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This paper develops a competitive model of trade between three countries with constant cost production and identical utility functions. Trade depends on country size and productivity, and may be limited to two of the countries. Regional trade is observed if they happen to be closer together. The two countries trading only with each other avoid export competition. A country is excluded from trade if it has too little production potential. In the model with three goods, trade is limited to two countries unless each ranks highest in production potential for a unique good.

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Regional Trade in a Purely Competitive Model

The regional trade literature is motivated by various exceptions to pure competition. In contrast, the present purely competitive model develops equilibrium regional trade limited to two of three countries based on their production potential. Each country maximizes identical Cobb-Douglas utility subject to classical constant cost production and balanced trade in international equilibrium. Under some conditions, regional trade occurs between two countries that happen to be closer together.

In the model with two goods, two countries avoid export competition limiting trade to each other. Trade might also exclude a country that is too small or unproductive to trade with the others. A large, productive economy might prefer autarky to global trade.

In the model with three goods, Thompson (2001) identifies possible patterns of global trade. Trade between all three countries occurs only with a 1-1 mapping between countries and goods in a Jones (1961) assignment.

The present purely competitive model follows the classical Torrens-Ricardo-Mill tradition developed by McKenzie (1954), Chipman (1965), and Eaton and Kortum (2012). The literature assumes conditions sufficient for a global equilibrium while the present paper explores outcomes when these sufficient conditions do not hold.

The regional trade literature relaxes perfect competition, beginning with the differential tariffs and resulting trade diversion of Viner (1950). Regional trade is motivated by game theoretic optimal tariffs in Johnson (1953); policy credibility in Staiger and Taellini (1987) and Whalley (1996), Hamilton and Whalley (2000), and Keenan and Riezman (1990); increasing returns in Krugman (1991); insurance against trade wars in Peronni and Whaley (1994); border effects in Engel and Rogers (1996), Helliwell (1998), and Anderson and van Wincoop (2003); various nontraditional issues in Fernández and Portes

(1998); geographic barriers in Eaton and Kortum (2002); and production externalities in Rossi-Hansberg (2005). In contrast, regional trade in the present purely competitive model depends on the geographical distribution of production potentials.

The first section presents the classical constant cost trade model with two countries and two goods. The second section adds a country to allow regional trade between any of the three pairs of countries. The third section presents the model with three goods that allows each country to rank highest in production potential for a unique good. The fourth section generalizes results to models with more goods.

1. Trade in the 2x2 model

The two countries are represented by k = A, B and the two goods by j = 1, 2. Given factor endowments E_k the fixed unit input coefficients a_{jk} imply linear production frontiers $E_k = \Sigma_j a_{jk}x_{jk}$ where x_{jk} is the output of good j. Complete specialization occurs at E_k/a_{jk}.

In autarky each country maximizes utility subject to its production frontier with consumption c_{jk} constrained to equal output $x_{jk.}$ Assume the Cobb-Douglas utility function $u_k = c_{1k}c_{2k}$ implying marginal utilities $u_{1k} = c_{2k}$ and $u_{2k} = c_{1k}$. The autarky relative price of good 1 in country k is a_{1k}/a_{2k}. The first order condition for utility maximization in autarky equates relative price to the marginal rate of substitution, $a_{1k}/a_{2Ak} = u_{1k}/u_{2k} = c_{2k}/c_{1k}$ implying equal consumption shares $a_{1k}c_{1k} = a_{2k}c_{2k}$. Half the input is employed producing each good, $E_k/2a_{jk} = c_{jk} = x_{jk}$.

