Written Exam at the Department of Economics Winter 2017–18

Advanced International Trade

3–hour closed–book exam

December 22 2017

SUGGESTED ANSWERS

Please note that the language used in your exam paper must correspond to the language for which you registered during exam registration.

This document consists of 9 pages in total.

NB: If you fall ill during an examination at Peter Bangsvej, you must contact an invigilator in order to be registered as having fallen ill. In this connection, you must complete a form. Then you submit a blank exam paper and leave the examination. When you arrive home, you must contact your GP and submit a medical report to the Faculty of Social Sciences no later than seven (7) days from the date of the exam.

Problem 1:

Consider an economy with one monopolistically competitive industry. In this industry, each firm produces a unique variety of a differentiated product. As in Melitz (2003), firms are heterogeneous in terms of their productivity level. A firm with productivity φ needs l workers to produce an output level of q of its variety:

$$l(\varphi) = f + \frac{q(\varphi)}{\varphi} \tag{1}$$

where f is a fixed cost of production.

Demand for firm φ's variety is defined as:

$$q(\varphi) = \frac{R}{P}\left[\frac{p(\varphi)}{P}\right]^{-\sigma} \tag{2}$$

where $\sigma > 1$ is a utility parameter describing the constant elasticity of substitution (CES), R is aggregate revenue, P is the aggregate price index and $p(\varphi)$ is the price set by firm φ. Firm revenues are given by $r(\varphi) = p(\varphi)q(\varphi)$. Prices are set as a constant markup over marginal costs, i.e., $p(\varphi) = \frac{\sigma}{\sigma-1}\frac{w}{\varphi}$. Let the wage be the numeraire, $w = 1$.

1. Show that the profits of firm φ is:

$$\pi(\varphi) = B\varphi^{\sigma-1} - f$$

Find an expression for B and discuss if B is common and exogenous to each firm in the economy.

Suggested answer:
Start from the definition of firm profits:

$$\begin{aligned}
\pi(\varphi) &= r(\varphi) - wl(\varphi) \\
&= r(\varphi) - (f + q(\varphi)/\varphi) && \text{[Use (1)]} \\
&= r(\varphi) - f - r(\varphi)p(\varphi)^{-1}\varphi^{-1} && \text{[Use } r = pq\text{]} \\
&= r(\varphi) - f - r(\varphi)\left(\frac{\sigma}{\sigma-1}\frac{1}{\varphi}\right)^{-1}\varphi^{-1} && \text{[Use pricing rule]} \\
&= r(\varphi) - f - r(\varphi)\frac{\sigma-1}{\sigma} \\
&= \frac{r(\varphi)}{\sigma} - f \\
&= \frac{1}{\sigma}RP^{\sigma-1}\left(\frac{\sigma}{\sigma-1}\frac{1}{\varphi}\right)^{1-\sigma} - f && \text{[Use (2)]} \\
&= \frac{1}{\sigma}RP^{\sigma-1}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\varphi^{\sigma-1} - f \\
&= B\varphi^{\sigma-1} - f
\end{aligned}$$

where $B = \frac{1}{\sigma} R P^{\sigma-1} \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} > 0$ is a common function of aggregate variables and the CES parameter. Firms take this object as exogenously given when choosing their optimal price. This is at the heart of monopolistic competition models where firms are assumed to be small relative to the market. As a result, strategic interactions between firms can be ignored. Since $\sigma > 1$ and $B > 0$, profits increase with firm productivity.

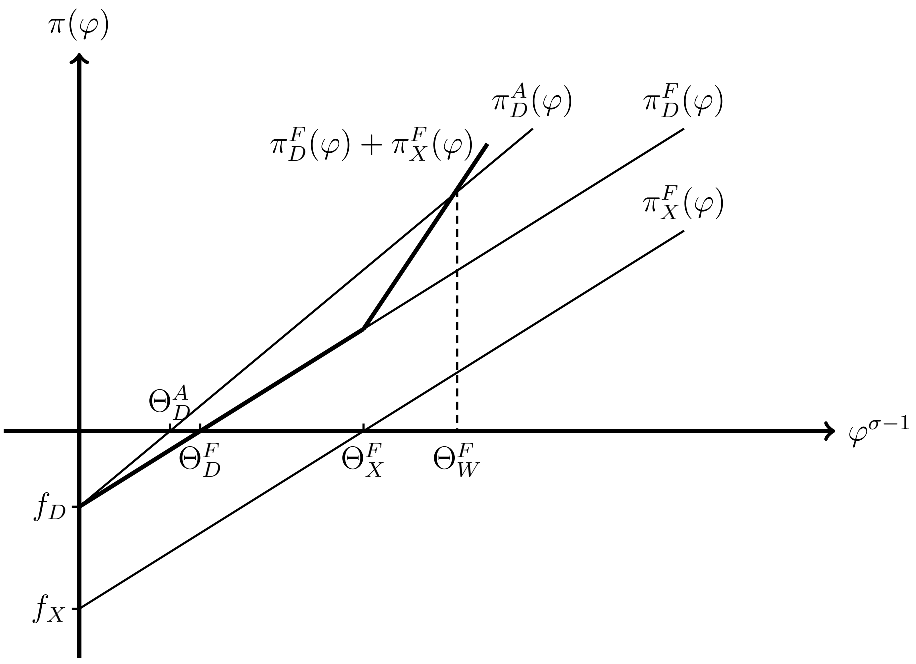
2. Suppose the economy opens up to trade with another yet identical country. Firms may now sell their varieties to foreign consumers and vice versa. The potential profits received by firms are:

