Final Exam -*Answers*
December 20, 2001

Answer all questions. Write your answers in a blue book.

Be sure to look ahead and budget your time. Don't waste time on parts of questions that you can't answer. Leave space and come back to them if you have time.

1. Suppose that a country were to discover an easy and costless fix for its educational system that would make all of its people, say, 10% more productive than they were before. That is, in any production relationship, any given output can be produced with 10% less labor than was needed before. Examine the implications of this change for the country's

   i) production,

   ii) trade,

   iii) real factor prices, and

   iv) overall level of economic well-being,

   in each of the following contexts. Assume in each case that the improvement in productivity occurs in only the one country, and assume also that preferences across industries are homothetic. **Do not** take the time to demonstrate the truth of your answers. Although you are welcome to scribble some diagrams to help you see what is happening, I will grade only the results that you state.

   (a) A Ricardian 2-good model of a small open economy, completely specialized under free and frictionless trade.

   This changes (reduces) labor requirements in the same proportion in both sectors, thus leaving relative labor requirements and comparative advantage unchanged. The country will continue to specialize in and export the same good as before, simply producing and exporting (10%) more of it. The real wage and per capita income will both rise by 10%.

   (b) Same as (a), but the country is large.

   Now the increased exports will cause the world price of the country's export good to fall. Unless it falls enough to permit the country to produce the other good as well, the country's production of the good will still rise, as will its export of it unless the fallen price stimulates its demand for the export good by even more than 10%, which is unlikely since the income effect acts against this. The deteriorated terms of trade offsets part – or conceivably all – of the improvement in real wage and real per capita income.

(c) The Dornbusch-Fischer-Samuelson continuum of goods model with free trade.

The relative unit labor requirements for this country compared to the other fall by 10% for all goods, expanding the range of goods for which it is competitive. It will produce somewhat more of all the goods that it previously produced, simply to meet the increased world demand that arises because of its own higher income and the reduced relative prices of these goods. More importantly, it will move into the production of a range of goods that were previously produced only by the other country, which will now cease producing those goods, and it will export them as well. The real wage of labor in this country will rise, although by less than 10%, and its real per capita income will also rise.

(d) Heckscher-Ohlin 2-good model of a small open economy that produces both goods but exports the labor-intensive good, under free and frictionless trade.

Except for per capita amounts, this is identical to a 10% increase in the endowment of (effective) labor of the country. With the fixed prices of a small open economy, the effects are therefore those of Rybczynski: output of the labor-intensive good expands, that of the capital-intensive good contracts, and the country both exports and imports more. Due to factor price equalization, however, the real wage per unit of effective labor does not change, and the real wage of actual labor therefore rises by 10%, the real return to the other factor remaining unchanged. Real per capita income therefore rises.

(e) Same as (d), but the country has a (non-prohibitive) tariff.

World prices remain unchanged because the country is small, and domestic prices, though different from world prices, therefore also remain unchanged with a constant tariff. The results for output, trade, and real factor prices are therefore the same as in (d). With additional trade, however, the country's government will collect more tariff revenue, the expenditure of which will add even more to overall national income.

(f) Specific factors model (with labor mobile between sectors and other factors specific) of a small open economy under free and frictionless trade.

The marginal product of labor rises by 10% in both sectors, for all levels of labor input, leaving the equilibrium allocation of labor between the sectors unchanged and raising the equilibrium wage and other factor prices also by 10%. Both supplies and demands of both goods expand by 10%, increasing both exports and imports by that amount as well. Per capita income rises by 10%.

(g) Krugman (1980) one-sector differentiated products model of two initially identical countries trading freely.