Figure 1 pictures production frontiers and utility maximization in autarky at points U_A and U_B. Assume country A has the lower relative autarky price of good 1,

$$a_{1B}/a_{2B} > a_{1A}/a_{2A}. \qquad (1)$$

With trade, the terms of trade as the relative price of good 1 is $p \equiv p_1/p_2$. The price of each good is determined where produced, $p_1 = a_{1A}w_A$ and $p_2 = a_{2B}w_B$ where w_k is the input price. Consumption with trade is limited to specialized production,

$$c_{1A} + c_{1B} = E_A/a_{1A} \qquad (2)$$
$$c_{2A} + c_{2B} = E_B/a_{2B}.$$

*Figure 1 *

Trade is balanced with export revenue equal to import spending in each country, $(E_A/a_{1A}) - c_{1A} = c_{2A}/p$ and $(E_B/a_{2B}) - c_{2B} = pc_{1B}$, implying

$$p = c_{2A}/c_{1B}. \qquad (3)$$

Each country consumes the same amount of each good $c_{jA} = c_{jB}$ equal to ½ the specialized output.

Equilibrium consumption levels with trade are pictured as T_A and T_B in Figure 1. Trade increases consumption of the import while consumption of the exported good remains at the autarky level. A smaller country would have better terms of trade, the small country theorem.

The terms of trade depend on endowments and export productivities. Substitute for p in (2) and (3) to obtain

$$p = a_{1A}E_B/a_{2B}E_A. \qquad (4)$$

The necessary conditions for trade are that the other country exports more than consumed in autarky. Trade requires production potentials ranked according to

$$A_1 > B_1 \qquad (5)$$
$$B_2 > A_2,$$

where $A_j \equiv E_A/a_{jA}$ and $B_j \equiv E_B/a_{jB}$. With trade, half of the specialized outputs are exported. The size and productivity restrictions in (5) imply the weaker comparative advantage in (1). Comparative advantage only predicts the direction of trade, not whether it occurs.

For specialization and trade, the terms of trade p must be flanked by relative autarky prices in (1) according to

$$a_{1B}/a_{2B} > p > a_{1A}/a_{2A} \quad (6)$$

From (4) and (6) relative country size must be flanked by relative inputs,

$$a_{1B}/a_{1A} > E_B/E_A > a_{2B}/a_{2A.} \quad (7)$$

These restrictions on size and productivity are critical conditions for trade.

2. Trade in the 2x3 model

The third country allows global trade between all three countries or trade limited to pairs of countries. Country C has the same structure as the other two with constant cost production $E_C = \Sigma_j a_{jC} x_{jC}$ and the identical utility function. Autarky production x_{jC} and consumption c_{jC} both equal $E_C/2a_{jC} = ½C_j$.

Expanding (1) assume country C has the comparative advantage in good 2 with country B in the middle,

$$a_{1C}/a_{2C} > a_{1B}/a_{2B} > a_{1A}/a_{2A}. \quad (8)$$

The limits to the terms of trade are set according to $a_{1C}/a_{2C} > p > a_{1A}/a_{2A}$. Country A would export good 1, and country C good 2. Middle country B could export either good.

Conditions necessary for trade extend (5) to the third country. Assume a mirror image ranking,

$$A_1 > B_1 > C_1 \quad (9)$$
$$C_2 > B_2 > A_2.$$

Restrictions on relative sizes and productivities implied by (9) are

$$a_{1B}/a_{1A} > E_B/E_A > a_{2B}/a_{2A}$$
$$a_{1C}/a_{1B} > E_C/E_B > a_{2C}/a_{2B} \quad (10)$$
$$a_{1C}/a_{1A} > E_C/E_A > a_{2C}/a_{2A}.$$

These restrictions are stronger and imply comparative advantage in (8).

There are 35 other rankings leading to various trade outcomes. For instance $A_2 > C_2 > B_2$ replacing the second condition in (9) implies country A is too large or productive to trade with the other two. There are 6 such rankings that result in trade between the two smaller countries. Assuming instead $B_2 > A_2 > C_2$ as the second condition in (9) country C would be isolated from trade because it is too small or unproductive. There are also 6 such rankings with trade excluding the small or unproductive economy. In these situations if countries with similar production potentials are located closer together, there is regional trade.

