ABSTRACT

Title of Dissertation: MULTINATIONAL CORPORATIONS AND DEVELOPING COUNTRIES: ENTRY MODE, TECHNOLOGY TRANSFER AND PERFORMANCE REQUIREMENTS

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This dissertation develops and tests a theoretical model of multinational corporation technology transfer to affiliates in developing countries. A bi-lateral moral hazard model is used to analyze a multinational corporation's decision to enter a new market via a wholly owned subsidiary, a joint equity venture or an arm's length contract. The model demonstrates that governments can enact Pareto improving policies that increase technology transfer from foreign investors. However, frequently employed and recommended interventions such as export promotion policies and local content regulation lower joint venture profits and decrease the incentive to transfer technology.

Empirical testing is conducted using a simultaneous equation limited dependent variable model. The results indicate that the determination of foreign ownership shares at the plant-level is consistent with the bi-lateral moral hazard model. Further, there is little if any indication that ownership is shared in international joint ventures as a means of sharing risk.

MULTINATIONAL CORPORATIONS AND DEVELOPING COUNTRIES: ENTRY MODE, TECHNOLOGY TRANSFER AND PERFORMANCE REQUIREMENTS

by

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One of the benefits of working on a dissertation near the Library of Congress is that the library has copies of all dissertations on microform. Whenever I needed to look up some derivation which was contained only in a dissertation and not subsequent published work, I began by reading the authors' Acknowledgements sections. I found this personal glimpse into another student's struggle to complete his/her dissertation to be both reassuring and inspirational. I feel that I owe it to not only all of those people who have helped me complete this dissertation, but also to any future graduate students like myself who enjoy reading more than just scholarly prose to write this particular section.

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CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

1.1 INTRODUCTION

Foreign direct investment (FDI) flows to developing countries have risen to an unprecedented level in the 1990s. Aitken and Harrison (1999) note that in 1997 FDI represented about 40% of all public and private capital flows to developing countries. Alongside this increased level of multinational corporation (MNC) engagement in the developing world, another trend must be noted. The nature of such involvement has also been transformed. Most significantly, MNCs have increased their usage of alternatives to wholly owned subsidiaries such as joint equity ventures (JVs) and non-equity inter-firm contractual arrangements.[1] These arm's length (non-equity) arrangements will be referred to as technology purchases (TPs).[2] Additionally, MNCs have sought important contributions from local counterparts that have had a significant impact on the ultimate success of an investment project.[3] Finally, it has become evident that policy makers in less developed countries (LDCs) seek out MNCs in order to gain access to their intangible assets such as advanced technology or marketing capability rather than the MNCs' stock of physical capital. The model of multinationals developed in this dissertation brings each of these observed tendencies to the forefront. In so doing, this

[1] Oman (1989) argues these alternative forms of investment are the single largest form of MNC involvement in the developing world since the 1970s. Caves (1996), Rugman (1986) and Beamish and Banks (1987) all note that few of the alternative forms of contracting and equity arrangements between MNCs and developing country firms have been viewed through the metric of formal economic modeling.
[2] This dissertation follows existing literature and employs a very broad concept of technology purchase. A TP may include royalty payments, management fees, patent and trademark infringement rights, copyright fees or any number of other licensing arrangements. Generally, these terms refer an arm's length (i.e., no equity involvement) exchange. However, the contracting mechanism employed in this paper also explains why a MNC may use these mechanisms in conjunction with equity.
[3] Beamish and Banks (1987), Miller et al. (1997) and Gomes-Casseres (1989) present evidence of both the type and importance of local contributions.

model is able to explain certain phenomena and address key questions that have previously escaped examination by formal economic theory.

1.2 LITERATURE REVIEW AND CRITIQUE

There are a number of weaknesses with current theoretical explanations of FDI. Chiefly, as noted in the introduction, MNCs have many available entry-mode options and current theory offers little insight into this choice. Models of FDI which rely heavily upon "New Trade Theory" do not address the causes or impact of shared ownership and assume away the possibility of contractual arrangements. Krugman (1983) who rules out licensing by assumption believing it to be "relatively unimportant in practice" is fairly typical. Even those papers which model MNCs' choice between direct ownership and contracting (e.g., Horstmann and Markusen (1987, 1996)) offer no insights into a MNC's choice between shared and sole ownership.

