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# 4 INCREASING RETURNS TO SCALE

## NEW TRADE THEORY

Empirical data indicates that a significant amount of trade occurs between similar countries, trade that is not explainable using traditional trade theory (Ricardian, specific factors and HOS models) where trade occurs due to existing comparative advantage between countries (technology, factor endowment differences). The high volume of trade between countries with similar technology and similar factor endowments went against the predictions of these theories. With little difference to exploit, these countries should have little to gain from trade, and yet, at least up to the 1970's when the revolution in trade theory began, it was precisely these developed (OECD) countries that seemed to have prospered most from their open trade with each other.

Given this “unexplainable” portion of trade, trade theorists began to look for other reasons for trade, reasons where trade could occur between similar countries and yield sizable gains from trade. The shift in emphasis from looking for reasons for trade to occur between different countries to looking for reasons for trade to occur between similar countries marks the break between the traditional (old) trade theory and the new trade theory. The newer theories still generally can be interpreted as having trade stem from some type of comparative advantage, but the source of comparative advantage is more subtle, and sometimes is not even existent in autarky, but develops with the opening up to trade. The hallmark of the new theories is that one can construct a scenario where exactly identical countries will trade with each other, where no trade would be predicted by the traditional theories. Some of the new reasons for trade are increasing returns to scale (IRS), imperfect competition (especially oligopoly), and differentiated goods (variety or quality).

As we study each of these models in turn, make sure you come away with an understanding of the answers to the following questions:

1. What failures of the traditional theory motivated construction of this model?
2. What is the fundamental reason for trade to occur (what is the source of comparative advantage? What efficiencies are exploited by rearranging production across countries under trade)?
3. What is the impact of trade on members of each country, each country as a whole, and the world as a whole?
4. What patterns of trade emerge and how do these patterns differ from traditional models?
5. How well does the model succeed in filling a hole in trade theory?
6. What is still missing from the picture? What could be added that would be a contribution to the literature?

The new trade theory holds many promising areas for future research – try to spot some!

## IRS

Existing trade theories were based on CRS (Ricardian) or DRS (HOS, Specific Factors), so theorists began to wonder what the properties of trade would be in an IRS world. In an IRS world, production costs fall with the level of production. In autarky, an IRS good would have to be produced in both countries, since each country has to produce what it consumes. Trade could potentially yield gains by concentrating production all in one country, so that production costs would be lower. As a modeling point, IRS at the level of the firm requires either subsidies to the firms (price at marginal cost leads to negative profits) or abandoning the perfect competition framework. However, if IRS are assumed external to the firm but internal to the national industry, perfect competition can be used without subsidies.

## IRS TERMS

Increasing returns to scale (IRS) are:

- *internal to the firm* if the firm's average costs depend on the firm's size,
- *external to the firm* if the firm's average costs do not depend on the firm's size,
- *internal to the industry* if the firm's average costs depend upon the size of the industry.

Furthermore, increasing returns to scale are:

- *national* if average cost depends on the size of the national industry or
- *international* if average cost depends on the worldwide size of the industry.

National IRS provides a need to rationalize production across countries but therefore introduces conflict between countries, whereas with international IRS (with homogeneous goods), location of production would not matter and so international IRS leaves pattern of trade determined by comparative advantage (like Ricardian model).

## BASIS FOR TRADE

IRS furnishes a basis for trade independent of comparative advantage. With IRS (external to firm, internal to national industry) can have two ex ante identical countries end up trading. The pure IRS model has the property that the role of countries has a random component, and is entirely random if the two countries are identical: ex ante a country is as likely to import or export the IRS good. Standard pure IRS model examines two countries and two goods. One good has national IRS external to the firm but internal to the national industry; other good has CRS for ease (and realism – ensures that results do not hinge on all goods having IRS, since many goods do not have IRS).

# NATIONAL IRS

## EFFICIENCY OF SPECIAL- IZATION

Inefficient to have both countries produce both goods, as in autarky. A preferred consumption bundle is feasible if rationalize production of IRS good through trade. The autarky equilibrium generally will not persist once trade is possible as both countries producing both goods not stable: if either country increases its production of IRS good an  $\varepsilon$ , IRS production will shift toward that country. If countries are exactly symmetrical, either country could get that head start, so the pattern of trade tends to be indeterminate if the cause of trade is IRS. Even if countries are not identical, country with smaller autarkic production of IRS could deliberately expand its production of IRS good in the move to free trade – so randomness persists even without symmetry. However, the country with the larger autarkic production of the IRS good is more likely to produce it (or produce more of it) under free trade in the sense of what would happen if neither country strategically expanded its IRS production.

