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**AUTHOR QUERIES - TO BE ANSWERED BY THE
AUTHOR**

Dear Author

Please address all the numbered queries on this page which are clearly identified on the proof for your convenience.

Thank you for your cooperation

Q1	Blomstrom and Kokko (1998) in text but 1999 in References.	
Q2	Does ‘the lemons problem’ need to be described?	
Q3	What is meant by ‘For concreteness’? For completeness?	
Q4	‘if condition stated in equation (26) is satisfied’ But this is condition (26).	
Q5	In equations (29) and (29a), should ‘h’ be ‘H’, as in the equations (30) and (30a)?	
Q6	Text missing? Please clarify sense. ‘...the dominant channel of technology transfer to LDEs, policies to.’	
Q7	Vishwarao (1994) in text but Vishwasrao in References. Which is correct spelling?	
Q8	Table and Figure captions required.	

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Foreign Direct Investment and Technology Transfer Under Uncertainty in a Liberalizing Host Economy

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ABSTRACT This paper tackles the issue of investment and optimal 'choice' of market structure for a foreign multinational enterprise (MNE) in a newly liberalized economy under uncertainty and in the presence of sunk costs. A minimalist duopolistic model is developed whereby a foreign investor's subjective belief about the probability distribution of policy uncertainty is endogenized as a function of the aggregate output in the tradable goods sector. The main propositions derived from the model are consistent with some unconventional empirical findings in the literature on Foreign Direct Investment (FDI), technology transfer to and crowding out of domestic firms in LDEs.

KEY WORDS: Cournot, FDI, MNE, Stackelberg, technology transfer, uncertainty
JEL CODES: F21, F23, L13, O40

1. Introduction

This paper considers the hitherto rather neglected issue of the optimal 'choice' of market structure for a multinational enterprise (MNE) in a liberalizing, less developed economy (LDE). In particular, following Rodrik (1991) we develop a highly stylized model in which a foreign investor's perception of policy uncertainty is a function of the aggregate output produced by the tradable goods sector in response to the reform program. An attempt at endogenizing the probability of failure of the economic liberalization program – or more broadly, any situation that could lead to a reduction in *ex-post* capital returns – in this manner

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51 seems especially appropriate. This is so because the political economy literature
 on economic liberalization has emphasized that an integral aspect of the potential
 durability of any economic reform program is the extent and pace at which aggregate
 output responds to the policy changes. As a result, this ‘supply response’ of
 56 the economy to the reforms ought to reduce opposition to the government’s economic
 program and create entrenched interests that have a stake in ensuring its
 sustenance (Rodrik, 1991; Serven, 1997).

The remainder of this paper is organized as follows. Section 2 discusses some
 preliminaries and assumptions of the model. Section 3 solves the model and
 outlines its main implications. Section 4 relates the main implications of the
 61 model to the available empirical evidence on FDI and technology transfer to the
 host LDE and the extent of crowding out of domestic enterprises. The final section
 provides some concluding observations.

66 **2. Model Preliminaries and Assumptions**

We limit our analysis to the minimalist case where the domestic market in a newly
 LDE is large enough for at most two firms, one foreign (MNE) and one domestic
 (D), both producing identical goods. One could think of the model as a two
 71 stage sequential game which is solved by backward induction. (Figure 1 describes
 the timing of the game.) In the first stage, the MNE decides whether or not to
 invest in time period 0, and in the second stage sub-game it chooses the type of
 market structure and the concomitant output level. In the first stage, the MNE
 is assumed to have a choice between expanding production capacity in the home
 (developed) country or investing in the LDE. We assume that the MNE’s only
 76 choice is between domestic production and investing in any *single* LDE. Our focus
 is on the interactions between the MNE affiliate and the domestic firm in the LDE.

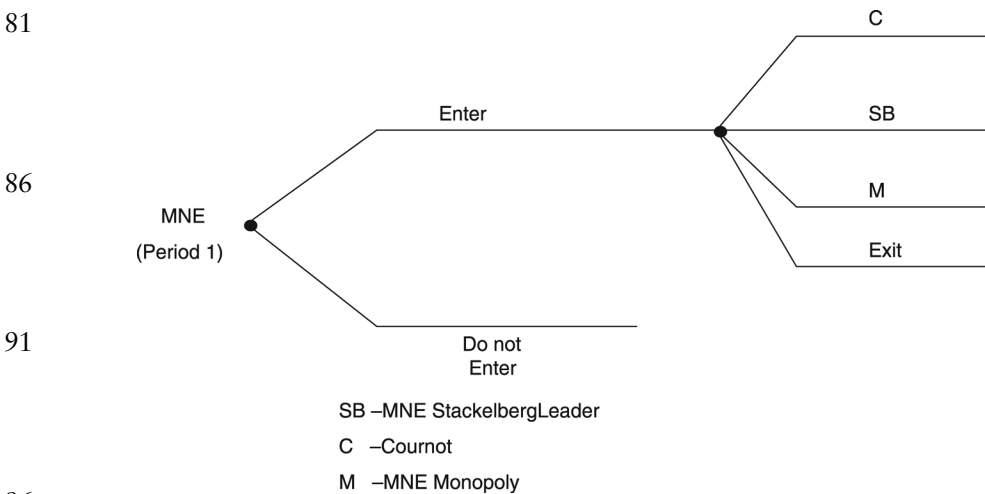


Figure 1.

101 For simplicity we assume that a risk-free, constant per period profit is
 obtainable from expanding home country capacity. In comparison, the expected
 aggregate profits from FDI are dependent on the type of market structure that is
 endogenously determined in the second stage sub-game. Specifically, in the sec-
 106 ond stage sub-game we consider a simple three-period discrete model and assume
 that, if the MNE enters the LDE (i.e. sets up production facilities) as soon as lib-
 eralization is initiated (time period 0), it can act as a Stackelberg leader vis-à-vis
 the domestic firm. The latter, while assumed already present in the market, will
 have to shift resources from the non-tradables to the tradables sector in light of
 the altered price incentives. This sectoral move of resources is presumed to entail
 111 some degree of sunk cost (Rodrik, 1991).

Following the international business and economics on MNEs (such as Dun-
 ning, 1993, chapter 11; Ethier & Markusen, 1996), the MNE is assumed to derive
 its leadership position from certain ‘knowledge-based’ firm-specific activities
 or assets such as R&D, superior technology, management and organizational
 116 know-how and marketing skills. These knowledge-based assets and activities are
 assumed to be freely appropriable by all the MNE’s subsidiaries and are embod-
 ied in the MNE’s marginal cost, thus providing the MNE with a cost advantage
 over the domestic rival (as in Sadanand, 1989). In other words we assume that
 technology is an imperfect public good – i.e. non-rival and non-excludable *intra-*
 121 *corporation* but excludable *inter-corporation*. The presence of these multi-plant
 scale economies provides the MNE with a distinct advantage over the domestic
 rival, and concomitantly seems to justify the assumption of the MNE being in a
 leadership position *à la* von Stackelberg. Counteracting this first-mover-advantage
 to the MNE is the presence of policy uncertainty regarding the durability of the
 126 liberalization program, which will diminish ex-ante returns. We make the realistic
 supposition that uncertainty only plagues the foreign investor (for instance, in the
 form of a threat of expropriation of foreign assets).

