shares $\lambda = \{\lambda_{ij}\}$, the initial income levels $Y = \{Y_i\}$, and the trade elasticity ε. Once the changes in income $\widehat{Y}$ have been solved for, the changes in expenditure shares $\widehat{\lambda} = \left\{\widehat{\lambda}_{ij}\right\}$ and the counterfactual tax revenues $\pi' = \{\pi'_i\}$ can be obtained from (23) and (25) respectively. Plugging them into (21) finally determines the welfare change $\widehat{C}_j$ in the counterfactual scenario. Hence, the welfare effects of trade cost changes can be evaluated estimating only the trade elasticity and not all the structural parameters of the model.

4 Gains from trade

The counterfactual proposed by Arkolakis, Costinot and Rodriguez-Clare (2012) to assess the contribution of actual trade to welfare is an autarkic scenario in which frictional barriers are prohibitive: $\phi'_{ij} = +\infty$ for all $i \neq j$. In this scenario, domestic goods absorb all expenditures, implying $\lambda'_{jj} = 1$ and thus $\widehat{\lambda}_{jj} = 1/\lambda_{jj}$, and there are no tariff revenues, implying $\pi'_j = 0$. Gains from trade for country j can be measured by the percentage fall in real expenditure due to moving from the actual situation to counterfactual autarky. Using (21) together with $\widehat{\lambda}_{jj} = 1/\lambda_{jj}$ and $\pi'_j = 0$ gives

$$G_j = 1 - \widehat{C}_j = 1 - \frac{1-\pi_j}{1-\pi'_j}\left(\widehat{\lambda}_{jj}\right)^{-\frac{1}{\varepsilon}} = 1 - (1-\pi_j)\left(\lambda_{jj}\right)^{\frac{1}{\varepsilon}} \tag{26}$$

which shows that for this specific counterfactual there is no need to solve the system of equations (24) as λ_{jj} is the observed expenditure share of the domestic good, π_j is the observed expenditure share of tariff revenue, and the trade elasticity ε can be estimated from a cross-sectional gravity regression based on (7). In particular, taking (7) in logs and using $P_{ii} = Y_i/Q_i$ gives

$$\ln X_{ij} = \ln\left(P_{ii}\right)^{-\varepsilon} + \ln\frac{E_j}{\sum_{i=1}^{n}\left(\phi_{ij}Y_i\right)^{-\varepsilon}\left(Q_i/\psi_{ij}\right)^{\varepsilon}} - \varepsilon\ln\left(\phi_{ij}\right) + \ln\left(\psi_{ij}\right)^{-\varepsilon} \tag{27}$$

which can be empirically implemented treating the first term on the right hand side as an exporter fixed-effect, the second term as an importer fixed-effect, and the fourth term as measurement error in trade flows orthogonal to $\ln\left(\phi_{ij}\right)$ in the third term. Using fixed effects yields a consistent estimate of the trade elasticity ε as discussed by Head and Mayer (2014), whose equation (31) embeds (27). Their Table 5 reports the findings of 32 gravity papers that estimate trade cost elasticities. It highlights a large variation in the point estimates with a standard deviation twice as large as the mean. A substantial part of this variation comes from methodological differences across papers. Head and Mayer (2014) choose 5.03 as their preferred estimate, corresponding to the median coefficient obtained using country fixed effects and tariffs for ϕ_{ij}.

Building on Head and Mayer (2014), the rounded value $\varepsilon = 5$ is used by Costinot and Rodriguez-Clare (2014) to evaluate G_j for a set of 27 EU countries and 13 other major countries with data on $X = \{X_{ij}\}$ drawn from the World Input-Output Database (WIOD) in 2008 (Timmer, 2012). The results of their computations based on (26) are reported in the first column of their Table 1 where $\pi_j = 0$ is assumed for simplicity. This assumption is motivated by the fact that, despite large trade flows, actual tariff revenues typically account only for a negligible share of aggregate expenditures, at least in the case of most OECD countries. Given (9), $\pi_j = 0$ for positive X_{ij} requires $t_{ij} = 0$.