## MULTIPLE EQUILIBRIA

Many different equilibria are possible in the pure IRS model. Country size and strength of IRS pick one of the four equilibria, but still historical accident or trade policy can play a role in selecting the equilibrium and which country is which within that equilibrium, as equilibria have mirror image equilibria where countries swap roles. Precise dynamics are complicated and have some undesirable properties: as a general rule, consider one country expanding its production of IRS good.

- Knife-Edge (both countries diversified) Unstable case where under free trade, countries stay the same as in autarky.
- Graham (one country specialized in IRS good, other diversified) If country is small and IRS are weak, even with one country specialized in IRS good, world relative demand for IRS good is not satisfied, so other country has to produce some of IRS good as well: one country produces only IRS good, other country produces IRS and CRS goods.
- FPE (one country specializes in CRS good, other diversified) If countries are big and IRS are strong, all of IRS production can fit in one country with resources to spare so the country producing the IRS good also produces

some of the CRS good and the other country produces only the CRS good. Since both countries produce the CRS good, factor prices are equalized across countries under free trade (wage equals value of marginal product of labor in producing the CRS good, which is the same in both countries).

- Ricardian (both countries specialize) In the middle, world relative demand for IRS good could be satisfied when each country is completely specialized (one in IRS good, other in CRS good). Complete specialization is even more common than in Ricardian model (recall kink in world PPF).

<b>PURE IRS EQUILIBRIA</b>	One Country	Other Country
Knife-edge	IRS and CRS	IRS and CRS
Graham	IRS	IRS and CRS
FPE	IRS and CRS	CRS
Ricardian	IRS	CRS

NOTE: Country roles can be reversed.

## NOT ALWAYS GAINS FROM TRADE

Free trade might possibly be worse for an individual country than autarky (for diversified country in Graham equilibrium, where other country is completely specialized in IRS good). Ex ante, not necessarily gains from trade for each country even though overall there are gains from trade. The losing country might be tempted to revert to autarky (imposing prohibitive tariffs); such protectionism would be detrimental to total world production. A scheme of international lump-sum transfers could make both countries better off (post-transfers) separately from free trade relative to autarky. The scenario where one country loses from trade is only one of three possible equilibria in the pure IRS model. Plus, even if a country ends up as the Graham loser, if trade occurs for other reasons such as factor endowment differences, gains from trade from other sources may wipe out losses due to IRS.

## COUNTRY SIZE

If countries' sizes differ substantially, FPE and gains from trade for both countries likely. One country specializes in producing the CRS good and the other country is diversified. Explains specialization and trade conflicts between nations. Trade is likely to be characterized by complete specialization. Any unnecessary split of production within an industry between the two countries inefficient. Graham case (similar countries) one country specializes in the IRS good; FPE case (unequal countries) smaller country specializes in the CRS good for efficiency.

## STRENGTH OF SCALE ECONOMIES

In Graham equilibrium, IRS production split between countries. Stronger the IRS, the less likely such a split will occur. So case for protection limited to similarly sized countries with weak IRS.

## Ethier *Econometrica* 1982

Examines the consequences of increasing returns when two countries are alike in every respect except potentially for size (only one factor of production). Shows that in such a setting IRS behaves much as the Ricardian model. Shows Graham's claim that a small country may lose from trade if the two countries are nearly the same size and IRS are weak.

## IRS in a Ricar- dian Setting

- Two countries
- Two goods: wheat ( $W$ ) and manufactures ( $M$ )
- One factor of production: labor ( $L$ ) – Labor constraint requires that

$$L_W + L_M = L \quad (4.1)$$

where  $L_M$  and  $L_W$  are the labor allocated to the manufactures and wheat sectors and  $L$  is the total labor supply.

- CRS technology in producing wheat – normalize so that one unit of labor makes one unit of wheat. Thus, output of wheat  $W$  equals the labor devoted to wheat production  $L_W$ .

$$W = L_W \quad (4.2)$$

- IRS external to the firm (but internal to the national industry) in producing manufactures – each firm takes  $k$  as a given so that it behaves as if it faces a CRS technology where one unit of labor makes  $k$  units of manufactures. Thus, output of manufactures  $M$  equals the productivity parameter  $k$  times the labor devoted to manufacturing production  $L_M$ .

