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Cost Asymmetry and Taxation: Implications for Multinational Activity

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Abstract

This paper presents a novel approach to examining multinationality which features the associated proximity versus concentration trade-off. Borrowing an important tool that is widely used in the strategic trade policy literature, I employ a third country model to examine the effects of a specific policy initiative and a firm-specific advantage on individual firm configuration. The main findings are that taxes hurt the inefficient firm more, causing it to choose the exporting rather than the multinational method of serving markets. Consequently, multinational production is associated with cost-efficiency while the inefficient firm is more likely to be an exporter.

Cost Asymmetry and Taxation: Implications for Multinational Activity

1.1 Introduction

This paper presents a novel approach to examining multinationality, which features the associated proximity versus concentration trade-off. Borrowing an important tool that is widely used in the strategic trade policy literature, I employ a third-country model[1] to examine the effects of a specific policy initiative on individual firm configuration. The adoption of this tool allows me to derive explicit results, which are summarised in a simple diagram. In addition, I introduce a firm-specific advantage as a method of introducing the idea of firm asymmetry, a progression not previously exploited in the literature to date. I do this to examine how firm asymmetry (on the basis of cost) affects the method firms choose to serve a market. For example, are cost-efficient firms more likely to be multinational?

Previous literature has relied heavily on the assumption of homogeneity between firms. Broadly speaking, this literature falls into two main strands: the strategic and non-strategic literature. The strategic literature concentrates on the idea of mutual firm interdependence, where the profit of one firm is directly affected by the strategy choice of the rival firm(s) and where multinational behaviour can act as a deliberate motive to gain market share. Strategic considerations would not arise under conditions of perfect competition or a pure monopoly, unless potential entry is feasible. As a consequence, the strategic literature relies on simple models of oligopoly, more specifically, it tends to concentrate on duopoly models under partial equilibrium assumptions. For example, Horstmann & Markusen (1992) develop a two-firm, two-country model whereby market structure is determined endogenously by the underlying parameters of the model. Following Helpman (1985), a distinction between firm and plant specific fixed costs is made. Firm-specific fixed costs (F) represent knowledge-based assets, divisible across plants, constituting a once-off payment. This firm-specific fixed cost is distinct from plant-specific fixed costs (G) that must also be incurred at a plant level. Whereas a potential competitor in a host country must incur both firm- and plant-specific fixed costs, a multinational need only incur the associated plant-specific fixed cost. On the other hand, per unit transport costs must be incurred on all exports from the respective domestic countries. Thus the proprietary asset advantage referred to by Dunning (1981) is represented in this instance by the given technology (F), which generates economies of multi-plant production. Marginal costs are constant and uniform across firms. Each country

produces a homogenous good Z. A firm in country h produces a good X with increasing returns to scale whereas a firm in country f produces a symmetric substitute good Y. Equilibrium results from a two-stage game. In stage one, firms choose the method (if at all) to serve their respective markets. In stage two, the producers play a Cournot game. Moves are simultaneous and the game is solved by backward induction. The range of Nash equilibrium outcomes include the single plant duopoly (exporting), the two-plant duopoly (multinationality) and the two-plant monopoly (multinational monopoly) and depend on the relative sizes of F, G, and transport costs (t). Multinational behaviour arises the greater are increasing returns at a corporate level (F) relative to those at a plant level (G). It also arises the greater are fixed costs F (at a corporate level) and transport cost relative to plant-specific fixed costs G. The market structure is a function of the underlying given technology.

The non-strategic literature is characterised (almost without exception) by models that include a differentiated goods sector. This, coupled with free-entry assumptions lead to models of monopolistic competition, with increasing returns acting as a possible motivation for the emergence of multinational behaviour. Brainard (1993) examines the emergence of multinationalism in a differentiated goods sector, concentrating on the proximity versus concentration argument. Multinationality supplants two-way trade the greater are transport costs relative to fixed plant costs. It also emerges the greater are increasing returns at a corporate level relative to those at a plant level. The analysis also permits the emergence of national firms in equilibrium, a consideration not explored in the Horstmann & Markusen model. In another model, Markusen & Venables (1998) explore the role of factor endowments in determining the existence of multi-plant firms, extending previous analysis by Helpman (1984) & Helpman & Krugman (1985) by introducing trade costs. Furthermore, they use these tools to introduce and endogenise firm asymmetry. That is, in their model costs (both variable and fixed) are measured in terms of labour costs, which in turn are directly related to factor endowments, a standard feature of the Hechscher-Ohlin model. Again they concentrate on the proximity versus concentration trade-off and distinguish between plant and firm specific fixed costs. They also make allowances for the existence of national firms in equilibrium. Here, multi-pant production is associated with similarities in country size and relative factor endowments. Furthermore, low transport costs are associated with a contraction of multinationalism, similarly any increases in fixed costs causes the region where multinationals exist to contract.

The model I present below adopts the basic structure of the Horstmann & Markusen model. For instance, the two-stage game set-up persists, while I too, concentrate on the proximity versus concentration tension between multi-plant production and trade. However, unlike the Horstmann

[1] The “third market model” referred to in the text is due to Brander (1995). See also Brander & Spencer (1985).

and Markusen's model, I do not make the distinction between fixed costs incurred at a plant and corporate level. Instead I presume, quite simply, that multinationalism is associated with a sunk fixed cost G. Also, in contrast to a reciprocal-market model, I use a third market model. As a consequence, rival oligopolist firms produce for, and compete only in a third market. This permits one to ignore competition effects in domestic markets and instead concentrate on the relationship between firms' cost-structure and multi-plant production. Furthermore, since in this model policy is effective only when firms choose to be multinational,[2] it allows me to consider the interaction between, policy and firm-heterogeneity on individual firm configuration. Finally, unlike the Markusen & Venables model, I examine asymmetry that is derived purely from cost-efficiency discrepancies between firms and its consequences for multinationality.

The basic assumptions of the model are set out in section 1.2. In section 1.3 and 1.4 I present the results for the basic model and for the case of taxation. In section 1.5 I extend the analysis to consider firm asymmetry and in section 1.6 I present these results in the context of taxation. The final section 1.7 presents some concluding remarks of the paper.

1.2 The Basic Model – Assumptions and Notation

Suppose there are two firms, Firm 1 and Firm 2, potentially multinational, each located in their respective home markets, (Country 1 and 2). Initially, both firms serve their own markets with a homogeneous good. Production of the good is characterised by increasing returns to scale. Thus each firm has an incentive to expand current production and exploit further, existing economies of scale. This provides them with the incentive to serve a third market, Country 3. This market has a potential demand for the good, which is not being met by indigenous industry. However, there exists the following tension: if a firm wishes to exploit advantages associated with concentration it must incur the necessary transport-costs associated with transferring the good from the site of production to the site of consumption. Alternatively, if a firm wishes to exploit proximity advantages associated with locating production within the host or third country, it must absorb the additional costs of establishing a plant there. The problem is represented in a two-stage game. Firstly, firms must decide whether or not to enter the third market. Assuming entry, they must decide whether to serve the market via exports, or to serve the market via local production i.e. becoming multinational. In the second stage of the game, firms simultaneously

[2] In this model, the role of domestic governments in Country 1 and 2 is ignored. Instead firms face a pure profit tax (levied by the government of the third country) only when firms choose to locate production in the third country.

choose their outputs in a quantity-setting game. Thus, contrary to previous work which concentrates to a large extent on reciprocal market models, in this model, firms compete only in a third market. As a consequence, competition in domestic markets for market share does not occur. Thus the analysis here allows one to concentrate on the relationship between firms' costs and its ability to serve a market.