Figure 1 describes the gains from trade for 20 selected EU countries – Costinot and Rodriguez-Clare (2014) place the remaining 7 EU members in a residual category comprising both EU and non-EU countries. Percentage gains from trade are measured along the vertical axis and countries are arranged from left to right in decreasing order of gains from trade along the horizontal one. The flat dashed line represents average trade gains at 5.27%. Different fill patterns identify different groups of countries: Southern countries (Greece, Italy, Portugal, Spain) are identified by a checkered fill; Eastern countries (Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia) by a blank fill; Northern countries (Denmark, Finland, Great Britain, Ireland, Sweden) by a diagonal fill, and Western countries (Austria, Belgium, France, Germany, Netherlands) by a solid fill. All countries are in grey except for the four largest countries that are in black.

The figure shows that: (i) gains from trade are positive for all countries; (ii) all Southern countries and all the largest countries enjoy lower than average gains from trade; (iii) above average gains from trade mostly benefit small non-Southern countries; (iv) within all geographical groups gains from trade fall with country size. Overall, gains from trade tend, therefore, to be smaller for larger or more peripheral countries. The reason is that these countries tend to have larger λ_{jj} since they buy relatively more from themselves. As ε is the same for all countries, by (26) larger λ_{jj} translates into smaller computed gains from trade.

5 Fortress Europe

Using autarky as a counterfactual scenario makes the calculation of the changes in expenditure shares $\widehat{\lambda} = \left\{\widehat{\lambda}_{ij}\right\}$ straightforward. But this a very specific case. In other scenarios, calculating $\widehat{\lambda} = \left\{\widehat{\lambda}_{ij}\right\}$ requires first solving (24) and (25) for the counterfactual changes in incomes $\widehat{Y} = \left\{\widehat{Y}_i\right\}$. As an example, one can follow again Costinot and Rodriguez-Clare (2014) who consider a counterfactual scenario in which the US unilaterally imposes an import tariff of 40% on all its trading partners: $t'_{iUS} = 0.4$ for any country i other than the US. They point out that this is close to the tariff level observed in the US in the late 19th and early 20th centuries.

The welfare changes caused by the 40% tariff in each trading partner of the US are reported in Column 1 of their Table 2. Based on their computations, **Figure 2** describes the welfare change $\widehat{C}_j$ from US protectionism for 19 of the 20 EU countries appearing in Figure 1. The excluded country is Ireland. As its welfare loss of 0.91% is more than four times larger than the welfare loss of any other country, its inclusion in Figure 2 would have blurred the cross-country variation of welfare changes. Percentage welfare losses are measured (in absolute value) along the vertical axis and countries are ranked from left to right in decreasing order of welfare loss along the horizontal one. The flat dashed line at 0.10% corresponds to the average welfare loss across the selected 19 countries. The different fill patterns have the same interpretation as in Figure 1.

The figure shows that: (i) all countries face welfare losses due to US protectionism; (ii) all Southern countries and all Eastern countries except Hungary suffer lower than average welfare losses; (iii) above average welfare losses are mostly concentrated in Northern and Western countries; (iv) all the largest countries besides Germany suffer below average welfare losses. Most of the difference in the group rankings between Figures 1 and 2 is driven by the shift of Eastern countries from left to right, which reflects the disproportionate orientation of their trade towards EU partners rather than towards the US.

6 Robustness

The Armington model is useful but also too simple. The key insight of Arkolakis, Costinot and Rodriguez-Clare (2012) is that the methodology illustrated in the Armington case can be readily applied to all NQTMs, defined as models that share four primitive assumptions (Dixit-Stiglitz preferences, one factor of production, linear cost functions, perfect competition or monopolistic competition) as well as three macro-level restrictions (balanced trade, aggregate profits as a constant share of aggregate revenues, CES import demand system).

In discussing these issues Costinot and Rodriguez-Clare (2014) show that, when NQTMs feature only one sector, a strong equivalence result holds: conditional on given counterfactual changes in expenditure shares $\widehat{\lambda} = \left\{\widehat{\lambda}_{ij}\right\}$ and the same trade elasticity ε, alternative NQTMs must predict the same welfare changes as the Armington model. This does not imply, however, that different models necessarily yield the same predictions on the counterfactual changes in expenditure shares caused by any given policy experiment. It does not imply either that the strong equivalence survives the introduction of additional real world features such as multiple sectors, tradable intermediate goods and multiple factors of production. Hence, the same policy shock may be predicted to have different welfare effects depending on the specific NQTM the analysis relies on.