While the MNE acting as a Stackelberg leader is the status quo or default case,
 two other possibilities need to be considered. First, we consider the question of
 131 a firm’s choice between being a Stackelberg leader or a monopolist (the latter
 through pre-emption of rivals). Limiting focus to identical good, entry deterrence
 is modeled by assuming that the ‘aggressive’ firm invests in excess capacity (for
 instance, see Dixit, 1982; Friedman, 1983). Second, we explore the choice between
 Cournot and Stackelberg, a comparison that the IO literature has almost com-
 136 pletely disregarded, as conventional wisdom maintains that the profit and output
 of a Stackelberg leader always outweigh what would be attained under Cournot
 competition. Accordingly, conventional wisdom suggests that a potential market
 leader would never consider surrendering this position to compete in the sense of
 Cournot.¹

141 However, to preview the main results of the model, we show that the endoge-
 nization of foreign investor’s policy uncertainty as a function of total output in the

146 ¹Spencer & Brander (1987) is a rare exception. They show that a potential Stackelberg leader might
 forsake the leadership advantages to compete in Cournot fashion, preferring to wait until (demand)
 uncertainty is diminished. Thus, their paper can be seen as highly complementary, although distinct
 from the model developed here.

151 tradable goods sector could render the above generalization invalid. If one inter-
 156 prets the MNE sacrificing its leadership position and lowering the marginal costs
 of the domestic firm (and thus the industry) as being a consequence of technology
 transfer to the host economy's firm, this goes some way to endogenizing technol-
 ogy transfer from MNEs to the host LDE economy.² Such an interpretation of
 the model is an initial step towards formalizing the ambiguous effects of FDI on
 technology transfer to LDEs, as highlighted by Blomstrom & Kokko (1998).

3. The Model

161 As noted, to maintain focus on the interactions in the LDE we simply assume that
 the MNE can obtain an *aggregate* discounted risk-free (or certainty equivalent)
 profit of $(\Pi^{\text{MNE}})^H$ by choosing to service the foreign (third) market by expanding
 domestic production. The MNE compares this with the expected profit from
 166 investing in the LDE in determining whether to undertake FDI in the LDE (i.e. use
 the LDE as an export base). The expected profit in the LDE depends on the type
 of market structure, namely whether the MNE acts as a Stackelberg leader (status
 quo), a monopolist, or a Cournot competitor. In order to determine formally if
 and under what conditions the FDI option is chosen, it is necessary to compute the
 expected returns from investing in the LDE under alternative market structures.
 171 This is the focus of the remainder of the section.

Assume that the aggregate demand in the LDE can be represented by a quasi-
 linear utility function. This assumption allows us to abstract from income effects.
 Accordingly, utility maximization yields a linear demand schedule that can be
 written in inverted form as:

$$176 \quad P_t = a - Q_t \quad t = 1, 2 \quad (1)$$

where P = price, Q = quantity and $Q_t = (q_t^{\text{MNE}} + q_t^{\text{D}})$, the first and second
 terms in parenthesis refer to the MNE's and the domestic firm's (D) output,
 181 respectively. We have allowed for the slope of demand to be 1 without loss of
 generality for the purposes at hand.

Assume that production capacity must be built prior to entry ($t = 0$). Denote
 F^{MNE} and F^{D} to be the one-time fixed or irreversible costs that must be incurred
 by the MNE and firm D, respectively. This capital, once committed, cannot be
 186 recouped should the return on investment turn out *ex post* to be less than antic-
 ipated. Examples include costs of establishing a local presence (including those
 involved in assessing investment viability), any pre-signed contractual obligations
 that must be fulfilled, and the lemons problem due to asymmetric information

191 ²This contrasts with the bulk of the literature, which assumes such transfers to occur exogenously
 like 'manna-from-heaven' despite the overwhelming empirical literature to the contrary (Pack &
 Saggi, 1997). Wang & Blomstrom (1992) is a rare exception, in which technological spillovers are
 modelled as a differential game involving an MNE affiliate and local firm. The MNE's dynamic
 optimization objective is to choose how much to invest in the importation of new technology and the
 196 domestic firm decides how much to invest in learning to imitate technology. We follow Vishwarao
 (1994) in recognizing that the establishment of an overseas subsidiary is an effective internalization
 option, independent of resources spent by the host economy to imitate the technology.

201 relating to the resale of durables. Thus, the interaction of irreversibility and
 uncertainty leads to the trivial but important conclusion that is described in
 Proposition 1. It will be proved more vigorously in Section 3.6.

206 **Proposition 1** *The greater the degree of uncertainty in the LDE, the lower the
 likelihood of it obtaining FDI.*

Assume that the MNE and firm D face constant marginal production costs
 of c^{MNE} and c^{D} , respectively. The MNE's superior technology is embodied in
 its marginal cost function. Hence, $c^{\text{MNE}} < c^{\text{D}}$, or alternately, $c^{\text{MNE}} = (c^{\text{D}} - b)$,
 211 where $b > 0$. Assume that the MNE begins with a subjective, exogenous prior
 belief (p_1) regarding the possibility of a deleterious investment environment,
 which will diminish *ex ante* returns. Following Usher (1965) and many others
 since, we model this situation as a per unit tax or (f) on profits, with $f > 0$.
 216 The more pessimistic this prior (i.e. higher p_1), the less attractive the LDE is as an
 investment site to the MNE. We assume that this probability is updated in the next
 period (p_2), where $p_2 = p_2(Q_1)$, with $\partial p_2 / \partial Q_1 = p_2^1(\cdot) < 0$. In other words, as
 mentioned, the updated subjective probability of policy reversal (or more broadly,
 any perceived deterioration in the investment environment due to policy uncer-
 221 tainty) in time period 2 is modeled as a decreasing function of aggregate output
 that has already been attracted to the tradable good sector in the previous period.
 For simplicity we assume that both firms are risk neutral. Solely to minimize the
 use of terminology we ignore the expectations operator and assume common
 discount factors to be held by both firms, which in turn are approximated to one.

