

## Increasing Returns to Scale

# 1 New Trade Theory

According to traditional trade theories (Ricardian, specific factors and HOS models), trade occurs due to existing comparative advantage between countries (technology, factor endowment differences).

Empirical data shows a significant amount of trade occurs between similar countries, countries with similar technology and similar factor endowments.

With little difference to exploit, these countries should have little to gain from trade, yet seem to have prospered from trading 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.

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 does not even exist 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.

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, ask:

1. What failures of the traditional theory motivated construction of this model?
2. Why does trade occur?
3. What is the impact of trade on members of each country, each country as a whole, and the world?
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? Try to spot promising areas for future research.

## 2 IRS

Existing trade theories based on CRS (Ricardian) or DRS (HOS, Specific Factors), so 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 can yield gains by concentrating production all in one country, so that production costs 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.

## 2.1 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 world-wide 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).

## 2.2 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 trade.

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).

## 3 National IRS

### 3.1 Efficiency of Specialization

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.

Autarky equilibrium generally will not persist once trade is possible as both countries producing both goods not stable: if either country increases production of IRS good an  $\varepsilon$ , IRS production will shift toward that country.

If countries are exactly symmetrical (or if the country with the smaller autarkic production of IRS deliberately expands its production), either country could get that head start, so the pattern of trade tends to be indeterminate if the cause of trade is IRS.

## 3.2 Multiple Equilibria

Many different equilibria types possible, plus equilibria have mirror images where countries swap roles.

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.

- 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).

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| <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           |

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NOTE: Country roles can be reversed.

### 3.3 Not Always Gains from Trade

Free trade can be worse for one country than autarky (diversified country in Graham equilibrium, where other country is completely specialized in IRS good).

Not necessarily gains from trade for each country even though overall there are gains from trade.

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) relative to autarky.

Scenario where one country loses from trade is only one of three possible (stable) equilibria in 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.

## 3.4 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 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.

## 3.5 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.

## 4 Ethier *Econometrica* 1982

- Examines 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 same size and IRS are weak.

## 4.1 IRS in a Ricardian Setting

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

$$L_W + L_M = L \quad (1)$$

where  $L_M$  and  $L_W$  are labor allocated to manufacturing and wheat sectors and  $L$  is 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  $L_W$ .

$$W = L_W \quad (2)$$

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

$$M = kL_M \quad (3)$$

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

$$k = L_M^{\alpha-1} \quad (4)$$

Combining yields

$$M = L_M^{\alpha-1} L_M = L_M^\alpha \quad (5)$$

Therefore, average cost of producing a unit of manufactures falls as country makes more manufactures (as more labor is devoted to manufactures). Thus,

PPF bows in as in Figure 4.1. Insert implication of production function for manufactures (5)

$$M = L_M^\alpha \rightarrow L_M = M^{\frac{1}{\alpha}} \quad (6)$$

and production function for wheat (2)

$$W = L_W \rightarrow L_W = W \quad (7)$$

into labor constraint (1)

$$L_W + L_M = L \rightarrow W + M^{\frac{1}{\alpha}} = L \quad (8)$$

to find that PPF is

$$M = (L - W)^\alpha \longleftrightarrow W = L - M^{\frac{1}{\alpha}} \quad (9)$$

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

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

$$P_W = w \quad (10)$$

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

$$P_M = \frac{wL_M}{M} \quad (11)$$

- Thus, using price of wheat (10) and price of manufactures (11), relative price of manufactures in terms of wheat is

$$p \equiv \frac{P_M}{P_W} = \frac{wL_M/M}{w} = \frac{L_M}{M} = \frac{L_M}{L_M^\alpha} = L_M^{1-\alpha} = M^{\frac{1}{\alpha}-1} \quad (12)$$

