

## **The Growth and Development of Nations in the Global Economy**

### **Problem Set 1: Trade in a North-South Model**

*Due 24 September*

---

This problem set puts forward a “North-South” trade and growth model that allows interactive exploration of the conventional comparative advantage-based theory of trade. It highlights three specific implications of this model:

1. Both North and South can benefit from free trade.
2. Growth in the world economy is characterized by a pattern of convergence in which the South grows faster than the North such that Southern income levels eventually catch-up with those of the North.
3. Decentralized market regulation of the economy not only sees to it that trade is mutually beneficial, and that growth is convergent, but that it also generates an economic outcome which cannot be improved upon (in a well defined way) given the real structural constraints of technology and resources. Put differently, this third implication is that any non-market regulation of the economy is at best superfluous, and at worst destructive.

1. The simulation model you will analyze below assumes a world of two countries—the North which is assumed to have a relatively abundant supply of physical capital; and the South which has a relatively abundant supply of labor. Both economies can produce a manufactured good (computers, whose production is relatively capital-intensive) and an agricultural good, (bananas, whose production is relatively labor-intensive). Both countries have access to the same technologies which are define as follows:

$$X_a = L_a^{(1-\alpha)} K_a^\alpha ; \text{ and,}$$

$$X_m = L_m^{(1-\beta)} K_m^\beta .$$

where  $X_a$  is the quantity produced of the agricultural good which can be physically produced from inputs of labor ( $L_a$ ) and capital ( $K_a$ ). Symmetric definitions apply to the manufacturing sector where  $X_m$  is the quantity of computer output, and  $L_m$ , and  $K_m$  are the production inputs. The symbols  $\alpha$  and  $\beta$  simply represent the parameters of the technology and it is assumed that  $\beta > \alpha$  (i.e., the manufactured good is more capital-intensive than the agricultural good). The simulation assumes that  $\beta=0.8$  and that  $\alpha=0.2$ . Please use these same assumptions in answering this question.

- a. Consistent with the simulation model assume that North and South have the following initial endowments of productive factors:

	North	South
<i>Initial Labor Endowment</i>	25	30
<i>Initial Capital Endowment</i>	40	10
<i>Capital-Labor ratio</i>	40/25=1.60	10/30=0.33

Suppose that the North devoted all of its labor and capital to the production of computers. How many computers could it produce in total? How many bananas could it produce if it only produced bananas? What is the ratio of maximal computer to maximal banana production in the North?

If the North devoted all of it resources to producing computers, then the number of computers manufactured would be:

$$X_m = 25^{.2} (40^{.8}) = 36.41 \text{ computers}$$

If the North only produced bananas, then the number of bananas produced would be:

$$X_a = 25^{.8} (40^{.2}) = 27.46 \text{ bananas}$$

The ratio of maximal computer to maximal banana production in the North is equal to:

$$36.41/27.46 = 4 \text{ computer} / 3 \text{ bananas} = 1.33 \text{ computers} / 1 \text{ banana}$$

- b. What is the ratio of maximal computer to maximal banana production in the South?

$$X_m = 30^{-.2} (10^{.8}) = 12.46 \text{ computers}$$

$$X_a = 30^{.8} (10^{-.2}) = 24.1 \text{ bananas}$$

$$12.46/24.1 = .52 \text{ computers} / 1 \text{ banana} = \text{approx. } 1 \text{ computer} / 2 \text{ bananas}$$

- c. Why are the two ratios that you calculated in parts (a) and (b) different? Explain why the North have a comparative advantage in computers, and why the South has a comparative advantage in bananas.

*The two ratios are different because the two countries have different factor endowments. The North has a much higher Capital- Labor ratio and therefore has a comparative advantage in the production of capital-intensive computers. This means that it must give up fewer units of bananas per unit of computers it produces. In contrast, the South has a much smaller Capital-labor ratio and therefore has a comparative advantage in the production of labor-intensive bananas. This advantage means that the South must forgo fewer computers in order to produce bananas.*

- d. Now let's approximate the marginal productivity of capital in both economies when they engage in maximal computer production. To do this, calculate how many *additional* computers the north can maximally produce if we give them one more unit of capital (so that they are producing computers with 25 units of labor and 41 units of capital). Calculate the same thing for the South (when they are given one extra unit of capital for a total of 11 units).

