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## Procompetitive gains from trade and comparative advantage

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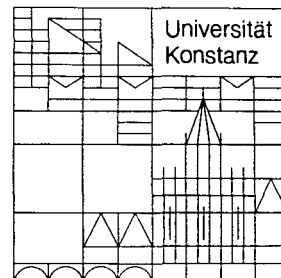
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**Procompetitive Gains from Trade  
and Comparative Advantage**

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**PROCOMPETITIVE GAINS FROM TRADE  
AND COMPARATIVE ADVANTAGE**

**Albert G. Schweinberger**

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PROCOMPETITIVE GAINS FROM TRADE  
AND COMPARATIVE ADVANTAGE

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Abstract:

The concepts of comparative and "noncomparative" advantage gains/losses from trade are made precise, related to each other and to an aggregate measure of trade gains in a general equilibrium model with increasing returns to scale and imperfect competition (with any finite number of goods and factors). Making use of concepts of the theory of output rationing a novel necessary condition for trade gains is derived and interpreted. Subject to certain assumptions the theorems of comparative advantage for goods trade and the H-O theorem in its factor content form are generalized to economies with increasing returns to scale and imperfect competition.

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PROCOMPETITIVE GAINS FROM TRADE  
AND COMPARATIVE ADVANTAGE

I

INTRODUCTION

According to a recent textbook on the theory of international trade, see Markusen and Melvin 1988, page 177, there are - in addition to the standard comparative advantage gains - the following five potential "noncomparative advantage" gains (in the presence of increasing returns to scale and imperfect competition): (a) pro-competitive gains, (b) decreasing average production cost, (c) exit of redundant firms, (d) increased product diversity and (e) specialisation in plant and equipment. A similar classification can also be found in a recent OECD survey, see Richardson 1988.<sup>1</sup>

These references and other recent work undoubtedly shed significantly more light on the complex issue of trade gains/losses in these circumstances. However they also leave open a number of crucial questions:

- (1) How are these various gains/losses to be made precise and measured in a model with any finite number of goods and factors?
- (2) How are they related to each other and, most importantly, does there exist an aggregate measure of trade gains which can be linearly decomposed into the various effects listed above?

Below in part I propositions 1 - 3 attempt to answer these and other questions. They focus on the comparative advantage and pro-competitive gains as well as decreasing average costs.

The apparently novel approach is to relate explicitly the derivation of necessary or sufficient conditions for trade gains under increasing returns and imperfect competition to the theory of output rationing in the form of general cost-benefit analysis (see e.g. Drèze and Stern 1986). As will be shown, both increasing returns and imperfect competition can be interpreted (under certain conditions) as giving rise to conceptually the same distortion, namely output rationing which diagrammatically is reflected in the well known non-tangency solution (on this concept see e.g. Markusen and Melvin 1984).

This approach has at least two advantages. Firstly, it integrates the trade literature with standard second best welfare theory and secondly, it allows for more insightful interpretations of the results (e.g. in terms of appropriately defined shadow prices).

A key task which apparently so far has not been undertaken is to isolate and identify the standard comparative advantage gains on the one hand and the noncomparative advantage gains on the other. To this end a hitherto neglected property of general equilibrium models under increasing returns to scale and imperfect competition is utilised. Generally, the autarkic equilibrium may be nonunique (spatially separate equilibria exist) even in one household economies. Furthermore the various equilibria may be Pareto rankable. Assuming Pareto rankability necessary or sufficient conditions for welfare gains which are due to procompetitive and scale effects will be derived. The latter - as will be shown - can occur independently of the comparative advantage gains. This property of models with increasing returns and imperfect competition can also be harnessed to achieve the derived isolation and identification of non comparative advantage gains if for given commodity prices alternative equilibria exist in a small open economy, see e.g. Kemp and Schweinberger (1991).

The key idea underlying the modelling and interpretation of "noncomparative advantage" gains is that the sum of the procompetitive effects and the (average cost) scale effect can be defined and interpreted as a rationing effect. The rationing is to be interpreted relative to the first best solution which would be achieved (with lump-sum subsidies and taxes feasible) by means of marginal cost pricing. The rationing effect is defined as the change in the outputs in two equilibria valued at the shadow prices (in the sense of cost benefit analysis).

Noncomparative advantage gains from trade occur only if (for given commodity prices) trade leads to a realisation of other equilibria in which the severity of rationing implied by the existence of imperfect competition and increasing returns to scale has been loosened in an appropriately defined sense. Noncomparative advantage gains from trade are per se independent of changes in commo-

dity prices, however the set of equilibria which is consistent with given commodity prices may vary considerably with commodity prices. There may thus exist free trade equilibria which for given commodity prices are superior or inferior to the autarkic equilibrium.

Turning to the comparative advantage gains precise conditions are derived under which there are gains from trade but a country may on average export (import) goods which are relatively more expensive/cheaper in the autarkic equilibrium. This follows if the noncomparative gains expressed in terms of the rationing effect dominate (in a precise sense) the comparative advantage gains.

Conversely it will be shown that if trade loosens the rationing implied by increasing returns to scale and imperfect competition, using the free trade shadow prices for the purpose of evaluation, but tightens it, using the autarkic shadow prices, a country must be realising comparative advantage gains, i.e.: must (on average) be exporting/importing goods which are relatively cheaper/dearer in the autarkic equilibrium than in the free trade equilibrium (see proposition 3).

To interpret procompetitive and scale effects in terms of the theory of rationing certain assumptions are indispensable. First and foremost factor markets are assumed to be perfectly competitive and distortion free. Since in the real world factor markets are often more distorted than commodity markets this assumption has to be judged as very restrictive (however it seems to be widespread in the received literature).

Another restrictive assumption which is required is that the relevant support prices (marginal costs or revenues) play in the distorted economy a role similar to the role of market prices in distortion free economy. This entails that all the results are not truly global as in e.g. Kemp and Schweinberger (1991). However the advantage of this assumption is obvious. It enables us to shed more light into the black boxes of productivity effects (which normally are devoid of any kind of theoretical explanation). Since these black boxes appear to be a major weakness in this area of research it appears arguable that the benefits of the insights gained outweigh the costs.