$$\pi_D(\varphi) = B^F \varphi^{\sigma-1} - f_D$$
$$\pi_X(\varphi) = B^F \varphi^{\sigma-1} - f_X$$

where profits from domestic sales are equal to π_D, whereas profits from export sales are given by π_X. Assume that the fixed costs of exporting is greater than the cost of serving the domestic market, $f_X > f_D$. Assume moreover that the B-parameter is lower in the open economy compared to autarky, i.e., $B^F < B^A$.

Draw potential firm profits in the open and closed economy settings using a graph with $\varphi^{\sigma-1}$ on the first axis and profits on the second axis. Describe which firms serve the domestic market and which firms export. Do all exporters increase their total profits relative to their autarky profit levels?

Suggested answer:
Domestic profits in autarky, $\pi_D^A(\varphi)$, and domestic profits in the open economy, $\pi_D^f(\varphi)$, have the same intercept (f_D) but the slope of the profit function is higher in autarky. That is, profits are higher in autarky for any given level of productivity since $B^A > B^F$. This is depicted in the figure below.



Similarly, the open economy profits from domestic and exports sales have the same slope, but different intercepts due to the assumption that exporting is more costly than domestic sales. Note that $\pi_D^F(\varphi)$ and $\pi_X^F(\varphi)$ have different slopes in Melitz (2003) due to the presence of a variable trade cost. This is not the case here. The profit functions define three cutoff values: Θ_D^A, Θ_D^F and Θ_X^F. In autarky, firms with productivities above Θ_D^A are active in the market and earn positive profits. When the economy opens up to trade, only firms with productivities above Θ_D^F remain active in the market. In other words, firms with productivity levels ranging from Θ_D^A to Θ_D^F will no longer earn positive profits in the open economy setting and will therefore exit the market. Firms with productivities above Θ_X^F earn enough positive profits from exports to overcome the additional fixed costs of doing so. As a result, firms with productivity levels between Θ_D^F and Θ_X^F serve the domestic market only, while the most productive firms sell their output in both countries. Opening up to trade allows the most productive firms to expand their production and they will therefore increase their labor demand. This bids up the real wage in the domestic economy. Since wages are normalized to one, the real wage goes up because the aggregate price index decreases (which is why $B^A > B^F$). The higher cost of production is exactly why the least efficient firms are forced to exit the market after the economy opens up to trade, i.e., $\Theta_D^F > \Theta_D^A$. Trade gives firms new opportunities to earn profits, but it also requires them to pay additional costs. As a consequence, the least efficient exporters earn less profits in the open economy relative to autarky. On the other hand, firms with productivity levels above Θ_W^F increase their overall profits and are strictly better off in the free trade equilibrium.

3. Does the transition from autarky to free trade generate welfare gains for consumers? Provide a short and complete discussion of the role of firm heterogeneity for the possible gains from trade.

   Suggested answer:
   In Melitz (2003), trade increases welfare because of increases in aggregate productivity as well as being able to consume foreign varieties. In Krugman (1980), firms are identical and only the second source of gains is present. Productivity gains are present when firms are heterogeneous in terms of their productivity. In this situation, trade leads to increases in aggregate productivity from two distinct selection mechanisms. According to the domestic market selection effect trade forces the least efficient firms to exit the market, while the export market selection effect implies that exporters increase their market shares in the domestic economy. Overall, resources are reallocated towards more productive firms. Higher aggregate productivity translates into a lower aggregate price index. As a result, consumer welfare increases with trade-induced productivity gains. This mechanism is one of the key contributions of Melitz (2003).