226 3.1 *Firms' Objective Functions*

We consider the firms' maximization problems assuming the MNE has entered the
 LDE. Our primary focus is on the MNE. We assume for simplicity that the MNE
 231 attempts to maximize individual subsidiary profits, as opposed to global profits
 from branches world-wide. Given that all the interesting strategic interactions
 occur in the first time period, and in order to generalize the results of the model,
 we follow Fischer (1992) in 'black-boxing' the second time period. The aggregate
 objective functions of the MNE and firm D for $t = 1$ and 2 are shown below:

236
$$\max_{q_1^{\text{MNE}}, q_2^{\text{MNE}}} \pi^{\text{MNE}}$$

$$= [(a - Q_1) - c - fp_1](q_1^{\text{MNE}}) + [(a - Q_2) - c - fp_2(Q_1)](q_2^{\text{MNE}}) \quad (2)$$
(a) (b)

241
$$\max_{q_1^{\text{D}}, q_2^{\text{D}}} \pi^{\text{D}} = [(a - Q_1) - c - b](q_1^{\text{D}}) + [(a - Q_2) - c - b](q_2^{\text{D}}) \quad (3)$$
(a) (b)

246 The terms (a) and (b) in equations (2) and (3) refer to the net returns in time
 periods 1 and 2, respectively. We assume the satisfaction of conditions to ensure
 all profits and outputs are positive. Note that $p_2(\cdot)$ is modeled explicitly as a

251 function of Q_1 with the assumption that the MNE internalizes this interaction when it optimizes in $t = 1$. However, we maintain the assumption in the paper that the domestic rival does not recognize this relation. This appears to be a reasonable assumption as, *a priori*, one is not able to sign the effect of $(\partial\pi_2^D/\partial p_2(\cdot))$. Specifically, while on the one hand conventional Cournot rivalry
 256 implies $(\partial\pi_2^D/\partial p_2(\cdot)) > 0$, on the other, as p_2 gets ‘too large’, the *ex-ante* profits of the MNE will decline, and at a certain point will lead the MNE to choose not to undertake investments in the economy. This in turn will endanger the reform program, in the process hurting firm D too, which has sunk costs in the tradable goods sector.³

261

3.2 Quantity Reaction Functions Under Uncertainty

Solving the first-order necessary and sufficient condition for $t = 1$, the quantity reaction functions (RF) of the MNE and firm D are shown below, respectively:

266

$$q_1^{\text{MNE}} = \left(\frac{1}{2}\right) [a - c - fp_1 - q_1^{\text{D}} - w]. \text{ --- } -RF_1^{\text{MNE}} \quad (4)$$

271

$$q_1^{\text{D}} = \left(\frac{1}{2}\right) [a - c - b - q_1^{\text{MNE}}]. \text{ --- } -RF_1^{\text{D}} \quad (5)$$

where: $w \equiv fq_2^{\text{MNE}}p_2'(Q_1)$ and $p_2'(Q_1) < 0$. In q_1^{D} and q_1^{MNE} space, the slope of $RF_1^{\text{D}} = -1/2$ as would be expected under linear demand. More interesting is the slope of RF_1^{MNE} which can be written as follows:

276

$$\left[\left(\frac{\partial q_1^{\text{D}}}{\partial q_1^{\text{MNE}}} \right) \right] = -2 - fq_2^{\text{MNE}} \cdot p_2''(Q_1) \quad (6)$$

281

In the absence of the uncertainty, the slope of $RF_1^{\text{MNE}} = -2$, as would be expected. However, in the presence of uncertainty we cannot sign the slope of RF_1^{MNE} *a priori*, let alone determine its absolute value. This is because of two off-setting effects. The MNE could benefit by reducing q_1^{MNE} . If this raises Q_1 and consequently reduces $p_2(\cdot)$, it is equivalent to an upward shift of the RF_2^{MNE} .

286

Countering this benefit is the fact that a fall in q_1^{MNE} will lead to a decline in π_1^{MNE} (conventional Cournot outcome). We therefore have the interesting case where the MNE could perceive its output to either be a strategic substitute to that of firm D (RF_1^{MNE} is downward sloping) or a strategic complement (RF_1^{MNE} is upward sloping), as defined by Bulow *et al.* (1985) (also see Dowrick, 1986).⁴

291

³The assumption of ‘passivity’ by firm D allows us to abstract from issues relating to profit-shifting strategic policies by the host country government in favor of its domestic firm.

296

⁴We maintain the assumption of concavity of π_1^{MNE} in Q_1 , i.e. $[(\pi_1^{\text{MNE}})'(p_2'(\cdot))] \leq 0$. This is sufficient to ensure that q_1^{MNE} and q_1^{D} are net substitutes. Given this assumption, since $1 < RF_1^{\text{MNE}} < 2$, we are assured of a non-trivial, deterministic outcome.

301 Note that the introduction of uncertainty endogenously into the model chal-
 lenges, if not invalidates, the conclusion by Bulow, Geanakoplos & Klemperer
 (1985) and others that quantity competition in linear demand curves ‘will *always*
 yield strategic substitutes’ (emphasis added). This apart, depending on the value
 and sign of $[(\pi_1^{\text{MNE}})(p_2''(\cdot))]$, the slope of RF_1^{MNE} need not be strictly monotonic.
 306 We are thus faced with the very real possibility of not obtaining a deterministic
 outcome. This, as well as the distinct (although related) example by Fudenberg &
 Tirole (1984), are specific instances of the more general (and relatively-neglected)
 problem of attempting to extend quantity reaction functions to intertemporal
 models as noted by Friedman (1983).
 311

3.3 MNE as Stackelberg Leader (default case)

As noted, if the MNE enters in $t = 0$, it can, because of the free transferability
 of certain activities across all subsidiaries, act as a Stackelberg leader. From
 316 equations (1) and (2), the optimal quantities and profits of the MNE and total
 industry output in $t = 1$ and 2 are easily obtainable (denoted by SB*):

$$321 \quad (q_1^{\text{MNE}})^{\text{SB}^*} = \left(\frac{1}{2}\right) [a - c + b - 2fp_1] - w \quad (7)$$

$$(q_1^{\text{D}})^{\text{SB}^*} = \left(\frac{1}{4}\right) [a - c - 3b + 2fp_1 + 2w] \quad (8)$$

$$326 \quad (Q_1)^{\text{SB}^*} = \left(\frac{1}{4}\right) [3a - 3c - b - 2fp_1 - 2w] \quad (9)$$

$$(\pi_1^{\text{MNE}})^{\text{SB}^*} = \left(\frac{1}{4}\right) [a - c + b - 2fp_1 + 2w][(q_1^{\text{MNE}})^{\text{SB}^*}] \quad (10)$$

$$331 \quad (\pi_2^{\text{MNE}})^{\text{SB}'} = \left(\frac{1}{8}\right) [a - c + b - 2fp_2(Q_1^{\text{SB}^*})]^2 \quad (11)$$

3.4 Monopolization by MNE through Entry Deterrence

336 The MNE could choose to monopolize the market through deterring entry to firm
 D. Dunning (1993, 431) has argued that ‘because of their unique ... advantages,
 MNEs may ... enter into new markets and create their own barriers to potential
 competitors ... or, as a result of ... their aggressive business practices, drive out
 competitors from existing markets...’. As is quite commonly done, we assume
 341 in particular that this is accomplished via an irrevocable capital investment (K)
 at $t = 0$ that is fully known to firm D. For concreteness, we might think of this
 investment to be in advertising or brand management, which increases the MNE’s
 market share to such an extent that D finds it unprofitable to enter the market.
 It is fairly intuitive that the closer the cost structure of the two firms, the greater
 346 would need to be the deterrent in order to ensure that entry by domestic rival is
 feasible, i.e. $K = K(b)$, with $K'(\cdot) < 0$.

