International Trade 1, FDPE, Spring 2010

Lecture 7: Applications of Monopolistic Competition

Pertti Haaparanta

May 5, 2010

Today

- Monopolistic competition: Other than SDS-preferences.
- Monopolistic competition and variety of productive inputs.
- Firm heterogeneity.

Monopolistic Competition with Variable Demand Elasticity 1

- Recall that with SDS-preferences with trade liberalization there are no changes in (producer) real wages or size of individual firms.
- The only change is the possible change in the variety produced.
- Some of this hinges just on the fact that with SDS-preferences price elasticity of demand is constant.
- To see this assume more generally preferences

$$u = \sum_{i=1}^{n} v\left(c_i\right), v' > 0, v'' < 0$$

where $v\left(c_i\right)$ = the utility that can be derived from variety i.

Monopolistic Competition with Variable Demand Elasticity 2

- Consumer budget constraint is

$$\sum_{i=1}^{n} p_i c_i = I$$

which leads to the FOC

$$v'(c_i) = \lambda p_i$$

Assume that each variety has such a small share in aggregate consumption that one can neglect the impacts of its price on the marginal utility of income λ.

- Thus

$$c_i = (v')^{-1}(\lambda p_i), \frac{dc_i}{dp_i} < 0$$

- Assume the same technology as before:

$$L_i = \alpha + \beta y_i$$

Monopolistic Competition with Variable Demand Elasticity 3

- The FOC for profit maximisation is MR = MC:

$$p_i \left(1 - \frac{1}{\eta}\right) = \beta w$$

where η = the price elasticity of demand. In general

$$\eta = \eta\left(c\right)$$

- This implies that all firms charge the same price: they face the same marginal cost and price elasticity of demand.
- The pricing equation gives one relationship for the determination of the real wage:

$$\frac{p}{w} = \beta\left(\frac{\eta}{\eta - 1}\right) \tag{1}$$

Monopolistic Competition with Variable Demand Elasticity 4

- With free entry, price has to equal average cost:

$$p = \frac{w(\alpha + \beta y)}{y} \Rightarrow \qquad (2)$$
$$\frac{p}{w} = \frac{\alpha}{Lc} + \beta$$

  with $y = Lc$.
- These are two equations in two unknowns, the real wage and the consumption level of each variety.
- The properties of the equilibrium are determined by the assumptions on the price elasticity of demand.
- With SDS it is constant, but this need not to be the case.

Monopolistic Competition with Variable Demand Elasticity 5

- In general

$$\eta = \eta(c)$$

but the sign is not restricted by the theory, as

$$\eta = -\frac{dc}{dp}\frac{p}{c} = -\frac{\lambda}{v''}\frac{p}{c} = -\frac{v'}{v''c}$$

- Assume, that the elasticity is lower at higher levels of consumption (e.g. implied by linear demand function), $\eta' < 0$. Then

$$\frac{p}{w} = \beta\left(\frac{\eta}{\eta - 1}\right)$$

- is an increasing function of the consumption/capita. Figure.
- Trade: Two identical countries. In (2) double the labor force.

Monopolistic Competition with Variable Demand Elasticity 6

- Trade increases the real wage, and increases the available number of varieties.
- But now the number of varieties produced in each country is reduced, and firms that remain in the market become bigger.
- Why?
- Real wages increase as trade reduces firms market power: less of each variety is consumed per consumer as new varieties become available.
- The increase in real wage makes people to reduce less their consumption as would otherwise happen. This is the reason why the output by each firm increases.
- In this case, trade leads to reorganisation at both the firm and industry level. Some firms have to close down in each country, and the remaining firms grow. At the industry level there is both job creation and job destruction.

Monopolistic Competition with Variable Demand Elasticity 7

- Firms that continue operating have become more efficient after trade is opened: their average costs fall.
- Trade improving efficiency?
- Do exports increase productive or do firms that are more productive export?

Monopolistic competition in the production of intermediate goods 1

- Ethier (1982) was the first to realize that applying the SDS-function as a production function one could model the productivity gains from increased division of labor.
- This is a simplified version of the Ethier model.
- So assume, 2 final goods are produced, under perfect competition.
- Good 1 is assembled by competitive firms by using only components produced by a monopolistically competitive industry.
- The assembly production function is

$$\left(\sum_{i=1}^{n} q_i^{\theta}\right)^{\frac{1}{\theta}} \tag{3}$$

where q_i is the amount of component i used in assembly.