*North:*

$$X_{m0} = 25^{-.2} (40^{.8}) = 36.41 \text{ computers}$$

$$X_{m1} = 25^{-.2} (41^{.8}) = 37.14 \text{ computers}$$

$$37.14 - 36.41 = .73 \text{ computers more}$$

*South:*

$$X_{m0} = 30^{-.2} (10^{.8}) = 12.46 \text{ computers}$$

$$X_{m1} = 30^{-.2} (11^{.8}) = 13.44 \text{ computers}$$

$$13.44 - 12.46 = .98 \text{ computers more}$$

- e. What do you think this difference in the marginal productivity of additional

capital means for the ability of South to converge with North?

*The difference in the marginal productivity of additional capital between the North and the South suggests that the South's ability to converge with the North in the future will depend on its ability to acquire capital. As shown above, for each additional unit of capital given to both countries the South gains more. This result suggests that growth in capital in both countries will slowly even out the economic levels of the two countries.*

## 2. Autarchy and Differential Scarcity in North and South

To begin the problem, start the Gauss program and then enter **the following command into the Gauss command window:**

**run autarchy.prg.gcg <<enter>>**

- a. As you run the **autarchy.prg.gcg** program, you will be asked a few simple questions and be given the opportunity to record output from the computer program. You will need to take down information from the graphs that are shown, as well as record information from the autarchy equilibrium tables that are produced. You should fill in the following three tables prior to exiting the program. There are some additional questions for you to answer concerning the output you get from following the tables.

**Table 1a: Economic Scarcity in the South**

Initial Level of Computer Production which you choose	Number of Units of Bananas given up when four more computers are produced	Relative Price of Computers (Number of bananas given up per computer at this margin of computer production) < You have to calculate this yourself!>
0	4	$4/4 = 1$ banana
2	5	$5/4 = 1.25$ bananas
4	6	$6/4 = 1.5$ bananas
8	12	$12/4 = 3$ bananas

**Table 1b: Economic Scarcity in the North**

Initial Level of Computer Production which you choose	Number of Units of Bananas given up when four more computers are produced	Relative Price of Computers (Number of bananas given up per computer at this margin of computer production) < You have to calculate this yourself!>
4	1.5	$1.5/4 = .375$ bananas
16	2.5	$2.5/4 = .625$ bananas
24	4	$4/4 = 1$ banana
32	6	$6/4 = 1.5$ bananas

b.

**Table 2: Autarchy Equilibrium**

	Production		Consumption		Equilibrium Prices				Income		Consumer Utility
	Ban	Comp.	Ban.	Comp.	Ban	Comp	Lab.	Cap.	Total	Per-Capita	
South	14.6	7.55	14.6	7.55	1	1.933	.4867	1.46	29.2	.973	10.50
North	16.65	22.075	16.65	22.075	1	.754	.666	.416	33.3	1.33	19.173

c. Prices:

1. In what sense are the numbers you calculated for the third column of Tables 1a and 1b real economic or scarcity prices?

*The numbers I calculated in the third column of tables 1a and 1b are real economic prices in the sense that they reflect the amount of bananas that must be given up in order to produce an additional computer. Because the two countries must decide between producing computers or producing bananas, the price of each computer is essentially the number of bananas that were not produced in order to devote resources to the production of computers.*

2. Focusing on the numbers for the south, what happens to the relative price of computers as the level of computer production increases?

*In the south, the relative price of computers increases as the level of computer production increases.*

3. Intuitively, explain why this happens?

*The relative price of computer production increases in because the South is unable to use the two factors of production effectively. This is probably because the south is relatively abundant in labor and relatively depleted in terms of capital thus in an attempt to increase computer production the south would devote a large amount of labor, but small amount of capital to producing computers. The problem is that relatively quickly the South's labor engaged in computer production will outstrip its capital's capacity. After such an event occurs the marginal returns to dedicating more labor to computer production will fall because that labor has increasingly limited access to the capital necessary for computer production. Because the South must take an increasingly large amount of labor from banana production in order to gain additional computers, the cost of those computers also increases as each computer cause a larger drop in banana production.*

d. Comparing Prices:

1. How do relative prices for computers compare between North and South?

*The relative price of computers is much smaller in the North (.754 bananas), than in the South (1.933 bananas).*

2. Why are these prices different at the same level of production?

*The price of computers in the North and the South would be different even at the same level of production because the two countries have different capital to labor ratios. Because computers are most effectively produced using a large amount of capital, the South (which has relatively little capital) must compensate by using a much larger amount of labor than would be necessary in the North (where capital is abundant). This means that the South would have to divert a much larger portion of its labor away from banana production than the North would, thus creating a higher price of computer in terms of bananas even at the same production level.*

3. Assuming identical consumer preferences between North and South (as in this model), what would you expect production patterns between the two countries to look like in autarchy in terms of the relative and absolute numbers of computers produced and consumed (given that the North is relatively well endowed with capital as assumed here)?