Each firm produces the good at a constant marginal cost determined by the parameters c and λ. Whereas c is a variable cost component, λ measures the cost advantaged (disadvantage) for Firm 1 (Firm 2). The marginal cost functions for the two firms are therefore:

$$\textbf{Firm 1}:\ c+\frac{1}{2}\lambda \tag{1}$$

$$\textbf{Firm 2}:\ c-\frac{1}{2}\lambda \tag{2}$$

where

$$-2c \prec \lambda \prec 2c \tag{3}$$

For each unit of the good exported, firms must pay an amount t, which represents the cost of transporting the good. On the other hand multinationals must incur a fixed cost G, representing the cost of opening an additional plant.

Country 3 has the following linear inverse demand function:

$$p = 1 - q_1 - q_2 \tag{4}$$

where q_1 is the output supplied by Firm 1 and q_2 is the output supplied by Firm 2.

The profit functions associated with selling the good to the third country, under the alternative production strategies appear as equations (49) to (56) (when a=0) in section A.2 of the Appendix[3].

Each profit expression contains a variable profit element, namely operating profits, while those profit expressions associated with multinational behaviour contain an additional fixed cost element. While the parameters c, λ and t determine operating profits, the parameter G represents the fixed cost associated with multi-plant production. It may be worth noting that operating profits depend positively on a firm's relative efficiency. In this model, positive values of

[3] A full derivation of these profit expressions can be found in section A.1 of the Appendix (equations (5) to (48))

λ places Firm 1 at a cost advantage over Firm 2. The more efficient a firm is (low c and positive λ for Firm 1, or low c and negative λ for Firm 2) the higher is individual firm profit. Operating profits are also influenced by the parameter t. Transport costs serve to reduce the operating profits of a firm who incurs this cost. On the other hand, it serves to increase profit of a firm whose rival stands to incur the cost. Finally, higher operating profits are associated with monopolistic behaviour. The presence of a rival firm serves to reduce profits, especially if the rival is a multinational firm who can command a higher share of the market.

1.3 The Case of Identical Firms

In this section, I solve the game for the simplified case of symmetry between firms. This unequivocally sets the parameter λ equal to zero. This provides the reader with a reference game, which will become useful in later stages of the model. This version of the game should make explicit the tension between two key parameters of the model: t and G and their role in contributing to the emergence of multinationality as an equilibrium phenomenon.

The game is solved by backward induction. Thus, we first must obtain equilibrium outputs and hence prices and profits for each firm under every conceivable combination of the firms' stage one choice. The full derivation of these outcomes can be found in section A.1 of the Appendix. Having ultimately solved the second stage of the game, one must turn to the optimal first-stage strategy of each firm, given the strategy of the other firm. The equilibrium solution concept is Nash, where each firm makes an optimal choice given it has correct beliefs regarding its opponents optimal choice.

The Nash equilibria outcomes for a given parametrisation are depicted in Figure 1 below. On a point of notation, the equilibrium outcomes have the following representation: MM – two-plant duopoly; EE – export-duopoly; ME/EM - has firm one (two) choosing to be multinational while firm two (one) is an exporter; MO/OM – two-plant monopoly. Simply put, the strategy of exporting is denoted by "E" while "M" confirms the strategy of multinationalism. The strategy representing a firm's choice not to serve the market in question is shown by an entry of "O". The figure is generated by considering the various profit boundaries for which firms are indifferent between alternative production strategies. For example, the boundary between the regions MM and EM/ME, gives the combinations of G,t for which Firm 1 and Firm 2 are indifferent between one-plant and two-plant production (provided that the other firm is multinational).

For ease of interpretation, it may be convenient to divide the two-dimensional space of Figure 1 according to two main cost thresholds, giving rise to three distinct regions of transport cost levels.

(a) Low transport costs: At or below a cost level of $t=(1-c)/2$,[4] each firm chooses between the strategies of exporting or becoming multinational. For sufficiently low levels of G,[5] it is profitable for each firm to be multinational and we obtain the outcome MM, a two-plant duopoly or dual multinationalism. As G increases the multinational option becomes less and less attractive. Firstly, fixed costs reach a level such that it is feasible only for one firm to be multinational which leads us to the equilibria EM/ME.[6] Further increases in G induces both firms to opt out of the multinational option altogether and the EE equilibrium results.[7]

(b) Intermediate transport costs: For intermediate cost levels, and for sufficiently low levels of G,[8] both firms choose to be multinational. Beyond this critical value of G, multinationality is profitable for one firm only if the other firm opts out of the market. At higher levels of G,[9] the EE equilibrium emerges, as firms prefer to incur intermediate levels of transport costs than high fixed costs.

(c) High transport costs: At or beyond a cost level equal to $t=1-c$,[10] firms must choose to either serve the market by being multinational or to remain out of the market. Again, for sufficiently low levels of G, the multinational strategy is preferred. For instance at a fixed costs level of $G < (1-c)^2/9$,[11] the multinational duopoly MM results, while for levels of $G < (1-c)^2/9$, the multinational monopoly MO/OM are the Nash equilibrium outcomes. Firms opt out of the market altogether at a fixed cost level of $G > (1-c)^2/4$. [12]

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[4] The derivation of this condition on t can be found in Appendix A.3, equation (57).
[5] That is, $G < 4t(1-c-t)/9$ [See equation (58), Appendix A.3].
[6] That is $G > 4t(1-c-t)/9$.
[7] That is $G > 4t(1-c)/9$. [See equation (59), Appendix A.3].
[8] That is $G < (1-c)^2/9$. [See equation (61), Appendix A.3].
[9] See equation (63), Appendix A.3.
[10] The derivation of this condition on t can be found in Appendix A.3, equation (60).
[11] See equation (61), Appendix A.3.

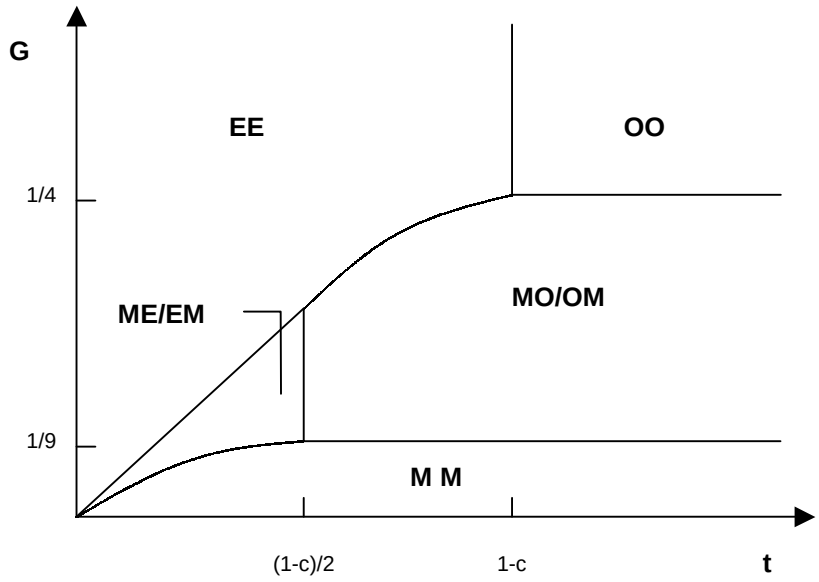

Figure 1:
Equilibria with homogenous firms

In summary, this symmetric game generates the following symmetric equilibrium outcomes: MM; EE; OO. Asymmetric outcomes, namely: ME/EM and MO/OM[13] obtain for particular G,t levels and represent the presence of the fixed cost parameter. In a particular range of G, the market can at most support one multinational. Provided transport costs are below the critical value of $t < (1-c)/2$ we obtain the outcomes ME or EM. Beyond this critical value (and assuming that the other firm is multinational) the exporting option disappears and the outcome OM or MO emerges. Overall, Figure 1 displays the following pattern: increases in t bring about the emergence of multinationalism whereas increases in G make the exporting option more popular. For sufficiently high levels of both t and G, firms do not serve the market and the OO outcome obtains in equilibrium. Alternatively, dual multi-plant production arises when fixed costs are small relative to transport cost. For intermediate values of fixed costs and transport costs, the asymmetric equilibrium ME or EM arises. Finally, when transport costs are large relative to fixed costs, the multinational monopoly structure becomes dominant. These results are analogous to that of

[12] See equation (62), Appendix A.3
[13] The determination of which outcome will emerge as an equilibrium outcome, i.e. either EM or ME, MO or OM is beyond the scope of this model.