As a first example one can reconsider the gains from trade. Costinot and Rodriguez-Clare (2014; Table 1) show that introducing multiple sectors and intermediate goods leads to substantial increases in the gains from trade for given trade shares. In the case of perfect competition, introducing multiple sectors increases average gains from trade for our EU countries from the baseline 5.27% reported in **Figure 1** to 20.10%. Considering also intermediate goods further increases average gains to 33.78% or 34.83% depending on the chosen measure of intermediate good shares. The effect of intermediate goods (but not of multiple sectors) is amplified under monopolistic competition *à la* Krugman (1980): gains from trade evaluate to 19.11% with multiple sectors and 41.62% with the addition of intermediate goods; they rise to 48.70% when firm heterogeneity is also considered as in Melitz (2003).

Another example can be found in Table 3 of Costinot and Rodriguez-Clare (2014), which compares the predictions of different models for a third counterfactual scenario: a generalized protectionistic surge leading to a 40% increase in worldwide import tariffs. European Countries are sorted into the usual four geographical groups (with zero tariffs within groups) but, differently from Figures 1 and 2, the list of selected EU members is now longer, and EU countries are bundled together with non-EU ones. In particular: Southern Europe now includes also Cyprus, Malta and Turkey; Eastern Europe also Bulgaria, Estonia, Latvia, Lithuania and Russia; Northern Europe includes the same countries as before; Western Europe includes also Luxemburg. Welfare effects are computed for alternative NQTMs featuring perfect or monopolistic competition, with or without intermediates, with or without heterogeneous firms. Costinot and Rodriguez-Clare (2014) show that, consistently across models, the worldwide tariff increase reduces welfare in all countries, with larger average losses predicted by models with monopolistic competition and intermediate goods.

While focusing on averages is interesting, looking at the correlations between countries' losses across models is also important for assessing how sensitive predictions are to model specification. Fot the 40% increase in worldwide import tariffs, these correlations are reported in **Table 1**. The large correlation between columns 1 and 4 (perfect competition) as well as between colums 2, 3, 5 and 6 (monopolistic competition) show that predictions are fairly robust when alternative models keep the same market structure. They are, instead, not that robust when market structure changes across models: the correlations between columns 1 or 4 on the one side and between colums 2, 3, 5 or 6 on the other are still large but negative. Hence, while considering or not intermediate goods mostly affects the level of the average welfare effects, the choice of market structure also impacts on the cross-country distribution of those effects.

7 Conclusion

This chapter has discussed whether and how 'new quantitative trade models' (NQTMs) can be fruitfully applied to quantify the welfare effects of trade liberalization, thus shedding light on the trade-related effects of further European integration.

On the one hand, the chapter has argued that NQTMs have the potential of being used to supplement traditional CGE analysis thanks to their tighter connection between theory and data, their appealing micro-theoretical foundations, and their enhanced attention to the estimation of structural parameters. On the other hand, further work is still needed in order to exploit their full potential for policy analysis.

First, the predictions of NQTMs seem to be very sensitive to the choice of market structure. This is revealed by comparing perfect competition with monopolistic competition as in Costinot and Rodriguez-Clare (2014). In this respect, more work on the comparison with oligopoly would be useful (see, e.g., Arkolakis, Costinot, Donaldson and Rodriguez-Clare, 2012) as well as more attention to the actual market structures that characterize different sectors.

Second, NQTMs are mostly silent on the 'dynamic' effects that policy intervention may have on economic growth, through more competition, innovation and technology adoption. While these effects are possibly the most important, including them is a tough challenge. While NQTMs currently embed most 'canonical' static trade models, any specific class of 'canonical' dynamic trade models is yet to be identified.

Finally, from a methodological point of view, the validation checks, which are a crucial passage in macroeconomics from calibration to simulation, have increasingly gone missing in NQTMs. Recent works tend to favor the implementation of models that are 'exactly identified'. These are models in which the number of free parameters to be calibrated equals the number of observed moments of the data, and thus yield a trivially perfect fit. The question is whether simulations based on this sort of tautology are really useful for policy design. In this respect, renewed attention should be devoted to models that are 'overidentified', i.e. models in which the number of free parameters is smaller than the number of moments of the data. For these models the validation checks are not trivially passed, and can thus be used as meaningful evidence that a model is a more or less reasonable representation of reality than its alternatives.

