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## Efficiency Gaps, Love of Variety and International Trade

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# **Efficiency Gaps, Love of Variety and International Trade**

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## **Abstract**

This paper develops a general equilibrium model of trade with technical heterogeneity amongst monopolistically competitive firms and countries. With free-entry, the existence of technical asymmetries between firms leads to the endogenous determination of the equilibrium average efficiency of the industry. It is shown that trade reduces (increases) the minimum efficiency required to survive in the more (less) efficient country. This has important welfare implications: **(1)** contrary to the constant elasticity of substitution homogeneous firms model, through its effects on the efficiency composition of the industry, trade affects welfare even when there is no love of variety, and **(2)** there are circumstances in which trade liberalisation leads to a loss of consumer welfare.

**JEL Classification: F12, L11**

**Key words: monopolistic competition, international trade, efficiency gaps.**

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## 1. INTRODUCTION

The standard representative consumer monopolistic competition models of trade are based on assumptions of homogeneity both between firms within countries and across countries. These assumptions have two important consequences. First, trade liberalisation normally results in symmetrically distributed market shares<sup>1</sup>. Second, trade is a source of welfare gains, given its rationalising effects on industries (e.g. Smith and Venables, 1988) and the increase in the number of varieties available for consumption it generates. Normally, these gains are also symmetrically distributed between countries.

The assumptions of homogeneity on which these results rest, however, are at odds with the existing evidence which suggests that (1) inter-firm differences in performance and market shares are distinguishing features of real world industries and (2) a high degree of specialisation still characterises the trade pattern of similar countries. For instance, Mueller (1986) reports the existence of significant and persistent profitability differences among US firms within industries. Cubbin and Geroski (1987) and Mueller (1990) confirm these results for the UK and in a more recent study Oulton (1998) finds a wide dispersion of labour productivity across UK companies within sectors. At the international level, Dollar, Wolff, and Baumol (1988) report a considerable variation across industrial countries in the value added per-employee, and Dollar and Wolff (1993) find that industrial countries' degree of convergence of aggregate labour productivity to US levels is highly heterogeneous across industries.

This paper constructs a theoretical model of trade in which monopolistically competitive firms and countries are characterised by different efficiency levels<sup>2</sup>. The analysis is carried out within a general equilibrium framework with two similar but not identical countries. In each country, there is a monopolistically competitive sector and a perfectly competitive one. In the former, firms are characterised by asymmetric levels of cost efficiency. Countries are identical in every respect but in the cost distribution of firms in the monopolistic sector. In this sector, market structure is determined endogenously via free-entry and exit. With technical heterogeneity, this leads to a mechanism of competitive selection whereby the efficiency of the marginal firm in the industry is determined endogenously. This implies that

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<sup>1</sup> The exceptions to this result stem from transport costs (Krugman, 1980) and/or from asymmetric preferences (Venables, 1987, 1994).

<sup>2</sup> The effects of firm heterogeneity on market structure and profitability within a partial equilibrium, closed economy, monopolistic competition model are analysed in Montagna (1995).

the cost efficiency composition of the equilibrium population of firms is determined within the model.

The endogenous determination of industry efficiency represents another channel, alongside the number of varieties, through which trade may affect welfare. The opening up of trade changes the competitive environment in which firms operate. This implies that in each country trade modifies the efficiency structure of the equilibrium population of firms. In particular, we find that trade liberalisation reduces (increases) the minimum efficiency required to survive in the more (less) efficient country. Hence, free trade has rationalising effects on the structure of industry efficiency only in the less efficient country.

A second innovation of the model is to allow for different degrees of “*love of variety*” (*LOV*). The preference for diversity plays a crucial role in the determination of the welfare effects of trade in the Dixit-Stiglitz-Krugman model of monopolistic competition. This contrasts with monopolistically competitive macroeconomic models - e.g. Blanchard and Kiyotaki (1987), Startz (1989) - where the number of product varieties has no effect on the representative consumer’s indirect utility. Following Benassy (1996), we adopt a more general specification of the utility function where the standard Dixit-Stiglitz (1977) “*love of variety*” and the “*no love*” are the two limiting special cases. This allows to highlight interesting interactions between the efficiency and the variety effects of trade liberalisation. In particular, we show that, contrary to the constant elasticity of substitution homogeneous firms model, trade liberalisation – through its effects on the efficiency composition of the industry – affects welfare even when there is no love of variety. Furthermore, the analysis suggests that the adverse efficiency effects of trade for the more efficient country may result in overall welfare losses if *LOV* is sufficiently low.

The rest of the paper is organised as follows. The autarkic equilibrium is analysed in Section 2. Section 3 sets out the free trade model. The effects of trade on industry efficiency are discussed in Section 4. Sections 5 and 6 analyse the pattern and the welfare effects of trade, respectively. Section 7 draws some conclusions.

## **2. THE MODEL: AUTARKY**

The model is developed in a general equilibrium framework with two countries called home (*h*) and foreign (*f*). In each country there is an imperfectly competitive industry producing a horizontally differentiated manufacturing good and a perfectly competitive industry producing a homogeneous agricultural commodity. Labour is the only factor of production

and is assumed to be perfectly mobile between the two sectors within each economy. We assume that the two countries are endowed with the same quantity of labour.

## 2.1. Consumers

On the demand side, the two countries are identical in every respect. In each economy, there is an aggregate representative household which has (i) a homothetic utility over a composite differentiated manufacturing good  $D_j$  ( $j=h,f$ ) and a homogeneous agricultural good  $A_j$  and (ii) a CES sub-utility over varieties. The first stage of utility maximisation entails to solve the following problem

$$(1) \quad \begin{aligned} \underset{D_j, A_j}{\text{Max}} \quad U_j &= \frac{A_j^{1-\mu} D_j^\mu}{\mu^\mu (1-\mu)^{1-\mu}}, \quad 0 < \mu < 1 \\ \text{s.t.} \quad M_j &= A_j + P_j D_j, \end{aligned}$$

where the price of the agricultural good (taken as the numeraire) is set to unity,  $P_j$  is the price index of the differentiated bundle of goods, and  $M_j$  is aggregate income. The latter is given by

$$(2) \quad M_j = w_j \bar{L}_j + \Pi_j,$$

where  $w_j$  is the economy wide wage rate,  $\bar{L}_j$  is total labour endowment and  $\Pi_j$  is total profits in country  $j$ . The solution is given by the following demand functions:

$$(3) \quad A_j = (1-\mu)M_j,$$

$$(4) \quad D_j = \mu \frac{M_j}{P_j}.$$

We follow Benassy (1996) and adopt a representation of consumers' preferences over the varieties of the differentiated good which allows one to "disentangle" the taste for

variety parameter from the degree of market power and substitutability between varieties. This allows to distinguish situations where consumers do not value the number of varieties *per se*, but perceive them as not being too close substitutes for each other, from others in which preferences reward the availability of a large number of products regardless of the degree of substitutability between them. Let  $\lambda \in [0,1]$  be the constant parameter which reflects the extent to which the CES quantity index explicitly incorporates the so-called “*love of variety*”.  $\lambda=0$  and  $\lambda=1$  correspond to the two extreme cases of “*no love*” and of “*maximum love*” respectively (see Benassy, 1996, for details). Assuming a continuum of varieties, the price and quantity indexes for the horizontally differentiated good with a range  $N_j$  of varieties will then be defined as follows

$$(5) \quad P_j = \left( N_j^{\lambda-1} \int_1^{N_j+1} P_{ji}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}},$$

$$(6) \quad D_j = \left( N_j^{(\lambda-1)/\sigma} \int_1^{N_j+1} D_{ji}^{(\sigma-1)/\sigma} di \right)^{\frac{\sigma}{\sigma-1}},$$

where  $P_{ji}$  and  $D_{ji}$  are price and consumption of the variety produced by firm  $i \in [1, N_j + 1]$  in country  $j$  ( $j=h,f$ ) respectively, and  $\sigma > 1$  is the constant elasticity of substitution between varieties. Note that equations (5) and (6) imply that the “mass” of available varieties in the product space is equal to  $N_j = (N_j + 1) - 1$ . For expositional simplicity, henceforth we shall refer to  $N_j$  as the “number” of varieties available in the industry.