- From production possibilities frontier (9),  $W + M^{\frac{1}{\alpha}} = L$  implies

$$dW + \frac{1}{\alpha} M^{\frac{1}{\alpha}-1} dM = 0 \quad (13)$$

- Therefore, slope of PPF or MRT equals

$$\frac{dW}{dM} = -\frac{1}{\alpha} M^{\frac{1}{\alpha}-1} = -\frac{M^{\frac{1}{\alpha}}}{\alpha M} = \frac{-L_M}{\alpha M} \quad (14)$$

- From (12), relative price differs from slope of PPF by a factor of  $\alpha$

$$p = \frac{L_M}{M} = -\alpha \frac{dW}{dM} \quad (15)$$

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

$$p = \frac{L_M}{M_o} = \frac{L - L_W}{M_o} = \frac{L - W_o}{M_o} \quad (16)$$

as with line drawn in Figure 4.1.

- From relative price of manufactures (12)

$$p = M^{\frac{1}{\alpha}-1} \quad (17)$$

## 4.2 Autarkic Equilibrium

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

$$\frac{p}{p^*} = \left( \frac{L^*}{L} \right)^{\alpha-1} \quad (18)$$

**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.*

## 4.3 Efficient Patterns of World Output

- Assume two identical countries. Foreign country is the same as home country ( $\alpha = \alpha^*$ ) except that foreign labor supply  $L^*$  need not equal 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 maximum that smaller country can produce, any pattern of specialization is efficient so long as at least one country specializes.
- If world output of manufactures exceeds smaller country's capacity, then efficiency requires that larger country make as much manufactures as possible to reap economies of scale.

- In other words, so long as larger country is making some wheat, efficiency requires that smaller country make no manufactures.
- This prescription is same as in Ricardian model if 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).*

## 4.4 Small Open Economy

- Suppose that have a small country that is so small it can trade at a given relative price of manufactures.
- If world relative price of manufactures exceeds its autarky relative price of manufactures, country will specialize in manufactures; if its autarky price exceeds world price it will specialize in wheat.
- Country will gain from trade in either case: TPF will lie everywhere above PPF as in Figure 4.2.
- Contracting IRS good need not imply losses from trade for a small country.
- Implication that specialization leads to gains from trade is same as in Ricardian model.

- If world price equals autarky price, country will remain incompletely specialized and as in Ricardian model will neither gain nor lose.
- Here any incompletely specialized equilibrium is unstable: if world price changes very slightly, 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.*

## 4.5 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.*

## 4.6 Graham's Argument for Protection

- Only time a country loses from trade is incompletely specialized (smaller) country in Graham case, where larger country produces only manufactures and smaller country produces wheat and manufactures.
- Due to larger country's higher output of manufactures, smaller 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 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 demand for IRS good is not so strong that one country is completely specialized in IRS good while other remains diversified, Graham case is not very likely.
- IRS need not be dependent only size of domestic market. If, for example, source of IRS is division of labor, then its size of world market that matters.

## 5 Ethier JIE 1979

- IRS at international level removes strong tendency toward specialization, removes 'arbitrariness' and leaves a theory about interdependency of production around world.
- 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.

### 5.1 Production

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

$$m = T(W) \quad (19)$$

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

$$M = km \tag{20}$$

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

$$k \equiv (m + m^*)^{\alpha-1} \tag{21}$$

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

## 5.2 Efficient World Production

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

$$\max_{m, m^*} M^W \equiv k(m+m^*) = (m+m^*)^\alpha \longleftrightarrow \max_{m, m^*} m+m^* \quad (22)$$

subject to constraint that world output of wheat must equal some feasible level  $W + W^* = W^W$ .

- Varying world production of wheat  $W^W$  traces out world PPF.
- IRS disappear from picture of efficient factor allocation!
- Efficient allocations with internationally decreasing costs are same as efficient allocations for constant returns to scale.

- World PPF will commonly have both concave and convex portions so IRS does appear in 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 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 other country.
- Note however that this describes what should happen for production efficiency – no more.

- In fact, autarkic relative prices need not indicate comparative advantage – if 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.
- Volume of interindustry trade is minimum of  $M$  and  $M^*$  – volume of interindustry trade is extent that one country's output of manufactures exceeds 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.