

# 14.581 Problem Set 2 (The Ricardo-Viner and Heckscher-Ohlin Models)

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Complete all questions (100 total marks). Due by Monday, March 28th (4pm) to Sahar or Dave, or to be left in folder outside Dave's office.

1. (15 marks) Bloom (*Econometrica*, 2009) uses firm-level data to estimate firm-level responses to an aggregate shock (the shock of interest to him is a shock to 'uncertainty', but clearly a shock of interest to trade economists would be different), and how these firm-level responses aggregate up to an aggregate-level response.
  - (a) Discuss the elements of Bloom's microeconomic model that make it similar to the Specific Factors model, and those which do not.
  - (b) Outline an empirical paper that could use (a slight extension or amendment of) Bloom's methodology to look at the response of an economy to a trade liberalization (or perhaps exchange rate devaluation) shock. Describe the various steps that this exercise would entail.
  - (c) A hallmark of the field of International Trade is an attention to general equilibrium features generating interactions across markets. How does Bloom (2009) introduce GE forces into his empirical work? What complications arise?
2. (35 marks) This question asks you to work through a simple, analytic  $2 \times 2 \times 2$  H-O model.
  - (a) To start with, assume there is just one country (call it  $H$ ), which is endowed with  $L$  units of labor and  $K$  units of capital. There are two goods. Good 1 is produced with the production function  $Y_1 = AL_1^\alpha K_1^{1-\alpha}$ , good 2 is produced with the production function  $Y_2 = BL_2^\beta K_2^{1-\beta}$ , and  $\alpha > \beta$ . Production is perfectly competitive, in both goods and factor markets. The country has one representative consumer with Cobb-Douglas tastes:  $U = C_1^\mu C_2^{1-\mu}$ . Solve for the

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\*Many of these problems are derived from a previous course that I taught with Arnaud Costinot.

equilibrium goods prices (choose  $p_1 = 1$  as the numeraire), factor prices, and production and consumption quantities.

- (b) Now suppose there are two countries ( $H$  and  $F$ ). Country  $H$  is now endowed with  $\phi L$  units of labor and  $\psi K$  units of capital, whereas country  $F$  is endowed with  $(1 - \phi)L$  units of labor and  $(1 - \psi)K$  units of capital (with  $\phi \in (1/2, 1)$  and  $\psi \in (0, 1/2)$ ). Explain the concept of the integrated equilibrium and solve for it (ie for all prices and quantities).
- (c) Solve for the free trade equilibrium (ie for all prices and quantities) in this 2-country world under the restriction that both goods are produced by both countries (ie there is incomplete specialization) by working with all of the agents' first-order conditions. In factor space, draw an Edgeworth box (of dimensions  $L$  and  $K$ ) for this 2-country world and illustrate the region of this Edgeworth box in which each country's endowment must lie (ie the values of  $\phi$  and  $\psi$ ) in order for the incomplete specialization equilibrium will obtain. Which country contains the relatively richer workers and capitalists in this world?
- (d) Solve for the amount of each good that each country is exporting/importing to/from the other country. Comment on which country is exporting which good.
- (e) Solve for the factor content of trade between each country.
- (f) Now suppose that country  $H$  is only producing good 1; find the restrictions on  $\phi$  and  $\psi$  such that this is true. Hence sketch the output of good 1 by country  $H$  as a function of  $\phi/\psi$ . What does this relationship imply about how one should approach the estimation of so-called 'Rybczinski regressions'?
- (g) Finally, suppose that there is a third good whose production function is  $Y_3 = L_3^\gamma K_3^{1-\gamma}$ . Describe and illustrate (in the Edgeworth box diagram) the restriction on  $\phi$  and  $\psi$  such that both countries are producing all three goods. How much of each of the three goods will each country produce? How much of each of the three goods will they trade? Solve for the factor content of each country's net exports.
3. (10 marks) Consider a neoclassical economy with  $G > 2$  goods (indexed by  $g$ ) and  $F > 2$  factors (indexed by  $f$ ), with  $G = F$ .
- (a) Is  $G = F$  a reasonable assumption to make?
- (b) Derive a relationship between the 'Stolper-Samuelson derivative' ( $\frac{dw_f}{dp_g}$ ) and the 'Rybczinski derivative' ( $\frac{dy_g}{dV_f}$ ). Comment on the intuition behind this relationship.
- (c) Describe how you would design an empirical paper that would aim to test this relationship.
4. (20 marks) The HO model without FPE.

- (a) Factor prices are clearly not equal around the world. Discuss why this might be the case. Of the reasons you have just given, discuss which you think is most plausible (against the backdrop of the literature on Heckscher-Ohlin empirics).
  - (b) Consider a country  $c$  with a vector of factor endowments  $V^c$  whose production can be characterized by a revenue function,  $r^c(p^c, V^c)$ , where  $p^c$  is the vector of goods prices in country  $c$ . Another country  $c'$  is exporting a vector of goods  $T^{c'c}$  (in physical units) from  $c'$  to  $c$ . Consider the thought experiment that instead of country  $c'$  sending these goods to country  $c$ , country  $c'$  instead sent the factors that were needed to produce these goods when they were made in country  $c'$  (which we call the factor content of exports from  $c'$  to  $c$ , denoted by the vector  $F^{c'c}$ .) What can you say about the size of  $T^{c'c}$  relative to  $F^{c'c}$ ?
  - (c) Now make some additional assumptions, of the sort that are commonly made in Heckscher-Ohlin settings, to derive the following bilateral relationship between factor prices in countries  $c$  and  $c'$  (call them vectors  $w^c$  and  $w^{c'}$ ):  $(w^{c'} - w^c) \cdot F^{c'c} \leq 0$ . If there are  $N$  countries in the world, how many predictions does this theory make?
  - (d) Can you make additional predictions about *tri*-lateral relationships between factor prices in countries A and B, and the factor content of exports from a third country C to either A or B? How many predictions does this theory make?
  - (e) Describe an empirical exercise that you could perform to test this set of predictions in the H-O model. What would be its attractions relative to other empirical HO approaches.
5. (10 marks) Describe an extension of the model in Costinot, Donaldson and Komunjer (2010) that would add Heckscher-Ohlin features to it. Now outline an empirical paper that would use this extension to make as useful a contribution to the empirical H-O literature as possible. Be sure to state exactly what regression(s) or other empirical tests/exercises you're proposing, how they follow from the model, and what the estimates would tell us. State any attractive features of this approach you can think of, relative to existing empirical work on the H-O model.
6. (10 marks) Consider the sections of Costinot (Ecta 2009) that deal with a Heckscher-Ohlin-style model (ie Sections 5 and 6). Describe the best possible empirical paper you can imagine writing that would test this model's predictions. What are the pros and cons of this approach to H-O empirics compared to other approaches we have studied?

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