$$M = kL_M \quad (4.3)$$

However, due to IRS internal to the industry,  $k$  depends upon the size of the manufactures industry in the country where  $\alpha > 1$  for IRS

$$k = L_M^{\alpha-1} \quad (4.4)$$

Combining the definition of  $k$  (4.4) with the production function for manufactures (4.3) yields

$$M = L_M^{\alpha-1}L_M = L_M^\alpha \quad (4.5)$$

Therefore, the average cost of producing a unit of manufactures falls as the country makes more manufactures (as more labor is devoted to manufactures). Thus, the PPF bows in as in Figure 4.1. Insert the implication of the production function for manufactures (4.5)

$$M = L_M^\alpha \rightarrow L_M = M^{\frac{1}{\alpha}} \quad (4.6)$$

and the production function for wheat (4.2)

$$W = L_W \rightarrow L_W = W \quad (4.7)$$

into the labor constraint (4.1)

$$L_W + L_M = L \rightarrow W + M^{\frac{1}{\alpha}} = L \quad (4.8)$$

to find that the PPF is

$$M = (L - W)^\alpha \longleftrightarrow W = L - M^{\frac{1}{\alpha}} \quad (4.9)$$

The maximum amount of  $W$  that can be produced (vertical intercept) is the labor supply  $L$ . The maximum amount of  $M$  that can be produced (horizontal intercept) is  $L^\alpha$ .

Due to perfect competition in the wheat industry, the price of a unit of wheat must equal its cost, which equals the wage (condition for no profits)

$$P_W = w \quad (4.10)$$

Assume average cost pricing prevails in the manufacturing industry for zero profits (IRS external to the firm or internal to the firm with free entry) so that the price of manufactures equals average cost (pay  $w$  for  $L_M$  units of labor that produces  $M$  units of output)

$$P_M = \frac{wL_M}{M} \quad (4.11)$$

Thus, using the price of wheat (4.10) and the price of manufactures (4.11), the relative price of manufactures in terms of wheat is

$$p \equiv \frac{P_M}{P_W} = \frac{wL_M/M}{w} = \frac{L_M}{M} = \frac{L_M}{L_M^\alpha} = L_M^{1-\alpha} = M^{\frac{1}{\alpha}-1} \quad (4.12)$$

From the production possibilities frontier (4.9),  $W + M^{\frac{1}{\alpha}} = L$  implies

$$dW + \frac{1}{\alpha}M^{\frac{1}{\alpha}-1}dM = 0 \quad (4.13)$$

Therefore, the slope of the PPF or the MRT equals

$$\frac{dW}{dM} = -\frac{1}{\alpha}M^{\frac{1}{\alpha}-1} = -\frac{M^{\frac{1}{\alpha}}}{\alpha M} = \frac{-L_M}{\alpha M} \quad (4.14)$$

From (4.12), we have the relative price differs from the slope of the PPF by a factor of  $\alpha$

$$p = \frac{L_M}{M} = -\alpha \frac{dW}{dM} \quad (4.15)$$

Since  $\alpha > 1$ , the relative price exceeds the MRT. Thus the socially optimal quantity of  $M$  is not produced. The relative price for any production pattern  $(W_o, M_o)$  is found by connecting a line through that point with the maximal production of  $W$

$$p = \frac{L_M}{M_o} = \frac{L - L_W}{M_o} = \frac{L - W_o}{M_o} \quad (4.16)$$

as with the line drawn in Figure 4.1. From the relative price of manufactures (4.12)

$$p = M^{\frac{1}{\alpha}-1} \quad (4.17)$$

## Autarkic Equilibrium

If a constant fraction  $\gamma$  of income is spent on manufactures, the ratio of autarkic relative prices is

$$\frac{p}{p^*} = \left( \frac{L^*}{L} \right)^{\alpha-1} \quad (4.18)$$

**Proposition 1** *If both countries produce both goods in autarky and have identical preferences, then the larger country will have the lower autarkic relative price of manufactures.*

## Efficient Patterns of World Output

Assume two identical countries. The foreign country is the same as the home country ( $\alpha = \alpha^*$ ) except that the foreign labor supply  $L^*$  need not equal the domestic labor supply  $L$ .

- Complete specialization in both countries is clearly efficient; diversification in both is not.
- If world output of manufactures is no bigger than the maximum that the smaller country can produce, any pattern of specialization is efficient so long as at least one country specializes.
- If world output of manufactures exceeds the smaller country's capacity, then efficiency requires that the larger country make as much manufactures as possible to reap economies of scale. In other words, so long as the larger country is making some wheat, efficiency requires that the smaller country make no manufactures. This prescription is the same as in the Ricardian model if the larger country has comparative advantage in manufactures.

**Proposition 2** *If world output of manufactures is large enough for the pattern of specialization to matter (larger than the capacity of the smaller country), then the efficient patterns are precisely those dictated by comparative advantage as in the usual Ricardian model (the larger country has comparative advantage in manufactures, the IRS good).*

## Small Open Economy

Suppose that have a small country that is so small it can trade at a given relative price of manufactures. If the world relative price of manufactures exceeds its autarky relative price

of manufactures, the country will specialize in manufactures; if its autarky price exceeds the world price it will specialize in wheat. The country will gain from trade in either case: the TPF will lie everywhere above the PPF as in Figure 4.2. Contracting the IRS need not imply losses from trade for a small country. The implication that specialization leads to gains from trade is the same as in the Ricardian model. If the world price equals the autarky price, the country will remain incompletely specialized and as in the Ricardian model will neither gain nor lose. Here any incompletely specialized equilibrium is unstable: if the world price changes very slightly, the country will specialize.