Monopolistic competition in the production of intermediate goods 2

- The assembly producer minimizes unit costs

$$\min_{\{q_i\}} \sum p_i q_i \tag{4}$$

$$s.t. \left(\sum_{i=1}^{n} q_i^{\theta} \right)^{\frac{1}{\theta}} \geq 1$$

- This gives the unit cost

$$P = \left(\sum p_i^{\frac{\theta}{\theta-1}} \right)^{\frac{\theta-1}{\theta}}$$

- This is also the price of final good 1.

Monopolistic competition in the production of intermediate goods 3

- The intermediate good producers know that the demand for their product is given by

$$q_i = \mu \left(\frac{p_i}{P}\right)^{\frac{1}{\theta-1}} \frac{I}{P} \tag{5}$$

as, in equilibrium, the value of sales of good 1 is equal to the share of good 1 in consumer expenditure. By 0-profit, this equals the total value of purchases of the intermediates. The aggregate purchases are then the value of purchases divided with the intermediate price index.
- Assume that only labour is used as an input in production of the intermediates.
- The price charged by each intermediate good producer is then

$$p = \frac{\sigma}{\sigma - 1}\beta w$$

with $\sigma \equiv \frac{1}{1-\theta}$

Monopolistic competition in the production of intermediate goods 4

- The amount of each intermediate good produced is with free entry

$$y = \frac{\alpha(\sigma - 1)}{\beta}$$

- Assuming again that one unit of output in sector 2 requires a units of labour, and taking the price of good 2 as numeraire and assuming (like already above implicitly) Cobb-Douglas preferences, the demand for labour by sector 2 is

$$(1 - \mu) L$$

- Thus, since the rest of the labour is used by intermediate good producers, the number of intermediates produced is

$$n = \frac{\mu L}{\alpha \sigma}$$

Monopolistic competition in the production of intermediate goods 5

- Unlike in the standard final good mpc model, here the number of varieties affects the productivity in the sector 1 production. Just rewrite the production function as

$$\left(\sum_{i=1}^{n} q_i^{\theta}\right)^{\frac{1}{\theta}} = n^{\frac{1}{\theta}} y \tag{6}$$

- There are increasing returns with respect to the number of varieties produced.
- This productivity gain will be transmitted to the consumer price of good 1, and is thus a source of welfare gains.
- If two identical countries like above, begin to trade with each other without any trade barriers, the "only" thing that happens is that the number of intermediates that can be used in production increases.

Monopolistic competition in the production of intermediate goods 6

- As all production levels stay constant the aggregate production of good 1 increases. Simultaneosly its price declines, making consumers willing to buy it.
- The productivity gain remains, even though each intermediate is used only $\frac{1}{2}$ of the amount used before trade was opened, as the number of intermediates doubles:

$$(2n)^{\frac{1}{\theta}} \frac{y}{2} = 2^{\frac{1}{\theta}-1} n^{\frac{1}{\theta}} y > n^{\frac{1}{\theta}} y \tag{7}$$

- An interesting extension here would be to consider the case where also intermediates use the assembled good as an input.
- In this case, the total cost of producing the intermediate would be

$$C_i = (\alpha + \beta y_i) w^{\kappa} P^{1-\kappa} \tag{8}$$

if all costs need the same combination of labour and the assembled good and that this combination uses a Cobb-Douglas technology.

Monopolistic competition in the production of intermediate goods 6

- The aggregate production of each component is still fixed by the free entry condition, as above, and is given by the same expression as above.
- Good 1 production is now divided between the consumers and producers of the intermediates.
- The main implication of the extension is on the price of the assembled good.
- The individual intermediate price is now

$$p = \frac{\sigma}{\sigma - 1} \beta w^{\kappa} P^{1-\kappa}$$

Monopolistic competition in the production of intermediate goods 7

- The price of the assembled good is

$$P = n^{\frac{1}{1-\sigma}} p = n^{\frac{1}{1-\sigma}} \frac{\sigma}{\sigma - 1} \beta w^{\kappa} P^{1-\kappa} \Rightarrow \tag{9}$$

$$P = \left(n^{\frac{1}{1-\sigma}} \frac{\sigma}{\sigma - 1} \beta \right)^{\frac{1}{\kappa}} w$$

- This shows that the impacts on the price from increased number of varieties are now magnified due to the circular causation:
- With larger number of intermediate good varieties, assembly productivity increases.
- Thus, the price of the assembled good falls, reducing marginal cost and thereby the price of each intermediate. This feeds back to the price of the assembled good etc.
- Now, interestingly also, the equilibrium number of intermediates is different.