In the second stage of utility maximisation the problem of the representative consumer is to maximise (6) subject to  $P_j D_j = \int_1^{N_j+1} P_{ji} D_{ji} di$ . The resulting demand for each variety  $D_{ji}$  will be given by

$$(7) \quad D_{ji} = N_j^{\lambda-1} D_j \left( \frac{P_{ji}}{P_j} \right)^{-\sigma}.$$

## 2.2. Agriculture

In both countries agriculture is perfectly competitive and produces a homogenous output under conditions of constant returns to scale. Assuming unit labour requirements, the production function of the agricultural good in country  $j$  is

$$(8) \quad L_{Aj} = A_j,$$

where  $L_{Aj}$  is the labour force employed in this sector. It follows that the zero-profit condition in agriculture implies a unit wage, hence  $w_j = 1$ .

## 2.3. Industry

Firms in the differentiated industrial sector employ an increasing returns to scale technology which uses labour as both fixed and variable input. Given that labour is perfectly mobile within each economy, the nominal wage rate is determined in the agricultural sector. Hence, the total cost function facing a typical firm  $i$  is

$$(9) \quad C_{ji} = \alpha + \beta_{ji} Q_{ji},$$

where  $Q_{ji}$  is output and  $\alpha$  and  $\beta_{ji}$  are constant parameters denoting the fixed and marginal labour requirements, respectively. The falling average cost gives rise to the incentive to specialisation from which a one-to-one correspondence emerges between the number of varieties and the number of firms in the industry. The fixed cost  $\alpha$  is assumed to be identical for all firms and across countries. Marginal costs of production, however, are assumed to be firm-specific. Thus, we depart in this from the existing literature and assume that the monopolistically competitive industry consists of firms that can be distinguished from each other not only for the type of good they produce, but also on the basis of their efficiency<sup>3</sup>. Within each country, let the first firm,  $i=1$ , be the most efficient one with respect to which all other firms can be ranked. In order to capture the efficiency ranking of firms, we can then define a continuous variable  $\rho_j(i)$ , such that  $\beta_{ji} = \rho_j(i)$  with  $\rho_j(1) = \phi_j$  and  $\rho_j'(i) \geq 0$  for all  $i \geq 1$ . For simplicity we also assume a monotonic ranking and an efficiency distribution



with only one firm per efficiency level. This implies that within each country successive entrants will be less efficient than incumbents are<sup>4</sup>. We shall assume that the distribution of firms' efficiencies is country-specific. For simplicity, let the "shape" of the marginal cost distribution be the same for both economies, so that the two countries' population of firms will only differ in the level of efficiency of the most efficient firm. We shall therefore adopt the following specific functional form for firms' marginal costs  $\beta_{ji} = \rho_j(i) = \phi_j i^\delta$ . Thus,  $(\phi_h - \phi_f)$  represents the efficiency gap between countries while  $\delta$  determines the degree of technical heterogeneity between firms and is assumed to be the same in both countries;  $\delta=0$  corresponds to the standard homogenous firms case.

Each firm chooses its price  $P_{ji}$  to maximise its profit, ignoring the effect of its action on the industry price index. Given the cost function in (9) and assuming that  $Q_{ji} = D_{ji}$  for all  $i$ , the profit of a typical firm  $i$  in country  $j$  is  $\Pi_{ji} = (P_{ji} - \beta_{ji})D_{ji} - \alpha$ . This implies the following optimal price rule:

$$(10) \quad P_{ji} = \omega \beta_{ji},$$

where  $\omega = \frac{\sigma}{\sigma-1}$  is the constant mark-up over marginal cost. Equation (10) suggests that - for any given market structure - country  $j$ 's industry is characterised by an asymmetric equilibrium spectrum of prices, quantities, market shares and profits distributed according to the values of  $\beta_{ji}$  with lower cost firms having larger market shares and higher profits. Substituting (4), (7) and (10) into the profit function, the typical firm's profit will be given by

$$(11) \quad \Pi_{ji} = \frac{\omega^{-\sigma}}{\sigma-1} \mu M_j N_j^{\lambda-1} P_j^{\sigma-1} \beta_{ji}^{1-\sigma} - \alpha.$$

## 2.4. The free-entry equilibrium

In each country market structure in the monopolistically competitive industry is determined endogenously via free-entry. Note that, given the assumed ranking between firms, the larger the number of firms characterising the equilibrium market structure the lower is the average

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<sup>3</sup> Romer (1994), in a model which analyses the welfare costs of trade restrictions, assumes that firms are characterised by different fixed production costs.

efficiency of the industry. In equilibrium there should be no new entry or exit and the marginal firm ( $i = N_j + 1$ ) will break even. Thus,  $\Pi_{j(N_j+1)}(\beta_{j(N_j+1)}) = 0$  where  $\beta_{j(N_j+1)} = \phi_j(N_j + 1)^\delta$  is the marginal cost of the least efficient firm in the industry. Effectively,  $\beta_{j(N_j+1)}$  is the industry efficiency cut-off point. Firms whose marginal cost is smaller than  $\beta_{j(N_j+1)}$  will make positive profits, that is  $\Pi_{ji}(\beta_{ji} < \beta_{j(N_j+1)}) > 0$ . Thus, contrary to the standard monopolistic competition model, firm heterogeneity implies that positive profits persist in the long-run for the non-marginal firms.

The endogeneity of  $\beta_{j(N_j+1)}$  implies that in this model the cost efficiency composition of the industry is endogenous. Clearly, for any given  $N_j$ ,  $\beta_{j(N_j+1)}$  will be larger the larger is the degree of heterogeneity between firms  $\delta$ : the more heterogeneous are firms' technologies, the lower will be the equilibrium average efficiency of the industry. Also, note that ceteris paribus  $\partial\beta_{j(N_j+1)}/\partial\phi_j > 0$ .