A second weakness is that prior models have mis-characterized the knowledge transfer process. Most models of FDI assume that MNCs possess knowledge-based assets that can be costlessly or inexpensively transferred to an additional location. Prior research calls into question this non-rivalry assumption. Teece (1976) finds that it "is quite inappropriate to regard existing technology as something that can be made available at zero social cost." Indeed, the author finds that transfers within the same company are quite costly. Contractor (1985) echoes this point.

Several explanations have been offered for the costly nature of such transfers. For example, knowledge may be embodied in the individuals who employ the expertise. Contractor (1985, p. 19) argues that "technology transfer is not the transfer of only codified information in patents, blueprints, manuals and so on. Rather it is the transfer of a production or distribution capability that may also require interpersonal contact of a long duration." Thus, technology transferred by MNCs may closely resemble North's (1990) concept of tacit knowledge. However, even though some research has analyzed the impact of costly transfer (e.g., Wang and Blomstrom (1992)), there has been little analysis as to the reason for the costliness. In particular, there has been little or no formal analysis of the market failures that make such transfers costly.[4] This observation that knowledge transfer may be costly is particular damaging to models in which MNCs choose equity over arm's length transfer because they fear disclosure of proprietary information to third parties. Finally, given Mansfield and Romeo's (1980) finding that as a rule technological secrets are not revealed more rapidly under licensing than they would be with trade or other entry modes, only one reliable conclusion remains. The fear that proprietary knowledge may become public information may indeed affect the decision to engage in a particular economy or the type of activity conducted (see Lee (1996)), but it will not have a strong impact on the decision among trade, licensing and FDI.

There are also questions regarding the strategic and dynamic implications of current explanations of entry-mode. Contrary to the prediction of Horstmann and Markusen (1987), licensing arrangements may act as a stepping stone to future expansion via FDI. Contractor cites several examples and Giannitsis (1991) concludes that "licensing was often the preferred instrument for entering the Greek market before deciding on other forms of investment (subsidiary, share participation, acquisition of

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[4] There has been a great deal of discussion of these market failures (see Caves (1996) for a summary) but

licensee firm).” This sort of behavior could not arise in the context of Horstmann and Markusen’s model. The authors note that “were the home-country only to license for a finite number of periods, the licensee would always have the incentive to dissipate [the value of the license] before [it] was revoked.” In a later paper, Horstmann and Markusen (1996) acknowledge this weakness and simply assume that MNCs can write short-term contracts. Additionally, Fikkert (1994) and Giannitsis (1991) find that equity investment and other forms of technology purchase are complementary activities. In all current models, equity investment is a substitute for licensing which arises when transaction costs to third parties are prohibitively high.

Finally, many explanations of FDI only explain import substituting investment and are frequently tied to retailing and distribution networks. While some foreign investors seek to capture market share in the host country, others target export markets or involve both production and distribution activities. While no claim is made that the model developed in this dissertation is a general model of all multinational activities, the problems of moral hazard and hidden action are relevant to both import substituting and export-oriented activities as well as production and distribution.

1.3 SUMMARY OF MODEL AND RESULTS

The model developed here relies upon bi-lateral moral hazard. The essence of this approach is that collaboration between MNCs and local partners is best modeled as an interaction between two input providers, each subject to an incentive constraint. The market failures arise because the actual amount of these inputs provided by a particular

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relatively little formal modeling. Horstmann and Markusen (1996, 1987) are two exceptions.

party is not observable by any other party. Equity ownership provides a claim to profits and thereby generates the incentive to contribute such unobservable inputs. Because shared ownership is necessary for each partner to provide an unobservable input, this model demonstrates a motivation for JVs; a frequently relied upon contracting mechanism heretofore ignored. However, moral hazard alone is not capable of explaining the choice among the rich array of possible entry modes: wholly owned subsidiaries (WOSs), equity joint ventures and arm's length exchange of proprietary assets.[5]

MNCs obviously choose the entry mode that generates the greatest profits. To explain the choice among these alternatives, the model developed here allows differential abilities in each of the unobservable resources. The two unobservable inputs are managerial ability required to transfer and adapt technology, and managerial supervision of local supply networks and regulatory requirements. MNC management is more proficient at the former of these tasks and local managers at the latter. JVs arise when production technology dictates that each unobservable resource is vital to the production process and each partner is particularly skilled at its respective managerial tasks. If the intangible contributions of the local firm are relatively unimportant or capably performed by the MNC, the MNC has no incentive to share equity and will open a wholly owned subsidiary. Similar logic indicates when a MNC will maximize its profits through non-equity involvement with an LDC partner. The equilibrium entry mode emerges from the optimizing behavior of the MNC and local counterpart and