Monopolistic competition in the production of intermediate goods 8

- With the same assumptions as above on the production of good 2, the amount of labour that is left for intermediate good producers is μL.
- The demand for labour, by Shephard's lemma, is

$$n\kappa\left(\alpha+\beta y\right)\left(\frac{P}{w}\right)^{1-\kappa} \tag{10}$$

- Use (9) to get the demand

$$n\kappa\left(\alpha+\beta y\right)\left(\left(n^{\frac{1}{1-\sigma}}\frac{\sigma}{\sigma-1}\beta\right)^{\frac{1}{\kappa}}\right)^{1-\kappa}$$

Monopolistic competition in the production of intermediate goods 9

- The equilibrium condition is, after substituting the equilibrium output of the intermediate producer

$$n^{\frac{1-\kappa\sigma}{\kappa(1-\sigma)}}\alpha\sigma\left(\frac{\sigma}{\sigma-1}\beta\right)^{\frac{1-\kappa}{\kappa}} = \mu L \tag{11}$$

- Assume that $\kappa\sigma > 1$ (this seems to be a stability condition) which implies that $0 < \frac{1-\kappa\sigma}{\kappa(1-\sigma)} < 1$.
- As the market for the final good 1 grows, the number of intermediates produced grow proportionately faster.

Monopolistic competition in the production of intermediate goods 10

- There is a new channel for trade effects:
- The access, through trade, to additional varieties increases productivity in production of good 1.
- Thus, its price falls.
- This induces, in existing firms, substitution away from labour to the assembled good.
- Thus, with a given number of firms, demand for labour falls.
- To preserve the equilibrium, new firms must enter.
- Thus, in equilibrium with trade, both countries produce a larger number of varieties.
- This is the productivity impact from international production networks.
- In the labour market, old firms reduce employment through rationalisation, new firms employ labour.

Monopolistic competition in the production of intermediate goods 11

- Jobs are destroyed in old firms and created in new firms.
- At the same time, component imports from abroad increase: this looks as if jobs were outsourced abroad.

Firm Heterogeneity and Trade 1

- There is plenty of evidence that in a given industry heterogeneity among firms (size, productivty etc) exists and persists.
- Should be taken into account when evaluating the impacts of expansion of trade, for example.
- Exporting firms seem to be larger and more productive, but is this because of exports or is it just selection to exports?
- Tybout et. al.: Mainly selection.
- The first model: Melitz 2003, ECTA.
- Monopolistic competition: Easy to model the existence of different firms (varieties) and add heterogeneity among them.

Firm Heterogeneity and Trade 2

- Assume the economy is divided in two sectors, one producing under perfect competition a homogenous good, one differentiated goods.
- The consumer utility function is

$$U = C_M^{\mu} C_A^{1-\mu}$$

where M = differentiated good sector, A = homogenous good sector, and

$$C_M = \left(\int_0^N c\left(i\right)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}$$

- This gives the demand for individual varieties as before

$$c\left(i\right) = \frac{p\left(i\right)^{-\sigma}}{P^{1-\sigma}} \mu Y$$

and

$$P = \left(\int_0^N p\left(i\right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}$$

Firm Heterogeneity and Trade 3

- Labor is the only factor of production in both sectors.
- In sector A the production of one unit of requires one unit of labor. Choose the price of A as the numeraire and we have

$$1 = p = w$$

- In M-sector it is assumed that firms that plan to produce have to employ, **before starting producing**, persons inventing a blueprint for the new product.
- The number of people needed is F_E.
- The expected lifetime profits of the firm must cover this cost.
- Lifetime: In each period firms have a Poisson hazard rate δ of having to cease operating.