Using (10) and (11), the zero profit condition for the marginal firm in country  $j$ , that is  $\Pi_{j(N_j+1)} = 0$ , implies

$$(12) \quad \mu M_j N_j^{\lambda-1} \left( \frac{P_{j(N_j+1)}}{P_j} \right)^{1-\sigma} = \sigma \alpha .$$

Also, using (10) and recalling that  $\beta_{ji} = \phi_j i^\delta$ , we have

$$(13) \quad P_{j(N_j+1)} = \omega \phi_j (N_j + 1)^\delta .$$

Thus, for any given equilibrium market structure, the differentiated industry price in (5) implies

$$(14) \quad P_j = (N_j)^{(\lambda-1)/(1-\sigma)} \omega \phi_j \left[ \frac{(N_j + 1)^\theta - 1}{\theta} \right]^{\frac{1}{1-\sigma}} ,$$

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<sup>4</sup> One could easily assume that a number of firms exist per efficiency type instead. This however would not significantly affect the qualitative nature of the results.

where  $\theta = \delta(1-\sigma) + 1$ .

The total manufacturing labour requirement is given by  $L_{Dj} = \int_1^{N_j+1} C_{ji} di$  which - using equations (4), (7), (10) and (14) - yields the following differentiated sector aggregate labour demand

$$(15) \quad L_{Dj} = \frac{\mu}{\omega} M_j + \alpha N_j .$$

The labour market equilibrium requires equating the exogenously given labour supply ( $\bar{L}_j$ ) with the total labour demand from the two sectors, that is

$$(16) \quad \bar{L}_j = L_{Aj} + L_{Dj} .$$

Given perfect competition in the homogeneous sector, the economy wide profits are given by the aggregate differentiated industry profits  $\Pi_j = \int_1^{N_j+1} \Pi_{ji} di = P_j D_j - L_{Dj}$  which, using equations (4) and (15), can be written as

$$(17) \quad \Pi_j = \frac{\mu}{\sigma} M_j - \alpha N_j .$$

Equations (2)-(4), (8), and (12)-(17) characterise the general equilibrium of the model. Given the complexity of the algebra involved, we have used a simulation exercise to solve the model for the following parameter values:  $\phi_h=1$ ,  $\phi_j=(1.1, 1.2)$ ,  $\sigma=(2.1, 2.3, \dots 11.9)$ ,  $\lambda=(0, 0.003, 0.005, \dots 1)$ ,  $\alpha=0.001$ ,  $\delta=1$ ,  $\mu=0.7$ ,  $\bar{L}=1$ .

## 2.5. Analysis of the autarkic equilibrium

Solving the labour market equilibrium condition for  $M_j$  yields

$$(18) \quad M_j = \sigma(\sigma - \mu)^{-1} (\bar{L} - \alpha N_j),$$

which implies that total income only depends on  $N_j$ ,  $\bar{L}$ ,  $\sigma$  and  $\mu$ . Also, substituting equations (14) and (13) into the zero profit condition in (12) yields

$$(19) \quad \mu M_j (N_j + I)^{\theta-1} \left[ \frac{(N_j + I)^\theta - I}{\theta} \right]^{-1} = \sigma \alpha .$$

Hence, (18) and (19) can be solved to determine  $N_j$  and imply that the equilibrium number of firms is invariant to both  $\lambda$  and  $\phi_j$ . This clearly means that the number of firms in the two countries is identical. Assume that the home country has the more efficient marginal cost distribution, i.e.  $\phi_h < \phi_f$ . The equality of the autarkic number of firms then implies that the home country will be characterised by a higher minimum efficiency (i.e.  $\beta_{h(N_h+I)} < \beta_{f(N_f+I)}$ ) and will have a higher average industry efficiency.

As a result, it is obvious from equation (14) that the only difference between the two countries' price indexes is determined by the efficiency gap. Given that  $\frac{\partial P_j}{\partial \phi_j} > 0$ , the more efficient country's equilibrium price index is always smaller than that of the foreign country.

As is evident from Figure 1, the equilibrium number of firms is negatively related to  $\sigma$ . The parameter  $\sigma$  can be seen as reflecting the toughness of price competition. As it increases, firms' monopoly power and their mark up fall. As a result, cost efficiency becomes more important for competition in the industry and a smaller number of more efficient firms will survive in equilibrium.

Two main factors affect the differentiated good price index, the number of varieties and the efficiency composition of the industry. From equation (14) it is obvious that when preferences reward product diversity (i.e.  $\lambda > 0$ ), the direct effect of the number of varieties on the price index is negative: consumers perceive a lower price index the larger is  $N_j$ . However,  $P_j$  is also positively related to the industry's efficiency cut-off point: the larger is  $\beta_{j(N_j+I)}$  the lower is the minimum efficiency required to survive in equilibrium and the worse will be the efficiency structure of the industry. For  $\lambda=0$ , the number of varieties affects the price index only through the marginal cost composition of the existing population of firms.

The assumed distribution of firms' marginal costs implies that as the number of firms falls, the average industry efficiency increases and the price index falls. Thus, given that  $\frac{\partial N_j}{\partial \sigma} < 0$ , it follows that when  $\lambda=0$ ,  $\frac{\partial P_j}{\partial \sigma} < 0$ . When preferences reward product diversity and  $\lambda > 0$ , the effect of changes in the number of firms on the price index is not unambiguous and, consistently,  $\frac{\partial P_j}{\partial \sigma}$  is not monotonic. As Figure 1 illustrates, when  $\lambda > 0$ ,  $\frac{\partial P_j}{\partial \sigma}$  is positive (negative) for sufficiently small (large) values of  $\sigma$ .

**Figure 1 here**

The intuition behind this is as follows. As  $\sigma$  increases (and  $N_j$  falls) the efficiency composition of the industry improves. For  $\lambda > 0$  the net effect on the price index depends on which of the efficiency and variety effects dominates. At sufficiently small values of  $\sigma$ , price competition is not strong enough for the (price reducing) efficiency gains to dominate the (price increasing) fall in the number of varieties. When  $\sigma$  is large, further increases in  $\sigma$  will result in a fall in  $P_j$  because price competition is strong enough for the adverse variety effect on the price index to be more than offset by the improvement in the efficiency composition of the industry.

Note that from (14) we obtain  $\frac{\partial P_j}{\partial \phi_j} > 0$  which suggests that, for all values of  $\lambda$ , the more efficient country will be characterised by a lower equilibrium price index.

Finally, given that  $N_h = N_f$ , equation (18) implies the equality of equilibrium income in the two countries (i.e.  $M_h = M_f$ ). It then follows from (15) that  $L_{Dh} = L_{Df}$ .

To summarise, in the autarkic equilibrium, the two countries' differentiated sectors produce the same number of varieties using the same total amount of labour. The different efficiency composition of the two industries, however, is reflected in different price indexes. Given the equality of income in the two countries, it follows from (4) that in the less efficient country a smaller aggregate quantity of the differentiated good will be produced by on average smaller firms.

### 3. FREE TRADE

Trade in goods is assumed to take place in a context where transport costs and all other barriers to trade are absent and consumers do not discriminate amongst goods produced in different countries as, for example, in Venables (1987, 1994). Thus, the opening up of trade leads to larger and fully integrated good markets. Labour is assumed to be immobile across countries.

In the manufacturing sector, consumers in each country will be able to choose from the overall number of varieties produced in the free trade market. This number is denoted by  $N_t$ , where the subscript “ $t$ ” indicates trade, and is given by

$$(20) \quad N_t = N_{th} + N_{tf},$$

where  $N_{ij}$  is the number of monopolistically competitive firms in country  $j$ .