[5] As noted in Footnote 2, our contracting mechanism allows MNCs to employ management fees, licensing payments and such in joint equity operations. Because of this and our definitions of the components of the optimal contract, this three-way division fully categorizes all forms of MNC involvement with LDC collaborators.

ultimately hinges on the exogenous production technology and idiosyncratic managerial skills.[6]

This approach draws a direct connection between the intangible assets LDCs seek out and the unobservable resources MNCs provide. Therefore, a key advantage of this model is that it enables the investigation of the impact of public policy on a MNC's contribution of intangible assets and its choice of entry mode. Particular attention is paid to technology transfer since this is perhaps the most important, if not sole reason LDCs seek out FDI. Not surprisingly given this rather unique approach, very different conclusions regarding policy towards MNCs are reached. In fact, it is shown here that policies others have proposed to mitigate distortions created by multinationals actually reduce the incentive of foreign firms to contribute intangible assets. A very important implication of this model is policies such as sales taxes, export promotion programs and local content policies all decrease MNCs' incentive to establish joint ventures and to transfer technology regardless of entry mode.

This dissertation represents a significant improvement over prior research in a number of areas. First, by modeling an explicit class of market failures rather than simply asserting their existence, this paper explains a MNC's choice over a wider array of possible entry modes. Second, the model deals directly with the issue of public policy and the intangible benefits of FDI. Third, unlike prior explanations of entry mode, this model is consistent with costly technology transfer. Fourth, although static, this model provides a reasonable interpretation for the commonly observed behavior of initial MNC entry in an arm's length fashion followed by subsequent entry via

[6] Similar models have been employed to study sharecropping in agriculture (Eswaran and Kotwal (1985))

ownership. Namely, the MNC's acquisition of skills relevant to the local economy has decreased the MNC's incentive to share rents with a partner. Finally, because problems of hidden action are relevant to a wide variety of activities, this model of FDI is much more widely applicable than prior models.

A key focus of the theoretical portion of this dissertation is on the determination of MNC entry mode and equity share. As scarce as the theoretical work has been in this area, empirical work is even more rare. While there has been a substantial amount of interest in the determinants of the share of industry output produced by foreign owned firms in developing countries, this author is unaware of any prior empirical study which has analyzed the determinants of the foreign equity stake at the firm or plant level. Perhaps due to this lack of investigation, there is a presumption that the same forces are at work at the micro and macro level.

When confronted with data on foreign entries into the Indonesian manufacturing sector, this theory holds up quite well. The results indicate that contrary to perceived wisdom, there are important differences between the determinants of the share of an industry's output produced by foreign owned firms and foreign ownership at the plant-level. At the plant-level, ownership is used as an incentive mechanism and is unresponsive to factors such as industry concentration and scale economies that are important indicators of aggregate foreign presence. Additionally, risk does not have a significant impact on ownership share and certainly does not have the impact presumed throughout the literature.

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and franchising in the modern retail sector (Bhattacharyya and LaFontaine (1995) and Romano (1994)).

Chapter 2 of this dissertation presents the theoretical model and derives basic theoretical implications. Chapter 3 examines the impact of public policy on MNC entry mode and technology transfer. Chapter 4 compares aggregate determinants of foreign ownership share to plant level determinants using a simplified version of the theoretical model developed in the first half of the dissertation. Finally, Chapter 5 concludes and presents policy implications.

CHAPTER 2: MODEL AND THEORETICAL IMPLICATIONS

2.1 INTRODUCTION

The model developed in this chapter endogenizes a MNC's choice among various entry modes: wholly owned subsidiary (WOS), joint equity venture (JV) or technology purchase agreement (TP). This is accomplished by explicitly modeling the market failures likely to arise in inter-firm collaboration. The market failures in this model are caused by hidden action in the transfer of advanced MNC technology and managerial activities tied directly to the local economy.[7] It is costly to monitor these activities and therefore they are not contractible.