Given (9) country A exports and consumes $a_1 \equiv ½A_1$ while country C exports and consumes $c_2 \equiv ½C_2$. Country B exporting good 1 would compete with country A for C_2 earning its share $s_{B1} \equiv B_1/(A_1+B_1)$ of the export market for good 1. Country B would consume $b_1 \equiv ½B_1$ with utility $u_{B1} = b_1 s_{B1} c_2$. Its utility exporting good 2 would be $u_{B2} = s_{B2} a_1 b_2$ where $b_2 \equiv ½B_2$ and $s_{B2} \equiv B_2/(B_2 + C_2)$. Assume $u_{B1} > u_{B2}$ with country B exporting good 1.

The results of autarky K, global trade G, and the three versions of regional trade R_{kh} between countries k and h are in Table 1. Utility is the product of consumptions of the two goods. Country C ranks trade regimes according to $G > R_{AC} > R_{BC} > K = R_{AB}$. The terms of trade for C are best in G with the other two countries exporting good 1.

* Table 1 *

Country A ranks $R_{AC} >$ G consuming c_2 in R_{AC} but only its share $s_{A1} = 1 - s_{B1}$ in G. Country A also ranks $R_{AC} > R_{AB} > K = R_{BC}$.

Country B would export good 1 to country C in R_{BC} ranked ahead of autarky, $R_{BC} > K$. Country B also ranks R_{BC} ahead of G as it avoids competing in the good 1 export market. Its ranking of G and K are ambiguous. While countries A and B both prefer trading with only C, it prefers global trade.

Figure 2 pictures trade regimes where $A_1 = 20$, $B_1 = 16$, $C_1 = 2$, $A_2 = 2$, $B_2 = 14$, and $C_2 = 30$. Country C ranks $R_{AC} > R_{BC}$. Country B ranks K > G in ruling out global trade. Countries A and C enter R_{AC} excluding B.

* Figure 2 *

Trade limited to two countries cannot be ruled out. If the two countries happen to be located closer together, the result is regional trade. Adding a third good to the model leads to the possibility that two of the countries benefit more from regional trade than global trade.

3. Trade in the 3x3 model

The third good allows each country to have a unique export advantage in its own good relative to both other countries and both other goods. Utility maximization in autarky implies producing and consuming ⅓ of each output $a_h \equiv \frac{1}{3}A_h$ for h = 1, 2, 3 with similar results for b_h and c_h. Each country can export ⅓ of its output of up to two goods in exchange for ⅓ of the outputs of the other goods.

The direction, level, and gains from trade extend global production conditions (9) to the third good. Assume each country has a unique export advantage in a symmetric Jones (1961) assignment

$$\begin{aligned} A_1 &> B_1 > C_1 \\ B_2 &> C_2 > A_2 \\ C_3 &> A_3 > B_3. \end{aligned} \qquad (11)$$

Country A exports good 1, country B good 2, and country C good 3. The optimized utility of each country with global trade is $a_1b_2c_3$ as illustrated in Figure 3a where each country enjoys the dashed terms of trade surface beyond its production frontier.

* Figure 3 *

There are numerous other outcomes in the $6^3 = 216$ production potentials. In 48 of these, each country ranks first for its own good similar to (11). The result is unique specialization and trade for this

22% of possible production conditions. This subset of production possibilities provides the intuition in trade theory.

In another 24 or 11% of the production possibilities, the same country ranks first for every good implying it is too large or productive to trade. Trade may occur for two goods between the two smaller or less productive countries that would prefer global trade.

In another 24 of the production possibilities, one country ranks lowest for all goods making it too small or too unproductive to trade. In Figure 3b country B is too small resulting in R_{AC} with the dashed terms of trade line between goods 1 and 3.