Given the absence of transport costs and of any other factors generating market segmentation, consumers in both countries will face the common free trade price index:

$$(21) \quad P_t = (N_t)^{(\lambda-1)/(1-\sigma)} \left( \int_1^{N_{th}+1} P_{hi}^{1-\sigma} di + \int_1^{N_{tf}+1} P_{fi}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}.$$

It will prove useful to define  $P_{ij} = (N_{ij})^{(\lambda-1)/(1-\sigma)} \left( \int_1^{N_{ij}+1} P_{ji}^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$  which is a CES index of the prices of each country’s firms under free trade<sup>5</sup>. Making use of this, (21) can be rewritten as

$$(21') \quad P_t = \left\{ \left( \frac{N_{th}}{N_t} \right)^{1-\lambda} P_{th}^{1-\sigma} + \left( \frac{N_{tf}}{N_t} \right)^{1-\lambda} P_{tf}^{1-\sigma} \right\}^{\frac{1}{1-\sigma}}.$$

Given the symmetry which characterises the demand side of the model, it can be easily shown that the optimisation problem of consumers in the two countries yields the

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<sup>5</sup> Note that given the absence of barriers to trade,  $P_{ij}$  does not have an immediate economic interpretation.

following aggregate demand for each variety  $D_{iji} = \mu M_t P_t^{\sigma-1} N_t^{\lambda-1} P_{ji}^{-\sigma}$ , where  $M_t$  is the integrated market income:

$$(22) \quad M_t = M_{th} + M_{tf} ,$$

and each country's income is given by

$$(23) \quad M_{ij} = \bar{L}_j + \Pi_{ij} .$$

It is straightforward to show that the optimal price rule for a firm  $i$  operating in the integrated market will still be as in equation (10). It follows that the profit of a typical firm  $i$

in country  $j$  is  $\Pi_{iji} = \frac{\omega^{-\sigma}}{\sigma-1} \mu M_t N_t^{\lambda-1} P_t^{\sigma-1} \beta_{ji}^{1-\sigma} - \alpha .$

Under free trade, within each country there may not be equality between demand ( $A_{ij}^d$ ) and supply ( $A_{ij}^s$ ) of the agricultural good. From the first stage of utility maximisation

$$(24) \quad A_{ij}^d = (1 - \mu) M_{ij} .$$

On the supply side of the market, we have

$$(25) \quad A_{ij}^s = L_{Aij} ,$$

where  $L_{Aij}$  is the agricultural sector's total labour demand in country  $j$ .

### 3.1. The free trade equilibrium

As in autarky, market structure within each country is determined endogenously via free-entry. The zero profit condition for the marginal firm in country  $j$  is given by  $\Pi_{ij(N_j+1)}(\beta_{j(N_j+1)}) = 0$  which yields

$$(26) \quad \mu M_t N_t^{\lambda-1} \left( \frac{P_{j(N_j+1)}}{P_t} \right)^{1-\sigma} = \alpha \sigma ,$$

where

$$(27) \quad P_{j(N_j+1)} = \omega \phi_j (N_j + 1)^\delta .$$

In equilibrium,

$$(28) \quad P_{ij} = (N_{ij})^{(\lambda-1)/(1-\sigma)} \omega \phi_j \left( \frac{(N_{ij} + 1)^\theta - 1}{\theta} \right)^{\frac{1}{1-\sigma}} .$$

The expenditure on the differentiated commodity in country  $j$  is given by  $E_{Dij} = \int_1^{N_j+1} P_{ji} D_{ji} di$

which, using (28), yields

$$(29) \quad E_{Dij} = \mu M_t \left( \frac{P_{ij}}{P_t} \right)^{1-\sigma} \left( \frac{N_{ij}}{N_t} \right)^{1-\lambda} .$$

The total labour demand of the differentiated sector in country  $j$  is  $L_{Dij} = \int_1^{N_j+1} C_{ji} di$ . Using

(28) and (29), this becomes

$$(30) \quad L_{Dij} = \frac{1}{\omega} E_{Dij} + \alpha N_{ij} .$$

Subtracting (30) from (29) yields the total equilibrium profits in country  $j$ 's differentiated industry, that is

$$(31) \quad \Pi_{ij} = \frac{1}{\sigma} E_{Dij} - \alpha N_{ij} .$$



Finally, the total demand and supply of the agricultural good must equal to each other across the two countries:

$$(32) \quad A_{th}^s + A_{tf}^s = A_{th}^d + A_{tf}^d.$$

Equations (20)-(31) characterise the general equilibrium of the model<sup>6</sup>.

#### 4. THE EFFECTS OF TRADE ON INDUSTRY EFFICIENCY

Equation (26) suggests that in the free trade equilibrium  $P_{h(N_h+1)} = P_{f(N_f+1)}$ , which in turn implies the equality of the efficiency cut-off points in the two countries, i.e.  $\beta_{h(N_h+1)} = \beta_{f(N_f+1)}$ . Hence, the integration of the differentiated good market unifies the competitive conditions within which firms operate. A firm's competitive strength is determined by its relative efficiency with respect to all other firms operating in the free trade market and not only to the domestic ones. Note that given  $\phi_h < \phi_f$ , the equality of the cut-off points implies that the average industry efficiency is higher in the home than in the foreign country. The two country-specific autarkic cut-off points and the common free trade one are plotted together<sup>7</sup> in Figure 2 which illustrates that  $\beta_{h(N_h+1)} < \beta_{j(N_j+1)} < \beta_{f(N_f+1)}$ .

**Figure 2 here**

The free trade common minimum efficiency requirement is more stringent than that in the foreign country under autarky. The opposite holds true for the home country, whose autarkic minimum efficiency is higher than that required to survive in the integrated market. An important result of the model is therefore that free trade worsens (improves) the efficiency composition of the more (less) efficient country's industry. The reason for this is that free-trade leads the most inefficient foreign firms to be displaced by more efficient home firms; these home firms, however, have a marginal cost which is higher than that of the least efficient home firm under autarky. As a result, average efficiency falls with trade in the home country. Clearly, this analysis casts doubt on the general validity of the widespread belief

<sup>6</sup> Note that these equations also imply that equation (32) is satisfied.

<sup>7</sup> Given that the equilibrium number of firms is invariant to  $\lambda$ , the efficiency cut off point is not affected by it either.

that trade liberalisation, through competition, is always a source of industry rationalisation. Industry rationalisation will occur if trade increases the competitive pressure. Facing on average less efficient foreign firms reduces the competitive pressure on domestic firms and leads to a worse efficiency composition of the industry.

It is also easy to show that the relative efficiency effects of trade are more significant the larger is the efficiency gap between countries  $(\phi_f - \phi_h)$ . Intuitively, for the more efficient country's firms the competitive pressure to be efficient in the integrated market is lower the lower is the average cost competitiveness of the foreign country's firms. The latter, in turn, will face a tougher price competition the larger is their cost disadvantage.

Contrary to the constant elasticity of substitution homogeneous firms model, through its effects on the endogenously determined minimum level of equilibrium industry efficiency, trade affects the structure of output scales. The marginal firm's zero-profit condition in equation (26) yields  $D_{ij(N_j+1)} = \frac{\alpha(\sigma-1)}{\beta_{j(N_j+1)}}$  which is the same for both countries given the common efficiency cut-off point. Hence,  $\beta_{h(N_h+1)} < \beta_{j(N_j+1)} < \beta_{f(N_f+1)}$  implies that  $D_{f(N_f+1)} < D_{ij(N_j+1)} < D_{h(N_h+1)}$ : under free trade, the output scale of the marginal firm in the more (less) efficient country is smaller (larger) than in autarky.