351 Assuming *credible* deterrence (i.e. subgame perfect Nash equilibrium), from
 (equation (1)) the optimal values are summarized below (denoted by M^*):

$$(q_1^{MNE})^{M^*} = \left(\frac{1}{2}\right) (a - c - fp_1 - w) = (Q_1)^{M^*} \quad (12)$$

356 $(\pi_1^{MNE})^{M^*} = \left(\frac{1}{2}\right) (a - c - fp_1 + w)(q_1^{MNE})^{M^*} \quad (13)$

361 $(\pi_2^{MNE})^{M^*} = \left(\frac{1}{4}\right) [a - c - fp_2(Q_1^{M^*})]^2 \quad (14)$

In the absence of uncertainty ($p_1 = p_2 = 0$), the MNE will choose to invest
 in excess capacity if and only if this extra sunk cost is outweighed by the (variable)
 profits in the future periods. Since, under linear demand conditions and
 366 constant marginal costs, the output of a monopolist corresponds exactly to that
 of a Stackelberg leader (Figure 2), it must be that the *ex ante* variable profits of a
 monopolist exceed those of a Stackelberg leader $\forall q_t^{MNE}$. The firm will therefore
 invest in excess capacity to deter entry if and only if $K < [a - c]^2/4$.

However, in the presence of uncertainty, even assuming that $K(\cdot) <$
 371 $[(\pi_1^{MNE})^{M^*} - (\pi_1^{MNE})^{SB^*}]$ (see equation (16) below), to the extent that it is plausible
 that $(Q_1)^{M^*} < (Q_1)^{SB^*}$ (and since $p'_2(\cdot)$ and $\pi_2^{MNE} < 0$), it could be possible
 that $(\pi_2^{MNE})^{M^*} < (\pi_2^{MNE})^{SB^*}$. If this holds, and if $[(\pi_2^{MNE})^{SB^*} - (\pi_2^{MNE})^{M^*}] >$
 $[(\pi_1^{MNE})^{M^*} - (\pi_1^{MNE})^{SB^*}]$, it would be rational for the MNE not to monopolize

376

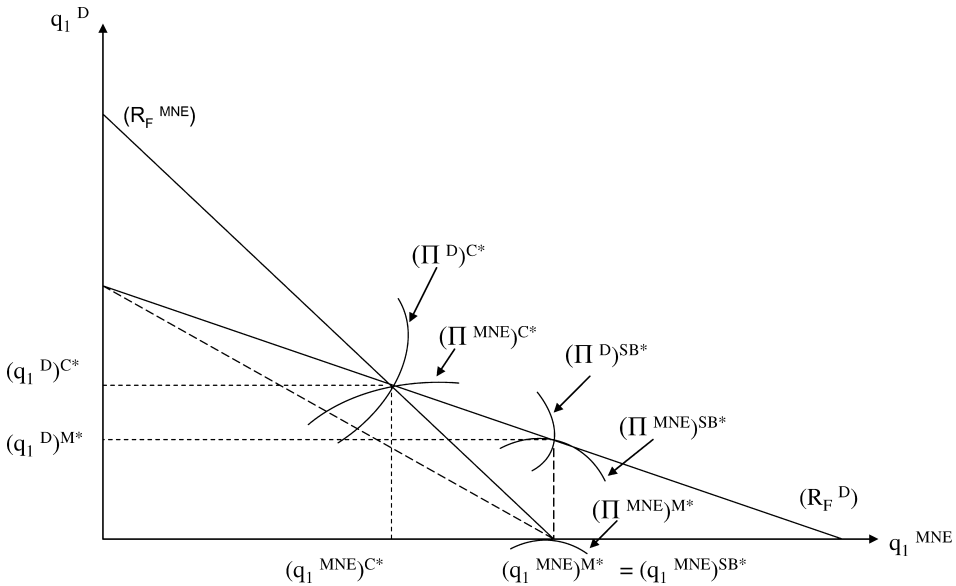


Figure 2.

396

Q8

401 the industry even if entry deterrence is credible. Specifically,

$$(Q_1)^{M^*} < (Q_1)^{SB^*} \text{ if } b < a - c \tag{15}$$

Thus, *ceteris paribus*, the more sensitive profit is to changes in the degree of uncertainty and/or the greater the elasticity of $p_2(\cdot)$ to Q_1 , the more likely that
 406 $(\pi^{MNE})^{SB^*} > (\pi^{MNE})^{M^*} - K(\cdot)$. Specifically, if $b = 0$, the condition simplifies to:

$$LHS = s(fp_1)^2 + 2(fp_2(\cdot))^2 - 2w(fp_1) + w(a - c) - 2(a - c)^2 - 8K(0) > 0 \tag{16}$$

411 While the explicit solution for inequality (16) is difficult to be derived algebraically, we conduct a simple simulation to show its existence. The basic parameter values are listed in Table 1. Note that we recover w in equation (16) with its original definition $w \equiv fq_2^{MNE} p'_2(Q_1)$.

To see how uncertainty affects the inequality, we allow $p'_2(Q_1)$ to vary while holding everything else constant. The results are summarized in Table 2.

416 As we can see from the simulation above, the values of the left-hand side (LHS) increase as the absolute values of $p'_2(Q_1)$ get larger. When $p'_2(Q_1) = -0.23$, the value of the LHS turns into positive, which indicates the validity of the inequality (16). It is readily obvious that the greater the proxies for uncertainty ($p'_2(Q_1)$), the more likely that the condition given by equation (16) will hold.

421

Proposition 2 *The greater the degree of uncertainty the less likely that the MNE will dominate the market, i.e. the less the likelihood of crowding-out of the domestic rival.*

426 Proposition 2 is broadly consistent with the general finding that MNEs tend to prefer joint ventures to FDI the greater the perceived risk of the foreign market

Q8

Table 1.

431	f	p_1	p_2	a	c	$K(0)$	q_2^{MNE}
	10	0.3	-0.3	10	2	0	2

Table 2.