Firm Heterogeneity and Trade 4

- After planning of the new product has ended (success is certain) the firm organizes its production activities.
- There is uncertainty on how successful a firm is in building its processes: the firm draws its (un)productivity parameter, the unit labor requirement, $a(i)$ from a distribution $G(a)$.
- After the draw the firm makes a decision on whether to start producing.
- This is necessary also as it has to market the new product, thereby employing F_D persons who do not directly contribute to the production process.
- The expected operating profit has to cover this.

Firm Heterogeneity and Trade 5

- The operating profit is

$$\pi(i) = p(i)\,c(i) - a(i)\,wc(i) = [p(i) - a(i)]\,c(i)$$

- With monopolistic competion firms set the price

$$p(i) = \frac{\sigma}{\sigma - 1} a(i)\,w = \frac{\sigma}{\sigma - 1} a(i)$$

and

$$\begin{aligned} [p(i) - a(i)]\,c(i) &= \left[\frac{\sigma}{\sigma - 1} a(i) - a(i)\right] c(i) = \\ \frac{a(i)\,c(i)}{\sigma - 1} &= \frac{p(i)\,c(i)}{\sigma} \end{aligned}$$

Firm Heterogeneity and Trade 6

- With the demand function we have

$$p(i)\,c(i) = \left(\frac{p(i)}{P}\right)^{1-\sigma} \mu L$$

as labor is the only primary factor. Use the mark-up pricing to get

$$\left(\frac{p(i)}{P}\right)^{1-\sigma} \mu L = \left(\frac{\frac{\sigma}{\sigma-1}a(i)}{P}\right)^{1-\sigma} \mu L = a(i)^{1-\sigma}\left(\frac{\frac{\sigma}{\sigma-1}}{P}\right)^{1-\sigma} \mu L$$

and

$$\pi(i) = \frac{p(i)\,c(i)}{\sigma} = a(i)^{1-\sigma}\left(\frac{\frac{\sigma}{\sigma-1}}{P}\right)^{1-\sigma} \frac{\mu L}{\sigma}$$

Firm Heterogeneity and Trade 7

- Expected operating profit has to cover the marketing cost.
- Expected operating profit is

$$\frac{\pi(i)}{\delta}$$

- Thus, only productive enough firms choose to start production, with the least productive firm to operate being the one with

$$\frac{\pi(i)}{\delta} = F_D \Leftrightarrow a(i)^{1-\sigma}\left(\frac{\frac{\sigma}{\sigma-1}}{P}\right)^{1-\sigma}\frac{\mu L}{\sigma} = F_D \Leftrightarrow$$

$$a(i)^{1-\sigma}B = \delta\sigma F_D$$

- Here

$$B \equiv \left(\frac{\frac{\sigma}{\sigma - 1}}{P} \right)^{1-\sigma} \mu L$$

- Clearly, as $\sigma > 1$, only firms with low enough unit labor requirement will start producing.
- Let that critical unit labor requirement be

$$a_D = \left[\frac{\left(\frac{\frac{\sigma}{\sigma - 1}}{P} \right)^{1-\sigma} \mu L}{\delta \sigma F_D} \right]^{\frac{1}{\sigma - 1}}$$

- Larger markets can, ceteris paribus, support more inefficient firms.

- But firms thinking of starting the planning process know all this. With free entry they will start planning only if the expected productivity is high enough so that expected operating profits can cover he planning costs:

$$\int_0^{a_D} \left(a^{1-\sigma} B - \delta\sigma F_D\right) dG\left(a\right) = F_E \tag{12}$$

- This condition determines the number of varieties produced (B or the price level).
- How does one go ahead?

Firm Heterogeneity and Trade 10

- For analytic solutions the standard practice is to assume that the the distribution for the labor productivity is Pareto-distribution with distribution function

$$H(b) = 1 - \left(\frac{\kappa}{b}\right)^{\theta}$$

Since $a \equiv \frac{1}{b}$

$$P\{a \leq z\} = P\left\{\frac{1}{b} \leq z\right\} = P\left\{b \geq \frac{1}{z}\right\} =$$

$$\left(\frac{\kappa}{\frac{1}{z}}\right)^{\theta} = (\kappa z)^{\theta}$$

- The cdf for the unit labor requirement is thus

$$G(a) = (\kappa a)^{\theta} = a^{\theta}$$

with $\kappa = 1$.

Firm Heterogeneity and Trade 11

- One can now solve B from (12).