

14.581 Problem Set 1 (Gains From Trade and the Ricardian Model)

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Complete all questions (100 total marks). Due by Wednesday, March 9 to Sahar or Dave.

1. (10 marks) Consider a Ricardian model with a continuum of goods, indexed by z , and two countries, indexed by $i = N, S$, each endowed with L_c units of labor. w_i denotes the wage in each country. Constant unit labor requirements in country i and industry z are given by:

$$a_i(z) = \alpha_i e^{\beta_i z}, \quad (1)$$

where $\alpha_S > \alpha_N > 0$ and $\beta_S > \beta_N > 0$. Hence North (N) has an absolute advantage in all goods and a comparative advantage in high- z goods. Start by assuming that $z \in [0, 1]$ and that households have identical Cobb-Douglas preferences in both countries, of the following form:

$$U_i = \int_0^1 \ln c_i(z) dz. \quad (2)$$

- (a) Solve implicitly for the relative wage, w^N/w^S , and the “cut-off” good, \tilde{z} .
 - (b) Study the welfare implications in both countries of a decrease in α_S .
 - (c) Study the welfare implications in both countries of a decrease in β_S . [Maintain the assumption that $\beta_S > \beta_N$] Explain the difference between the settings in (a) and (b).
2. (10 marks) Continue with the environment in Question 1 but now assume that $z \in [0, +\infty)$ and that households have non-homothetic preferences in both countries:

$$U_i = \int_0^{+\infty} c_i(z) dz, \quad (3)$$

with $c_i(z) = 0$ or 1 for all z . In addition, we assume that all households are endowed with one unit of labor in both countries.

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

- (a) Compute $c_i(z)$ as a function of w_i in both countries.
 - (b) Solve implicitly for the relative wage, w^N/w^S , and the “cut-off” good, \tilde{z} .
 - (c) Study the welfare implications in both countries of a decrease in α_N . Explain the difference between the settings in (a) and (b).
3. (10 marks) Continue with the environment in Question 1 (ie return to the assumptions that $z \in [0, 1]$ and that households have preferences given by (1).) However, technology is now characterized by local external economies of scale

$$a_i(z) = \frac{\alpha e^{\beta_i z}}{A[q_i(z)]}, \quad (4)$$

where $\alpha > 0$ is a constant, $q_i(z) \geq 0$ is the output of good z in country i , and $A(\cdot)$ is strictly increasing, concave, and everywhere has an elasticity smaller than one.

- (a) Show that there exists multiple free trade equilibria under perfect competition.
 - (b) Show that one country can be worse off under free trade than under autarky.
4. (10 marks) Continue with the environment in Question 3. (ie this is the economy in Question 1 but with external economies of scale given by (4).) However, now allow there to be, in each country i and industry z , $n_{iz} > 2$ firms competing a la Bertrand.
- (a) Show that there exists a unique free trade equilibrium under Bertrand competition.
 - (b) Show that free trade is always Pareto superior to autarky.
5. (25 marks) Consider the model in (the extremely influential work of) Eaton and Kortum (2002). This question will ask you to work through and comment on the key results in this paper. For simplicity, throughout this question set the unit cost of production c_i equal to simply w_i (that is, no intermediate goods are used in production).
- (a) Explain what the parameter θ in the EK2002 model captures. Given this understanding, explain how you expect the interdependence of countries in this model to scale with θ . Discuss further how you expect concepts like the size of the gains from trade, the extent to which trade flows rise as trade costs fall, and the extent to which foreign technology shocks affect economic outcomes at home, all to vary with θ .

