Answer Three Questions. Answer at least one question from Part I and at least one question from Part II. Answer All Parts to Each Question.

PART I.
1. Answer all parts

a) Consider the specific factor model with two goods (C, M), one mobile factor (L), and one factor specific to each sector \((K_c, K_m)\). Each good is produced under constant returns to scale, using the two factors \((Q_i = F^i(K_i, L_i); \quad i = C, M)\).

i. Given world prices, show how an increase in \(K_c\) affects output and factor prices. Do the same for an increase in \(L\). Does the Rybczynski theorem (or the magnification theorem) hold? Explain.


b) Consider the Dornbusch-Fischer-Samuelson model of a two country Ricardian world with a continuum of goods. Call the countries US, Europe (E); index the goods by \(z\); let \(A^U(z), A^E(z)\) denote the labor requirement per unit output in each country, and order the goods so that: \(d\beta(z)/dz < 0\), where \(\beta(z) \equiv (A^E(z)/A^U(z))\). Assume preferences are Cobb-Douglas and internationally identical so that (flow) demand for good \(z\) in country \(i\) is given by: \(D^i(z) = \left(\alpha(z)Y^i/P^i(z)\right)\), where \(Y^i\) denotes income, and \(\int_0^1 \alpha(z)dz = 1\).

i. Given the labor stocks for each country, find the trading equilibrium and compare it to the autarky equilibrium for each country. If the US is uniformly more productive than Europe (i.e., \(A^U(z) < A^E(z) \quad \forall z\)), how can European producers compete with U.S. producers?

ii. Assume labor productivity (for every good) is higher in the US than in Europe. Show how a movement in labor from Europe to the US affects the free trade equilibrium and real wages in each country. How is overall economic efficiency affected by this movement?

c) Use the revenue-expenditure function approach to show that, if lump sum transfers are allowed, there are gains from trade even if agents are heterogeneous.

i. Show how the proof can be extended even if lump sum transfers are not feasible; in your proof, be sure to indicate what policies the government should use. \(\{\text{If you cannot provide a formal proof, discuss the logic of your proposed policies and indicate why these policies are preferred to trade policies}\}\)
2. Answer all parts.

a) Briefly describe the results of the basic 2 good, 2 factor Heckscher-Ohlin model concerning the pattern of trade and the impact of trade on factor prices. When is free trade a perfect substitute for factor movements? Relate your answer to the concept of the integrated equilibrium.

i. Assume the model is extended to N goods and M factors, with N>M. Under the standard assumptions (constant returns, identical technology, identical and homothetic preferences) what – if anything – can be inferred about trade patterns, factor price equalization and/or the factor content of trade? Prove your result. Does the fact the number of goods exceeds the number of factors mean factor price equalization is less likely? Explain.

b) Consider a H-O model with 2 traded goods, and one non-traded good. Assume the non-traded good is the most labor-intensive of the three goods. Assume initially that technology is internationally identical. Show how, for a small country, Hicks neutral technical progress in the (relatively labor-intensive) import good will affect domestic prices of all 3 goods, factor prices, and outputs. Will free trade in goods equalize factor prices and the price of non-traded goods? Be as specific as possible.

c) Consider a Heckscher-Ohlin type model with two sectors, two goods \( (C, M) \) and two factors \( (K, L) \). Assume there is joint production in each sector. Thus, let \( Z_i \) denote the activity level of sector \( i \), and \( C_i, M_i \) denotes the output of each good in sector \( i \). For simplicity, we assume in each sector that output are in fixed proportions to the activity level of that sector. Mathematically:

\[
C_1 = \alpha Z_1; \quad M_1 = (1-\alpha)Z_1 \quad \text{and:} \quad Z_1 = F(K_1, L_1)
\]
\[
C_2 = \beta Z_2; \quad M_2 = (1-\beta)Z_2 \quad \text{and} \quad Z_2 = G(K_2, L_2)
\]

As usual, the production functions \( F, G \) exhibit constant returns to scale, and we assume that sector 2 is the capital intensive sector (note that if \( \alpha = 1, \beta = 0 \) this would reduce to the standard H-O). For simplicity, assume \( \alpha > \beta \). Finally, assume internationally identical technology.