As is well known, from a point of view of policy making, the issue of gains/losses from trade is rather less important than the issue of gains/losses from trade liberalisation. An important objective of an appendix is to derive the relevant conditions for welfare gains/losses from trade liberalisation with increasing returns and imperfect competition and to relate them to the analogous conditions for trade gains/losses. As will be shown, subject to a certain assumption about the sign of governmental revenue the conditions for trade gains/losses can directly be reinterpreted as conditions for gains/losses from trade liberalisation.

Another purpose of part I is to lay the groundwork for the generalisation of the factor content version of the H-O theorem in part II. In this context the following definition is useful: a country, with given factor endowments, is said to experience the standard rationing effect if increases in differences between prices and marginal costs or revenues (i.e. shadow prices) are on average associated with falls in outputs. Varian (1985) proved that the standard rationing effect holds in a closed economy with price discrimination between households, convex cost and quasi-linear utility functions; see also Schmalensee (1981). Changes in factor endowments in closed or open economies may result in a reversal of the standard rationing effect. The assumed reversal of the standard rationing effect plays a key role in the derivation of the results of part II.

To gain a better understanding of the economic meaning of the assumed reversal of the standard rationing effect the bound condition on the necessary and the sufficient conditions for welfare gains which has been established in part I is utilised. These upper and lower bound conditions represent generalisations of analogous results proved by Schmalensee (1981) and Varian (1985) to a general equilibrium production model with increasing returns to scale, imperfect competition, and international trade.

The other novelty of the approach in part II lies in constructing an equivalent autarkic equilibrium which features the same consumption levels and factor prices as the given trading equilibrium yet normally the prices faced by consumers and producers as well as the output vector are different. It is referred



to as a controlled equivalent autarkic equilibrium because commodity taxes have to be imposed to control the outputs.<sup>2 3</sup> If a controlled equivalent autarkic equilibrium exists and the implicit changes in factor endowments entail a reversal of the standard rationing effect the H-O theorem in its factor content version can be generalised to economies with increasing returns to scale and imperfect competition.

This result, stated as proposition 4, extends and generalises a similar result concerning perfectly competitive, constant returns to scale economies which can be found in Neary and Schweinberger (1986). To the best of our knowledge only Krugman (1990) has attempted a generalisation of the H-O theorem in its factor content form to economies with increasing returns to scale. However his approach is rather different. He reduces the economy to a standard constant returns to scale economy by means of the assumption that the number of primary distortion free factor markets is at least equal to the number of commodities produced under constant returns to scale. Assuming also identical production functions (between countries) the equalisation of factor prices is guaranteed.

Finally, the following caveat seems appropriate. Whilst all our results represent generalisations of results of standard perfectly competitive economies, it cannot be denied that the generalisations themselves do not hold under as general assumptions as the equivalent perfectly competitive results. An example here would be the assumption of controllability of outputs through commodity taxation (on the concept of controllability in perfectly competitive economies see Woodland 1982, on the same issue under imperfect competition see Laffont 1988, Ch. 3). However, nevertheless it seems a worthy purpose to try to obtain results which are as general as possible.

## PART I

### (A) ALTERNATIVE APPROACHES

The model of imperfect competition and increasing returns to scale to be analyzed in part I is very general. There are any (finite) number of goods and factors and international trade may take place in goods as well as factors. All firms whether perfectly or imperfectly competitive maximise profits.<sup>4</sup> At least one good is as-

sumed to be produced under perfect competition and with CRS production functions. Most importantly all factor markets, in contrast to goods markets, are perfectly competitive and distortion free. A restrictive assumption is that entry to industries by new firms is ruled out. Subject to this assumption there may be fixed as well as variable costs and outputs may be priced at or above average cost.

The initial aim is to prove that both distortions - namely increasing returns to scale as well as imperfect competition - may (subject to the stated assumptions) be modelled, using the ratioing approach, by one and the same concept: a constrained national revenue or income function (on this concept see e.g. Woodland 1982). The crucial message in this context is that the marginal revenues play the role of support prices.

As is well known, under constant or increasing returns to scale, whether or not the latter are external or internal, the following economy cost function can be shown to exist (see e.g. Woodland 1982).

$$C = C(w, y) \tag{1}$$

where  $C$  denotes the economy cost (a scalar)  
 $w$  the vector of factor prices and  
 $y$  the vector of outputs (which is treated parametrically).

Assuming differentiability of  $C(\cdot)$  in  $w$  and  $y$  it can readily be shown (see e.g.: Markusen and Schweinberger 1990) that:

$$wC_{wy}dy = MCdy = 0 \tag{2}$$

where:  $C_{wy}$  denotes the Jacobian matrix of the factor demand functions  $C_w(\cdot)$  with respect to the output vector of the whole economy and  $MC$  the vector of marginal costs.

From the assumption of profit maximisation:

$$MC = MR \quad (3)$$

It follows from expression (3) that only interior solutions for equilibrium outputs are considered.

Combining expressions (2) and (3) we have:

$$MR \, dy = 0 \quad (4)$$

Expression (4) proves that at least in a neighbourhood of the perfectly competitive equilibrium in factor markets, the assumption of cost minimisation induces the existence of an envelope function of the form:

$$Y = Y(MR, k) = MRy \quad (5)$$

where:  $Y$  denotes the value of output at the respective marginal revenues [which will be shown to be the support prices of a national income or revenue function  $R(\cdot)$ ].

From expression (4) the function  $Y(\cdot)$  has the property:

$$Y_{MR}(\cdot) = y \quad (6)$$

Making use of expressions (5) and (6) the following national income or revenue function may be defined:

$$py = R(p, MR, y, k) = Y(MR, k) - (MR-p)y \quad (7)$$

where:  $Y_{MR}(\cdot) = y$  and  
 $p$  denotes the vector of goods prices.

The function  $R(\cdot)$  is readily recognisable as a constrained national income or revenue function. Marginal revenues may be regarded as support prices, i.e.: the prices (of goods) which would induce a perfectly competitive economy to produce, for given factor endowments, the given outputs  $y$ . From this follows that increasing returns to scale and imperfect competition, locally and subject to

the stated assumptions, may be treated as a rationing of outputs relative to a hypothetical perfectly competitive economy with increasing returns to scale and marginal cost pricing. The latter as is well known is only feasible with lump sum subsidies to firms which are assumed to be raised by means of lump sum taxes.