436	LHS	$p'_2(Q_1)$	LHS	$p'_2(Q_1)$	LHS	$p'_2(Q_1)$	LHS	$p'_2(Q_1)$	LHS	$p'_2(Q_1)$
	-92	0								
	-89.2	-0.01	-61.2	-0.11	-33.2	-0.21	-5.2	-0.31	22.8	-0.41
	-86.4	-0.02	-58.4	-0.12	-30.4	-0.22	-2.4	-0.32	25.6	-0.42
441	-83.6	-0.03	-55.6	-0.13	-27.6	-0.23	0.4	-0.33	28.4	-0.43
	-80.8	-0.04	-52.8	-0.14	-24.8	-0.24	3.2	-0.34	31.2	-0.44
	-78	-0.05	-50	-0.15	-22	-0.25	6	-0.35	34	-0.45
	-75.2	-0.06	-47.2	-0.16	-19.2	-0.26	8.8	-0.36	36.8	-0.46
	-72.4	-0.07	-44.4	-0.17	-16.4	-0.27	11.6	-0.37	39.6	-0.47
	-69.6	-0.08	-41.6	-0.18	-13.6	-0.28	14.4	-0.38	42.4	-0.48
	-66.8	-0.09	-38.8	-0.19	-10.8	-0.29	17.2	-0.39	45.2	-0.49
446	-64	-0.1	-36	-0.2	-8	-0.3	20	-0.4	48	-0.5

451 (Contractor 1989). However, Proposition 2 is a much stronger result, insofar as
 it suggests that the MNE will transfer technology and assist domestic firms, even
 without actually forming such cooperative agreements and obtaining royalties or
 lump-sum fees thereof. This proposition will be reinforced in Section 3.5 when
 456 it is more likely for the MNE to choose Cournot competition over Stackelberg
 competition under the circumstance of more uncertainties.

The MNE may achieve their intended market structure by allowing more
 technology transfer to the host economy. This leads to the following proposition:

461 **Proposition 3** *The greater the degree of uncertainty the higher the level of
 technology transfer from FDI to the host economy.*

Proposition 3 is basically a restatement of Proposition 2 by adding the pre-
 sumption that the MNE chooses to dominate the market less by allowing more
 technology transfer from FDI to the host economy. This presumption seems
 466 plausible under the current model set-up. If Stackelberg competition, instead
 of monopoly, is of the MNE's interest, it may help the domestic firm to boost
 production by transferring cost-control technology, even for free.⁵

More interesting is the case of the b term. It is easily verified that b enters
 the left-hand side of the inequality (16) with a negative sign. Nonetheless it also
 471 enters indirectly through $K(\cdot)$. However, it can be shown that the net effect of an
 increase in b is to reduce the left-hand side of condition given by inequality (16)
 under fairly weak assumption. Therefore, the larger marginal cost differentials
 (b) make it more unlikely for the MNE to move from monopoly to Stackelberg
 competition. To put it formally, we have Proposition 4.

476 **Proposition 4** *The greater the technological gap between the MNE and domestic
 rival – as proxied by marginal cost differentials (b) – the more likely that the
 MNE will crowd-out the domestic rival.*

481 Intuitively, the greater the cost advantage enjoyed by the MNE, the more profits
 it could get from monopolizing the market. This in turn, makes it less likely
 for the MNE to reduce the market share/encourage competition by transferring
 technology. In addition, it may be more difficult for the MNE to successfully
 transfer its technology to the domestic firm if their cost structures are more
 486 different. This proposition suggests that the host economy can enjoy more positive
 spill-over effects from FDI if the domestic firm has a similar marginal cost schedule
 with the MNE. Therefore, we can restate Proposition 4 in the following way.

491 **Proposition 5** *The greater the technology gap between the MNE subsidiary and
 the domestic firm the lower the level of technology transfer from FDI to the host
 economy.*

496 ⁵As one referee suggests, it may not be reasonable to assume technology transfer at no cost. We could
 therefore add a lump-sum technology transfer fee in the model. It does not affect the prediction
 of the model. Instead, it may give the MNE more incentive to less dominate the market by selling
 technology.

501 3.5 Feasibility of Cournot–Nash Competition Under Uncertainty

As noted, in an environment of complete certainty, a rational economic agent will never forsake its Stackelberg leadership position in order to compete in Cournot fashion under previously held assumptions. This is readily obvious from Figure 2 which shows that the firm’s profit and output if it were a Stackelberg leader would clearly exceed those attained if it were involved in Cournot–Nash competition. However, intuitively, if the aggregate output in $t = 1$ under Cournot competition exceeds that under Stackelberg leadership by the MNE, it is plausible that a firm could reap greater profits (in $t = 2$) from competing in a Cournot market structure rather than being a Stackelberg leader. As noted, from an economic perspective this Cournot outcome may be interpreted as resulting from the MNE revealing its technological advantages to firm D. This in turn reduces overall industry costs to c . The optimal values for the Cournot case are summarized below (denoted by C^*):

516
$$(q_1^{\text{MNE}})^{C^*} = \left(\frac{1}{3}\right) (a - c - 2fp_1 + b - 2w) \quad (17)$$

$$(q_1^{\text{D}})^{C^*} = \left(\frac{1}{3}\right) (a - c + fp_1 - 2b + w) \quad (18)$$

521
$$(Q_1)^{C^*} = \left(\frac{1}{3}\right) (2a - 2c - fp_1 - b - w) \quad (19)$$

$$(\pi_1^{\text{MNE}})^{C^*} = \left(\frac{1}{3}\right) (a - c - 2fp_1 + b + w)(q_1^{\text{MNE}})^{C^*} \quad (20)$$

526
$$(\pi_2^{\text{MNE}})^{C^*} = \left(\frac{1}{9}\right) [a - c + b - 2fp_2(\cdot)]^2 \quad (21)$$

It can be easily verified that if:⁶

531
$$(Q_1)^{C^*} > (Q^{\text{SB}^*}) \text{ if } 2(fp_1 + w) > (a - c + b) \quad (22)$$

Accordingly, it is possible that $(\pi_2^{\text{MNE}})^{C^*} > (\pi_2^{\text{MNE}})^{\text{SB}^*}$. If this inequality is satisfied, even if $(\pi_1^{\text{MNE}})^{C^*} < (\pi_1^{\text{MNE}})^{\text{SB}^*}$, it’s possible that $[(\pi_2^{\text{MNE}})^{C^*} - (\pi_2^{\text{MNE}})^{\text{SB}^*}] > [(\pi_1^{\text{MNE}})^{\text{SB}^*} - (\pi_1^{\text{MNE}})^{C^*}]$. In such a case it would be rational for the MNE subsidiary to transfer technology to firm D and allow for Cournot competition, in the process reducing overall industry costs.