Horstmann and Markusen (1992) and supports the tension between the two key parameters, G and t, namely fixed and transport cost, in determining individual firm plant configuration type.[14]

1.4 The Case of Taxation

This section analyses the extent to which a profit tax inhibits multinational activity. That is, in this model, the tax is levied on total profits (as opposed to operating profits) from production taking place in the third country. As a consequence, it becomes effective only if the firms from country 1 and 2 become multinational. Similarly, it can be avoided by choosing the alternative exporting strategy. Thus the following analysis will concentrate on the extent to which the tax will prohibit multinational activity. The amended profit functions appear as equations (49)-(56) in section A.2 of the Appendix.

For convenience, the results of the analysis are again presented in G,t space. This makes for ease of comparison of the pre- and post-tax sequence of equilibrium. The broken lines that feature in Figure 2 correspond to the pre-tax scenario and should act as an indicator of how the introduction of a tax has changed the equilibria regions of the G,t space. Indeed comparison of Figure 1 and 2 provide us with an overview of the extent to which the introduction of a tax could reverse previous investment decisions.

Since the emphasis here is on the effects of taxation on multinational activity, I proceed by segmenting the G,t space according to the type of equilibrium that it generates; equilibria representing multinational presence (MM, ME, EM, MO, OM) and equilibrium representing non-multinational activity (EE, OO). Note that the introduction of a profit tax has not altered the range or sequence of equilibria. However, it does alter the dominance of the opposing multinational versus exporting strategies.

(a) The multinational outcomes: It is evident from Figure 2 that regions corresponding to multinational activity have contracted in size. The tax on multinationals' profit has caused this strategy to be a less attractive method of serving the foreign market. As we move from the origin along the horizontal axis, it is evident that with taxation, the dual multinational equilibrium emerges now only at higher transport cost levels or worse trading conditions. Following on from the initial emergence of multinational activity, the pattern continues: the regions accommodating the equilibria ME, EM, MO, OM all contract. For the given

[14] With the exception that in their model, certain equilibria (namely EM/ME) are ruled out with appropriate qualifications.

parameterisation, firms are more disposed to endure the costs of exporting (t) than to endure the additional fixed costs associated with multinational activity and be penalised by taxation.

(b) The non-multinational outcomes: It is immediately obvious form Figure 2 that for the same levels of transport costs, firms are more willing than before to pursue the exporting option. The EE equilibrium is more dominant than before, encroaching areas that previously represented multinational outcomes (MM, ME, EM, OM, MO). The region OO remains unaltered.

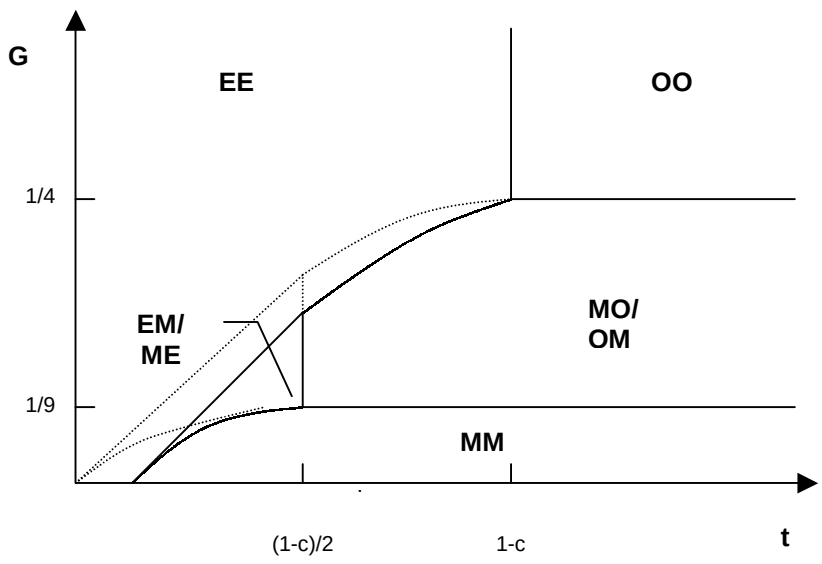

Figure 2:
Equilibria with homogenous firms and taxation (20%)

The tax serves to encourage arms length penetration of the market while it quashes proximity advantages associated with locating nearer consumers.[15] The consequences of the tax become even more compelling if one considers the possibility of cost discrepancies between firms. For example, will the implementation of a tax result in the market being served more by relatively cost-efficient firms who can more readily absorb the addition cost burden? Furthermore, are these firms more likely to be multinationals or exporters? I turn to these important questions in the following sections.

1.5 Asymmetry Between Firms

I now extend the previous analysis to consider the role of the parameter λ. Recall, λ is a variable cost parameter that measures that cost discrepancy between the two firms. Positive values of λ place firm 1 at a cost advantage whereas negative values of λ place firm 2 at a cost advantage. Here, I limit the analysis to consider positive values only, conferring a definite cost advantage of Firm 1 over Firm 2.

Before turning to the results presented by Figure 3, it is worth considering the likely impact of positive λ in the equilibrium space. In section 1.3 I mentioned two variable cost thresholds, above which (for a given value of G), firms found the ME/EM and EE outcomes unprofitable. With asymmetry between firms these two thresholds still exist but at different cost levels depending on the firm in question.[16] For example, the thresholds are higher for the more cost-efficient firm, thus efficiency offering more extensive production possibilities for that firm. The converse is true for the cost-inefficient firm. As a result, the regions corresponding to the various equilibrium regimes will undoubtedly alter in the G,t space. Furthermore, it will also be responsible for the emergence of new regions corresponding to asymmetric equilibria, namely MO/EM, MO and EO. With this in mind, we can now turn our attention to the results of the full (asymmetric) model, presented as Figure 3 below.

For analytical purposes, I proceed by dividing the G,t space into five regions according to four threshold values for t, referred to as t_1*-t_4* in equations (64) to (67) in section A.3 of the Appendix. t_1* and t_2* represent threshold values, beyond which Firms 1 and 2 (respectively) find it unprofitable to be an exporter facing a multinational rival. t_3* and t_4* represent threshold values beyond which Firms 1 and 2 (respectively) find the exporting strategy unprofitable. In each region, each firm chooses its strategy from a range of potential strategy options: exporting, becoming multinational or opting out of the market altogether. However the range of available strategy choices is not static, nor are they identical between firms as we move from region to region. In region one, three and five, both the efficient and inefficient firm choose from the same range of available strategy choices. In regions two and four, owing to cost discrepancies, their possible strategy choices differ.