Solving expression (6) for the vector MR in terms of outputs  $y$ , the national income function  $R(\cdot)$  may be written as:

$$\tilde{R} = \tilde{R}(p, y, k) = py \quad (8)$$

The principal concept which is to be used for welfare analysis can now be defined:

$$B(p, y, k, u) = E(p, u) - \tilde{R}(p, y, k) \quad (9)$$

where:  $E(p, u)$  is a standard household cost or expenditure function

Expression (9) represents a constrained form of a national Trade Expenditure Function (see e.g. Lloyd and Schweinberger 1988). In contrast to the concepts used in Helpman (1984) or Kemp and Schweinberger (op.cit.) it does not contain a term for supernormal profits. Thus this approach reveals that the additional assumption of imperfect competition (in addition to increasing returns to scale and average cost pricing) does not give rise - from a conceptual viewpoint - to a separate distortion. Of course, outputs, prices and marginal revenues are generally different with imperfect competition and possible monopoly profits but both distortions are conceptually the same - they are equivalent to output rationing. In the case of imperfect competition this output rationing is - needless to emphasize - price manipulable (if the imperfectly competitive firms know the relevant demand functions, what Hart (1985) calls the objective approach). From these considerations it also follows that: (a) there is no need to provide, as in e.g. Helpman (1984), two separate proofs for gains from trade under on the one hand increasing returns to scale and on the other imperfect competition with limited entry. (b) the apparently widely held view that a proof of gains from trade under imperfect competition is especially difficult and to become manageable - must sterilise imperfect competition is false.<sup>5</sup>

There appear to be three approaches to the modelling of gains or losses from trade under imperfect competition and increasing returns to scale highlighting the integration with and the generalisation of the approach under perfect competition and constant returns to scale:

(1) The approach in Helpman (1984) which requires strong assumptions such as separability in production functions, homothetic preferences and constant returns to scale (under imperfect competition) respectively in order to obtain global results.

(2) The approach in Kemp and Schweinberger (op.cit.) which derives very general necessary and sufficient conditions however at the cost of unexplained (in terms of optimisation theory) productivity effects.

(3) The approaches by Markusen and Melvin 1984 and the present formal rationing approach which by their very nature can not lead to truly global results. This follows because the constrained trade expenditure function, expression (9), clearly per se captures only the aspect of the nontangency solution (see Markusen and Melvin 1985) but conceals the aspect of nonconvexity of the production possibility set.

To make the third approach operational it is assumed that all marginal costs and revenues are positive and that there exists a neighbourhood around the free trade or autarkic equilibrium such that the function  $Y(\cdot)$ , defined over that neighbourhood reaches a maximum at given MR and k. This assumption implies, of course, that the results to be stated are not truly global.<sup>6</sup> As is well known from the analysis of nonconvex economies we should not expect to obtain as general results as in convex economies. Furthermore it seems important to obtain (subject to the constraints of the problem) as general results as possible.

(B) RATIONING AND COMPARATIVEAND NONCOMPARATIVE ADVANTAGE GAINS.

As explained before, a key purpose of part I is to derive and interpret the comparative as well as the so called noncomparative advantage gains/losses and to relate them to an aggregate measure of trade gains/losses. The noncomparative advantage gains comprise (inter alia) the so called procompetitive gains and the gains due to falling average production costs (which we refer to as scale effects), see e.g. Markusen and Melvin (1988).

To this end first the shadow prices (in the sense of cost benefit analysis) associated with the constrained output are defined. Differentiating  $B(\cdot)$  partially with respect to the vector  $y$ , taking into account the envelope properties of  $Y(\cdot)$ , it follows from expressions (7), (8) and (9) that:

$$B_y = -(p - MR) \quad (9)$$

Since an increase (decrease) in  $B$  entails (from Walras Law), assuming the feasibility of lump sum compensation (in a multihousehold economy), a welfare decrease (increase) it follows that the relevant Hicksian shadow prices are given by the vector

$$\pi(y) = (p - MR) \quad (10)$$

In equilibrium the Hicksian shadow prices are, of course, equal to the Marshallian shadow prices. The shadow prices  $\pi(y)$  should be carefully distinguished from the support prices used in the definition of  $Y(\cdot)$  which represent the marginal revenues. From the above analysis it also follows that locally a necessary and sufficient condition for a welfare improvement through trade in goods and factors is:

$$dB = mdp + (k^d - k)dw - (p - MR)dy < 0 \quad (11)$$

where:  $m$  stands for the excess demand for goods and  $(k^d - k)$  for the excess demand for factors.

Since  $m = k^d - k = 0$  in the original autarkic equilibrium it follows that expression (11) cannot be used to relate possible non comparative advantage gains to the "laws" of comparative advantage in goods and factor trade familiar from perfectly competitive economies. To achieve this a more global approach is necessary.

From the properties of the household expenditure or cost function:

$$E(p^0, u') \leq p^0 x' \quad (12)$$

where:  $x'$  stands for the consumption vector under free trade, zero's as superscripts refer to the autarkic equilibrium.

From the assumption that the function  $Y(\cdot)$  is maximised over a neighbourhood for given MR and  $k$ :

$$Y(MR^0, k') \geq MR^0 y' (MR', k') \quad (13)$$

From profit maximisation and the hypothesis of diminishing marginal revenue productivity:<sup>7</sup>

$$Y(MR^0, k') \leq Y(MR^0, k^0) + w^0 (k' - k^0) \quad (14)$$

From expressions (12) and (13):

$$E(p^0, u') \leq p^0 x' - MR^0 y' + Y(MR^0, k') \quad (15)$$

From expressions (14) and (15):

$$E(p^0, u') \leq p^0 x' - MR^0 y' + Y(MR^0, k^0) + w^0 (k' - k^0) \quad (16)$$

Expression (16) may be rewritten, deducting and adding  $p^0 y'$ , and changing the sign:

$$\begin{aligned} -E(p^0, u') &\geq -p^0 (x' - y') - (p^0 - MR^0) y' - Y(MR^0, k^0) \\ &\dots - w^0 (k' - k^0) \end{aligned} \quad (17)$$

Adding on the left hand side of (17)  $E(p^{\circ}, u^{\circ})$  and on the right hand side  $Y(MR^{\circ}, k^{\circ}) + (p^{\circ} - MR^{\circ})y^{\circ}$  from the expenditure income equality in the autarkic equilibrium:

$$E(p^{\circ}, u^{\circ}) - E(p^{\circ}, u') \geq -(p^{\circ} - MR^{\circ})(y' - y^{\circ}) - (p^{\circ} - p')(x' - y') - (w^{\circ} - w')(k' - k^{\circ}) \quad (18)$$

To focus on the precise meaning of the concept of non comparative advantage gains it is first assumed that there are two autarkic equilibria or that for given commodity prices there are two trading equilibria.