In sum, for the more efficient country, trade liberalisation does not result in a "rationalised" manufacturing industry, but in a worse efficiency composition and a smaller marginal output scale. The rationalising effects of trade liberalisation, however, occur with respect to the less efficient country, which will experience a more efficient industry structure and a larger marginal firm's output scale.

The equality of the free trade efficiency cut-off points implies  $(N_{th} + 1) = (N_{tf} + 1) \left( \frac{\phi_f}{\phi_h} \right)^{1/\delta}$ , from which it follows that  $N_{th} > N_{tf}$ .

Furthermore,  $\beta_{h(N_h+1)} < \beta_{j(N_j+1)} < \beta_{f(N_f+1)}$  yields  $N_{tf} < N_j < N_{th}$ . Therefore, contrary to the standard constant elasticity of substitution model where  $N_t = N_h + N_f$ , in this model it will generally be the case that  $N_t \neq N_h + N_f$ , i.e. trade changes the overall number of varieties produced in the world economy.

## 5. THE PATTERN OF PRODUCTION AND TRADE SPECIALISATION

In the free trade equilibrium there will be intra-industry trade in manufactures. The fact that  $N_{th} > N_{tf}$  already suggests that the home country, with its higher relative efficiency in the manufacturing industry, will be relatively specialised in the production of the differentiated good. Consistently, the home country will hold a larger share of the integrated market expenditure on the differentiated good. Equation (29) implies

$$(33) \quad \frac{E_{Dth}}{E_{Dtf}} = \left( \frac{P_{th}}{P_{tf}} \right)^{1-\sigma} \left( \frac{N_{th}}{N_{tf}} \right)^{1-\lambda}.$$

It is easy to show that for all values of the relevant parameters  $\frac{P_{th}}{P_{tf}} < 1$ , which is plausible since the home country has both a higher equilibrium average industry efficiency and a larger number of firms. Thus given that  $\frac{N_{th}}{N_{tf}} > 1$ ,  $\frac{E_{Dth}}{E_{Dtf}}$  always exceeds unity. Therefore, a larger share of the integrated market income is spent on the manufacturing good produced in the more efficient country.

Consistently with the trade pattern thus emerged, the more efficient country will employ a larger share of its labour endowment in manufacturing, as is clear from equation (29), which yields  $L_{Dth} - L_{Dtf} = \omega(E_{Dth} - E_{Dtf}) + \alpha(N_{th} - N_{tf}) > 0$ .

Note that, ceteris paribus, the extent of the home country's specialisation in the production of the differentiated good is greater the larger is  $\sigma$ . This is clear, considering that when the elasticity of substitution between varieties is large, firms' market power is small and cost competitiveness is very important. Finally, other things equal, the home country's output of the agricultural good will be smaller the larger is  $(\phi_f - \phi_h)$ , that is the extent of specialisation will be directly related to the efficiency gap between countries. Figure 3 illustrates these points.

**Figure 3 here**

## 6. THE WELFARE EFFECTS OF TRADE

There are two main channels through which trade changes consumers' welfare in this model. These are (1) the number of varieties of the differentiated good and (2) the efficiency structure of the industry.

Market integration increases the number of varieties available for consumption to each set of consumers since  $N_i > N_j$ . The wider choice of goods implies that if there is love of variety (i.e.  $\lambda > 0$ ) consumers will ceteris paribus perceive the free trade price index to be lower than the autarkic one. Hence, the variety effect of market integration will contribute to an increase in the level of welfare.

In the standard monopolistic competition model with identical firms, trade unambiguously increases welfare when there is love of variety ( $\lambda > 0$ ). However, with  $\lambda = 0$  consumers' welfare would not be affected in the constant elasticity of substitution case, given that trade would not change output scale. In this model, instead, the endogenously determined efficiency structure of the industry provides an additional channel through which trade affects consumer welfare. By changing the industry efficiency cut-off point, trade affects the price index. Thus, welfare will be affected by trade even when there is no love of variety.

Trade has an opposite impact on the price index for the two countries' consumers. As we saw, the common free trade efficiency cut-off point lies between the two countries' autarkic ones. As a result, the free trade price index reflects an average cost efficiency which is lower (higher) than the more (less) efficient country's autarkic one. This implies that with respect to autarky, the efficiency effect of trade will contribute to an increase (fall) of the price index for consumers in the more (less) efficient country.

It follows that, for foreign consumers the move to free trade leads to an unambiguous fall in the price index of the differentiated good, given that both the number of varieties and efficiency effects are positive.

As far as the more efficient country is concerned, the variety and the efficiency effects of trade on the price index work in opposite direction. Consumers will face a lower (higher) price index depending on whether the variety effect dominates the efficiency effect (or vice versa). This will ultimately depend on the degree of love of variety. If  $\lambda$  is sufficiently small, the efficiency effect of trade will dominate the variety effect and the free trade price index will be higher than the autarkic one. The opposite will happen for

sufficiently large values of  $\lambda^9$ . Figure 4 plots the ratio  $\frac{P_h}{P_t}$  for the two limiting cases of  $\lambda=0$  and  $\lambda=1^{10}$ .

**Figure 4 here**

When  $\lambda=0$ , the efficiency effect of trade dominates the variety effect and  $\frac{P_h}{P_t} < 1$ . For  $\lambda=1$ , the variety effect dominates and  $\frac{P_h}{P_t} > 1$ .

To assess the overall welfare effects of trade for the two countries we need to examine their indirect utility functions. From equation (1) the autarkic and free trade indirect utilities are given by

$$V_j = M_j P_j^{-\mu} \quad (34)$$

$$V_{ij} = M_{ij} P_t^{-\mu},$$

from which we obtain 
$$\frac{V_j}{V_{ij}} = \frac{M_j}{M_{ij}} \left( \frac{P_j}{P_{ij}} \right)^{-\mu}.$$

To determine the overall welfare effect of trade we need to assess how it affects total income. Figure 5 plots the ratio  $\frac{\Pi_j}{\Pi_{ij}}$ . Clearly, the home country's total profits increase with

trade, while the foreign country's fall<sup>11</sup>. Given (23), it follows that  $\frac{M_f}{M_{tf}} > 1$  while  $\frac{M_h}{M_{th}} < 1$ .

Thus, as far as the foreign country is concerned, trade has a positive welfare effect through the price index but a negative one through total income. Our numerical simulations suggest

<sup>8</sup> Note that the number of variety welfare effect of trade is symmetric for the two countries since  $N_t - N_j$  is the same for both countries.

<sup>9</sup> In general, it can be shown that for any given  $\lambda < 1$ ,  $\frac{P_h}{P_t} > 1$  will be more likely to hold the smaller is  $\sigma$ .

<sup>10</sup> The two curves are plotted on independent scales, with  $\lambda=0$  on the right hand side axis and  $\lambda=1$  on the left hand side axis.

<sup>11</sup> It is straightforward to show that this holds for all values of  $\lambda$ .

that the net welfare effect for the foreign country is positive for all values of the relevant parameters.