Again, one can think of the country as having an unchanged technology but 10% more effective labor than before (per person). In the Krugman (1980) model, individual firms continue to employ the same amount of (effective) labor and produce the same output, responding to the increased effective labor supply by the entry of more identical firms. Thus the country expands its number of firms, varieties, and income by 10%, producing the same amount of each as before but selling somewhat more at home (due to the increased income) and less abroad. On the other hand, its total exports and imports expand, since the other country, with unchanged production, exports a somewhat larger fraction of its output, and imports a somewhat larger fraction of its consumption, due to the increased share of the expanding country in world production and income. The wage of effective labor remains unchanged, but is worth somewhat more because of the increased number of varieties available. The real wage of actual labor, each unit of which is endowed with 10% more effective labor, therefore rises unambiguously.

2. The following are (very approximate, to make your calculations simpler) data for national income and population for the United States and for the world as a whole (including the U.S.):

	Population (millions)	Income ($billions)
United States	300	8,000
World	6,000	32,000

Assume for simplicity that in all countries, the available labor force equals exactly 1/3 of the population and that U.S. trade is balanced.

(a) Applying the Heckscher-Ohlin-Vanek Theorem, what should the net labor content of U.S. trade be?

The HOV Theorem says that $F_{ij} = V_{ij} - s_i V_j^W$, where F_{ij} is the factor content of country i's trade in factor j, V_{ij} is its endowment of that factor, s_i is country i's share of world expenditure, and V_j^W is the world endowment of factor j. With balanced trade, income equals expenditure, so s_i is the ratio of incomes. Endowments of labor are 1/3 of the population numbers shown above, so F_{UL} = (1/3)300 – (8,000/32,000)(1/3)6000 = 100 – (1/4)2000 = 100 – 500 = –400.

(b) Explain in words what it means for the net labor content of U.S. trade to be what you said in part (a).

It means that the amount of labor employed in U.S. exports minus that needed to produce U.S. imports, is –400 million (person years), or that the labor needed to produce U.S. imports in a given year is 400 million more than the labor needed to produce U.S. exports.

(c) Under the assumptions of the HOV Theorem, write and explain the formula showing how to calculate the net labor content of U.S. trade, and explain in words what data would be needed to apply this formula.

Assuming identical, constant-returns-to-scale technologies in all countries and factor price equalization, all countries use the same quantities of factors per unit of output in all industries. Let $A=\{a_{jk}\}$ be the therefore common matrix of unit factor requirements of factor j for good k. Let $T_i = \{t_{ik}\}$ be country i's vector of net exports – that is, t_{ik} is its exports minus imports of good k. Then the net factor content of country i's trade is $F_i = AT_i$. Focusing on labor (j=L) and the U.S. (i=U), and expanding this out,

$$F_{UL} = \sum_k a_{Lk} t_{Uk} = \sum_k a_{Lk} X_{Uk} - \sum_k a_{Lk} M_{Uk}$$

where X_{Uk} and M_{Uk} are U.S. exports and imports of good k, respectively. The data needed, therefore, are U.S. trade by commodity for some year, plus the labor inputs and commodity outputs of all industries in the U.S. for that same year.

(d) Based on the empirical work of Trefler and others, approximately what would you expect to find if you were actually to measure the net labor content of U.S. trade? Explain your expectations in terms of that literature.

Trefler found, in his "mystery of the missing trade," that the actual factor content of trade is far, far less than is predicted by the HOV Theorem. Thus I would expect F_{UL} to be measured as much smaller, in absolute value, than the predicted –400 million person years. In addition, Leontief found, a long time ago, that U.S. exports were more labor intensive than its imports, suggesting that, if that is still true, we might actually find this net labor content of U.S. trade to be positive, rather than negative. Bowen et al.'s sign test (repeated by Davis and Weinstein), also suggest not much more than a 50% chance of getting the sign right, which also suggests that we might find a positive number here.