Definition I: An economy with increasing returns to scale and imperfect competition is said to have potential noncomparative advantage gains if:

$$(p^{\circ} - MR^{\circ})(y' - y^{\circ}) > 0.$$

Definition II: An economy with increasing returns to scale and imperfect competition is said to have potential procompetitive gains if:

$$(p^{\circ} - AC^{\circ})(y' - y^{\circ}) \geq 0$$

Definition III: An economy with increasing returns to scale and imperfect competition is said to have potential gains from scale effects if:

$$(AC^{\circ} - MC^{\circ})(y' - y^{\circ}) \geq 0$$

As can be seen from the preceding definitions, the potential noncomparative advantage gains, which can be interpreted as a rationing effect (evaluated at the shadow prices in the initial equilibrium) can be linearly decomposed into potential procompetitive gains from trade and potential gains from scale effects.

From expression (18) it is clear that if either two alternative autarkic equilibria are compared or two trading equilibria exist for given commodity prices that:

$$E(p^{\circ}, u^{\circ}) - E(p^{\circ}, u') \geq (p^{\circ} - MR^{\circ})(y' - y^{\circ}) \quad (19)$$



Therefore assuming that there are gains from changing to this other equilibrium implies:

$$(p^{\circ} - MR^{\circ})(y' - y^{\circ}) \geq 0 \quad (20)$$

i.e.: there are potential noncomparative advantage gains.

To highlight the opposite extreme, assume two CRS, perfectly competitive economies which differ according to tastes, endowments and technologies. Since they will gain from international trade we have from expression (18):

$$(p^{\circ} - p')(x' - y') + (w^{\circ} - w')(k' - k^{\circ}) \geq 0 \quad (21)$$

i.e.: the law of comparative advantage in the trade of goods and/or factors. The expression on the left hand side of (21) is referred to as the potential comparative advantage gains.

As can be seen from expression (18) a measure of the total potential gains from trade is given by:

$$(p^{\circ} - AC^{\circ})(y' - y^{\circ}) + (AC^{\circ} - MC^{\circ})(y' - y^{\circ}) + (p^{\circ} - p')(x' - y') + (w^{\circ} - w')(k' - k^{\circ}) \quad (21a)$$

This measure of the total potential gains from trade can be linearly decomposed into potential procompetitive gains, gains from scale effects and the comparative advantage gains from goods and factor trade. The former, i.e.: the non comparative advantage gains may dominate the comparative advantage gains. This entails that there may be gains from trade yet the laws of comparative advantage in goods and factor trade may not be satisfied. Expression (21a) tells us precisely under which conditions this possibility arises.

These results are now formalised and summarised in the following proposition 1:

Proposition 1:

Assume gains from trade in an economy with increasing returns and/or imperfect competition (subject to the stated assumptions). Then the sum of the potential comparative advantage, the pro-

competitive and scale effect gains (for definitions see above) form an upper bound to the total gains from trade as measured by the money metric:  $E(p^0, u') - E(p^0, u^0)$ .

Yet another interpretation of expression (18) is possible. Compare two closed economies with different factor endowments but with the same production technologies and tastes. In this case expression (18) becomes:

$$E(p^0, u^0) - E(p^0, u') \geq -(p^0 - MR^0)(y' - y^0) - (w' - w^0)(k' - k^0) \quad (22)$$

Expression (22) states a necessary condition for welfare improving changes in factor endowments in a closed economy. This is relevant for the generalisation of the H-O theorem in part II.

Turning to the derivation of a sufficient condition for gains from trade, the envelope properties of the household expenditure function imply:

$$E(p', u^0) \leq p'y^0 \quad (23)$$

because in the autarkic equilibrium  $x^0 = y^0$ .

From the properties of the function  $Y(\cdot)$ :

$$Y(MR', k^0) \geq MR'y^0(MR^0, k^0) \quad (24)$$

$$\text{and } Y(MR', k^0) \leq Y(MR', k') + w'(k^0 - k') \quad (25)$$

From expressions (23) - (25):

$$E(p', u^0) \leq (p' - MR')y^0 + Y(MR', k') + w'(k^0 - k') \quad (26)$$

From expression (26), changing the sign and adding  $E(p', u')$  and  $Y(MR', k') + (p' - MR')y'$  on the left and right hand side respectively:

$$E(p', u') - E(p', u^0) \geq (p' - MR')(y' - y^0) + w'(k' - k^0) \quad (27)$$

From Walras law in goods and factor markets  $w'(k'-k^0) = 0$ , i.e.: factor trade must be balanced. Expression (27) gives rise to the following proposition 2.

Proposition 2:

Assume that there are actual noncomparative advantage gains, i.e.: that the sum of actual procompetitive gains,  $(M_{p'} - AC')(y' - y^0)$ , and the actual gains from scale effects,  $(AC' - MC')(y' - y^0)$  is positive. Then there are gains from trade (subject to the stated assumptions) and the sum of the actual procompetitive gains and the gains from scale effects form a lower bound to the gains from trade measured by the money metric  $E(p', u') - E(p', u^0)$ .

Finally the following proposition 3 which is a corollary of propositions 1 and 2 seems of interest.

Proposition 3:

Assume that there are actual noncomparative advantage gains but potential noncomparative advantage losses (for the relevant definitions see the preceding text). Then, subject to the stated assumptions, there must be potential comparative advantage gains, i.e.: the law of comparative advantage in good and factor trade must be satisfied.

