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Partial Equilibrium Modelling with Heterogeneous Firms: A Framework for UK Trade Policy

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The Trade Economics of Brexit

1. Brexit costs have driven niche producing firms out of the EU export market

challenges faced by UK firms:

- increased costs mainly due to supply chain issues (Clarke et al., 2023; Thissen et al., 2020;)
- labour shortages and Skill issues (Tiwasing, 2021; Clarke et al., 2023)
- productivity (Bloom et al., 2019; Chen et al., 2018)

2. Brexit has had a large negative impact on UK goods exports, with particularly large impact on smaller firms (Du et al., 2023; Bailey et al., 2023; Freeman et al., 2022)

5.51 mn -99.9% - SMEs (UK Small Business Demographics, 2024):

- new custom costs → supply chain disruptions (Gao et al., 2021; Freeman et al., 2022)
- increased labour acquiring costs; lower access to skilled labour (Tiwasing, 2021)
- extensive margin of exports shrunk (Freeman et al., 2022)

3. considerable variation in how different industries are affected: trade cost changes; EU market dependence; technology adoption (Gasiorek et al., 2018)

Firm Productivity and Competitiveness

higher firm productivity shapes a country's export supply potential

- changes in import competition and in access to imported inputs and export markets affect firms' incentives to upgrade productivity through technological innovation or adoption (Bustos, 2011; Goldberg, Khandelwal, Pavcnik and Topalova, 2010; Lileeva and Trefler, 2010)
- firms with higher productivity levels find it profitable to incur the additional fixed and variable costs of exporting; the least productive firms do not export because their profit margins are insufficient to cover the additional costs (Melitz, 2003)

lower firm productivity, lower competitiveness

- Melitz (2003) underscores the importance of productivity in determining a firm's ability to compete internationally and highlights the dynamic gains from trade through the reallocation of resources towards more productive firms
- the ultimate determinant of the productivity of a nation's economy concerns the firm competitiveness, within that economy (Porter, 2004)

In this paper

- simple framework for Trade Policy
- consider the role of firm heterogeneity
- Melitz-style firm entry and exit
- partial equilibrium model
- Brexit
- the case of Northern Ireland

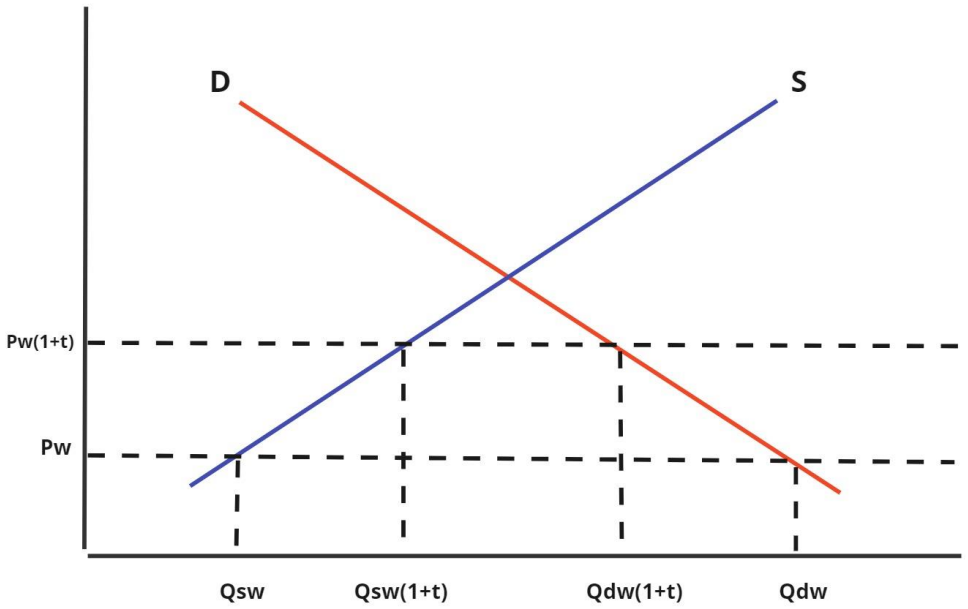
Partial Equilibrium Modelling

- evaluation of the impact of modifications in trade policies for a particular market
- estimation of the demand and supply functions for a market – while assuming no change in other markets

ADVANTAGES:

- evaluates, in a simple, quick, and partial manner, the consequences of trade policies
- requires minimal data
- further disaggregation than in CGE models

Visual Example



Import Tariff in a non-specific product
Pw will increase to Pw(1+t)

Increase in domestic supply: domestic producers are more competitive because they are not subject to the tariff

Reduction in demand: due to higher price

Decrease in quantity of imports

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The Model: Demand (1)