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[15] At higher taxation levels this pattern becomes more exaggerated with regions hosting the exporting duopoly outcome expanding at the expense of those regions hosting multinational outcomes. At a tax level of approx. 78%, the region hosting the outcome ME/EM disappears altogether.

[16] See equations (64) – (67) is section A.3 of the Appendix.

(a) O-t_1*: At or below a cost level of $t_1^* = \frac{1}{2}\left(1-c-\frac{3}{2}\lambda\right)$, each firm chooses between the strategies of exporting or becoming multinational. For sufficiently low levels of G[17], it is profitable for both firms to engage in multinational behaviour and the equilibrium outcome MM obtains in equilibrium. With cost asymmetry, increases in G mean that the cost inefficient firm finds it increasingly difficult to absorb the fixed cost associated with becoming multinational. As a result, for fixed costs immediately beyond the initial value for G,[18] the equilibrium outcome ME is dominant. There also exists a small region, within the region corresponding to the ME outcome,[19] where both firms find it profitable to be multinational provided that the rival firm is not (i.e. the rival firm will be an exporter in this region). It may be worth noting that the following regions corresponding to multinational behaviour, EM/ME and MM have contracted in comparison to the symmetric case (Figure 1). In addition we witness the emergence of a new region, namely ME. That is, firm one who is faced with a cost advantage is now in a better position to absorb the fixed costs of opening an additional plant. Firm two, on the other hand, being at a cost disadvantage, is now less willing to become multinational. Furthermore, Firm 2 finds it increasingly difficult to be an exporter competing with a cost-efficient multinational. For sufficiently high fixed cost levels,[20] both firms choose to be exporters and the equilibrium outcome EE results.

(b) t_1*- t_2*: In this region, where, $t_1^* = \frac{1}{2}\left(1-c-\frac{3}{2}\lambda\right)$ and $t_2^* = \frac{1}{2}\left(1-c+\frac{3}{2}\lambda\right)$ each firm chooses between the strategies of exporting or becoming multinational. However, it is now no longer profitable for Firm 2 (as an exporter) to compete with Firm 1 (as a multinational). As a result, in this region the equilibrium outcome ME disappears and is replaced by the equilibrium outcome MO. For sufficiently low levels of G,[21] both firms choose the multinational option and the dual-plant duopoly MM emerges in equilibrium. Beyond this value of G, the market can at most support one multinational firm. Initially this opportunity is afforded to Firm 1 and the multinational monopoly outcome MO emerges. As fixed costs increase,[22] Firm 2 will enter as a multinational only if Firm 1 chooses the exporting option. Otherwise it opts out of the

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[17] That is, $G \prec \frac{4}{9}\left(1-c-\frac{3}{2}\lambda-t\right)t$ [See equation (68) in section A.3 of the Appendix.]

[18] That is, $G \succ \frac{4}{9}\left(1-c-\frac{3}{2}\lambda-t\right)t$ [See equation (68) in section A.3 of the Appendix].

[19] That is, $G \succ \frac{4}{9}\left(1-c+\frac{3}{2}\lambda-t\right)t$ and $G \prec \frac{4}{9}\left(1-c-\frac{3}{2}\lambda\right)t$ [See equations (69) and (70) in section A.3 of the Appendix].

[20] That is, $G \succ \frac{4}{9}\left(1-c+\frac{3}{2}\lambda\right)t$ [See equation (71) in section A.3 of the appendix].

[21] That is, $G \prec \frac{1}{18}\left(1-c-\frac{3}{2}\lambda\right)^2$ [See equation (72) in section A.3 of the Appendix].

[22] That is $G \succ \frac{4}{9}\left(1-c+\frac{3}{2}\lambda-t\right)t$ [See equation (69) in section A.3 of the Appendix].

market altogether. This brings us to the region EM/MO in the figure below. Further increases in fixed cost G[23] leads Firm 1 to enter the market as a multinational. Since Firm 2 cannot compete (profitably) with a multinational in this region, the outcome MO obtains in equilibrium. As fixed costs increase further,[24] both firms can enter the market as exporters and the exporting duopoly emerges again in equilibrium.

(c) t_2* - t_3*: In this region, where $t_2^* = \frac{1}{2}\left(1-c+\frac{3}{2}\lambda\right)$ and $t_3^* = 1-c-\frac{3}{2}\lambda$ **,** both firms choose between the strategy of exporting and becoming multinational. It emerges that in a particular range of G, it is only profitable for a firm to be multinational only if the rival firm opts out of the market. For sufficiently low levels of G[25] the dual-plant duopoly emerges again. Beyond this value of G, it is profitable for Firm 1 to stay multinational in this region, on the other hand, Firm 2 cannot compete with a multinational in this region and opts out of the market leading to the MO outcome. For higher levels of G,[26] it is profitable for either of the two firms to become multinational, provided that the rival firm opts out. In other words, the market can at most support one multinational firm. As fixed costs increase further,[27] this possibility is no longer feasible for Firm 2 and the equilibrium MO results. For sufficiently high levels of G,[28] neither firm finds a dual-plant strategy profitable and the exporting duopoly outcome EE results in equilibrium.

(d) t_3* - t_4*: In this region of both high transport and fixed cost, where $t_3^* = 1-c-\frac{3}{2}\lambda$ and $t_4^* = 1-c+\frac{1}{2}\lambda$ **,** Firm 1 chooses between the strategies of exporting and becoming multinational. Firm 2 however, no longer finds exporting a profitable strategy. It must therefore incur the fixed cost associated with a dual-plant structure if it wishes to enter the market. For low levels of G,[29] the dual-plant duopoly emerges and the MM outcome emerges in equilibrium. Beyond this fixed cost level, Firm 1 chooses to remain multinational. Firm 2 cannot compete with a multinational in this region and so the equilibrium MO results. As fixed costs continue to increase,[30] the market can once again, support one multinational, either Firm 1 or Firm 2

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[23] That is, $G \prec \frac{4}{9}\left(1-c-\frac{3}{2}\lambda\right)^2$ [See equation (70) in section A.3 of the Appendix].

[24] That is, $G \succ \frac{1}{144}\left(20-40c+32t-12\lambda+20c^2-32ct-16t^2+12\lambda c+48\lambda t-27\lambda^2\right)$ [See equation (73) in section A.3 of the Appendix].

[25] See Footnote 21.

[26] That is, $G \succ \frac{1}{18}\left(1-c+\frac{3}{2}\lambda\right)^2$ [See equation (74) in section A.3 of the Appendix].

[27] That is, $G \succ \frac{1}{144}\left(20-40c+32t+12\lambda+20c^2-32ct-16t^2-12\lambda c-48\lambda t-27\lambda^2\right)$ [See equation (75) in section A.3 of the Appendix].

[28] See Footnote 24.

[29] See Footnote 21.

[30] See Footnote 26.

and the region MO/OM persits in the equilibrium space. Further increases in G[31] make it unprofitable for the inefficient firm to remain in the market and Firm 1 enjoys a multinational monopoly while as fixed costs increase further,[32] Firm 1 enjoys an exporting monopoly and the region EO emerges for the first time.

(e) **$t > t_4$*:** In this final region, where $t_4^* = 1 - c + \frac{1}{2}\lambda$**,** the exporting strategy is no longer profitable for either firm. Consequently, each firm chooses either to be multinational or to remain out of the market. Again, for sufficiently low fixed cost levels,[33] the dual-plant duopoly MM emerges. As G increases Firm 1 persits with the strategy of multinationalism and as a consequence, Firm 2 opts out of the market and we obtain the region MO. For higher fixed cost levels,[34] Firm 2 finds it profitable to compete with Firm 1 for the multinational monopoly, which moves us into the region MO/OM. Further increases in G drive the inefficient firm out of the market leaving Firm 1 to enjoy a multinational monopoly. Finally, as G increases further,[35] neither firm will choose to serve the market and the equilibrium outcome OO obtains.