*Given the assumptions that the North is relatively well endowed with capital and that the North and South have identical preferences, I would expect that the autarchic production and consumption of the North in absolute terms would be larger than that of the south for both computers and bananas. This is due to the fact that the two countries have relatively similar amounts of labor (25 in the North vs. 30 in the South), but vastly different amounts of capital (40 in the North vs. 10 in the South). This imbalance of capital means*

*that the North could out produce the south in computers while leaving most of its labor force free to also out produce the south in bananas. In relative terms I would expect each country in autarchy to produce and consume amounts of the two goods in a way that reflects the ratio of the price of bananas to the price of computers. With this in mind I would predict that the South would produce roughly twice as many bananas as computers because computers cost about twice as much. In a similar pattern I would expect the North to produce and consume about four computers for every three bananas because each computer is worth roughly three-fourths of a banana*

e. Production and Prices:

1. Do the autarchy equilibrium production patterns bear out your expectations?

*The autarchy production patterns do bear out my expectations. The North does, in fact, produce and consume more computers and bananas in absolute terms, while the two countries each seem to produce in a manner that echoes the ratio of prices for the two goods. The north does consume about 4 computers for every three bananas ( $22.075/16.65 = \text{approx. } 1.33$ ), and the south does appear to consume about 1 computer for every two bananas ( $14.6/7.55 = \text{approx. } 1.934$ ).*

2. How do the equilibrium prices for computers compare to the relative prices you calculated earlier for the two economies?

*The equilibrium prices for the two economies fall within the range of the relative prices that I calculated in tables a and b. The prices are substantially lower than when the economies dedicate all of their resources to computer production, yet they are still above when either country is specializing in banana production.*

3. Why aren't more computers produced and consumed in the south given that southern consumers have the same love of computers as northerners?

*More computer are not produced in the South because they are just too costly in terms of the utility people have to give up to produce them. Because of the low ratio of capital to labor in the South people have to give up many bananas in order to produce more computers. Thus, in spite of the identical preferences for computers of people in the North and the South, the southern population chooses to substitute banana production for computer production. This activity allows them to achieve a greater overall utility given their allotment of resources.*

f. Consumers:

1. If you were a southern consumer, would you be interested in access to the international market?

*A southern consumer would be interested in gaining access to the international market because of the relatively low prices of computers. These lower prices would cause the*

*domestic price of computers to fall within the South allowing consumers to achieve higher utility levels with the same amount of income.*

2. Why or why not?

*See above*

3. If you were a southern worker, would trade liberalization appear promising?

*Trade liberalization would appear promising to the southern worker because following liberalization there would be a push for the South to specialize in the production of labor-intensive bananas due to its relative abundance of labor and resulting comparative advantage. The transition to a type of production that uses a greater amount of labor would cause labor to become increasingly scarce, which in turn would cause wages to rise. The promise of increased wages would make trade liberalization appealing to a southern worker.*

4. What if you were a southern capitalist (the owner of capital)?

*For a southern capitalist trade liberalization would not be appealing at all because it would cause the South to shift away from the production of capital-intensive computers. This would cause the demand for capital and rents received by capitalists to fall, damaging the profits of those capitalists.*

### **3. Static Gains from Trade**

In simplest terms, trade between economies allows two things to happen. First, it loosens the linkage between domestic consumption patterns and domestic production patterns—*i.e.*, consumers do not have to consume exactly what domestic producers turn out. In more lyrical language, it permits consumers to shop for bargains.

The second impact of trade is that it also loosens the linkage between producers and the domestic market—*i.e.*, it also permits producers to search for markets where prices are better.

Trade does not completely eliminate those linkages however, since consumer income is linked to production outcomes and balanced trade requirements (simply imposed in this model as there is no external finance to cover trade deficits) link production and consumption choices. This problem analyzes what happens as the two autarchic economies studied in the previous section open up to international trade.

#### *a. Trading from the autarchic production pattern*

This first part of the problem studies what happens when Southern producers do not adjust their production patterns to international trading opportunities, but Southern

consumers are allowed to buy foreign goods at a set of given world prices (those in the North). You get to do the shopping for Southern Consumers (!) by deciding how many computers you would like to buy. The computer will automatically adjust to your choices by making sure that enough Southern Products are exported so that you have the income (and foreign exchange) needed to pay for your computer shopping.