Proposition 1, 2 and 3 should be interpreted on the basis of the theory of output rationing. The presence of scale effects and imperfect competition can subject to the stated assumptions, be duplicated in a perfectly competitive economy with marginal cost pricing and output rationing as reflected in the constrained revenue function. The fundamental new insights of the rationing approach are as follows:

(1) noncomparative advantage gains can occur only if trade in goods and factors loosens the severity of output rationing implied the existence of scale economies and imperfect competition in a well defined sense. For the measurement of the severity of output rationing two different sets of shadow prices in the sense of cost benefit analysis may be used: the shadow prices in the autarkic

equilibrium and under trade. Trade may in general loosen or tighten the severity of rationing however measured. If trade loosens the severity of rationing, using the shadow prices of trade for the purpose of measurement, trade implies gains. This holds even if the law of comparative advantage in goods and factor trade is violated. If the latter is the case and there are gains it follows that trade must also loosen the severity of rationing when autarkic shadow prices are used for measurement.

(2) The rationing effect, the inner product of shadow prices and output changes can linearly be decomposed into the well known concepts of procompetitive gains from trade and gains from scale effects.

Finally it should be pointed out that all the results contained in proposition 1, 2 and 3 feature a striking formal analogy with most basic and very well known results of normative consumer choice theory; namely that price changes are welfare improving if the value of consumption increases at the new prices and only if the value of consumption increases at the initial equilibrium prices. Of course in the context of international trade (as known from induced preference theory) the consumption levels have to be replaced by imports and the value of imports at the free trade prices must be equal to zero (in the absence of transfers). Comparing two autarkic equilibria of the same economy shadow price changes are welfare improving if the value of consumption increases at the new shadow prices and only if it increases at the initial shadow prices. As proved in Drèze and Stern (1986) many results of distortion free economies can be directly translated into results in economies with quantity rationing simply by replacing actual by shadow prices.

### (C) FURTHER INTERPRETATIONS AND RESULTS

Expressions (18) and (27) which give rise to propositions 1 and 2 respectively have two other interesting interpretations.

(a) They can be regarded as generalisations of results derived by Schmalensee (op.cit.) and Varian (op.cit.) regarding the social welfare effects of price discrimination and

(b) They can be applied to the theory of market segmentation (see e.g. Brander 1981 or Markusen and Venables 1988) which recently played an important part in the New International Economics.

The key contribution of Varian is to have derived bound conditions on the change in social welfare if there is the possibility of price discrimination between households. As Varian points out, see page 871 op.cit., his analysis is based on the use of classical measures of consumers' plus producers' surplus. The most general preference structure for which this is possible is that of quasi linear utility (constant marginal utility of income). Varian's analysis also does not contain any factor markets and appears to be strictly partial equilibrium.

Expressions (18) and (27) are general equilibrium generalisations of Varian's results, see especially page 875, which do not require the assumption of quasi linear utility functions, i.e.: expenditure functions of the form:  $U = V(p)$ , where  $V(p)$  is some concave price index. Also expressions (18) and (27) apply to open as well as closed economies.

To relate the present approach to Varian's it is assumed that there is only one good which is supplied to different households at different costs (the cost of preventing resales may be included in these) and at different prices. In other words, physically the same good supplied to a different household is treated as a different good. In order to derive exact closed economy general equilibrium analogues of the Varian results (see page 875 op.cit.) quasihomothetic preferences (or Gorman polar forms), see e.g. Deaton and Muellbauer 1980 p.144 or Gorman 1961, are postulated.

Expressions (18) and (27) can thus be rewritten as:

$$- b(p^{\circ})DU \geq -(p^{\circ}-MR^{\circ})(y'-y^{\circ}) - w^{\circ}(k'-k^{\circ}) - (p^{\circ}-p')(x'-y') \quad (28)$$

$$b(p')DU \geq (p'-MR')(y'-y^{\circ}) + w'(k'-k^{\circ}) \quad (29)$$

where  $DU = U' - U^{\circ}$  and  $b(p)$  stands for the price index regarding discretionary expenditure in the household expenditure (cost) function:  $a(p) + b(p)u$ .

As is well known, see Sonnenschein and Roberts 1976 and 1977, Dierker and Grodal 1986 or Böhm 1990, normalisation is a far from trivial issue in an economy with imperfect competition because it changes the objective function of firms and has in general important implications for the (non)-existence of the general equilibrium. However in the present case of one household economies with quasihomothetic preferences it seems natural to assume that firms maximise profits in terms of the price index  $b(p)$ . Having assumed  $b(p) = 1$  expressions (28) and (29) become:<sup>8</sup>

$$(p^{\circ}-p')(x'-y') + (p^{\circ}-MR^{\circ})(y'-y^{\circ}) + w^{\circ}(k'-k^{\circ}) \geq DU \geq (p'-MR')(y'-y^{\circ}) + w'(k'-k^{\circ}) \quad (30)$$

Varian's assumption of convex cost functions is equivalent to assuming that  $Y(\cdot)$  is maximised for given MR in a neighbourhood of the autarkic or free trade equilibrium. Also the change in the pattern of price discrimination in the present approach is due to assumed exogenous changes in factor endowments and/or international trade. However in Varian's approach the change is due to the exogenous possibility of supplying different households or markets. The latter is, of course, also relevant to international economics if an economy is opened up to trade.

To conclude this subsection it is simply noted that by replacing the term households by markets all of the above analysis and results can be applied to the theory of market segmentation which has played such an important part in explaining trade in identical commodities, see e.g. Brander 1981.

#### (D) REVERSALS OF STANDARD RATIONING EFFECTS

##### AND THE H-O THEOREM

As explained in the introduction it is proven in part 2 that the factor content version of the H-O theorem holds under imperfect competition and increasing returns to scale if the standard rationing effect, i.e.:  $[(p'-MR') - (p^{\circ}-MR^{\circ})](y'-y^{\circ}) \leq 0$  is reversed through the changes in factor endowments associated with the factor content of commodity imports in an equivalent autarkic equilibrium.

The intuition underlying the standard rationing effect is clear. An increase in differences between prices and marginal revenues or costs, on average, increases the severity of rationing and therefore induces, on average, a fall in output; but this holds only for closed economies and given factor endowments. Changes in factor endowments may reverse the standard rationing effect. The purpose of this subsection is to throw more light on this assumption.