i. Will free trade still be a perfect substitute for factor movements in this model? Can you still predict the pattern of trade in goods from knowledge of factor endowments? Explain.

ii. Do the Stolper Samuelson theorem and the magnification (or Rybczynski) theorem still hold? Explain carefully.
3. Consider the extension of the H-O model to the Helpman (or Krugman) variant with two industries, food \((F)\) and manufactures \((M)\), and two factors \((K, L)\). Food is a homogeneous good, produced under constant returns to scale, while there are a potentially infinite number of varieties of manufactures. Each manufactured good has the same technology, which exhibits increasing returns to scale (at least under some interval); both \(K\) and \(L\) are used to produce \(M\), and \(M\) is capital-intensive relative to \(F\). As in class, preferences are weakly separable.

a) Show how the equilibrium is derived for a closed economy (or an integrated world economy). In doing so, you may use the structure employed in class (production is homothetic). What determines the number of varieties of manufactures that will be produced? Will trade occur between identical countries? If so, explain why and discuss whether it is welfare improving.

b) Next, assume there are two countries \((A, B)\), where \(A\) is capital-abundant compared to \(B\). Discuss how the free trade equilibrium is derived and discuss the pattern of trade between countries. Will free trade equalize factor prices? Explain.

c) Given the aggregate stock of world capital and labor, show how a movement of capital from country \(B\) to country \(A\) would affect output levels in each country, the pattern of trade, the volume of trade in goods, factor prices and the standard of living in each country.

d) Finally, suppose a third country, \(C\) – which previously was in autarky equilibrium – opens up trade with \(A\) and \(B\). Assume \(C\) has identical preferences and technology as \(A\) and \(B\), and that \(C\)’s resources (of both capital and labor) were the same as the combined resources of \(A\) and \(B\). Discuss how the removal of \(C\)’s prohibitive trade barriers affects world equilibrium prices, factor prices, the trade pattern, and welfare. Also, discuss the resulting bilateral pattern of trade between all countries \((A\ vs.\ B,\ A\ vs.\ C,\ etc.)\).
PART II.

4. Answer all parts.

   a) Consider a small economy that produces, consumes two goods (C, M). Suppose the country is small, facing given world prices. Further, suppose that domestic production of C creates a negative externality (pollution) that harms domestic residents. The pollution is strictly internal to the country, so that foreign C production does not hurt domestic residents and domestic C production does not harm foreign residents.

      i. What is the first-best policy in this situation? Does it include commercial policy? Might this policy affect the pattern of trade for the economy? If so, how?

      ii. If the only feasible policy is commercial policy, what should that policy be? Set up the optimization problem and show how to calculate the second best commercial policy. Compare the magnitude of the second best policy to that of the first best policy and explain your answer. Naturally, relate your policy to the pattern of trade.

   b) Use the same situation as part a (two goods; production of C creates a negative externality that affects only domestic residents; small country), except also assume that the Heckscher-Ohlin model holds. Thus, the two goods (C, M) are produced using two factors (K, L) and assume good C is labor-intensive. Further, assume technology is not internationally identical.

      i. Assume there is no government policy to combat the pollution. Further, assume domestic wages are above international wages. Compare the domestic wage rate to the shadow price of labor within the economy. Will limited labor inflows help or hurt the country? Explain.

      ii. Repeat part (i) assuming the first best policy is used to combat pollution. Compare the domestic wage rate to the shadow price of labor within the economy, and discuss how labor inflows will affect domestic welfare.

      iii. Finally, assume that only trade policy can be used to combat the market failure. Show how the shadow price of labor compares to the market wage rate. Explain your conclusion.

   c) Suppose the semiconductor industry in a developing economy is young, and its productivity is lower than among foreign competitors. Furthermore, assume that under free trade imports of semiconductors undermine the profitability of domestic firms. However, due to learning-by-doing, each semiconductor firm’s future productivity is related to current output. Assuming the country is small and the domestic industry is competitive:

      i. What is optimal government policy? Does it include trade policy? Justify your answer, and be sure to consider both the case where future productivity is related only to the firm’s own current output, and the case where any firm’s future productivity is related to the current industry output.

      ii. Suppose there are two industries within this economy, and that both experience learning-by-doing. What is the appropriate policy prescription? Explain.
5. Answer all parts.

