New Trade Theory:
Part I. Introduction to monopolistic competition and the extensive margin of trade

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February 4, 2013

1 Background: The Evolution of Trade Theory

Trade Theories:
Classical: Richardo (1815)
Neo-classical: Heckscher-Ohlin (1919 and 1933)
New Trade: Krugman (1979 and 1980)
New-new Trade: Melitz (2003)

What about Armington (1969)?

The Armington formulation of regionally differentiated goods is immediately appealing from an empirical perspective. Any observed pattern of trade can be exactly accommodated, and this pattern is independent of the elasticity of substitution. The Armington composite is given by:

$$Q_{is} = (\sum_s \lambda_{irs} q_{irs}^{\rho})^{1/\rho}$$

Notice that there is at least one free parameter, λ_{irs}, for each trade flow (degrees of freedom = $(R \times R) - (R \times R - 1)$).

For CGE modelers: the goal is to measure policy impacts. Response is the critical empirical measure (ρ); we just need to calibrate λ_{irs} to give us a good starting point.

For Trade Theorists: the goal is to explain trade patterns. The Armington structure is "cheating" for theorists because it explains everything about the initial trade pattern (via idiosyncratic preference biases). Trade theorists are more focused on deriving a (production side or structured geographic) explanation of the λ_{irs}.

- Structural Gravity Models

  1. **Armington:** Anderson (1979) and Anderson and van Wincoop (2003).
  2. **Krugman:** Helpman and Krugman (1985 Ch.8)
  3. **Melitz:** Helpman, Melitz and Rubinstein (2008)
  4. Also: Eaton and Kortum (2002) and Deardorff (1998)

Table 1: Notation and Variable Definitions

Variable	Armington	Krugman	Melitz
Composite-commodity demand	Q_{jr}	Q_{kr}	Q_{hr}
Price index on composite commodity	P_{jr}	P_{kr}	P_{hr}
Number of entered firms			M_{hr}
Number of active firms		N_{kr}	N_{hrs}
Firm-level output		q_{krs}	$\tilde{q}_{hrs}$
Firm-level price		p_{krs}	$\tilde{p}_{hrs}$
Firm-level productivity			$\tilde{\varphi}_{hrs}$
Composite-input unit cost	c_{jr}	c_{kr}	c_{hr}
Composite-input supply	Y_{jr}	Y_{kr}	Y_{hr}

2 Three Trade Theories

For good i in region r take as given demand for the composite of domestic and foreign varieties, which is a function of the general-equilibrium price vector:

$$Q_{ir} = Q_{ir}(\boldsymbol{P}) \qquad \perp P_{ir}. \tag{1}$$

Also take as given the "output" level of good i in region s, which is also a function of the general-equilibrium price vector:

$$Y_{is} = Y_{is}(\boldsymbol{P}) \qquad \perp Y_{is}. \tag{2}$$

In the monopolistic competitions theories we will interpret Y_{is} as the "supply" of a single composite input.

2.1 Armington (Model A1)

$$P_{js} = \left[\sum_r (\tau_{jrs} c_{jr})^{1-\sigma_j}\right]^{1/(1-\sigma_j)} \qquad \perp Q_{js} \tag{3}$$

$$Y_{jr} = \sum_s \tau_{jrs} Q_{j,s} \left(\frac{P_{js}}{\tau_{jrs} c_{jr}}\right)^{\sigma_j} \qquad \perp c_{jr} \tag{4}$$

Combining equations (1) and (2) with equation (3) and (4) we have a square system $[4 \times R \times J]$ that defines the trade equilibrium.

The τ_{jrs} term is usually interpreted as reflecting the real resource cost of transport (iceberg transport costs). Notice, however, that we could interpret τ_{jrs} as an "unobserved" trade cost parameter. We can choose the τ_{jrs} to calibrate the trade equilibrium. Mathematically it enters the model in a way that is indistinguishable from a standard CES distribution parameter (λ_{jrs} in the above example).

2.2 Krugman (Model A2)

$$P_{ks} = \left[\sum_r N_{kr} p_{krs}^{1-\sigma_k}\right]^{1/(1-\sigma_k)} \qquad \perp Q_{kr} \tag{5}$$

$$q_{krs} = Q_{ks} \left(\frac{P_{ks}}{p_{krs}}\right)^{\sigma_k} \qquad \perp p_{krs} \tag{6}$$

$$p_{krs} = \frac{\tau_{krs} c_{kr}}{1 - 1/\sigma_k} \qquad \perp q_{krs} \tag{7}$$

$$c_{kr} f_k = \sum_s \frac{p_{krs} q_{krs}}{\sigma_k} \qquad \perp N_{kr} \tag{8}$$

$$Y_{kr} = N_{kr} \left(f_k + \sum_s \tau_{krs} q_{krs}\right) \qquad \perp c_{kr} \tag{9}$$

Combining equations (1) and (2) with the Krugman specific equations (5) – (9) we again have a square system of dimension $[(5 \times R \times K) + (2 \times R \times R \times K)]$ that establishes the trade equilibrium.