Consider next the conditions under which $(\pi^{\text{MNE}})^{C^*} > (\pi^{\text{MNE}})^{\text{SB}^*}$. Specifically, if $b = 0$, the condition simplifies to:

541
$$2w^2 - (a - c - 2fp_1)^2 - 17w(a - c - fp_1) > (a - c - 2fp_2)^2 \quad (23)$$

(a) (b)

546 ⁶A more detailed explanation is carried out in Appendix 1.

551

Table 3.

f	p_1	p_2	A	c	$K(0)$	q_2^{MNE}
10	0.3	-0.3	10	2	0	2

556

Table 4.

$(a)-(b)$	$p'_2(Q_1)$	$(a)-(b)$	$p'_2(Q_1)$	$(a)-(b)$	$p'_2(Q_1)$	$(a)-(b)$	$p'_2(Q_1)$	$(a)-(b)$	$p'_2(Q_1)$
-200	0								
-182.92	-0.01	-3.32	-0.11	192.28	-0.21	403.88	-0.31	631.48	-0.41
-165.68	-0.02	15.52	-0.12	212.72	-0.22	425.92	-0.32	655.12	-0.42
-148.28	-0.03	34.52	-0.13	233.32	-0.23	448.12	-0.33	678.92	-0.43
-130.72	-0.04	53.68	-0.14	254.08	-0.24	470.48	-0.34	702.88	-0.44
-113	-0.05	73	-0.15	275	-0.25	493	-0.35	727	-0.45
-95.12	-0.06	92.48	-0.16	296.08	-0.26	515.68	-0.36	751.28	-0.46
-77.08	-0.07	112.12	-0.17	317.32	-0.27	538.52	-0.37	775.72	-0.47
-58.88	-0.08	131.92	-0.18	338.72	-0.28	561.52	-0.38	800.32	-0.48
-40.52	-0.09	151.88	-0.19	360.28	-0.29	584.68	-0.39	825.08	-0.49
-22	-0.1	172	-0.2	382	-0.3	608	-0.4	850	-0.5

571

To illustrate the possibility of such an inequality, we carry out a simulation as follows. Table 3 lists all initial parameter values while main results are contained in Table 4.

576

To see how uncertainty affects the inequality, we allow the variation of $p'_2(Q_1)$ while holding others constant. We denote the LHS of the inequality as (a) and the RHS as (b) . Therefore, inequality (23) can be rewritten as $(a)-(b) > 0$.

581

The simulation above clearly shows that the values of $(a)-(b)$ increase as the absolute values of $p'_2(Q_1)$ get larger. In particular, when $p'_2(Q_1) < -0.11$, $(a)-(b)$ starts to be greater than 0, which validates the possibility of the inequality (23).

The greater the degree of uncertainty (the higher the absolute value of $p'_2(Q_1)$), the higher the likelihood of MNE adopting Cournot competition while forsaking Stackelberg leadership. This result is consistent with Propositions 2 and 3 in the previous section.

586

While the condition given by equation (23) shows that the greater the cost advantage of the MNE the less likely the occurrence that the MNE's aggregate profit from Cournot competition will exceed that if it were a Stackelberg leader, the condition shown by equation (22) suggests the reverse. However, insofar as b works directly on the period 1 profit differential in equation (23) but only indirectly on second period profit (through Q_1 and $p_2(\cdot)$) in equation (22), it is reasonable to assume that the effect of b in condition shown in equation (23) dominates that in equation (22). This indicates that the larger the technology gap between the MNE and the domestic firm, the smaller the likelihood of technology transfer from FDI. Therefore, the MNE may take a larger share of the domestic market. These results are consistent with Propositions 4 and 5 in the previous section.

596

601 3.6 Factors affecting the decision to undertake FDI

Having explored in detail the MNE's expected profit under the various market structures if the MNE decides to undertake FDI in the LDE, we are now in a position to establish conditions that determine the MNE's choice of FDI versus domestic production and servicing the LDE via exports (H). The MNE's maximization problem in Section 3.2 implicitly assumed that the distortion or tax to profits (f) is 'small'. However, as noted by Rodrik (1991) and Rajan (1994), it is possible that the tax may be so 'large' that it is no longer profitable to maintain capital in the LDE, thus leading to a withdrawal of capital back to home country. The exact condition under which this will take place is:

611
$$(\pi^{\text{MNE}})^{\text{H}} > \min\{(\pi^{\text{MNE}})^{\text{S}}, (\pi^{\text{MNE}})^{\text{M}}, (\pi^{\text{MNE}})^{\text{C}} - K\} - F + G \quad (24)$$

where $(\Pi^{\text{MNE}})^{\text{I}}$ denotes the aggregate optimal *ex post* variable profits (in periods 1 and 2) from FDI under market structure I, where $\text{I} = \{\text{S}, \text{M}, \text{C}\}$; and G is the exit costs, i.e. costs of withdrawal of capital from the LDE (alternately, this can be thought of as fixed costs of re-entry into the MNE's home market).

To generalize the conditions, let p generically denote the probability of reduction in the variable profits in both periods. Let $(\Pi^{\text{MNE}})^{\text{CE}}$ denote the variable profits in the absence of a deleterious environment (i.e. $f = 0$) under market structure I. The expected variable profits from undertaking FDI in the LDE can be formally expressed as follows:

626
$$E(\pi^{\text{MNE}})^{\text{I}} = (1 - p)(\pi^{\text{MNE}})^{\text{CE}} + p(\pi^{\text{MNE}})^* \quad (25)$$

where $\forall \text{I}$,

626
$$E(\pi^{\text{MNE}})^* = (\pi^{\text{MNE}})^{\text{H}} - G \text{ if condition stated in equation (26) is satisfied} \quad \text{Q4} \quad (26)$$

$$= (\pi^{\text{MNE}})^{\text{CE}} - f \text{ otherwise.} \quad (27)$$

631 Finally, the decision to undertake FDI is:

$$\max E\{(\pi^{\text{MNE}})^{\text{S}}, (\pi^{\text{MNE}})^{\text{M}}, (\pi^{\text{MNE}})^{\text{C}} - K\} > (\pi^{\text{MNE}})^{\text{H}} + F \quad (28)$$

636 Consider first the case where the tax is 'small'. Let $(\pi^{\text{MNE}})^{\text{CE}*}$ be the maximum $(\pi^{\text{MNE}})^{\text{CE}}$ from the various market structures. Substituting conditions given by equations (27) and (24) into equation (28) gives:

$$(1 - p)(\pi^{\text{MNE}})^{\text{CE}} + p((\pi^{\text{MNE}})^{\text{CE}} - f) > (\pi^{\text{MNE}})^{\text{H}} + F \quad (29) \quad \text{Q5}$$

641
$$(\pi^{\text{MNE}})^{\text{CE}} > (\pi^{\text{MNE}})^{\text{H}} + pf + F \quad (29a)$$

Next consider the case where the tax is 'large'. Substituting conditions given by equations (26) and (24) into (28) derives:

$$(1 - p)(\pi^{\text{MNE}})^{\text{CE}} + p((\pi^{\text{MNE}})^{\text{H}} - G) > (\pi^{\text{MNE}})^{\text{H}} + F \quad (30)$$

646
$$(\pi^{\text{MNE}})^{\text{CE}} > (\pi^{\text{MNE}})^{\text{H}} + (pG + F)/(1 - p) \quad (30a)$$

651 Conditions (28), (29a) and (30a) make it explicit that the presence of sunk costs implies that FDI is a decreasing function of the degree of uncertainty in the LDE – a rigorous restatement of proposition 1.