Trade that excludes countries that are too small and unproductive, or too large and productive, may be a common cause of observed regional trade. Groups of similarly productive countries trade with each other. If they happen to be located closer together, regional trade is observed.

The other possibility is that a country does not rank highest for any good, accounting for a majority of the production possibilities. Regional trade may then maximize utility for it and the country ranking highest in the other good. For instance, if

$$\begin{aligned} &A_1 > B_1 > C_1 \\ &A_2 > C_2 > B_2 \\ &C_3 > B_3 > A_3, \end{aligned} \tag{12}$$

then R_{AC} maximizes utility for A and C. Table 2 reports outcomes for (12) assuming country A exports good 1 given $A_1 > A_2$.

* Table 2 *

The trade regime rankings for country A are $R_{AC} > G$ and $R_{AC} > R_{AB} > R_{BC} = K$. Rankings for country C are similar, $R_{AC} > G$ and $R_{AC} > R_{BC} > R_{AB} = K$. Rankings for country B are $G > R_{BC}$ and $R_{AB} > R_{AC} = K$. Country B is isolated by R_{AC} as shown in Figure 3c as A and C share the dashed terms of trade line

between goods 1 and 3. Similar isolation of unproductive economies may describe the trading situation of many countries in the world.

4. Trade with more goods and countries

The result that countries may prefer less than global trade generalizes to any number of goods. With an equal number of countries and goods, each country could rank highest in a Jones (1965) assignment. If some countries do not rank highest for any good they are excluded from trade as.

In the Graham model with more countries than goods, global trade cannot be optimal for all countries. Trade between a subset of countries cannot be ruled out.

With more goods than countries, trade excluding some countries may lead to higher gains for the trading countries. Consider the 4x3 model adding good 4 to (11),

$$\begin{aligned} &A_1 > B_1 > C_1 \\ &B_2 > C_2 > A_2 \\ &C_3 > A_3 > B_3 \\ &A_4 > B_4 > C_4. \end{aligned} \tag{13}$$

Each country ranks highest for at least one good, and country A for two goods. Assume $A_1 > A_4$ implying country A exports good 1. Results are reported in Table 3 where the countries consume ¼ of their exports, $a_h \equiv ¼A_h$ and so on.

* Table 3 *

Country A prefers global trade G in its ranking $G > R_{AC}$, $R_{AB} > K = R_{BC}$. In R_{AC} countries A and C trade all four goods. In R_{AB} countries A and B trade goods 1 and 2. The condition for country A to rank R_{AC} ahead of R_{AB} is $C_3/A_3 > B_2/C_2$. Country B would prefer regional trade with A, $R_{AB} > G > R_{BC} > K = R_{AC.}$ Country C ranks $G > R_{BC} > K = R_{AB}$ but $R_{AC} > G$ if $B_2/C_2 < A_4/C_4$. If C prefers R_{AC} then it would not trade with B. If country A also prefers R_{AC} over R_{AB} then trade isolates country B.

This principle that a subset of countries may prefer trade only among themselves extends to the continuum of goods in Dornbusch, Fischer, and Samuelson (1977) widening the present motivation for regional trade. The clustering of countries with similar production potentials results in regional trade, a testable hypothesis.

5. Conclusion

The present competitive trade model offers an alternative motivation for regional trade. Trade is limited to a subset of countries when conditions sufficient for a global equilibrium are relaxed. Production potentials determine specialization and trade with regional trade depending on the geographical distribution of production potentials. Countries can avoid global competition in their export markets with limited trade partners. Regional trade may also exclude smaller less productive countries.

Market imperfections or frictions are the cause of regional trade in the literature. Policy is then motivated to ease the market imperfections in this second best world. In the present first best competitive model, policy attention turns to stimulating production potential.

Results would be similar in a model with neoclassical production and concave production frontiers. Related factor proportions or specific factors models would examine the income redistribution due to regional trade. Differences in utility functions between countries can also be the source of regional trade. Simulations with countries growing or improving productivity would provide insight into how regional trade patterns evolve.