2.3 Melitz (Model A3)

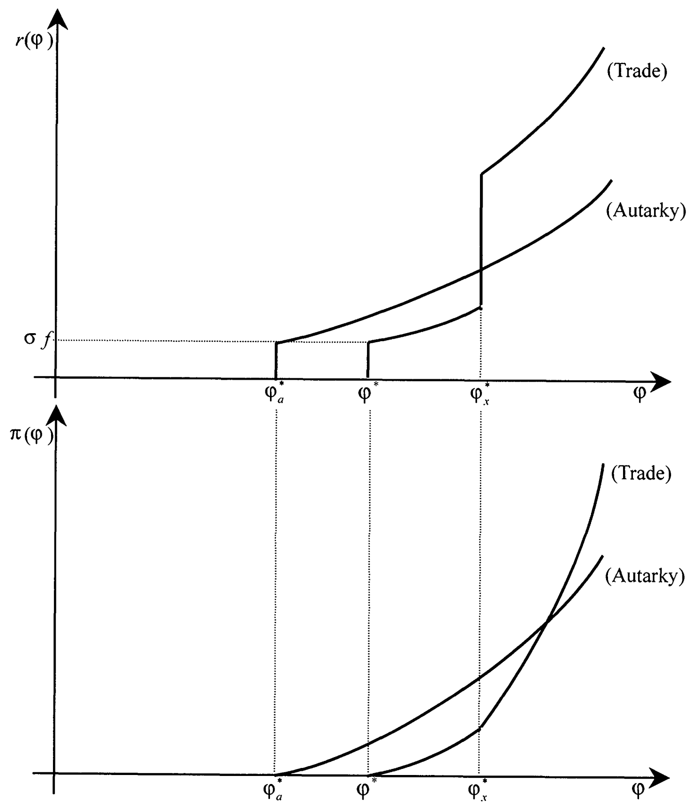

FIGURE 2.—The reallocation of market shares and profits.

Firm specific productivity is given by φ where cost equals $f + q/\varphi$. The productivity level is drawn from a Pareto distribution with shape parameter a and lower support b.
PDF:

$$g(\varphi) = \frac{a}{\varphi}\left(\frac{b}{\varphi}\right)^a$$

This allows Melitz to define the representative firm (drawing $\tilde{\varphi}$) and relate this firm to the marginal firm.

2.4 Melitz (Model A3)

$$P_{hs} = \left[\sum_r N_{hrs}\tilde{p}_{hrs}^{1-\sigma_h}\right]^{1/(1-\sigma_h)} \qquad \perp Q_{hs} \tag{10}$$

$$\tilde{q}_{hrs} = Q_{hs}\left(\frac{P_s}{\tilde{p}_{hrs}}\right)^{\sigma_h} \qquad \perp \tilde{p}_{hrs} \tag{11}$$

$$\tilde{p}_{hrs} = \frac{c_{hr}\tau_{hrs}}{\tilde{\varphi}_{hrs}(1-1/\sigma_h)} \qquad \perp \tilde{q}_{hrs} \tag{12}$$

$$c_{hr}f_{hrs} = \tilde{p}_{hrs}\tilde{q}_{hrs}\frac{(a+1-\sigma_h)}{a\sigma_h} \qquad \perp N_{hrs} \tag{13}$$

$$c_{hr}\delta f_{hr}^{s} = \sum_s \tilde{p}_{hrs}\tilde{q}_{hrs}\frac{(\sigma_h-1)}{a\sigma_h}\frac{N_{hrs}}{M_{hr}} \qquad \perp M_{hr} \tag{14}$$

$$\tilde{\varphi}_{hrs} = b\left(\frac{a}{a+1-\sigma_h}\right)^{1/(\sigma_h-1)}\left(\frac{N_{hrs}}{M_{hr}}\right)^{-1/a} \qquad \perp \tilde{\varphi}_{hrs} \tag{15}$$

$$Y_{hr} = \delta f_{hr}^{s}M_{hr} + \sum_s N_{hrs}\left(f_{hrs} + \frac{\tau_{hrs}q_{hrs}}{\tilde{\varphi}_{hrs}}\right) \qquad \perp c_{hr} \tag{16}$$

Equations (1), (2), and (10) – (16) form a square system of dimension $[(5 \times R \times H) + (4 \times R \times R \times H)]$ that establishes the Melitz trade equilibrium.

Exercises 1.1:

1. Hands-on Calibration of a Krugman MCP:

   (a) Copy the "Variable, Equation, and Model" code from Model A2 into a new program.

   (b) Calibrate these equations to the following bilateral trade data for a given commodity:

	Las Palmas	Madrid	Barcelona	Sevilla
LasPalmas	100	20	15	5
Madrid	25	1000	150	50
Barcelona	15	200	500	50
Sevilla	10	150	50	200

   Assume that the number of firms in each region is equal to total output. For example, there are 140 firms in Las Palmas. The calibration involves finding a set of trade costs (τ) that are consistent with the trade flows.

2. Run an experiment where you add 10% to the trade costs on the Las Palmas to Madrid link:
   τ("x","lpa","mad")=τ("x","lpa","mad")+0.1.

3. Recalibrate the model such that there are only two firms in Madrid and show that the results of the experiment are insensitive to this choice of scale.

4. How might we deal with an observed value for trade costs? Add a preference parameter that allows us to set $\tau_{krs} = 1 \forall krs$.

Exercises 1.2:

1. Convert model A1 into a one-factor one-sector general equilibrium [the Anderson-van Wincoop (2003) model]. You need to replace the Aggregate Demand and Input Supply equations with general-equilibrium equations and close the model with income-balance.

2. Convert model A2 into a one-factor one-sector general equilibrium [the Krugman (1980) model].

3. Show that the general-equilibrium versions of A1 and A2 (that you just created) yield the same welfare impacts from changes in τ [Arkolakis et al. (2012) equivalence].

4. Use the general-equilibrium version of A2 to analyze the impact on the number of firms and the output per firm of changes in τ. Does this give us insight into the equivalence result?

5. Add a tariff instrument in the general-equilibrium version of A2.