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[31] That is, $G \succ \frac{1}{4}\left(1-c-\frac{\lambda}{2}\right)^2$ [See equation (76) in section A.3 of the Appendix].

[32] That is, $G \succ \frac{1}{2}\left(1-c+\frac{\lambda}{2}-\frac{1}{2}t\right)t$ [See equation (77) in section A.3 of the Appendix].

[33] See Footnote 16.

[34] See Footnote 21.

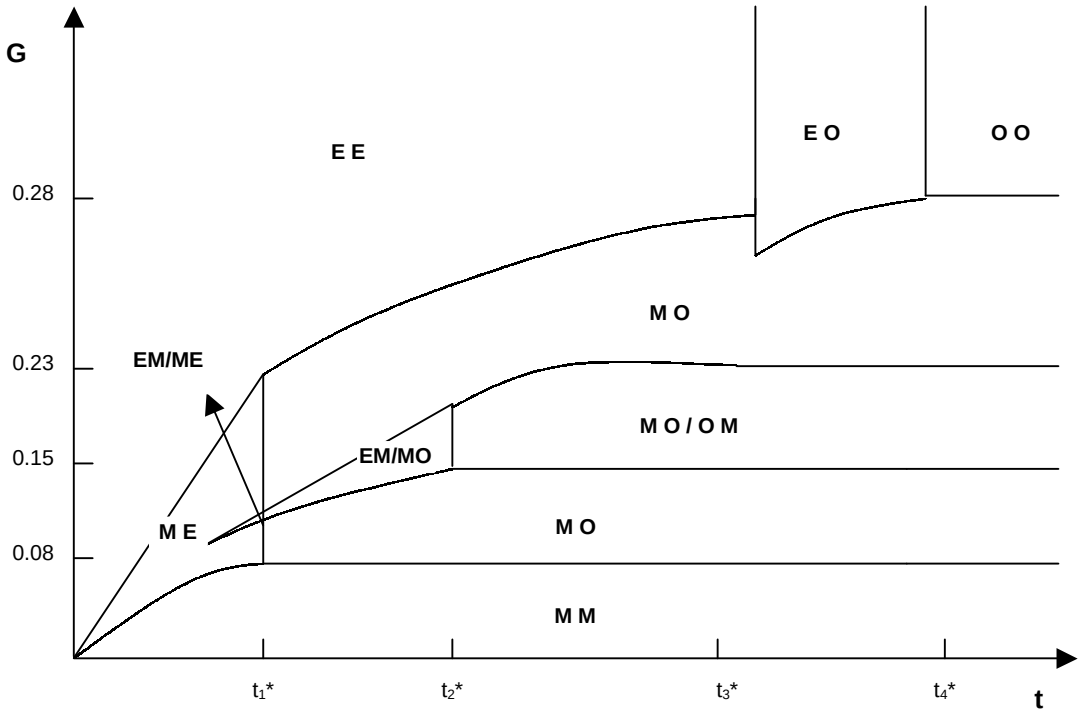

Figure 3:
Equilibria with asymmetric firms

Overall, there is a definite contraction of two-way multinationality and two-way exporting, the emergence of a multinational and exporting monopoly for the cost-efficient firm and a contraction of the region corresponding to a potential multinational monopoly for the cost-inefficient firm. Furthermore, within the overall space where a multinational monopoly is possible, for very low values of G, the efficient firm can push the inefficient firm out of the market, leading to the MO outcome. For high levels of G, the inefficient firm cannot compete with a cost efficient multinational, again leading to the MO outcome. The results follow from the premise that with lower (higher) production costs, a firm is better (less well) equipped to serve a market and indeed face competition.

[35] That is, $G \succ \frac{1}{4}\left(1-c+\frac{\lambda}{2}\right)^2$ [See equation (78) in section A.3 of the Appendix].

1.6 Asymmetry with a tax

When we considered the case of homogenous firms under conditions of taxation, we predicted that firms operating under conditions of low fixed and low transport costs (i.e. close to the origin), revised their production plans and opted for arms-length penetration of the market. This explains the shift from the MM to the EE or the EM/ME equilibrium. However in the latter case, we could not predict which firm would leave the third country. With asymmetry between firms, we can make more definite predictions. For example, consider again a firm, initially located close to the origin operating under low cost conditions, the equilibrium is MM in Figure 3 above. Next consider Figure 4 below and the implications for plant configuration under taxation. The multi-plant method for serving the foreign market is now less profitable. If the equilibrium changes, it is likely that it will be to the EE or ME outcome. Thus if only one firm changes its configuration it will be the cost-inefficient firm, multinationality is in this case associated with cost-efficiency, that is, the more cost-efficient firm can remain multinational while the inefficient firm cannot. Figure 4 also presents the full equilibrium in G,t space. The broken lines again represent the pre-tax scenario and can be used to see how the introduction of a tax has changed the dominance of certain equilibria regimes. Overall, taxation in the third country has impacted in a similar manner to that of the case of symmetry. It serves to inhibit multinational behaviour while it encourages arms-length penetration of the market. It has led to a contraction of the multinational duopoly region, an expansion of the exporting duopoly and exporting monopoly regions, a contraction of the regions EM/ME and EM/MO and the multinational monopoly regions MO and MO/OM.

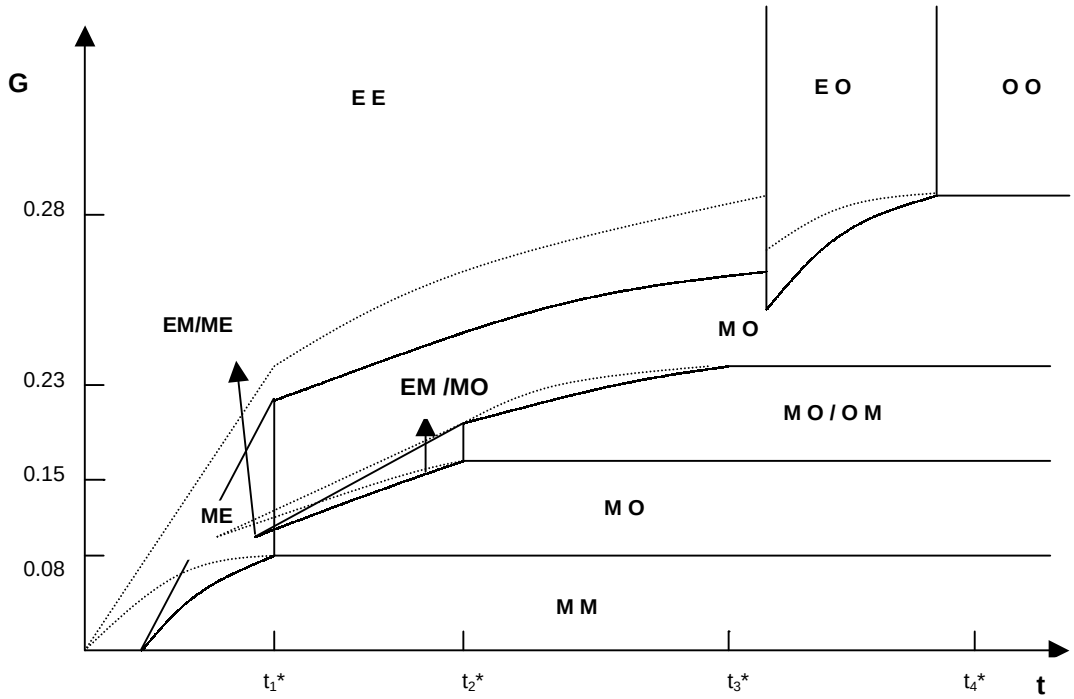

Figure 4:
Equilibria with asymmetric firms and tax (20%)

1.7 Concluding remarks

In this paper I have presented a simple third market model to illustrate the conditions under which multinational activity arises. As an extension to previous research, I impose an exogenous cost discrepancy between firms (measured by λ) to examine its influence on the method firms use to serve a given market. Although simple, the model produces a rich variety of equilibria encompassing symmetric and asymmetric outcomes. The range of these equilibrium outcomes draws our attention to the underlying tension between the various parameters of the model.