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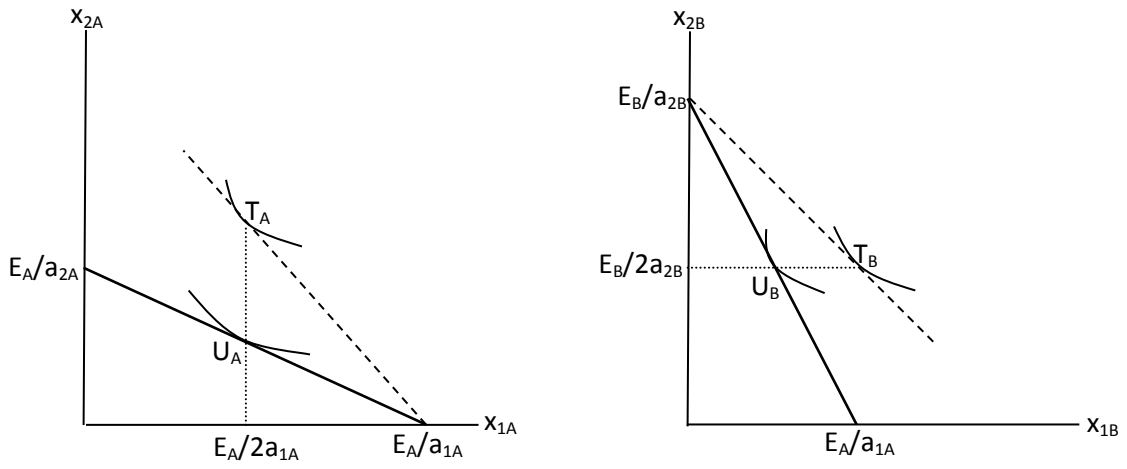


Figure 1. Specialization in the 2x2 Model

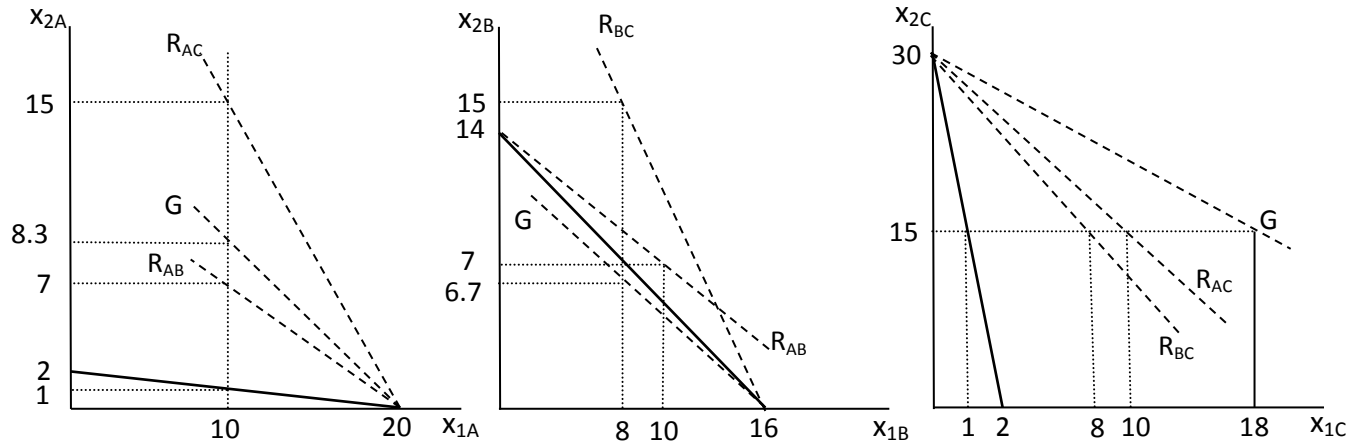
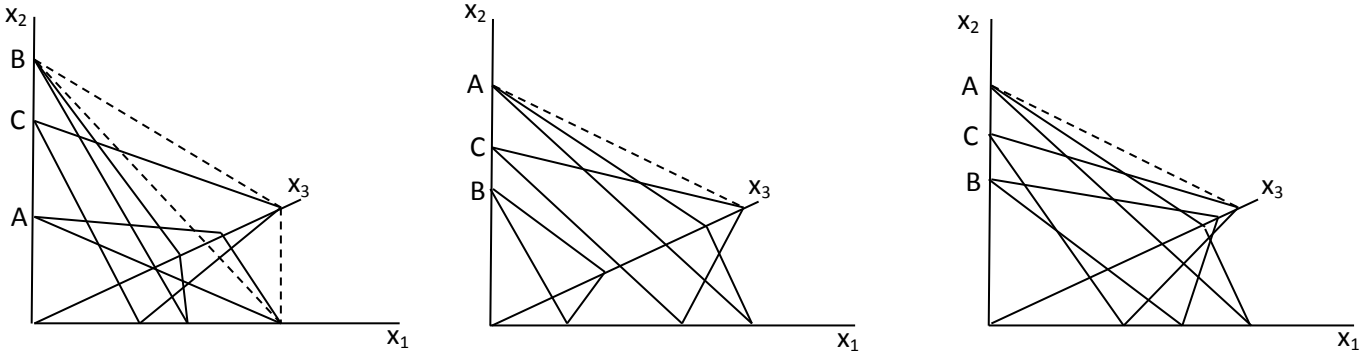