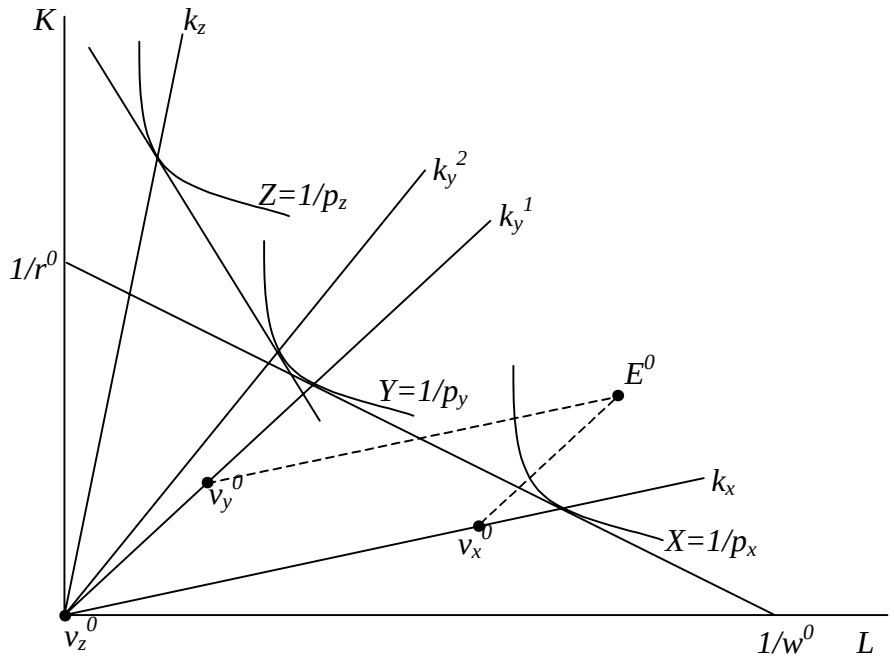
(e) Suppose that a large portion of GNP in all countries consists of non-traded goods. How, if at all, would this matter for the validity and/or the usefulness of the HOV Theorem?

It would not alter the validity of the theorem. The theorem follows from the following reasoning: $F = AT = A(Q–C) = AQ – AsQ^W = V–sV^W$. With non-traded goods, all this remains true; in particular, net trade is still equal to production minus consumption, since production equals consumption for all non-traded goods. However, the usefulness of the theorem may be diminished, since non-traded goods may make it less likely that at least one of the assumptions of the HOV Theorem is valid: factor price equalization. If most goods are non-traded, for example, then the small amount of trade that there is is unlikely to

equalize factor prices. There is much more likely to be specialization across countries (different cones) among the traded goods.

3. Suppose that there are two factors, capital and labor, and three goods, X, Y, and Z. Good X is the most labor intensive and good Z the most capital intensive. All of the goods are homogeneous products. There are many countries, with factor endowments sufficiently diverse that there is ***not*** factor price equalization, even though trade is free and frictionless. Consider a single small country in this world – call it Apnia – one whose initial factor endowments permit it to produce both goods X and Y and to export good X.

   (a) Draw a Lerner Diagram appropriate to this situation. Include a point showing the factor endowments of Apnia, then identify and label Apnia's nominal wage of labor, w^0, it nominal rental on capital, r^0, and the quantities of both factors employed in the three industries, labeled v_x^0, v_y^0, and v_z^0 respectively.