A multinational duopoly arises when fixed costs at a plant level are low relative to transport costs. On the other hand, the exporting duopoly outcome arises when transport costs are low relative to fixed costs. For low values of t and for intermediate values of G, the EM/ME outcomes obtain and for intermediate levels of both parameters, the multinational monopoly outcomes MO/OM obtain in equilibrium. Asymmetry, introduced into the model via the parameter λ, places Firm 1 at a cost advantage at the expense of Firm 2. It serves to reduce the possibility of a multinational duopoly as now Firm 2 is less capable of absorbing the fixed costs associated with multi-plant production. It also reduces the possibility of an exporting duopoly as Firm 1 is now more capable of absorbing the fixed cost and therefore more likely to opt for the multi-plant option. It is also responsible for the emergence of new regions in G,t space, accommodating new equilibrium outcomes (MO and EM/MO). They too represent Firm 1's superior ability to become multinational, while the opposite is true of Firm 2.

Taxation serves to reduce the profitability of being multinational and hence locating production in the third country. As a result, the region of G,t space occupied by multi-pant production contracts and is instead replaced by the exporting strategy. These results are consistent under conditions of asymmetry of firms. However, asymmetry considerations lend more interesting predictions to the model. Namely, the profit tax will most likely hurt the inefficient firm more, causing it to choose the exporting rather than the multinational option for serving the market. Consequently, it emerges that multinationality is associated with cost-efficiency while inefficient firms are more likely to be exporters.

It would perhaps be of use to extend the present analysis to consider the existence of a national firm in the third market. This extended model could be used once again to consider the role of cost discrepancies. For example it we initiated the analysis from the premise that national firms present in the third country are inefficient, and kept the assumption that Firm 1 is more cost-efficient than Firm 2, the introduction of a tax may well lead to the market being served by a larger proportion of inefficient firms, especially if demand in the third country is characterised by a home

market bias. In addition, it may be interesting to examine tax competition between two rival foreign/host countries, and its consequences for multi-plant production under conditions of asymmetry.

Appendix

The Appendix of this paper is arranged in the following manner. The first section, section A.1, derives the basic equations of the model and show how equilibrium outputs, prices and profits are solved for. The next section, section A.2 is a summary of profit expressions post-tax. The last section, section A.3 should act as an accompaniment to the four diagrams presented throughout the body of the text. It shows how various critical values and thresholds were solved for in the symmetric and asymmetric games.

A.1

The following section derives expressions for profits, and hence prices and outputs, under alternative plant configurations. To solve for the Cournot-Nash outputs, each firm maximises profits with respect to quantity. By substituting equilibrium outputs into the linear demand function, one can solve for equilibrium prices. Similarly, by substituting equilibrium outputs and prices into the profit expression, one can solve for equilibrium profits.

(A) Both firms export

Profit for Firm 1 is:

$$\pi_1 = \left(1 - q_1 - q_2 - c + \frac{1}{2}\lambda - t\right)q_1 \qquad \textbf{(5)}$$

Differentiating with respect to output (q1) gives:

$$q_1 = \frac{1}{2}\left(1 - c - q_2 + \frac{1}{2}\lambda - t\right) \qquad \textbf{(6)}$$

Profit for Firm 2 is:

$$\pi_2 = \left(1 - q_1 - q_2 - \frac{1}{2}\lambda - t\right)q_2 \qquad \textbf{(7)}$$

Differentiating with respect to output (q2) gives:

$$q_2 = \frac{1}{2}\left(1 - c - q_1 - \frac{1}{2}\lambda - t\right) \qquad \textbf{(8)}$$

Substituting equation (8) into equation (6) and solving for q1 gives Firm 1's equilibrium output:

$$q_1{*} = \frac{1}{3}\left(1 - c + \frac{3}{2}\lambda - t\right) \qquad \textbf{(9)}$$

Substituting equation (6) into equation (8) and solving for q2 gives Firm 2's equilibrium output:

$$q_2^* = \frac{1}{3}\left(1 - c - \frac{3}{2}\lambda - t\right) \quad \textbf{(10)}$$

Substituting q1* and q2* into the inverse linear demand function gives equilibrium prices:

$$p^* = \frac{1}{3}\left(1 + 2c + 2t\right) \quad \textbf{(11)}$$

Substituting equilibrium outputs (q1* and q2*) and equilibrium prices (p*) into the profit expression gives equilibrium profits for Firm 1 and Firm 2 respectively:

$$\pi_1^* = \frac{1}{9}\left(1 - c + \frac{3}{2}\lambda - t\right)^2 \quad \textbf{(12)}$$

$$\pi_2^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - t\right)^2 \quad \textbf{(13)}$$

(B) Both firms are multinational

Profit for Firm 1 is:

$$\pi_1 = \left(1 - q_1 - q_2 - c + \frac{1}{2}\lambda\right)q_1 - G \quad \textbf{(14)}$$

Differentiating with respect to output (q1) gives:

$$q_1 = \frac{1}{2}\left(1 - c - q_2 + \frac{1}{2}\lambda\right) \quad \textbf{(15)}$$

Profit for Firm 2 is:

$$\pi_2 = \left(1 - q_1 - q_2 - c - \frac{1}{2}\lambda\right)q_2 - G \quad \textbf{(16)}$$

Differentiating with respect to output (q2) gives:

$$q_2 = \frac{1}{2}\left(1 - c - q_1 - \frac{1}{2}\lambda\right) \quad \textbf{(17)}$$

Substituting equation (17) into equation (15) and solving for q1 gives Firm 1's equilibrium output:

$$q_1^* = \frac{1}{3}\left(1 - c + \frac{3}{2}\lambda\right) \quad \textbf{(18)}$$

Substituting equation (15) into equation (17) and solving for q2 gives Firm 2's equilibrium output:

$$q_2^* = \frac{1}{3}\left(1 - c - \frac{3}{2}\lambda\right) \quad \textbf{(19)}$$

Substituting q1* and q2* into the inverse linear demand function gives equilibrium prices:

$$p^* = \frac{1}{3}(1 + 2c) \quad \textbf{(20)}$$

Substituting equilibrium outputs (q1* and q2*) and equilibrium prices (p*) into the profit expression gives equilibrium profits for Firm 1 and Firm 2 respectively:

$$\pi_1^* = \frac{1}{9}\left(1 - c + \frac{3}{2}\lambda\right)^2 - G \quad \textbf{(21)}$$

$$\pi_2^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda\right)^2 - G \quad \textbf{(22)}$$