Assume that the initial equilibrium is autarky and then the economy is opened to trade. A controlled equivalent autarkic equilibrium is constructed by (inter alia) adding the factor content embodied in commodity imports to the initial factor endowments (for details see part 2). It will be proven that the H-O theorem holds if there is a reversal in the standard rationing effect in controlled equivalent autarkic equilibrium due to the changes in factor endowments associated with the factor content of commodity imports, i.e.:

$$[(p' - MR') - (p^0 - MR^0)](y' - y^0) \geq 0 \quad (31)$$

From expression (31) and also taking into account expression (30) it is seen that:

$$(w' - w^0)(k' - k^0) \leq 0 \quad (32)$$

i.e.: assuming that there is a reversal in the standard rationing effect due to endowment changes in a controlled equivalent autarkic equilibrium (with preferences being quasihomothetic) entails that the standard neoclassical relationship between factor endowments and factor prices (of the H-O model) holds. At the same time note that in a closed economy with unchanged factor endowments there can only be the standard rationing effect as derived by Varian, p. 375:

$$[(p' - MR') - (p^0 - MR^0)](y' - y^0) \leq 0 \quad (33)$$

from expression (30).

The economic meaning of this seems clear. Changes in factor endowments may counteract the standard rationing effect associated with an increase in shadow prices. As a matter of fact this factor endowment or Rybczynski effect may be strong enough to reverse the

standard rationing effect (which only holds for given endowments). As will be clear from part II these considerations lie at the heart of the generalisation of the H-O theorem.

## II

### EQUIVALENT AUTARKIC EQUILIBRIA AND

#### THE HECKSCHER-OHLIN THEOREM

The key idea underlying the factor content theory of trade (see e.g. Ethier 1984) is to relate a given trading equilibrium to an equivalent autarkic equilibrium. Essentially an equivalent autarkic equilibrium is derived from a given trading equilibrium by adjusting the vector of primary factor endowments by the vector of factors embodied in commodity imports or exports so that the consumption vector under trade becomes producible in an equilibrium without commodity trade.

It will now be demonstrated that the concept of an equivalent autarkic equilibrium can - with appropriate adaptation - be generalised to economies with increasing returns to scale and imperfect competition. This new concept which is referred to as a controlled equivalent autarkic equilibrium is the cornerstone of the proof of the H-O theorem.

To define the factor content of trade the economy cost function is utilised.

$$M = C_w(w', y') - k \quad (34)$$

where: M denotes the vector of factors embodied in commodity imports and  $w', y'$  the vectors of factor prices and consumption levels (respectively) of the given trading equilibrium. From expression (34) it is clear that the given vectors  $w'$  and  $y'$  are feasible in an autarkic equilibrium if factor endowments  $k$  are adjusted by M.



From the assumption of profit maximisation:<sup>9</sup>

$$C_Y(w', y') = MR = p^F \quad (35)$$

where:  $p^F$  denotes the vector of prices received by firms per unit of output.

It is assumed that the government controls the firms and sets the prices received by firms in order to ensure that they produce the consumption vector of the given trading equilibrium  $y'$ .

The prices faced by consumers  $p$  are determined in the following goods market equilibrium conditions:

$$D[p, Y(p^F, k+M) + (p-p^F)y'] = y' \quad (36)$$

where:  $D(\cdot)$  denotes a vector of Marshallian demand functions and  $p$  the vector of prices which households have to pay for the goods. Since preferences are assumed to be quasihomothetic, and for the reasons explained in the previous section, the prices  $p$  are normalised so that  $b(p)$  is equal to one.

The losses of firms are financed from the governmental revenue  $(p-p^F)y'$  and if necessary also by means of lump sum taxes. The latter do not appear in expression (36) because households wholly own firms and therefore are also recipients of the revenue resulting from any necessary lump sum taxes.

Since outputs are different in the given trading equilibrium and in the controlled equivalent autarkic equilibrium the marginal costs differ too. The expressions  $MC(w', y')$  may be referred to as equivalent autarkic marginal costs. Also there is no presumption that the prices paid by households are the same in the two equilibria. As will be obvious later these differences are immaterial with regard to the proof of the H-O theorem.

Expressions (34), (35) and (36) represent the controlled equivalent autarkic equilibrium. The equilibrium is equivalent in as

much as the vectors of outputs and factor prices are exogenous (determined by the vectors of consumption and factor prices in the given trading equilibrium). From the definition of the factor content of trade, expression (34), it is clear that  $w'$  and  $y'$  are feasible in an equivalent autarkic equilibrium. The issue is whether they are also realised - this is the issue of controllability (see e.g. Woodland 1982 or Laffont 1988 Ch.3). In other words can the government by a choice of  $p^F$  ensure that factor prices are  $w'$  and the outputs  $y'$ ? As is well known, see e.g. Laffont op.cit. this is a very complex issue which goes beyond the mere existence of an equilibrium (which we know from Sonnenschein and Roberts 1976 is not guaranteed) and does not allow an easy answer.<sup>10</sup>

Of course, it can also be argued that the issue of controllability in the sense of decentralisability is not central to the stated purpose. Central are the insights to be gained by relating a hypothetical equivalent autarkic equilibrium to a given trading equilibrium. If the government has enough information and control it can subject to existence, always implement such an equilibrium. Given the implementability of such an equilibrium the generalised version of the H-O theorem may now be proven.

Assume that the original equilibrium is the actual autarkic equilibrium. Prices paid by households are given by  $p^\circ$ , marginal revenues by  $MR^\circ$ , factor endowments and outputs by  $k^\circ$  and  $y^\circ$  respectively. The prices paid by households in the equivalent autarkic equilibrium are  $p$  and marginal revenues  $MR'$  (these are equal to the prices received by firms). The outputs are  $y'$  and the new factor endowments  $k'=k^\circ+M$ , where  $M$  is as defined in expression (34).

As explained in part I, the Hicksian = Marshallian shadow prices (in the controlled equivalent autarkic equilibrium) can be defined by partial differentiation of the relevant constrained trade expenditure function (which is based upon the constrained national income function with support prices  $MC' = MR' = p^F$ ).

In the light of these definitions proposition 4 may now be formalized:

Proposition 4

Assume quasihomothetic preferences and the indicated normalisation of prices. Subject to the assumptions stated in part I assume further that in the controlled equivalent autarkic equilibrium:

$$[(p' - MR') - (p^0 - MR^0)](y' - y^0) \geq 0$$

i.e.: that the standard rationing effect is reversed by changes in factor endowments.