Problem 2:

Consider a world economy consisting of $i = 1, ..., N$ countries. Each country produces a differentiated good using a constant return to scale technology that uses labor as the only production input. The supply of labor is inelastic and given by L_i. On the demand side, there is a representative agent in each country maximizing the following utility function:

$$U_j = \left[\sum_{i=1}^{N} c_{ij}^{(\sigma-1)/\sigma} \right]^{\sigma/\sigma-1} \tag{3}$$

where c_{ij} is the quantity of country i's good consumed by country j and $\sigma > 1$ is the elasticity of substitution between goods. Let X_{ij} denote the value of country j's total imports from country i:

$$X_{ij} = \left(\frac{p_{ij}}{P_j} \right)^{1-\sigma} Y_j \tag{4}$$

where $Y_j = \sum_{i=1}^{N} X_{ij}$ is total expenditure in country j and $P_j = \left[\sum_{i=1}^{N} p_{ij}^{1-\sigma} \right]^{1/(1-\sigma)}$ is country j's price index. Markets are perfectly competitive and optimal prices are set as $p_{ij} = w_i \tau_{ij}$, where $\tau_{ij} \geq 1$ is an iceberg trade cost between country i and country j. Balanced trade implies $Y_j = w_j L_j$. Let the wage in country j be our numeraire ($w_j = 1$).

Suppose country j is affected by a foreign shock that affects labor endowments and trade costs in all other countries in the world but country j. Accordingly, the foreign shock leaves country j's labor endowment as well as its ability to serve its own market unchanged.

1. Show that the foreign shock leads to the following changes in country j's price index:

$$d \ln P_j = \sum_{i=1}^{N} \lambda_{ij} (d \ln w_i + d \ln \tau_{ij}) \tag{5}$$

where $\lambda_{ij} = X_{ij}/Y_j$ is the share of country j's expenditure that is devoted to goods from country i and $d \ln x = \widehat{x} = dx/x$ denotes percentage changes. Provide a short and complete account of the relationship in (5).

Suggested answer:
The price index may be re-written as:

$$(1-\sigma) \ln P_j = \ln \left(\sum_{i=1}^{N} (w_i \tau_{ij})^{(1-\sigma)} \right)$$

Differentiate price index:

$$
\begin{aligned}
(1-\sigma)d\ln P_j &= \frac{1}{\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}} d\left(\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}\right) \\
&= \frac{1-\sigma}{\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}} \left(\sum_{i=1}^{N}(w_i\tau_{ij})^{-\sigma}(dw_i\tau_{ij}+w_i d\tau_{ij})\right) \\
&= \frac{1-\sigma}{\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}} \left(\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}\frac{(dw_i\tau_{ij}+w_i d\tau_{ij})}{w_i\tau_{ij}}\right) \\
&= \frac{1-\sigma}{\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}} \left(\sum_{i=1}^{N}(w_i\tau_{ij})^{1-\sigma}(d\ln w_i + d\ln\tau_{ij})\right) \\
&= \frac{1-\sigma}{P_j^{1-\sigma}} \left(\sum_{i=1}^{N}\frac{X_{ij}}{Y_j}P_j^{1-\sigma}(d\ln w_i + d\ln\tau_{ij})\right) \\
\implies d\ln P_j &= \sum_{i=1}^{N}\lambda_{ij}(d\ln w_i + d\ln\tau_{ij})
\end{aligned}
$$

where the second to last equation uses the expressions for import demand and the price index in country j. The relationship in (5) shows that country j's price index is an weighted average of the changes in wages and trade costs around the world. For instance, a lower trade cost between any country i and country j lowers P_j — country j's true costs of living index. Note that $\lambda_{ij} > 0$ since an agent with CES utility will always prefer to consume positive amounts of every available good. The foreign shock implies changes in country j's terms of trade as reflected in $d\ln P_j$.

2. Write down an expression for relative imports, $\lambda_{ij}/\lambda_{jj}$. Show that the foreign shock leads to the following changes in relative imports:

$$d\ln\lambda_{ij} - d\ln\lambda_{jj} = (1-\sigma)(d\ln w_i + d\ln\tau_{ij}) \tag{6}$$

Provide a short and complete account of the relationship in (6).

Suggested answer:
Relative imports are given by:

$$\frac{\lambda_{ij}}{\lambda_{jj}} = \frac{X_{ij}/Y_j}{X_{jj}/Y_j} = \frac{(w_i\tau_{ij}/P_j)^{1-\sigma}}{(1/P_j)^{1-\sigma}} = (w_i\tau_{ij})^{1-\sigma}$$

Differentiate expression for relative imports:

$$d\ln\lambda_{ij} - d\ln\lambda_{jj} = (1-\sigma)(d\ln w_i + d\ln\tau_{ij})$$

The relationship in (6) shows that changes in country j's relative imports is a function of the changes in wages and trade costs between i and j. A lower trade cost between any country i and country j improves country j's terms of trade, causing the latter to increase its relative imports since $1-\sigma < 0$. Relative imports, $\lambda_{ij}/\lambda_{jj}$, provides a convenient expression that eliminates P_j that captures multilateral changes in j's terms of trade.