(C) Firm 1 is multinational. Firm 2 exports

Profit for Firm 1 is:

$$\pi_1 = \left(1 - q_1 - q_2 - c + \frac{1}{2}\lambda\right)q_1 - G \quad \textbf{(23)}$$

Differentiating with respect to output (q1) gives:

$$q_1 = \frac{1}{2}\left(1 - c - q_2 + \frac{1}{2}\lambda\right) \quad \textbf{(24)}$$

Profit for Firm 2 is:

$$\pi_2 = \left(1 - q_1 - q_2 - c - \frac{1}{2}\lambda - t\right)q_2 \quad \textbf{(25)}$$

Differentiating with respect to output (q2) gives:

$$q_2 = \frac{1}{2}\left(1 - c - q_1 - \frac{1}{2}\lambda - t\right) \quad \textbf{(26)}$$

Substituting equation (26) into equation (24) and solving for q1 gives Firm 1's equilibrium output:

$$q_1{}^* = \frac{1}{3}\left(1 - c + \frac{3}{2}\lambda + t\right) \quad \textbf{(27)}$$

Substituting equation (24) into equation (26) and solving for q2 gives Firm 2's equilibrium output:

$$q_2{}^* = \frac{1}{3}\left(1 - c - \frac{3}{2}\lambda - 2t\right) \quad \textbf{(28)}$$

Substituting q1* and q2* into the inverse linear demand function gives equilibrium prices:

$$p^* = \frac{1}{3}\left(1 + 2c + t\right) \quad \textbf{(29)}$$

Substituting equilibrium outputs (q1* and q2*) and equilibrium prices (p*) into the profit expression gives equilibrium profits for Firm 1 and Firm 2 respectively:

$$\pi_1{}^* = \frac{1}{9}\left(1 - c + \frac{3}{2}\lambda + t\right)^2 - G \quad \textbf{(30)}$$

$$\pi_2{}^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - 2t\right)^2 \quad \textbf{(31)}$$

(D) Firm 1 is an exporter. Firm 2 is multinational

Profit for Firm 1 is:

$$\pi_1 = \left(1 - q_1 - q_2 - c + \frac{1}{2}\lambda - t\right)q_1 \quad \textbf{(32)}$$

Differentiating with respect to output (q1) gives:

$$q_1 = \frac{1}{2}\left(1 - c - q_1 + \frac{1}{2}\lambda - t\right) \quad \textbf{(33)}$$

Profit for Firm 2 is:

$$\pi_2 = \left(1 - q_1 - q_2 - c - \frac{1}{2}\lambda\right)q_2 - G \qquad \textbf{(34)}$$

Differentiating with respect to output (q2) gives:

$$q_2 = \frac{1}{2}\left(1 - c - q_1 - \frac{1}{2}\lambda\right) \qquad \textbf{(35)}$$

Substituting equation (35) into equation (33) and solving for q1 gives Firm 1's equilibrium output:

$$q_1{}^* = \frac{1}{3}\left(1 - c + \frac{3}{2}\lambda - 2t\right) \qquad \textbf{(36)}$$

Substituting equation (33) into equation (35) and solving for q2 gives Firm 2's equilibrium output:

$$q_2{}^* = \frac{1}{3}\left(1 - c - \frac{3}{2}\lambda + t\right) \qquad \textbf{(37)}$$

Substituting q1* and q2* into the inverse linear demand function gives equilibrium prices:

$$p^* = \frac{1}{3}\left(1 + 2c + t\right) \qquad \textbf{(38)}$$

Substituting equilibrium outputs (q1* and q2*) and equilibrium prices (p*) into the profit expression gives equilibrium profits for Firm 1 and Firm 2 respectively:

$$\pi_1{}^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - 2t\right)^2 \qquad \textbf{(39)}$$

$$\pi_2{}^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - 2t\right)^2 - G \qquad \textbf{(40)}$$

(E) Firm 1 as a multinational monopolist

Profit for Firm 1 is:

$$\pi_1 = \left(1 - q_1 - c + \frac{1}{2}\lambda\right)q_1 - G \qquad \textbf{(41)}$$

Differentiating with respect to output (q1) and solving gives:

$$q_1{}^* = \frac{1}{2}\left(1 - c + \frac{1}{2}\lambda\right) \qquad \textbf{(42)}$$

Substituting q1* and into the inverse linear demand function gives equilibrium prices:

$$p^* = \frac{1}{2}\left(1 + c - \frac{1}{2}\lambda\right) \quad \textbf{(43)}$$

Substituting equilibrium output (q1*) and equilibrium prices (p*) into equation (41) gives equilibrium profit:

$$\pi_1{}^* = \frac{1}{4}\left(1 - c + \frac{1}{2}\lambda\right)^2 - G \quad \textbf{(44)}$$

(F) Firm 2 as a multinational monopolist

Profit for Firm 2 is:

$$\pi_2 = \left(1 - q_2 - c - \frac{1}{2}\lambda\right)q_2 - G \quad \textbf{(45)}$$

Differentiating with respect to output (q2) gives:

$$q_2{}^* = \frac{1}{2}\left(1 - c - \frac{1}{2}\lambda\right) \quad \textbf{(46)}$$

Substituting q2* and into the inverse linear demand function gives equilibrium prices:

$$p^* = \frac{1}{2}\left(1 + c - \frac{1}{2}\lambda\right) \quad \textbf{(47)}$$

Substituting equilibrium output (q2*) and equilibrium prices (p*) into equation (45) gives equilibrium profit

$$\pi_2{}^* = \frac{1}{4}\left(1 - c - \frac{1}{2}\lambda\right)^2 - G \quad \textbf{(48)}$$

The introduction of a tax on profits does not impose much complexity on the stated model. Recall that the tax is on “pure” profits derived from production in the third country only. Consequently, it affects only those firms who become multinational and open an additional plant in the third country. Hence, profits firm the following plant configurations; Π_1(MM); Π_2(MM); Π_1(ME); Π_2(EM); Π_1(MO); Π_2(OM), will be reduced to (1-a) the original amount, where “a” is the value of the tax. The expressions for profit, taking taxation into account follow in the next section of the Appendix.

A.2

The following is a list of profit expressions for the model, post-tax.

Profits with taxation

Both firms export

$$\pi_1{}^* = \frac{1}{9}\left(1 - c + \frac{3}{2}\lambda - t\right)^2 \tag{49}$$

$$\pi_2{}^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - t\right)^2 \tag{50}$$

Both firms are multinational

$$\pi_1{}^* = (1-a)\left\{\frac{1}{9}\left[1 - c + \frac{3}{2}\lambda\right]^2 - G\right\} \tag{51}$$

$$\pi_2{}^* = (1-a)\left\{\frac{1}{9}\left[1 - c - \frac{3}{2}\lambda\right]^2 - G\right\} \tag{52}$$

Firm 1 is multinational, Firm 2 is an exporter

$$\pi_1{}^* = (1-a)\left\{\frac{1}{9}\left[1 - c + \frac{3}{2}\lambda + t\right]^2 - G\right\} \; ; \; \pi_2{}^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - 2t\right)^2 \tag{53}$$

Firm 1 is an exporter, Firm 2 is a multinational

$$\pi_1{}^* = \frac{1}{9}\left(1 - c - \frac{3}{2}\lambda - 2t\right)^2 \; ; \pi_2{}^* = (1-a)\left\{\frac{1}{9}\left[1 - c - \frac{3}{2}\lambda + t\right]^2 - G\right\} \tag{54}$$

Firm 1 is a multinational monopolist

$$\pi_1{}^* = (1-a)\left\{\frac{1}{4}\left[1 - c + \frac{1}{2}\lambda\right]^2 - G\right\} \tag{55}$$