**Figure 5 here**

Instead, with respect to the home country, the results suggest that adverse welfare effects may occur. For the more efficient country market integration can be welfare reducing for sufficiently low values of the degree of love of variety and of the elasticity of substitution between varieties. As we saw, income always increases as a result of trade liberalisation.

Hence, in those circumstances in which  $\frac{P_h}{P_t} > 1$ , the home country's welfare is increased by

trade. This will happen for a sufficiently high degree of love of variety ( $\lambda$ ). When  $\lambda$  is sufficiently small, the adverse efficiency effect of trade will dominate the number of variety effect and will result in  $\frac{P_h}{P_t}$  being less than unity. Clearly, for any given  $\lambda$ , the welfare loss

will be larger (or the welfare gain smaller) the smaller is the elasticity of substitution between varieties. This is obvious, given that a small  $\sigma$  reflects a high degree of monopoly power and will therefore result in an enhanced adverse efficiency effect of trade on the more efficient country's market structure. Hence, the smaller are  $\sigma$  and  $\lambda$ , the more likely will the effect of trade on price dominate its positive effect on income, thus resulting in a negative overall welfare effect. Figure 6 illustrate such cases.

**Figure 6 here**

To summarise, the less efficient country will always benefit from trade liberalisation. However, market integration may adversely affect the more efficient country's consumers who will face a higher price index for the differentiated good, due to the deterioration of their industry's efficiency relative to autarky. If variety *per se* is highly valued ( $\lambda$  is large), the welfare impact of a higher price index will be dominated by the positive welfare effects of increased product variety. If the degree of love of variety ( $\lambda$ ) is sufficiently low, however, the higher price index will dominate the increased product diversity effect of market integration, thus leading to a overall welfare loss.

## 7. CONCLUSIONS

This paper has analysed the implications of technical heterogeneity amongst firms and countries for the effects of trade. With technical heterogeneity, free-entry generates a mechanism of competitive selection which leads to the endogenous determination of industry efficiency. By affecting the competitive pressure characterising the environment within which firms operate, trade changes the minimum level of efficiency required to survive in equilibrium. As a result, the cost structure of the free trade population of firms will, on average, be characterised by an efficiency level which is lower (higher) than that in the more (less) efficient country's autarkic equilibrium.

The efficiency effects of market integration constitute an additional channel through which trade affects welfare. In a constant elasticity of substitution homogeneous firms model with love of variety, trade liberalisation would be unambiguously welfare improving. However, in the absence of preference for diversity, consumer welfare would be unaffected by trade. Instead, in the model developed here market integration affects welfare even in the absence of love of variety by changing the efficiency structure of the industry and, through it, the price index.

The results cast doubt on the efficacy of trade liberalisation in generating welfare gains based on its rationalising effects on industries. Indeed, depending on the toughness of price competition and on the degree of love of variety, the fall in efficiency can be sufficient to cause a net welfare loss in the more efficient country. The less efficient country, however, always gain from trade liberalisation.

To some extent, of course, the results of this paper depend on the functional forms adopted. Nevertheless, they suggest that circumstances may arise in which the existence of technical heterogeneity can cause adverse welfare effects. Thus, the results question the view emerging from the literature that the introduction of a monopolistically competitive market structure may strengthen the case for free trade.

Finally, the relaxation of the assumption of firm homogeneity raises interesting theoretical issues and suggests new avenues for research. In order to highlight its most immediate implications, in this paper we have followed a modelling strategy which allows for as direct a comparison as possible with the existing literature. One important theoretical point to notice, however, is that the existence of inter-firm efficiency gaps questions the plausibility of assuming away strategic interaction between firms, with firms not taking

account of their pricing decisions on the industry price level. Given the persistence in equilibrium of supernormal profits, one of the implications of this would be the emergence of strategic trade policy considerations.



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Figure 1. Autarkic number of firms and home price index ( $\lambda=1$ )

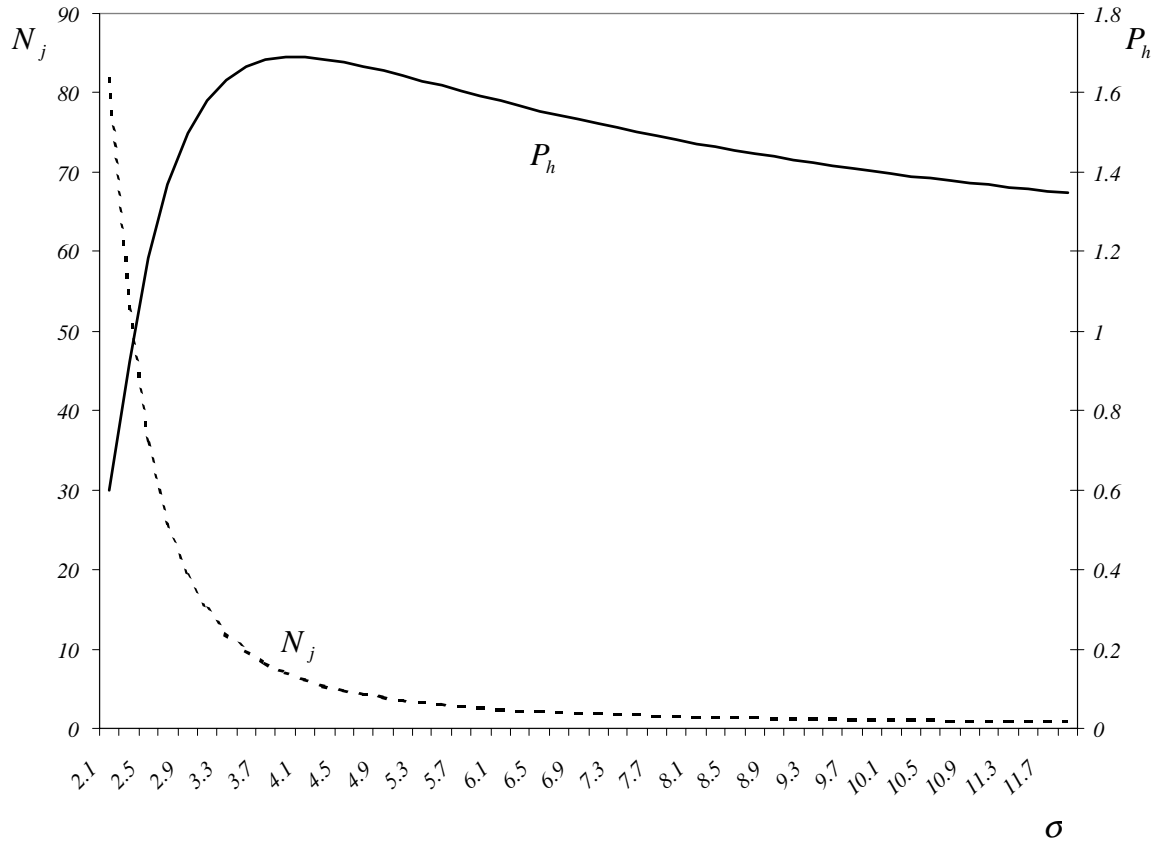


Figure2. Autarkic versus trade efficiency cut-off points ( $\lambda=0$ )