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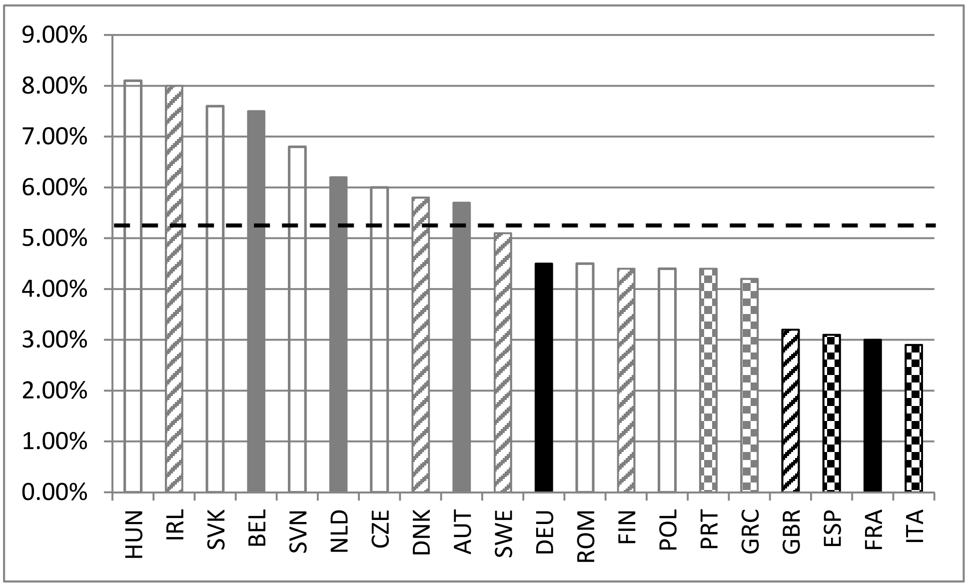
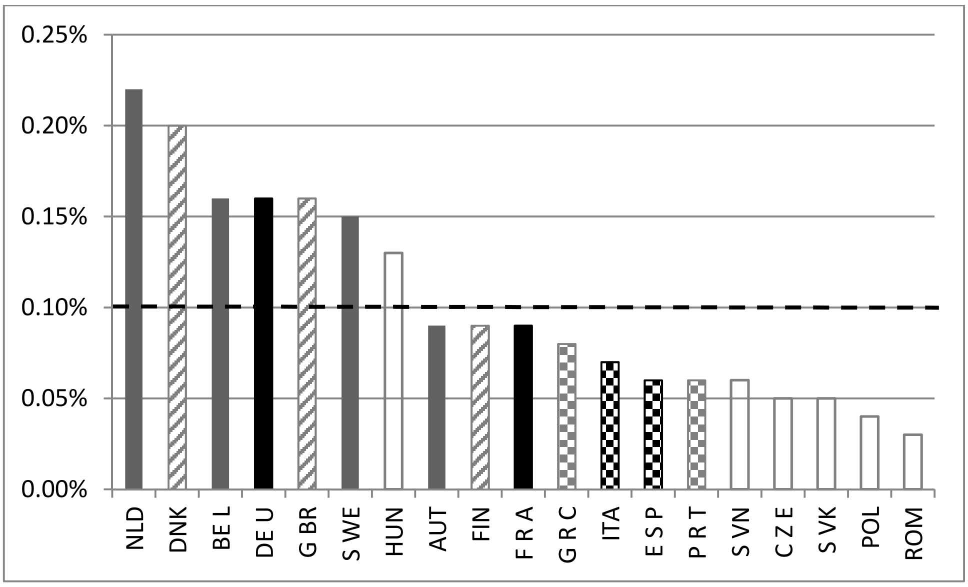


Source: Author's elaboration based on percentage gains from Table 1 in Costinot and Rodriguez Clare (2014).

Figure 1 - Gains from trade for selected EU countries



Source: Author's elaboration based on percentage losses from Table 2 in Costinot and Rodriguez Clare (2014).

Figure 2 - Welfare losses from US protectionism for selected EU countries

	Without Intermediates			**With Intermediates**		
	Perfect Competition	**Monopolistic Competition**		**Perfect Competition**	**Monopolistic Competition**	
		Krugman (1980)	**Melitz (2003)**		**Krugman (1980)**	**Melitz (2003)**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
(1)	1	-0.72098	-0.72613	0.998883	-0.63709	-0.72288
(2)		1	0.974937	-0.75233	0.986991	0.933616
(3)			1	-0.75753	0.932363	0.835422
(4)				1	-0.67063	-0.74652
(5)					1	0.955704
(6)						1

Source: Author's elaboration based on percentage losses from Table 3 in Costinot and Rodriguez Clare (2014).

Table 1 – Correlation of welfare losses from a worldwide tariff increase for 20 European countries

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