656 4. Relating the Model to Empirical Evidence

For the purposes of relating the main propositions of the model to the available empirical evidence, we restate them – in terms of levels, as opposed to likelihoods – as follows.

661 *The greater the degree of policy uncertainty in the host economy environment:*

- (1) the lower the level of FDI inflow (Proposition 1);
- (2) the less likely that the MNE will dominate the market, i.e. the less likelihood of crowding-out of the domestic rival (*Proposition 2*); and
- (3) the higher the level of technology transfer from FDI to the host economy. (*Proposition 3*).

666

The greater the technology gap between the MNE subsidiary and the domestic firm:

- (4) the greater the extent of crowding out of domestic enterprises by FDI (*Proposition 4*); and
- (5) the lower the level of technology transfer from FDI to the host economy (*Proposition 5*).

671

676 Proposition 1 is widely accepted in the theoretical literature (especially since the emergence of the options approach to investment). The proposition has been confirmed empirically by Aizenman & Marion (1999) using a series of correlations between broad measures of economic instability and private investment on data for 47 LDEs for the period 1970–92. The authors obtain similar conclusions are obtained when they use panel data of 92 countries over the period 1960–85. 681 Serven (1997) provides empirical evidence to show that macroeconomic and socio-political instability has negatively impacted private investment in Sub-Saharan Africa relative to other regions, especially East Asia.

Propositions 2 and 4 are rather difficult to verify in view of the fact that empirical work on the effects of market concentration in LDEs is sparse (Blomstrom & Kokko 1998). Nevertheless, it is revealing that, consistent with the available 686 limited empirical evidence, this model is one of the few (if not only) to show that the effects of FDI on market concentration cannot be determined a priori. Borensztein, Gregorio & Lee (1998) find that one cannot posit a prior relation regarding whether FDI *crowds-in* or *crowds-out* domestic firms. These ambiguous conclusions are consistent with the predictions of the model, which highlight the need 691 to account for the level of uncertainty of the host LDE environment. More direct evidence of Proposition 5 is provided by Teece's (1977) study on the costs of technology transfer. He found that these costs tend to be higher the lower the technological capabilities of the host economy. Without any rationale, Blomstrom & Kokko (1998) conclude that the evidence suggests that there is a larger risk that 696 foreign MNEs crowd out local firms in LDEs than in developed economies. We

701 hypothesize that this is due to the greater technological gap between firms in LDEs and the MNE subsidiaries.

Propositions 3 and 5 differ from most neoclassical models on technology transfer which have followed Findlay (1978), who develops a dynamic model in which the technology transfer (so-called ‘contagion effect’) is exogenously modeled as
706 a form of positive externality from the MNE subsidiary to the domestic rival (also see Rauch, 1986). Thus, Ethier & Markusen (1996) model the ‘automatic’ dissemination of a foreign firm’s knowledge as an ‘inevitable’ drawback of choosing direct investment over alternative means of servicing a foreign market, such as exporting.⁷ While such an ad hoc imposition of technology transfer in the
711 theoretic literature is broadly consistent with the literature on technological convergence, which assumes that international technological flows occur in an osmosis-like nature (Fagerberg, 1994), we draw attention to Romer (1994, 15), who has stated that the partial excludability of innovations is one of the ‘basic facts’ of cross-country economic growth.

716 In relation to this, empirical microeconomic studies have found low levels of TFP in LDE industrial firms even when they use identical equipment to that in developed countries (Pack & Saggi, 1997). This conclusion is complemented by the model developed by Wang & Blomstrom (1992). In their model, the rate at which new technologies are transferred rises with the host economy’s efficiency
721 in learning activities. This is so because, as the domestic firms become more efficient, the MNE, in order to maintain its market leadership position (assumed to take the form of higher demand), will bring in new technologies more rapidly, thus maintaining its technological gap with the domestic firms. Both models are at odds with the literature on technological convergence, which assume that the
726 technology growth rate of an LDE is inversely related to the gap between the technological capabilities of the LDE and the ‘best-practice’ techniques in the developed economies.

While statistical tests of the relation between technology transfer and FDI are a rarity, Blomstrom & Kokko (1998) conclude that there exists no direct relation
731 between FDI and the extent of technology transfer, with a number of studies actually suggesting a negative nexus (also see Pack & Saggi, 1997). Kokko (1996) has suggested that technology transfer is not determined by foreign presence alone, but rather by the simultaneous interactions between local and foreign firms. Specifically, the greater the foreign firm’s share in industry output in the host
736 economy (i.e. lower intensity of competition from domestic indigenous firms), the slower the extent of technology transfer.

Detailed industry data from the Mexican manufacturing industries (excluding enclave industries) in the 1990s supports his conclusion. Similarly, firm level evidence on FDI in Morocco and Venezuela leads Harrison (1996) to conclude that

741

⁷While Ethier & Markusen (1996) do stress their assumption of no property rights protection in the foreign country, almost all empirical studies which purport to establish the existence of an inverse nexus between low property rights protection and level of technology transfer have made the implicit assumption that technology transfer is an automatic consequence of FDI. Insofar as
746 countries with low levels of property rights protection invariably tend to be the ones with high levels of policy uncertainty (perceived uncertainty), such studies are actually testing and finding evidence in favor of Proposition 1, and not a negation of Proposition 3 (also see Vishwarao, 1994).

751 FDI ‘does not improve the productivity of domestic plants, possibly because multi-
 national corporations take market share from domestic plants, thereby reducing
 their capacity utilization.’ Kokko (1996, 527) has recognized the possibility that
 ‘some neglected factor(s) ... simultaneously determine(s) the behavior of for-
 eign firms ... and causes the correlation detected’. The model suggests that these
 756 latent factors are the degree of uncertainty of the investment environment in
 the host economy and the magnitude of the technology gap between the MNE
 and the domestic firm. Specifically, as predicted by the model, the less conducive
 the business climate and the greater the technology gap between the MNE and
 the domestic rival, the lower the extent of crowding out of domestic rivals and the
 761 greater the rate of technology transfer. (This nexus between technology transfer
 and crowding out of domestic firms is also rationalizable by the fact that tech-
 nology transfer is limited if there is an absence of domestic firms to benefit from
 these positive spillovers.)