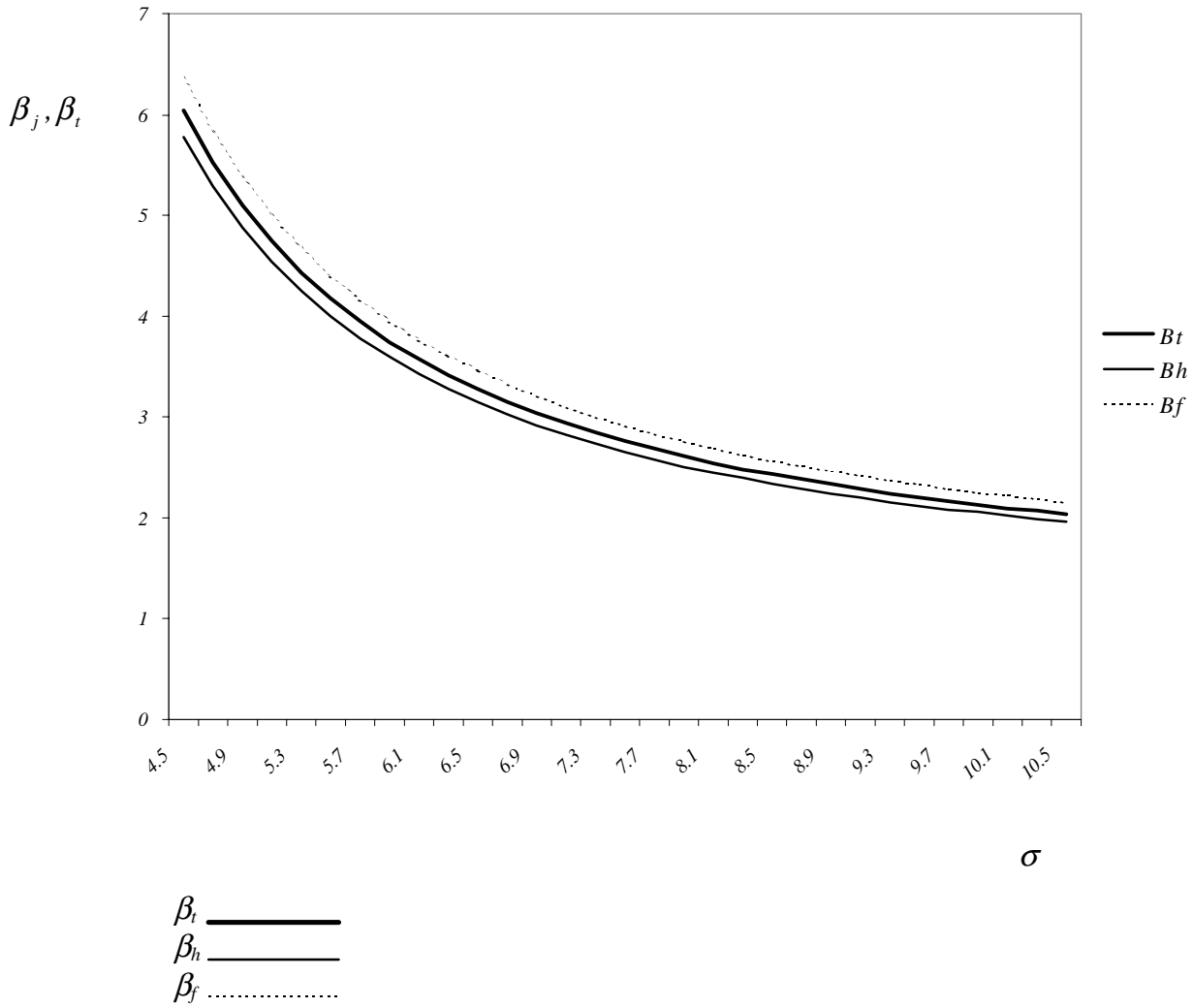
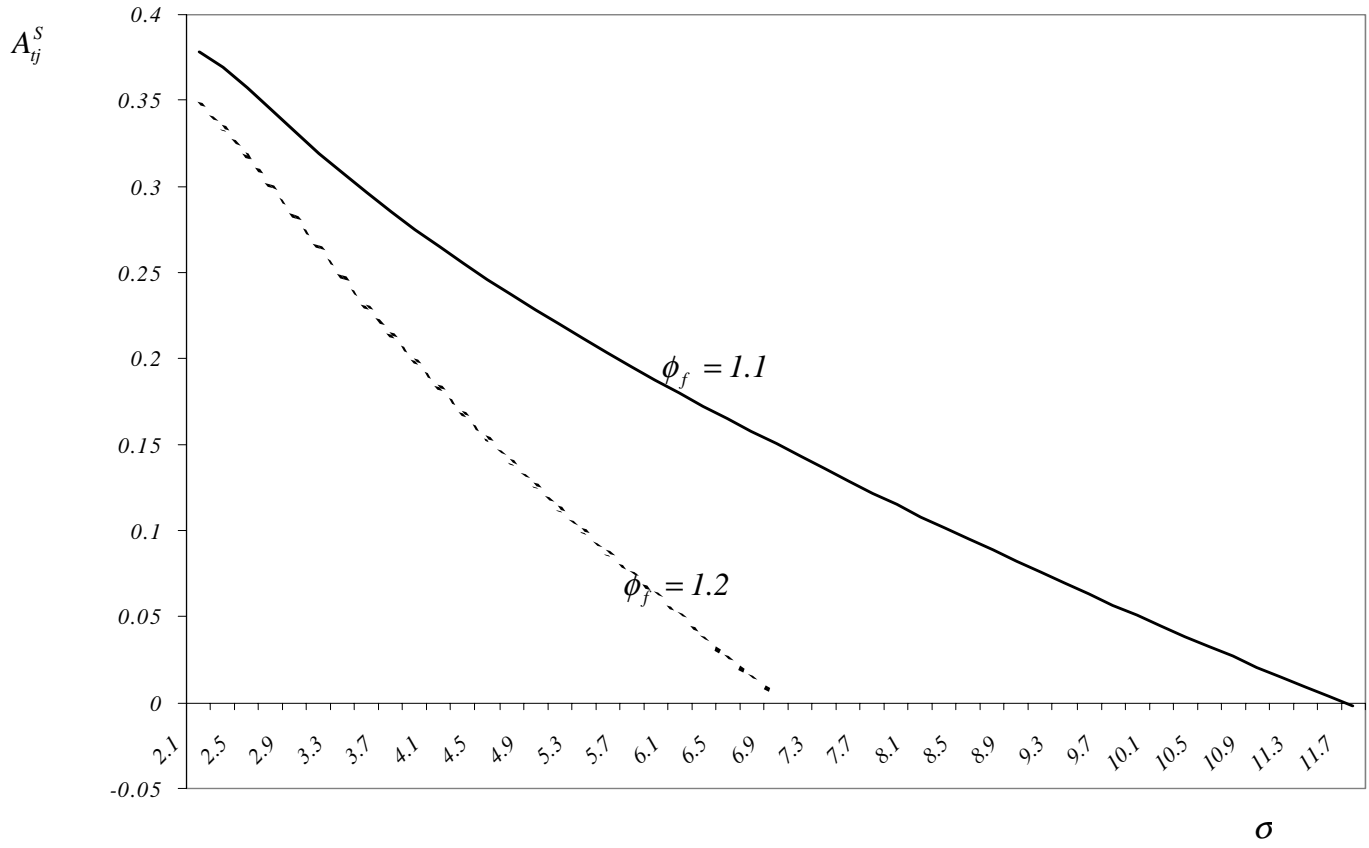