This approach is eminently in accord with the discussion of collaborative ventures appearing in both statistical examinations and case studies. As will be discussed below, operating in an unfamiliar developing country is an inherent disadvantage for MNCs who are frequently unfamiliar with both the written laws and informal practices. Contractor (1985) presents survey results that suggest that the vast majority of technology purchases involve a transfer of knowledge where effort is important. Dymsza (1988) cites particular cases when equity shares in JVs changed as the need for intangible contributions changed.[8] Similarly, Ramachandran (1993) finds that proxies for MNC effort positively co-vary with ownership percentage. Each of these observations points to moral hazard.

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[7] Dymsza (1988) notes the importance of complementary contributions by JV partners. For example, MNCs are expected to contribute "manufacturing technology, product know-how, patents, business expertise, and management development," while the local firm contributes "knowledge of the country environment and market, and contacts with the government, financial institutions, local suppliers and labor unions."

[8] For example, as the relative importance of contributions change in the favor of local firms, MNCs often reduce their equity stake. However, if it becomes evident that increased technology transfer is needed to achieve a collaboration's potential, MNCs often switch from a TP to a JV.

Moral hazard is also consistent with Teece's (1976) observation that technology transfer is costly. In this model, the transfer of technological capabilities is costly because it necessitates the expenditure of scarce managerial effort in addition to the costless reproduction of blueprints and technical manuals. MNCs' technological assets therefore closely resemble North's (1990) concept of "tacit knowledge" and not the excludable but non-rival assets traditionally examined in the literature. Tacit knowledge is not easily transferred through blueprints, manuals and other readily reproducible materials because know-how can be "embodied in employees" (Markusen (1991)) through such characteristics as corporate culture (Oman (1989)). Indeed, Arora (1996) finds that given tacit knowledge, tied sales of inputs can improve the efficiency of arm's length technology transfers. The intuition behind this result is the same as that behind the policy conclusions in Chapter 3.

2.2 THEORETICAL MODEL

In order to account for these characteristics of technology, this model assumes technical manuals, blueprints and other forms of disembodied technology must be combined with scarce managerial resources in order to produce effective know-how - capabilities useful in the production process. Let "B" be the blueprints or other dis-embodied knowledge and "e" unobservable managerial effort, and define effective know-how, "K" as

(2.1) $K=k(B,e,\delta_1)$

where k(.) is an aggregator function which is increasing and concave in B and e. The parameter δ_1 ($0 \le \delta_1 \le 1$) captures the relative importance of disembodied knowledge and managerial effort. When $\delta_1 = 1$, effort is redundant. As may be the case with very simple or older technology, blueprints are sufficient.

When engaging in production in a new country, a MNC must cultivate relationships with local suppliers. One reason for this is that the quality of inputs is important. Because quality matters, the amount of usable material inputs, "M," depends both on the observable quantity of locally purchased intermediate goods, "L," and the amount of managerial resources spent supervising and fostering connections, "c," with local suppliers.[9] Therefore, the amount of usable materials, "M," is defined as

(2.2) $M = m(L, c, \delta_2)$

where m(.) is a linearly homogeneous[10] aggregator function which is increasing and concave in L and c. The parameter δ_2 ($0 \le \delta_2 \le 1$) captures the relative importance of observable locally purchased intermediate inputs and "connections" in ensuring the availability of useable materials. If quality does not matter, δ_2 is equal to 1. Let e and c be measured in the same units.

The production process combines effective know-how, "K," with useable locally purchased materials, "M," and other traditional economic variables. Thus in the

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[9] Alternatively, in order to enter a new country, a MNC must obtain approval from a regulatory body. Obtaining such approval may depend on observable factors such as the possession of certain licenses or permits and also unobservable connections with the appropriate bureaucrats who will look the other way.
[10] Note that the aggregator function for usable locally purchased inputs is assumed to be linear homogeneous. If a firm needs to double the quantity of usable materials, it is reasonable that they would need to double the quantity of purchased materials and double the managerial effort spent sorting through the material. Given the nature of technology this additional restriction would make little sense for the function k(.). For example, taking "B" to be the blueprints for a production facility, in order to increase the effective know-how derived from these plans - by building a second identical production facility – a firm need only expend additional managerial resources overseeing construction and need not expend any further resources on design.

production function below, "L" is a vector of inputs for which quality matters, "I" is a vector of inputs such as labor, capital or other materials which can be used without the expenditure of additional managerial effort.[11]

(2.3) $Y = F(K,M,I) = F(k(B,e;\delta_1),m(L,c;\delta_2),I)$

Suppressing the parameters, this can be written as

(2.3a) $Y=F(L,I,e,c)$.