Putting Propositions 1 to 3 together leads us to the conclusion that, contrary to
 766 dominant neoclassical thinking, in an environment with negligible uncertainty,
 laissez faire may not be the optimal policy from the perspective of maximizing
 growth effects of investment. This is especially so as FDI is recognized as being
 the dominant channel of technology transfer to LDEs, policies to (Blomstrom
 & Kokko, 1998; Pack & Saggi, 1997). More specifically, Propositions 4 and 5
 771 together emphasize that government policy ought to take the form of support of
 domestic firms in terms of building up their technological capabilities. Failing this,
 there could be a vicious circle in which technologically backward local firms are
 crowded out by MNE subsidiaries, and in turn – because of the increasingly weak
 domestic firms – there is ever-decreasing rate of technology transfer from FDI. It
 776 is instructive to note that a broadly similar argument is made by Blomstrom &
 Kokko (1998). Their argument is based on the dynamic model developed by Wang
 & Blomstrom (1992), who find that the rate new technologies are transferred rises
 with the host economy’s efficiency in learning activities. This is so because, as the
 domestic firms become more efficient, the MNE, in order to maintain its market
 781 leadership position (assumed to take the form of higher demand), will bring in
 new technologies more rapidly, thus maintaining its technological gap with the
 domestic firms.

786 5. Concluding Observations

Taking a cue from the political economy literature on economic liberalization,
 this paper has developed a highly stylized, partial equilibrium, game theoretic
 model in which a foreign investor’s perception of policy uncertainty is taken to
 791 be a function of the aggregate output produced by the tradable goods sector in
 response to the reform program. While a MNE’s multi-plant operations could
 allow it the first mover advantage of being a potential Stackelberg leader, we
 show that the endogenization of uncertainty by the MNE might make a decision
 to forsake these leadership advantages to compete in Cournot fashion a rational
 choice. Insofar as the international business and economics literatures have sug-
 796 gested that the MNE advantages are derived from ‘knowledge-based’ firm-specific

801 activities or assets, we interpret this alteration of market structure as resulting from technology transfer from the MNE to the host LDE.

A review of theoretic works on foreign technology flows to LDEs has led Pack & Saggi (1997) to highlight three main limitations of the existing literature. First, most theoretical works on technology transfer to LDEs utilize a static framework
 806 to answer what, according to them, is an inherently dynamic issue. Our model remains open to this criticism. Second, they note that most models ignore the important interactions between MNE activities and the type of market structure in host LDEs, merely assuming market structure to be unchanging. By allowing for the endogenous determination of the market structure, our model has gone
 811 some way in addressing this criticism. Third, they note that most models assume, in an *ad hoc* manner, that the mere presence of FDI implies that technology is transferred domestically despite the voluminous empirical evidence to the contrary. As emphasized, technology transfer in our framework is the outcome of a strategic decision made by the MNE. Consequently, there is no inexorable link
 816 between FDI and technology transfer. To be precise, the most interesting results are that the extent of technology transfer from the MNE domestically is directly related to the degree of (perceived) policy uncertainty of the MNE about the host LDE, and inversely related to the technology gap between the technological capabilities of the host economy's domestic firm and that of the MNE affiliate.

821

Acknowledgements

Valuable research assistance by Nicola Virgill and Wukuang Cun is gratefully acknowledged. The usual disclaimer applies.

826

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876

Appendix 1. The comparison of the quantities under Stackelberg and Cournot competitions

Under Stackelberg competition, the leader's profit is:

881

$$\Pi^{\text{MNE}} = (a - (q^{\text{MNE}} + q^{\text{D}}(q^{\text{MNE}})))q^{\text{MNE}} - C^{\text{MNE}}(q^{\text{MNE}})$$

While the follower's profit function is:

886

$$\Pi^{\text{D}} = (a - (q^{\text{MNE}} + q^{\text{D}}))q^{\text{D}} - C^{\text{D}}(q^{\text{D}})$$

The follower's response function can be easily obtained:

891

$$q^{\text{D}} = \frac{a - q^{\text{MNE}} - (C^{\text{D}})'}{2}$$

with which we can rewrite the leader's profit function:

896

$$\Pi^{\text{MNE}} = \left(\frac{a - q^{\text{MNE}} + (C^{\text{D}})'}{2} \right) q^{\text{MNE}} - C^{\text{MNE}}(q^{\text{MNE}})$$

901 The optimal production of MNE follows:

$$(q^{\text{MNE}})^* = \frac{a + (C^{\text{D}})' - 2(C^{\text{MNE}})'}{2}$$

906 This implies:

$$(q^{\text{D}})^* = \frac{a - 3(C^{\text{D}})' + 2(C^{\text{MNE}})'}{4}$$

Thus, the total production under Stackelberg is:

911

$$(Q^{\text{SB}})^* = \frac{3a - 2(C^{\text{MNE}})' - (C^{\text{D}})'}{4}$$

Under Cournot competition the best response functions are:

916

$$q^{\text{MNE}} = \frac{a - q^{\text{D}} - (C^{\text{MNE}})'}{2}$$

$$q^{\text{D}} = \frac{a - q^{\text{MNE}} - (C^{\text{D}})'}{2}$$

921 With the optimal quantities:

926

$$(q^{\text{MNE}})^* = \frac{a + (C^{\text{D}})' - 2(C^{\text{MNE}})'}{3}$$

$$(q^{\text{D}})^* = \frac{a + (C^{\text{MNE}})' - 2(C^{\text{D}})'}{3}$$

Therefore, the total quantity under Cournot is:

931

$$(Q^{\text{C}})^* = \frac{2a - (C^{\text{MNE}})' - (C^{\text{D}})'}{3}$$

936 In general, when we assume that $(C^{\text{MNE}})' = (C^{\text{D}})' = C$, it is always the case that $(Q^{\text{SB}})^* = 3/4(a - C) > (Q^{\text{C}})^* = 2/3(a - C)$. However, if we assume different cost structures for both firms, we would reach a different prediction. In particular, when $(C^{\text{MNE}})' > a + (C^{\text{D}})'/2$, the optimal quantity under Cournot is greater than under Stackelberg. If we take into account the greater level of uncertainty in LDE and add such costs into MNE's cost schedule, it is possible for the MNE's marginal cost to be greater than the domestic firm's. If the above inequality holds due to the uncertainty, the optimal quantity under Cournot would be greater than under Stackelberg.

946