Then:  $(w^0 - w')M \geq 0$  [on average factors which are expensive (cheap) in the actual autarkic equilibrium relative to the given trading equilibrium will be imported (exported) in the form of goods].

Proof: from the assumptions and the preceding definitions, expression (32) of part I can be written as:

$$(w^0 - w')M \geq 0.$$

Q.E.D.

Probably the main message implicit in proposition 4 accords with intuition: if the effects of changes in factor endowments (i.e. the effects at work in any perfectly competitive CRS economy) dominate the distortionary rationing effects, then the H-O theorem (subject to other minor assumptions) holds in an economy with increasing returns to scale and imperfect competition. The contribution is that the above analysis and proposition 4 make the sense in which the endowment effect has to dominate the standard rationing effect,  $[(p' - MR') - (p^0 - MR^0)](y' - y^0) < 0$ , precise.

From an empirical point of view it is, of course, regrettable that proposition 4 has to be stated in terms of properties of a directly non observable equivalent autarkic equilibrium. However this limitation is intrinsic to the factor content approach (see also Deardorff 1982 and Deardorff and Staiger 1988).

To conclude we briefly comment upon the same general relationships and also the link between the gains from trade (if any) and the H-O theorem. As is well known in a distorted economy the H-O theorem is neither a necessary nor a sufficient condition for trade gains (see

Negishi 1972). In the present case it should be remembered that since outputs and prices (faced by households) are different in the trading equilibrium and the equivalent autarkic equilibrium, direct welfare comparisons between these equilibria are impossible. Focussing on the possible welfare gains or losses in the actual (initial) and then controlled equivalent autarkic equilibrium due to the changes in the factor endowments and the rationing pattern it should be emphasized that the condition:

$$[(p' - MR') - (p^0 - MR^0)](y' - y^0) \geq 0 \quad (37)$$

is neither a necessary nor a sufficient condition for welfare gains. This follows simply from expressions (28) - (30). Expression (37) is in this case to be understood in equivalent autarkic equilibrium magnitudes and refers to that equilibrium. An analogous statement can be made if expression (37) is interpreted as referring to the actual trading equilibrium. Also expression (37) may be satisfied if it refers to the controlled equivalent autarkic equilibrium and violated if it refers to the actual trading equilibrium. This follows because as emphasized outputs are different in the two equilibria.

If preferences are quasihomothetic and the price normalisation is as indicated it follows from expression (30) that:

$$\begin{aligned} & [(p' - MR') - (p^0 - MR^0)](y' - y^0) + (w' - w^0)(k' - k^0) \\ & - (p^0 - p')(x' - y') \leq 0 \end{aligned} \quad (38)$$

This expression can be used to compare the actual autarkic and the trading equilibrium as well as the actual autarkic and the controlled equivalent autarkic equilibrium. It is a most general relationship which contains many results.

What appears to be the most relevant result that follows from proposition 4 and expression (38) is now stated as proposition 5:

#### Proposition 5

Assume quasihomothetic preferences with the indicated normalisation of prices or homothetic preferences and the existence of a controlled equivalent autarkic equilibrium. Then the reversal of

the standard rationing effect, i.e.: expression (37) implies not only the factor content version of the Heckscher-Ohlin theorem but also the standard theorem of comparative advantage in goods trade (in the absence of factor trade).

The important message implicit in propositions (4) and (5) is that the stated assumptions with regard to preferences are sufficient (in addition to the other assumptions) to obtain results concerning the pattern of goods or implicit factor trade independently of the gains from trade. Since gains from trade are far from certain in the present context the alternative approach via homothetic preferences seems worth while. Also of course it should be remembered that a standard assumption of traditional perfectly competitive CRS trade theory is homotheticity of preferences.

#### RELATIONSHIP TO CGE MODELLING AND EMPIRICAL RESULTS

According to a recently published survey on empirical research on trade liberalisation with imperfect competition, see J. David Richardson (1989), the issue of the gains from trade liberalisation with imperfect competition is empirical because theory cannot provide a definite and clearcut answer to this important policy problem.

The main contention of the present paper is that the theoretical approaches of the received literature have failed to focus - within a reasonably general framework - on the relevant issues. Since it has been shown in the recent theoretical and empirical literature, see e.g. Cox and Harris (1986) or Harris (1984, 1985, 1986 and 1988) that all the results in this area of research are extremely sensitive to changes in the specification of the modelling concerning imperfect competition, it would seem that theory has an especially important part to play in obtaining results which hold under as general assumptions as possible. In focussing on the relevant more general approaches and results, theory can give an all important direction to empirical research. This (in our view) is lacking in the received literature. The key purpose of this paper has been to put forward an approach which can provide this direction.

Undoubtedly very recently serious doubt has been cast upon the desirability of free international trade under conditions of imperfect competition. This is highlighted by the fact that such a notable proponent of the recent approaches as Paul Krugman has publicly advocated the subsidization of US exports. The relevant question is: on the basis of which more general model or which empirical results has this been advocated?

The rationing approach put forward in this paper has inadvertently made assumptions which by their very nature favor the case for subsidization in one form or another; yet the conclusions, summarised in propositions 1 and 2 and their generalisation to subsidised or taxed international trade in the appendix show that the issue remains far from settled if we consider a more general framework.

The tentative contribution of the present analysis is to focus on those expressions which should be quantified in the empirical research based upon CGE modelling of trade liberalisation under imperfect competition. This has been achieved making considerably more general assumptions which have hitherto been adopted in the literature.

APPENDIX

Assume that superscript 0 refers to the free trade situation and 1 to the equilibrium with trade taxes or subsidies. Expressions (12) to (17) of the text only have to be reinterpreted. In deriving expression (18) from (17) it should be noted that  $p'(x'-y') \neq 0$  but equal to the governmental revenue  $(p'-q)(x'-y')$ , where  $q$  denotes the world market prices in the equilibrium with trade taxes and subsidies. Clearly  $q(x'-y') = 0$ , therefore  $T = p'(x'-y')$  = governmental revenue. Deducting  $p'(x'-y')$  and adding  $T$  on the right hand side of (17) the following necessary condition for welfare gains from the imposition of trade taxes and/or subsidies emerges:

$$(p^0 - p')(x' - y') + (p^0 - MR^0)(y' - y^0) + w^0(k' - k^0) + T \geq 0 \quad (39)$$

Proceeding similarly with the derivation of the sufficient condition (remembering that  $x^0 \neq y^0$ ) the following expression is arrived at:

$$(p' - MR')(y' - y^0) + w'(k' - k^0) + T \geq 0 \quad (40)$$

Comparing expressions (39) and (40) with (18) and (27) it follows at once that if  $T < 0$  then (18) still represents a necessary and if  $T > 0$  expression (40) a sufficient condition for welfare gains.