- (b) Derive the distribution of prices in country n , $G_n(p)$ (equation (6) in EK2002). Comment on the attractions of the Fréchet productivity distribution in this derivation—when did it simplify things? Would a simple expression like that in equation (6) be possible if countries each had their own parameter θ_i ?
- (c) Prove that the probability that country i provides a good at the lowest price in country n is simply country i 's contribution to country n 's price parameter Φ_n , or that $\pi_{ni} = \frac{T_i(w_i d_{ni})^{-\theta}}{\Phi_n}$. What sort of data could you use to test this prediction?
- (d) Prove that the price of a good that country n actually buys from any country i also has the distribution $G_n(p)$ —or that, for all goods consumed in country n , conditioning on the source of their production has no bearing on the good's price. Give the intuition for why this is true. What sort of data could you use to test this prediction?
- (e) Explain why the (constant) elasticity of substitution on consumer preferences, σ , does not enter the equation for trade flows (equation (10)). Was the assumption of CES preferences necessary for the derivation of equation (10)?
- (f) Derive equation (12). Interpret this result and give the intuition behind it.
- (g) Write welfare of country i in the model as a function of just one intuitive endogenous variable. Can you explain the intuition behind this result?
- (h) Some authors like to think of welfare of country i in models like this as the product of two (endogenous) terms or variables. The first term is often termed 'consumer market access' (CMA), which is meant to summarize how well consumers in country i are positioned for accessing markets that sell the goods they want. The second term is often termed 'firm market access' (FMA), and this is meant to summarize how well firms in country i are positioned to access markets at which they can sell the goods they produce. Obviously this is vague. But try to interpret these notions in a way that you think is sensible in the context of the EK2002 model and come up with an expression in which welfare can be written simply as the product of CMA and FMA (and some exogenous variables/parameters).
- (i) Imagine that trade is free between all countries. Derive a closed-form expression for the welfare level in country i as a function of exogenous variables only. Interpret this expression.
- (j) Imagine now that there are just two identical countries in the world (but trade is not free and instead incurs the standard iceberg cost d). Derive the simplest possible expression for the level of welfare in either of these countries as a function of d (feel free to make all the normalizations you want in order to focus on the role of just d).

Interpret this expression and give the intuition for it. Try evaluating this expression numerically at different values of d and θ that you think are plausible and discuss your answers. Are the gains from trade in this simple model ‘large’ or ‘small’?

- (k) EK2002’s preferred estimate of θ is 8.28. Explain how this estimate was arrived at. How well does this method fit with the EK2002 modeling approach? Offer your criticisms of this method more generally.
 - (l) Is the EK2002 preferred estimate of $\theta = 8.28$ ‘large’ or ‘small’? Defend your answer (there is obviously no right answer!) to your discussion of part (a).
6. (15 marks) This question asks you to discuss some recent empirical work on estimating the (reduced-form) gains from trade, and how this work relates to theoretical work on the gains from trade.
- (a) State how large the estimated ‘gains from openness’ are in Frankel and Romer (1999), and Feyrer (2009) Paper 1 and Feyrer (2009) Paper 2. Discuss whether you think the estimates in the two Feyrer (2009) papers are smaller or larger than the true average treatment effect of openness to international trade.
 - (b) Assuming that the estimates in Feyrer (2009) Paper 2 are unbiased estimates of the average treatment effect of an extra unit of international trade on a country’s real income, do these estimates make quantitative sense in the context of standard models of market distortions?
 - (c) Do the estimates in Feyrer (2009) Paper 2 line up with the predictions for the size of the gains from trade in the Eaton and Kortum (2002) model?
 - (d) Discuss an amendment to Feyrer (2009) Paper 2 that would explore the extent to which the theoretical predictions about the size of the gains from trade in Eaton and Kortum (2002) fit the data. Be clear about what regression you’re proposing, why you’re proposing it, and what the estimates would tell us.
 - (e) Have a quick look at Woodland (1980, ReStud) on “Direct and Indirect Trade Utility Functions”. Can you suggest an empirical application of these tools that would put restrictions on a cross-country empirical approach to estimating the gains from trade?
7. (10 marks) This question asks you to comment on the work of Costinot, Donaldson and Komunjer (2010).
- (a) Describe what you see to be the two most serious criticisms of this paper.
 - (b) Can you suggest a better (or at least alternative) instrument for producer prices than the one used by CDK (2010)?

- (c) Are there additional theoretical restrictions in the CDK (2010) model that are not being tested in the paper?
8. (10 marks) Consider the section of Costinot (Ecta 2009) that deals with the Ricardian model. Describe the best possible empirical paper you can imagine writing that would test this model's predictions.

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