- perfectly competitive multi-market model; allows simultaneously exports/imports between several partner countries
- each sector is treated as independent of the others
- 2-stage Dixit-Stiglitz constant elasticity of substitution demand system for differentiated products
- product varieties can be differentiated either at the country level (Armington, 1969), at the firm level (Krugman, 1979), or both (Eaton and Kortum, 2012)
- utility function of a representative consumer

$$\mathrm{X} = u(X_1, \dots, X_n) = (a_\iota X_i^\rho + \cdots + a_n X_n^\rho)^{\frac{1}{\rho}}$$

- $\sigma = \frac{1}{1-\rho}$ positive elasticity of substitution
- f firms in each country; within each country producers are symmetric and produce one variety (or more than one, symmetric varieties)
- the consumer chooses a consumption bundle that minimises the level of expenditures while retaining specific level of utility

$$\min_{X_{i=1,\dots,n}} Y = \sum_{i=1}^{n} P_i X_i, \qquad s.t.\ (X_1, \dots, X_n) = X$$

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The Model: Demand (2)

- Dixit-Stiglitz Price Index $P \equiv \left(\sum_{j=1}^{n} \alpha_j P_j^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$; Quantity Index $X_j = X a_j P_j^{-\sigma} P^{\sigma}$

the prices of other goods affect the demand for good *i* only through their effect on the price index P

- expenditure shares $s_i = a_i^{\frac{1}{\sigma}} \left(\frac{X_\iota}{X}\right)^{\frac{(\sigma-1)}{\sigma}}$, hence $\hat{X} = \sum_{i=1}^{n} s_i \hat{X}_i$

changes in variety prices or quantities affect the price and quantity indices proportionately to the market shares of the varieties

- CES property: for each good *i* demand is a constant elasticity function of the price P_i relative to the price index *P;* assuming that the demand for *X* is a function of the price index *P* with elasticity *v*, *v* > *σ*

the demand elasticity is $\frac{P_i}{X_i}\frac{\partial X_i}{\partial P_i} = -\sigma(1 - s_i) - v s_i$

when a firm has a small market share, its demand elasticity is close to the high elasticity of substitution between varieties, whereas when it has a large market share, its elasticity is closer to the smaller elasticity at the overall product level

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The Model: Endogenous Firms

- each “country” has firms that sell locally and firms that sell globally
- UK also has a class of firms that sell to the EU as well as locally, but not globally
- calibration generates variable profits per firm
- firm numbers modelled explicitly in the set-up, though this has no significance until firm numbers change
- for simulation we distinguish between two cases, a fixed and a variable number of firms in each market
- average variable cost at the firm-level $avcs = avcb \times \left(\frac{yb}{ys}\right)^{inte}$
- this setting allows to introduce fixed-cost trade barriers as well as ad valorem trade barriers, and to try different kinds of fixed cost distributions

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Fixed Costs and Firm Numbers

- FC modelled only for UK firms: firm-specific fixed costs are $Am \times n^{-1}$where *Am* is highest for UKG, lowest for UKL
- treating changes in firm numbers when firms move up or down the hierarchy:

e.g.,if the UKEU firm numbers increase, the productivity effect is different if it's caused by UKL firms moving into the EU market or by UKG firms moving out of the global market

a. the fixed cost of the marginal UKG firm is a constant elasticity function of the number of UKG firms:

if the number rises, as UKEU firms move into the RoW, the fixed cost of the marginal firm rises

b. the fixed cost of the marginal UKEU firm is related to the number of UKEU+UKG firms:

firms moving from UKEU to UKG has no implications for the productivity of the marginal UKEU firm; BUT if the number of UKEU+UKG firms rises, as some UKL firms move into international trade, the fixed cost of the marginal firm rises

c. the fixed cost of the marginal UKL firm is related to the number of UKL+UKEU+UKG firms:

firms moving from UKL to UKEU has no implications for the productivity of the marginal UKL firm; BUT if the total number of UKL+UKEU+UKG firms rises, as some firms enter into production, the fixed cost of the marginal firm rises

Preliminary Results - the Brexit Experiment

in the case of a variable number of firms in each market:

- increase of the number of UKG firms from 20 to less than 21
- decrease of the number of UKEU firms from 5 to 1.29
- decrease of the number of UK firms selling abroad and raises the number of local firms from 5 to 10.59
- the total number of UK firms rises from 30 to 32.66

discussion:

- a number of UKEU firms are driven out of the EU market; with no substantial turn into the Global market
- this makes being a UKG firm a little more attractive; local firms doubled:

importantly, UKEU firms switched to serving locally only, and hence, new firms entered the market aiming to take advantage of the higher average productivity level of the industry

Next Steps

- welfare calculations
- zero profit change with heterogenous firms
- introduce more complex hierarchy settings where the cost structure must be different
- adapt in Northern Ireland setting: different setup where firms are NI, NI+GB, NI+IRL, NI+GB+EU, and of course Global
- application: highly disaggregated data for Northern Irish firms

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