**Proposition 3** *A small country entering into international trade will specialize in the commodity for which it had a lower autarkic price and will gain from trade.*

Large Open  
Economy

**Proposition 4** *Under identical homothetic tastes, each country has a lower autarkic relative price in the good in which it has an advantage. Under free trade, each country will export the good in which it has comparative advantage. At least one country, and possibly both, specialize. The pattern of specialization is efficient.*

**Proposition 5** *There exists a range of values of  $L^*/L$  for which both countries gain from trade. This range becomes larger as scale economies become stronger.*

Graham's Ar-  
gument for  
Protection

The only occasion where a country loses from trade is the incompletely specialized (smaller) country in the Graham case. There, the large country produces only manufactures and the small country produces wheat and manufactures. Due to the large country's higher output of manufactures, the small country's manufacturing sector is relatively far less productive.

**Proposition 6** *The large country specializes in manufactures and must gain from trade. The small country gains from trade unless the countries are sufficiently similar in size and the IRS are sufficiently weak.*

External IRS are difficult to handle since they lead to multiple equilibria and can even justify protectionism because gains from trade are no longer guaranteed. However, if two countries are unequal in size and the demand for IRS good is not so strong that one country is completely specialized in IRS good while the other remains diversified, the Graham case is not very likely. IRS need not be dependent only the size of the domestic market. If, for example, the source of the IRS is the division of labor, then its the size of the world market that matters.

## Ethier JIE 1979

IRS at the international level removes the strong tendency toward specialization, removes the ‘arbitrariness’ and leaves a theory about the interdependency of production around the world. The high volumes of trade in intermediate goods and importance of multinational firms seems to suggest that economies of scale do not always fall off substantially with geographic separation.

### Production

Suppose wheat sector has diminishing returns so that the domestic scale of manufactures production (resources employed) is related to domestic wheat production through a typical PPF.

$$m = T(W) \tag{4.19}$$

Suppose the returns to scale in the manufacturing industry depend upon the scale of the world industry, such as if the production of manufactures involves some easily tradeable intermediate goods each of which requires some fixed cost of production.

$$M = km \tag{4.20}$$

As before, each firm takes  $k$  as a given and thus behaves as if it faces a CRS technology Now depends upon the scale of the world industry of manufactures  $m + m^*$ .

$$k \equiv (m + m^*)^{\alpha-1} \tag{4.21}$$

In this scenario, each country’s MRT depends upon the other country’s allocation of resources so a country’s PPF no longer exists, except conditional on the other country’s production.

## Efficient World Production

However, the world PPF is well defined and is constructed by choosing domestic and foreign scale of manufacturing operations to maximize world output

$$\max_{m, m^*} M^W \equiv k(m + m^*) = (m + m^*)^\alpha \longleftrightarrow \max_{m, m^*} m + m^* \quad (4.22)$$

subject to the constraint that world output of wheat must equal some feasible level  $W + W^* = W^W$ . Varying world production of wheat  $W^W$  traces out the world PPF. IRS disappear from the picture of efficient factor allocation! The efficient allocations with internationally decreasing costs are the same as the efficient allocations for constant returns to scale. The world PPF will commonly have both concave and convex portions so IRS does appear in the world PPF.

**Proposition 7** *Internationally increasing returns to scale have no effect on the efficient patterns of specialization.*

Comparative advantage reemerges (and ‘arbitrariness’ disappears) from maximizing world output given that a certain amount of wheat is produced in the world economy. If one country has a lower *MRT* (everywhere) for  $M$  in terms of  $W$ , we should start by producing  $M$  there and then produce it in the other country. Note however that this describes what should happen for production efficiency – no more. In fact, the autarkic relative prices need not indicate comparative advantage – if the larger country has comparative advantage in wheat. However, can show that production efficiency will indeed arise from free trade.

**Proposition 8** *Under free trade, the world pattern of production will be efficient.*

International IRS lead to intraindustry trade quite naturally – both countries trade components. The volume of interindustry trade is the minimum of  $M$  and  $M^*$  – the volume of interindustry trade is the extent that one country’s output of manufactures exceeds the other country’s,  $|M - M^*|$ , and hence net exports of manufactures have to be made up by imports of wheat. The more ex ante identical the countries are, the higher the volume of intraindustry trade in total trade. Ethier (1982) has developed a model which treats trade in intermediate goods in more detail. We turn to this after studying models of product differentiation.