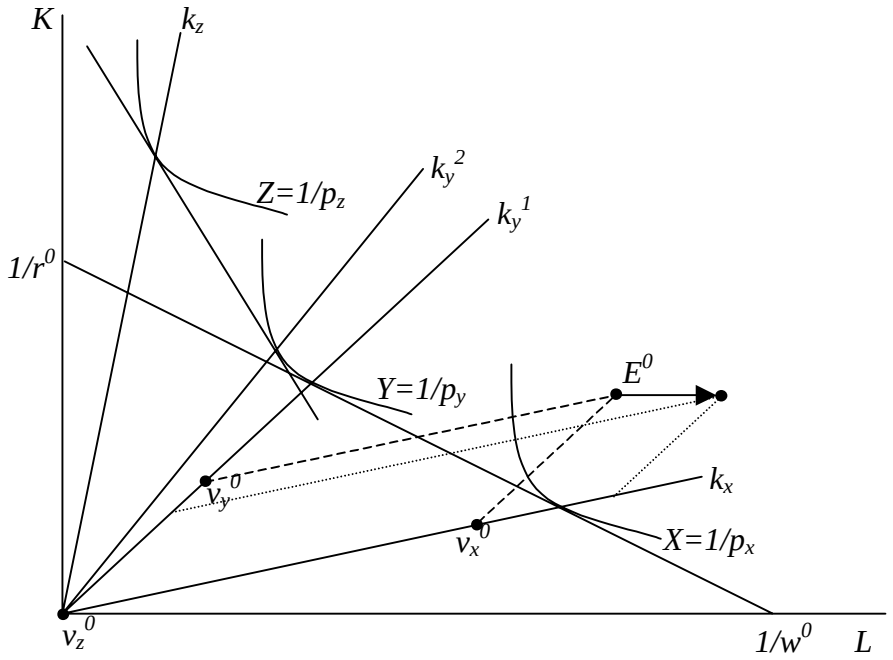


(b) What can you say for sure, based on the information given, about this country's pattern of trade? That is, what does or might it export, what does or might it import, and does it engage in intra-industry trade?

It produces X and Y but not Z, so it must import Z, and we are told that it exports X. It may either export or import Y (not both, since it is homogeneous), depending on its output of Y compared to its demand. If its demand for Z is large, then it is likely to have to export Y to pay for it. But if its endowment is very close to the ray k_x, then it will produce mostly X and have to import Y. This country will not *engage in intra-industry trade, since all of the products are homogeneous. (One could argue, instead, that since trade is costless, buyers may be indifferent between buying domestic and imported goods if both have the same price, and that therefore intra-industry trade is possible, but not necessary, in industries X and Y.)*

(c) Suppose now that the population in this country (only) becomes larger, increasing its labor force by the same proportion. The change is small enough that it continues to produce both X and Y. Its capital stock and all conditions in the rest of the world remain unchanged. Assuming homothetic preferences, how will the quantities of this country's exports and imports of each good change?

The endowment point of the country moves horizontally to the right, as shown below, and following Rybczynski, both factors are withdrawn from sector Y and added to sector X.



Income of the country expands but by a smaller proportion than the increase in population (since income from capital remains unchanged). Therefore demand for each good rises (with homothetic preferences), also by this smaller proportion. Output of good X rises by more than this proportion, so exports of X must rise. Output of Y, on the other hand, falls, so the country either exports less of it, or imports more of it. Imports of Z, which is not produced, rise with the increase in income.

(d) For the change in part (c), what will happen to the country's

i) Real wage of labor

Nothing. We are still in the same unchanged cone of diversification, and nominal factor prices are unchanged. Since prices of goods are also the same, real factor prices are the same as well.

ii) Real rental rate on capital

Nothing. See above.

iii) Total GDP

This rises, since the income of initial factors is unchanged, while the new labor earns a wage that adds to GDP.

iv) Per capita GDP

This falls, since workers earn the same wage, but the income from capital is divided across a larger population.

(e) Suppose now that industry Z produces differentiated products in the manner of Krugman (1980), not the homogeneous product assumed above. How would that change your answer to part (b)?

No change. The fact that Z is a differentiated product does not change the results. In particular, there is still no intra-industry trade, even in sector Z, since the home country, Apnia, does not produce Z. The reason that it does not produce Z is not, now, that potential firms could not sell any Z at a price higher than the imported varieties, since with product differentiation they can. However, free entry has already driven to zero the maximum profit that an entering firm can earn if it charges the same price and has the same costs as imported varieties. Since new entrants in Apnia would have higher costs (as is evident in the Lerner Diagram), their maximum profit must be negative.