Finally using the bound conditions and quasihomothetic preferences as well as the normalisation suggested in the text formally the same expression as (30) emerges and therefore expression (38) of the text remains unchanged too. The interpretations are, of course, a little different, for example:

$$(p^0 - p')(x' - y') = (p^0 - q)(x' - y') - T,$$

where:  $(q - p^0)(x' - y') \begin{matrix} > \\ < \end{matrix} 0$  may be regarded as a terms of trade deterioration (improvement).

But, subject to this interpretation expression (38) and all the reasoning and results based on it remain unscathed.

FOOTNOTES

- <sup>1</sup> It is impossible to mention here all the relevant literature. Our aim - in contrast to many articles and books - is to derive as general results as possible. Most of the literature consists of rather special results. But there are exceptions. Kemp and Negishi 1970 were the first to derive a globally valid sufficient condition for trade gains under increasing returns to scale. Ethier 1982 has proved conditions under which the larger country has a comparative advantage in the good produced under increasing returns to scale. Markusen 1981 is concerned mainly with gains from trade but also with trading patterns in imperfectly competitive economies. Helpman and Krugman 1985 also deal with the latter topic. Of course, many authors have analysed the factor content of trade in perfectly competitive constant returns to scale economies, see e.g. Helpman 1984, Brecher and Chaudri 1982 and 1984, Svensson 1984 and most recently in the context of services Melvin 1989. A very useful survey of the New International Economics can be found in Ch. 20 of Handbook of Industrial Organization, Vol. II, ed. by R. Schmalensee and R.D. Willig: Industrial Organization and International Trade by P.R. Krugman (1989). The seminal articles in a partial equilibrium framework are Bhagwati (1965) and Krishna (1984). Mention should also be made of the stimulating arguments for free trade in Krugman (1987).
- <sup>2</sup> By an equivalent autarkic equilibrium we mean an autarkic equilibrium in which the consumption vector under trade is produced by means of primary factor endowments adjusted by the factor content of commodity imports (in a trading equilibrium).
- <sup>3</sup> On the concept of controllability of outputs see e.g. Woodland 1982. The assumption of controllability is virtually universal in the received literature. It is reflected in the assumption of uniqueness (which is much stronger) in e.g. Krugman 1979. Commodity taxes, of course, abound in the real world.



- 4 In common with the existing very large literature we assume that firms maximise profits (and implicitly that profit functions are concave). As is well known these assumptions would have to be justified in a more general framework, see e.g. Hart 1985 and Dreze 1982. Another assumption is that the firms are not wholly controlled by households who have access to all information.
- 5 Counterexamples to this belief are contained in e.g. Markusen 1981 and Helpman 1984.
- 6 There are some special cases in which the results are truly global:
- (a) if the production possibility set is convex under variable returns to scale. It is well known that even universal increasing returns to scale do not necessarily imply nonconvex production possibility sets.
- (b) if as in e.g. J.D. Richardson (1989) production functions are constant returns to scale but there are fixed costs which give rise to imperfect competition. In this case the nonconvexity arises only on the boundaries of the production possibility set. Therefore assuming only interior solutions entails that all the results are global.
- 7 The assumption here is that factors are rewarded according to marginal revenue products. If production functions are homogeneous of degree greater than one this assumption may entail (from Euler's theorem) that the residual, i.e.: profits, are negative. This case, which has not been considered in the literature is ruled out by assumption.
- 8 An alternative is, of course, to assume as in the standard literature on CRS perfectly competitive economies that preferences are homothetic.
- 9 This assumption has been criticized in the context of imperfect competition, see e.g. Drèze (1972) or Hart (1985). However it abounds in the received literature.

<sup>10</sup> As explained in footnote (6) there are some important special cases in which controllability is satisfied. Furthermore it is implicitly assumed in virtually all the received literature (for an exception, see Kemp and Schweinberger 1991).

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**WORKSHOP ON**  
**ISSUES IN INTERNATIONAL ECONOMICS: QUESTIONS TO AND ANSWERS FROM**  
**COMPUTABLE GENERAL EQUILIBRIUM ANALYSIS**

**JULY 8-9, 1991**  
**UNIVERSITY OF KONSTANZ**

**MONDAY, JULY 8, 1991**

**10.00 Opening Address**

Wolfgang Franz (Dean, University of Konstanz)

Bernd Genser (University of Konstanz)

"General Equilibrium Economics: Computation and Application"

John Whalley (University of Western Ontario)

**11.00 Session 1: International Taxation**

"Value-Added Tax Harmonization in the EC"

Wolfgang Wiegard/Hans Fehr/Christoph Rosenberg (University of Regensburg)

"Commodity Tax Reform under the Restricted Origin Principle"

Andreas Haufler (University of Konstanz)

**14.30 Session 2: Factor Supply**

"Simulation Models of Labour Supply"

Alan Duncan (Institute for Fiscal Studies, London)

"An Intertemporal General Equilibrium Model for Austria with Application to Foreign Trade"

Christian Keuschnigg (University of Bonn)/Wilhelm Kohler (University of Innsbruck)

**17.00 Session 3: Environment**

"CGE Modelling of International Public Goods: Air Quality and Global Warming"

John Piggott (University of New South Wales)

**TUESDAY, JULY 9, 1991**

**09.00 Session 4: Imperfect Competition and Growth**

**"AGE Models in International Economics with Special Reference to Imperfect Competition and Increasing Returns to Scale"**

**Albert Schweinberger (University of Konstanz)**

**Growth and International Capital Movement: A Simulation Study**

**Karl-Josef Koch (University of Konstanz)**

**(presentation cancelled due to accident)**

**10.45 Round Table: "The Payoff of Investment in CGE - Modelling"**

**Chair: Bernd Genser**

**Introductory Statements:**

**John Chipman (University of Minnesota)**

**Friedrich Schneider (University of Linz)**

**Closing Address: Bernd Genser**