Figure 2. Specialization in the 2x3 Model (9)



3a. Global trade in (11) *3b. Small unproductive B* *3c. R_{AC} in (12)*

Figure 3. Specializations in the 3x3 Model

Table 1. Consumption with 2 Goods in (9)

	A		B		C	
	1	**2**	**1**	**2**	**1**	**2**
K	a_1	a_2	b_1	b_2	c_1	c_2
$\mathbf{R_{AB}}$	a_1	b_2	a_1	b_2	c_1	c_2
$\mathbf{R_{AC}}$	a_1	c_2	b_1	b_2	a_1	c_2
$\mathbf{R_{BC}}$	a_1	a_2	b_1	c_2	b_1	c_2
G	a_1	$s_{A1}c_2$	b_1	$s_{B1}c_2$	a_1+b_1	c_2

Table 2. The 3x3 model in (12)

	A			B			C		
	1	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
K	a_1	a_2	a_3	b_1	b_2	b_3	c_1	c_2	c_3
$\mathbf{R_{AB}}$	a_1	a_2	b_3	a_1	b_2	b_3	c_1	c_2	c_3
$\mathbf{R_{AC}}$	a_1	a_2	c_3	b_1	b_2	b_3	a_1	c_2	c_3
$\mathbf{R_{BC}}$	a_1	a_2	a_3	b_1	b_2	c_3	b_1	c_2	c_3
G	a_1	b_2	c_3	a_1	b_2	c_3	a_1	b_2	c_3

Table 3. The 4x3 model in (13)

	A				B				C			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
K	a_1	a_2	a_3	a_4	b_1	b_2	b_3	b_4	c_1	c_2	c_3	c_4
$\mathbf{R_{AB}}$	a_1	b_2	a_3	a_4	a_1	b_2	b_3	b_4	c_1	c_2	c_3	c_4
$\mathbf{R_{AC}}$	a_1	c_2	c_3	a_4	b_1	b_2	b_3	b_4	a_1	c_2	c_3	a_4
$\mathbf{R_{BC}}$	a_1	a_2	a_3	a_4	b_1	b_2	c_3	b_4	c_1	b_2	c_3	c_4
G	a_1	b_2	c_3	a_4	a_1	b_2	c_3	b_4	a_1	b_2	c_3	c_4