Figure 3. Free-trade agricultural output ( $\lambda=0$ )



**Figure 4. Autarky versus trade: Home price index**

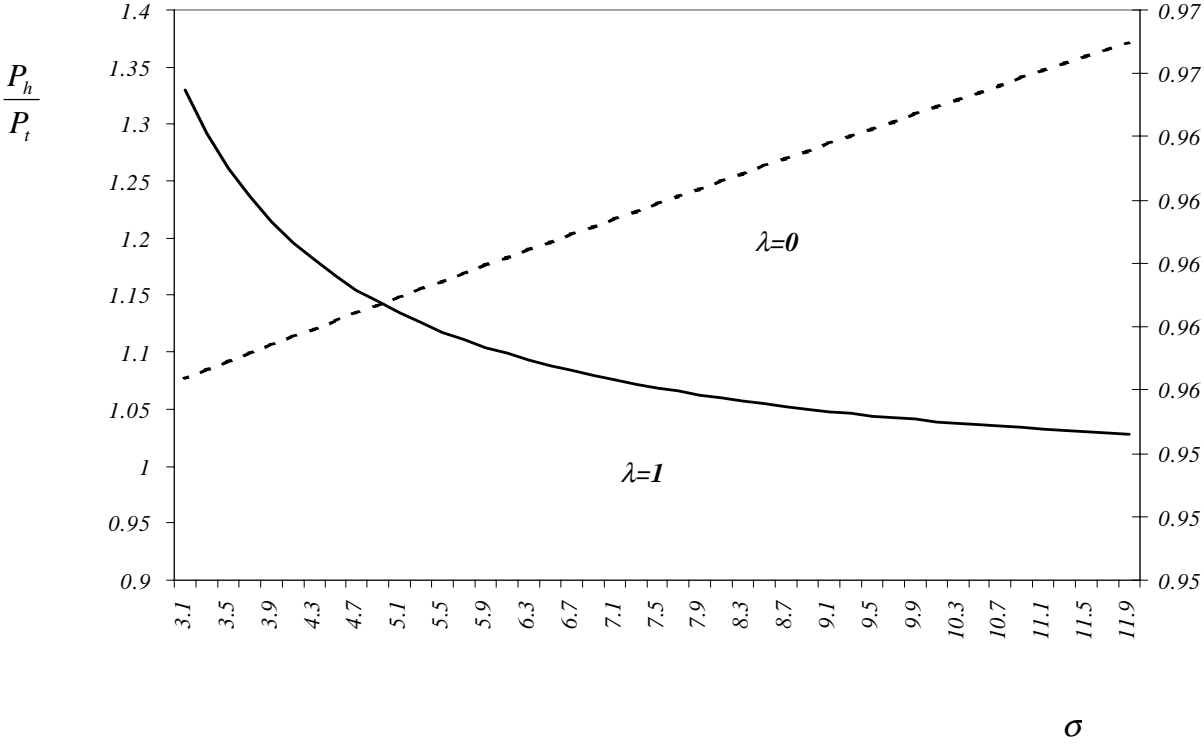
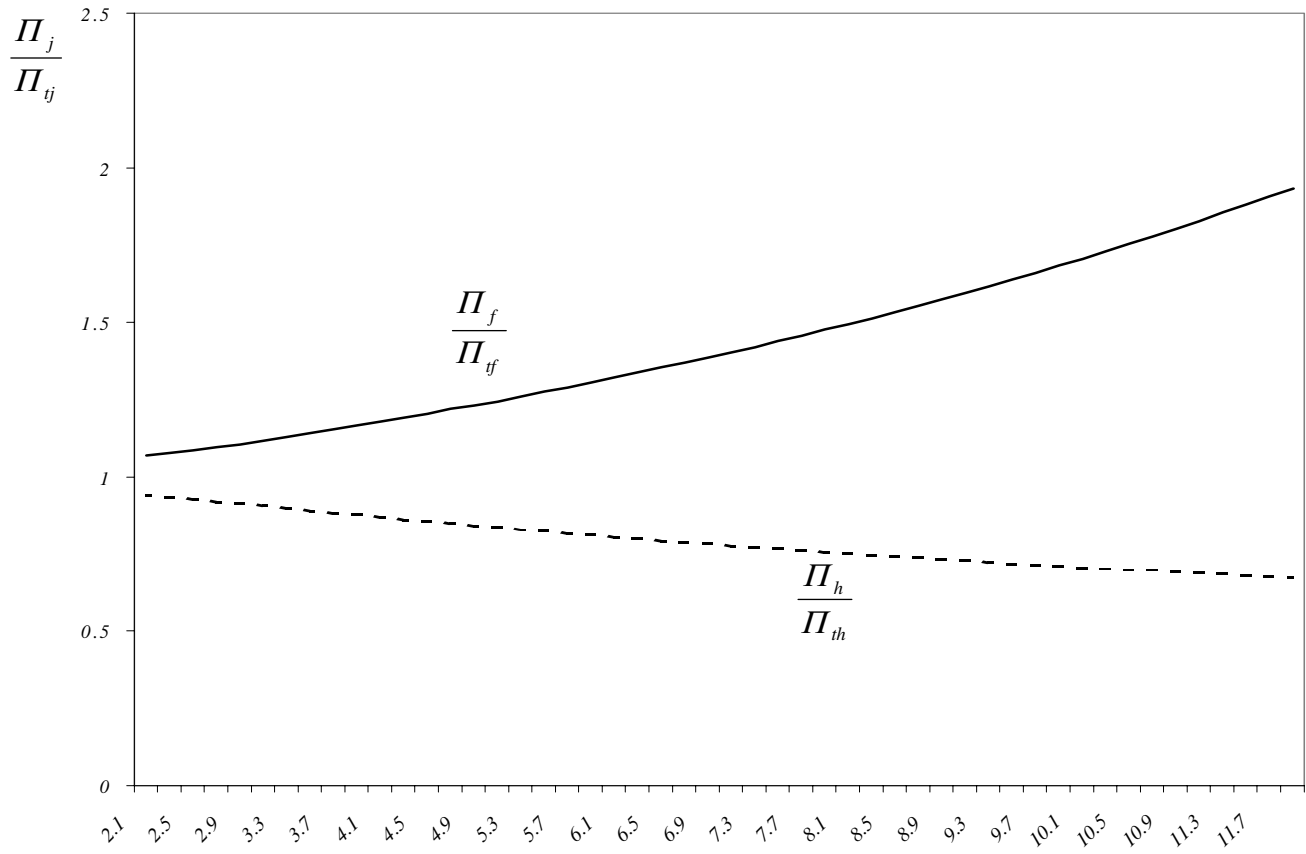


Figure 5. Autarky versus trade: Home and foreign profits  
( $\lambda=0$ )



$\sigma$

**Figure 6. Welfare effects of trade on the home country ( $\phi_f = 1.2$ )**