Firm 2 is a multinational monopolist

$$\pi_2 * = (1-a)\left\{\frac{1}{4}\left[1-c-\frac{1}{2}\lambda\right]^2 - G\right\} \quad \textbf{(56)}$$

A.3

Solving for critical values

(a) To solve for the value of t beyond which profit from the market structure EM/ME is negative, set Firm 1's (Firm 2's) profit arising from the market structure EM (ME) equal to zero and solve for t as a function of the other variables.

$$\bar{t}_1 = \frac{1}{2}(1-c) \quad \textbf{(57)}$$

(b) To solve for the value of G which makes a multinational firm indifferent between multi- and single plant production, given the other firm is multinational, set Firm 1's (Firm 2's) profits for the market structure MM equal to profit from the market structure EM (ME) and solve for G.

$$G = \frac{4t}{9}(1-c-t) \quad \textbf{(58)}$$

(c) To solve for the value of G which makes a multinational firm indifferent between multi- and single plant production, given the other firm is an exporter, set Firm 1's (Firm 2's) profit from the market structure EE equal to the profits from the market structure ME (EM), and solve for G.

$$G = \frac{4t}{9}(1-c) \quad \textbf{(59)}$$

(d) To solve for the value of t beyond which profit from the market structure EE is negative, set profit from the market structure EE (for either firm) equal to zero and solve for t.

$$\bar{t}_2 = 1-c \quad (60)$$

(e) To solve for the value of G at which a multinational is indifferent between serving and not serving the market, given the other firm is multinational, set Firm 1's (Firm 2's) profit from the market structure MM equal to the profit from the market structure OM (MO) and solve for G.

$$G = \frac{1}{9}(1-c)^2 \quad \textbf{(61)}$$

(f) To solve for the value of G which makes a multinational indifferent between serving and not serving the market, given the other firm is not serving the market, set Firm 1's (Firm 2's) profit from the market structure OO equal to profits from the market structure MO (OM) and solve for G:

$$G = \frac{1}{4}(1-c)^2 \qquad \textbf{(62)}$$

(g) To solve for the value of G which makes a firm indifferent between a multinational monopoly and an exporting duopoly, set Firm 1's (Firm 2's) profit from the market structure MO (OM) equal to profit from the market structure EE and solve for G:

$$G = \frac{1}{36}\left(5-10c+5c^2+8t-8ct-4t^2\right) \qquad \textbf{(63)}$$

(h) To solve for the value of t beyond which Firm 2's profit arising from the market structure ME is negative, set Firm 2's profits form the market structure ME equal to zero and solve for t:

$$t_1^* = \frac{1}{2}\left(1-c-\frac{3}{2}\lambda\right) \qquad \textbf{(64)}$$

(i) To solve for the value of t beyond which Firm1's profit arising from the market structure EM is negative, set Firms 1's profit from the market structure EM equal to zero and solve for t:

$$t_2^* = \frac{1}{2}\left(1-c+\frac{3}{2}\lambda\right) \qquad \textbf{(65)}$$

(j) To solve for the value of t beyond which Firm 2's profit from an exporting duopoly is negative, set Firm 2's profit from the market structure EE equal to zero and solve for t:

$$t_3^* = 1-c-\frac{3}{2}\lambda \qquad \textbf{(66)}$$

(k) To solve for the value of t beyond which Firm 1's profit from an exporting monopoly is negative, set Firm 1's profit from the market structure EO equal to zero and solve for t:

$$t_4^* = 1-c+\frac{1}{2}\lambda \qquad \textbf{(67)}$$

(l) To solve for the value of G which Firm 2 is indifferent between multi- and single plant production, given Firm 1 is multinational, set Firm 2's profit form the market structure MM equal to profit from the market structure ME and solve for G:

$$G = \frac{4t}{9}\left(1 - c - \frac{3}{2}\lambda - t\right) \quad \textbf{(68)}$$

(m) To solve for the value of G at which Firm 1 is indifferent between multi- and single plant production, given Firm 2 is multinational, set Firm 1's profit from the market structure MM equal to profit from the market structure EM and solve for G:

$$G = \frac{4t}{9}\left(1 - c + \frac{3}{2}\lambda - t\right) \quad \textbf{(69)}$$

(n) To solve for the value of G which makes Firm 2 indifferent between multi- and single plant production, given Firm 1 is an exporter, set Firm 2's profit from the market structure EM equal to profit from the market structure EE and solve for G:

$$G = \frac{4t}{9}\left(1 - c - \frac{3}{2}\lambda\right) \quad \textbf{(70)}$$

(o) To solve for the value of G at which Firm 1 is indifferent between multi- and single plant production, given Firm 2 is and exporter, set Firm 1's profit from the market structure ME equal to profit from the market structure EE and solve for G:

$$G = \frac{4t}{9}\left(1 - c + \frac{3}{2}\lambda\right) \quad \textbf{(71)}$$

(p) To solve for the value of G which makes Firm 2 indifferent between being multinational and not serving the market, given Firm 1 is multinational, set Firm 2's profit from the market structure MM equal to profit from the market structure MO and solve for G:

$$G = \frac{1}{18}\left(1 - c - \frac{3}{2}\lambda\right)^2 \quad \textbf{(72)}$$

(q) To solve for the value of G which makes Firm 1 indifferent between an exporting duopoly and a multinational monopoly, set Firm 1's profit from the market structure MO equal to profit from the market structure EE and solve for G:

$$G = \frac{1}{144}\left(20 - 40c + 32t - 12\lambda + 20c^2 - 32ct - 16t^2 + 12\lambda c + 48\lambda t - 27\lambda^2\right) \quad \textbf{(73)}$$

(r) To solve for the value of G which makes Firm 1 indifferent between being a multinational and not serving the market, given Firm 2 is multinational, set Firm 1's profit from the market structure MM equal to profit from the market structure OM and solve for G:

$$G = \frac{1}{18}\left(1 - c + \frac{3}{2}\lambda\right)^2 \quad \textbf{(74)}$$

(s) To solve for the value of G which makes Firm 2 indifferent between an exporting duopoly and a multinational monopoly, set Firm 2's profit from the market structure OM equal to profit from the market structure EE and solve for G:

$$G = \frac{1}{144}\left(20 - 40c + 32t + 12\lambda + 20c^2 - 32ct - 16t^2 - 12\lambda c - 48\lambda t - 27\lambda^2\right) \quad \textbf{(75)}$$

(t) To solve for the value of G which makes Firm 2 indifferent between a multinational monopoly and not serving the market, given Firm 1 will serve the market, set Firm 2's profit from the market structure MO or EO equal to profit from the market structure OM and solve for G:

$$G = \frac{1}{4}\left(1 - c - \frac{1}{2}\lambda\right)^2 \quad \textbf{(76)}$$

(q) To solve for the value of G which makes Firm 1 indifferent between a multinational monopoly and an exporting monopoly, set Firm 1's profit from the market structure MO equal to profit from the market structure EO and solve for G:

$$G = \frac{t}{2}\left(1 - c + \frac{1}{2}\lambda - \frac{1}{2}t\right) \quad \textbf{(77)}$$

(r) To solve for the value of G at which Firm 1 is indifferent between a multinational monopoly and not serving the market, given Firm 2 does not serve the market, set Firm 1's profit from the market structure MO equal to profit from the market structure OO and solve for G:

$$G = \frac{1}{4}\left(1 - c + \frac{1}{2}\lambda\right)^2 \quad \textbf{(78)}$$

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