3. Real income is a measure of welfare, i.e., $W_j = Y_j/P_j$. Show that the foreign shock leads to the following changes in real income:

$$d\ln W_j = \frac{d\ln \lambda_{jj}}{1-\sigma} \tag{7}$$

Provide a short and complete account of the relationship in (7).

Suggested answer:
Differentiate the welfare expression:

$$\begin{aligned} d\ln W_j &= d\ln Y_j - d\ln P_j \\ &= -d\ln P_j \\ &= -\sum_{i=1}^{N} \lambda_{ij}(d\ln w_i + d\ln \tau_{ij}) \\ &= \frac{\sum_{i=1}^{N} \lambda_{ij}(d\ln \lambda_{jj} - d\ln \lambda_{ij})}{1-\sigma} \\ &= \frac{d\ln \lambda_{jj}}{1-\sigma} \end{aligned}$$

where the second equation uses the fact that $d\ln Y_j = d\ln w_j = 0$ and the last equation uses the fact that expenditure shares add to one, i.e., $\sum_{i=1}^{N} \lambda_{ij} = 1$ and hence $\sum_{i=1}^{N} d\lambda_{ij} = 0$. The relationship in (7) shows that changes in welfare is a simple function of changes in the domestic expenditure share and the elasticity of substitution. Since $1-\sigma < 0$, changes in welfare is negatively related to changes in the domestic expenditure share. The intuition is straightforward: An improvement of country j's terms of trade makes imported goods more attractive relative to the domestic good. This causes the domestic expenditure share to decline. Welfare increases, however, as country j is better off due to the terms of trade improvement.

4. Calculate the welfare changes for a hypothetical country transitioning from autarky to a new equilibrium with trade. Assume that $\lambda_{jj} = 0.82$ and $\sigma = \{5, 10\}$. Explain how σ impacts the gains from trade. Discuss if other theories from the syllabus lead to similar predictions regarding gains from trade.

Suggested answer:
Write out welfare changes:

$$\begin{aligned} \ln W_j^F - \ln W_j^A &= \frac{1}{1-\sigma}(\ln \lambda_{jj}^F - \ln \lambda_{jj}^A) \\ &= \frac{1}{1-\sigma}(\ln \lambda_{jj}^F) \qquad \text{(since } \lambda_{jj}^A = 1\text{)} \\ &= \frac{1}{1-\sigma}(\ln 0.82) \\ &= \frac{0.1984}{\sigma - 1} \end{aligned}$$

Welfare changes amount to 4.96 pct. for $\sigma = 5$ and 2.22 pct. for $\sigma = 10$. Welfare appears to be decreasing in the elasticity of substitution. This is not surprising:

When goods become more substitutable, demand becomes more elastic. For a given domestic expenditure share, the gains from trade decrease in σ since domestic and foreign varieties are more substitutable. According to Feenstra (1994), the gains from trade in Krugman (1980) amounts to $\lambda^{-1/(\sigma-1)}$. This expression leads to near identical calculations as in the example from before. CES preferences are used in both theories, but the supply sides are quite different (perfect competition versus monopolistic competition). Nonetheless, the gains from trade are similar. Eaton and Kortum (2002) find a similar expression for the gains of trade in a Ricardian trade model. One key difference is that the Frechet dispersion parameter replaces the elasticity of substitution. As such, the gains from trade in the Eaton and Kortum-model cannot be computed with the information at hand. That said, trade theories with gravity predictions share similar expressions for the gains from trade despite the many differences in micro foundations.

Problem 3:

Answer True or False to each of the statements below. Briefly explain your answer.

1. The empirical study of Caliendo and Parro (2015) shows that the real wages of US workers decreased in response to North American Free Trade Agreement, while Mexican workers experienced a real wage increase.

   Suggested answer:
   False. The evidence shows that real wages increased in all three countries, with Mexico having the highest real wage increase and the US the lowest.

2. In a Specific Factors model with two industries and three factors (labor and industry-specific capital), a lower cost of offshoring labor-intensive tasks will unambiguously increase wages because of the productivity effect.

   Suggested answer:
   False. A lower cost of offshoring will affect wages through the productivity effect and the labor supply effect. The latter impacts wages negatively to ensure full employment. Unlike the Heckscher-Ohlin model, factor prices respond to factor supplies which is why the labor supply effect is present.

3. According to Autor, Dorn and Hanson (2013), import competition from China has significantly increased aggregate unemployment in the US.

   Suggested answer:
   False. Autor, Dorn and Hanson (2013) document a significant relationship between Chinese import competition and unemployment in local labor markets. This study emphasizes that trade shocks may have a large impact on local outcomes without affecting aggregate variables.

4. The Law of Comparative Advantage states that a country should, on average, import the goods that have lower relative autarky prices compared to other countries.

Suggested answer:
False. The Law of Comparative Advantage states that a country should, on average, *export* the goods that have lower relative autarky prices compared to other countries.