To begin the problem (assuming you are already in Gauss, as explained in question 1) simply enter:

**run shop.prg.gcg <enter>**

Fill in the following blanks:

**Table 3: Autarchic Production Patterns for the South:**

Computers: 7.55  
Bananas: 14.60

World Prices:  
Bananas: 1  
Computers: 1.933

Computer Consumption <Your choice>	Exports < Implied by production patterns and trade balance >	Imports < Implied by production patterns and trade balance >	Banana Consumption	Consumer Utility
4	3.55 computers	3.76 bananas	18.36	8.57
7	.55 computers	.59 bananas	15.19	10.31
11	3.65 bananas	3.45 computers	10.95	10.98
16	8.94 bananas	8.45 computers	5.66	9.51
21	14.24 bananas	13.45 computers	.36	2.76

*b. Free Trade Equilibrium*

Now suppose that producers also adjust their production patterns to the new international prices. A general equilibrium concept is used to determine the production and consumption patterns for the world economy, except this time there is a only a single set of product prices (common to both countries) which simultaneously clears all markets in

all countries (general equilibrium means that all prices adjust to the point where neither producers nor consumers desire to change their production and consumption decisions given those prices). To explore the impact of this complete liberalization, run the following program and fill in the blanks:

**run free.prg.gcg <enter>**

**Table 4: Free Trade Equilibrium**

	<i>South</i>	<i>North</i>
<i>Equilibrium Prices</i>		
Bananas	1.00	1.00
Computers	1.06	1.06
Labor	.59	.59
Capital	.65	.65
<i>Bananas</i>		
Production	21.61	11.10
Exports	9.42	0
Imports	0	9.42
Consumption	12.19	20.52
<i>Computers</i>		
Production	2.62	28.28
Exports	0	8.89
Imports	8.89	0
Consumption	11.52	19.38
<i>Consumer Utility</i>	11.85	19.94

c. *Analysis:*

1. What are the most striking changes in the free trade versus the autarchy equilibria you examined in question 1 above?

*One of the most striking changes between free trade and the autarchy we examined earlier is the dramatic drop in the price of computers in the South (from 1.933 to 1.06). In addition there is a sizeable increase in the overall consumer utility of the south from 10.50 in autarchy to 11.85 under free trade. Finally it is important to note that both countries have specialized to quite a large extent under free trade. The North is producing substantially*

more computers and fewer bananas while the South is producing almost exclusively bananas and very few computers.

2. What results most surprised you?

*The most surprising result for me was how little the North improved in terms of utility relative to the South. The South's utility jumped nearly 10 percent while the North gained just over 2.5 percent. This result suggests that free trade could be vehicle for North-South convergence.*

3. Are the gains from free trading "large"?

*The results shown above suggest that the gains from trade can be rather large. Granted, they are not going to instantaneously double a country's possible utility, but a ten percent gain in the utility achieved, as seen in the case of the south, is a significant gain considering he south did not have to expand either its labor or capital supply.*

d. *Pareto Optimality of Free Trade Equilibrium*

**Table 5: Plan versus Market in the South**

Southern Consumer Utility under Autarchy: 10.50 <from above>  
 Southern Consumer Utility under Free Trade: 11.85 <from above>

Computer Production <Your choice>	Implied Banana Production	Computer Consumption <Your choice>	Implied Banana Consumption	Consumer Utility
7.26	15.16	5.00	17.55	9.37
7.26	15.16	11.00	11.20	11.10
7.61	14.48	11.00	10.90	10.95
8.81	11.92	10.00	10.66	10.33
10.16	8.36	15.00	3.23	6.96

e. *Results:*

1. Were you as central planner able to beat the market?

*As a central planner I was never able to beat the utility achieved through the free trade*

*market.*

2. Are you a free trader now (explain your answer)?

*Although I acknowledge that free trade is certainly the best way to achieve maximum efficiency for an economy, I am not necessarily a free trader because there is often a difference between what is efficient and what is equitable. While free trade might produce the largest gains for the economy as a whole, it can also be damaging to large portions of the population by benefiting a select few at the cost of the vast majority. In addition free trade can run into potential problems of feasibility. For example, a powerful manufacturing lobby or labor union might alter a country's trade policy (for better or for worse). Similarly, free trade might not always be possible as a country might hesitate to totally relinquish its domestic production of strategically important goods (such as planes or cars) and thus leave itself at the mercy of other nations during times of instability or crisis.*