a) Consider a simple partial equilibrium model with domestic demand \( D(p, \alpha) \), and domestic supply \( S(p) \) where \( \alpha \) is a demand shift parameter (e.g., tastes) such that: \( D_\alpha > 0 \). Let \( p^a(\alpha) \) denote the autarky price, and assume the (exogenous) world price is such that \( p^w > p(\alpha) \) for the given values of \( \alpha \).

i. Show graphically the welfare loss due to an export tariff. Also, show whether there is an export quota that has the same effect as the export tariff. How does an increase in \( \alpha \) affect the equivalence between the tariff and quota?

ii. Show graphically the welfare loss due to an export subsidy. Can the export subsidy lead to lower welfare than autarky? Explain, and show graphically.

b) Again use a partial equilibrium model of the steel industry, with domestic demand \( D(p, \alpha) \) (equivalently, inverse demand \( p^d(c, \alpha) \), where \( c \) is domestic consumption). There is a single domestic firm that has marginal cost: \( MC = \phi(q) \), \( \phi' > 0 \). Absent other competition, this firm will exercise its domestic market power. Further, assume the world price \( p^w \) is exogenous, and under free trade the country would import steel.

i. Show the welfare losses due to a tariff, and then compare the tariff equilibrium with a quota equilibrium that results in the same level of imports. Given imports, which policy is better? Explain your result.

ii. Can you uniformly conclude one policy is better than the other? For a given level of imports, which tool would raise more revenue? Explain.

c) Use the same partial equilibrium model as in b), but assume the government can directly control domestic output (\( q \)) and imports (\( M \)). Domestic price is determined by the inverse demand curve \( p^d(c) \), where \( c = (q + M) \). The single firm receives this domestic price, so tax revenue collected by the government is just on imports, and is given by: \( TR(q, M) = \left( p^d(c) - p^w \right) M \). Assume the government’s goal is to maximize the sum of consumer and producer surplus, subject to a tax revenue constraint (i.e., \( TR(q, M) \geq \overline{TR} \)). Set up the optimization problem and solve it. Does an import tariff or an import quota more closely approximate this solution, given that there is a single firm? Explain.
6. Answer all parts.

a) Consider a two good ($C, M$), two country (U.S., Europe) model. Assume, under free trade, the US imports $C$ and exports $M$. For simplicity, let good $M$ be the numeraire, and let $p^w$ denote the world (relative) price of good $C$. Since there are only two countries, this price is endogenous, depending upon U.S. import demand for $C$, and European export supply of $C$.

i. Assuming Europe pursues free trade, derive the optimal (production, consumption, and trade) decisions for the U.S. What type of policy is required to support this optimum?

ii. Suppose the U.S., through treaty commitments is prohibited from using tariffs or quotas. If the U.S. can use domestic policies (consumption tax/subsidies, production tax/subsidies), can it replicate the optimal policy? Assuming only production policy can be used, derive the optimal policy and compare its magnitude to that of the first best policy.

b) Consider a small economy which produces and consumes $N$ goods. The country faces given world prices, but has import (export) tariffs on some goods, and quotas on some other goods. Let $T$ denote the set of goods on which there are tariffs, and $Q$ denote the set of goods on which there are quotas (one set may be empty).

i. In general, show how a reduction (but not elimination) of tariffs affects domestic welfare. Derive conditions which ensure that the tariff reduction is welfare enhancing.

ii. Repeat part (i) for quotas.

iii. Finally, suppose $N=3$ (3 goods), and suppose that under free trade the country would export good 1 and import goods 2 and 3. In addition, assume domestic production of good 1 causes pollution, that harms consumers. Assume initially that the government uses an export tax on good 1 (but no domestic policy) to combat the pollution. Given the export tax on good 1, how will an import tax on good 2 affect domestic utility? Prove your answer.

c) Consider the following partial equilibrium model of the microprocessor market. There are competitive European producers and consumers of microprocessors, with supply and demand given by: $S(p^e)$ and $D(p^e)$, respectively ($p^e$ is the European price). There is a single American exporter of microprocessor to Europe, and this firm has cost function $C(q_e)$, where $q_e$ denotes its exports to Europe. Given this structure, find Europe’s optimal import tariff (or subsidy) on microprocessors (first, clearly setup the optimization problem, then characterize the solution).