Assume:

(a1)
i. F(.) is strictly increasing in L, I, e and c.
ii. F(.) is concave in L, I, e and c.
iii. F(.) is continuous in L, I, e and c.
iv. F(.) is linearly homogeneous in L, I, e and c.
v. F(.) is bounded from above.
vi. $F(0,0,0,0)=0$

(a2) $F(L,I,0,c) = F(L,I,e,0) = 0$

The properties assumed in (a1) are standard and follow Diewert (1973).[12] Further, note (iv) captures the notion that "B" represents the public good aspect of knowledge while (a2) simply states that positive amounts of both e and c are required to produce positive output.

Uncertainty is introduced to ensure that the MNC and local counterpart are not able to impute values for e and c once profits have been realized. If firms could observe e and c in this fashion, they would be able to write contracts based on these ex-post realizations. The random variable, Θ, which has a mean of 1 is assumed to be, as in other models of this nature, unobservable. In this instance, Θ may be thought of as the

[11] Such factors might be homogeneous or purchased on international markets where quality is assured.
[12] Diewert assumes only that the production function is non-decreasing in its arguments.

effect of political uncertainty.[13] For simplicity, we assume the firm is a price taker with the price equal to 1. Profits are equal to

(2.4) Θ [F(L,I,e,c) – w' L – p' I]

As in Steven's (1994) and Biswas's (1998) models of FDI, political uncertainty impacts both revenues and variable costs.[14] However, in this model, the political/bureaucratic process extracts an uncertain tax rather than causes a shutdown.[15] In LDCs, both policies and the application of them may involve a random component if bureaucrats either lack certain skills or are corrupt. Given the limited purpose of uncertainty in bi-lateral moral hazard models, this seems to be a reasonable characterization.

This model departs from models presented in the retailing literature in that the MNC need not engage in joint production.[16] Either a MNC or the local firm may go it alone through a WOS or TP respectively. In addition to the patent or basic skill, B, possessed by the MNC, this model proposes that each partner possesses an additional type of firm specific asset or skill. Resources spent by a MNC fostering connections with local suppliers are a fraction as effective as local firm resources, therefore $c=\gamma_m c_m$ $(0 \leq \gamma_m \leq 1)$ if the MNC were to open a wholly-owned subsidiary and provide the non-marketable input c. If managerial effort spent fostering connections by the local firm, c_l

[13] This paper assumes uncertainty in the local environment prevents the actual amount of managerial inputs from being observed but does not alter any other input choices. This approach is taken by Eswaran and Kotwal (1985) and Bhattacharyya and LaFontaine (1995). Because Romano directly assumes the amount of managerial inputs cannot be observed, he does not introduce uncertainty.

[14] Political/bureaucratic uncertainty affects only revenues in Wei (1997) and thus distorts input choices. In the present context, the only role of the unobservable random variable is to ensure that efforts may not be imputed from observed profits. As in all bi-lateral moral hazard models, we are not interested in the impact of uncertainty *per se*.

[15] Batra (1986) suggests that a Pigouvian tax on the profits of a MNC may be necessary to offset distortions introduced by MNCs. As demonstrated by Bhattacharyya and Lafontaine (1995), we could also have modeled this as a random lump-sum tax rather than a random tax rate.

[16] In this sense, the model is similar to Eswaran and Kotwal (1985).

and c_m are measured in the same units, $\gamma_m c_m$, gives efficiency units of managerial effort. Likewise the MNC has an advantage in transferring knowledge. Hence, $e=\gamma_l e_l$ ($0 \leq \gamma_l \leq 1$) if the input e is provided by the local firm after a technology purchase.[17] Again, e_l and e_m are measured in the same units and $\gamma_l e_l$ measures local firm managerial effort devoted to technology transfer in efficiency units.

Since L and I can be purchased in the market, they will always be chosen to equal their first best values regardless of ownership structure. Risk neutral firms will seek to maximize expected profits. Therefore,

(2.5) $\text{Max}_{L,I}\ E\{\Theta\ [F(L,I,e,c) - w'\ L - p'\ I]\} \equiv \text{Max}_{L,I}\ F(L,I,e,c) - w'\ L - p'\ I$

Define the restricted profit function,

(2.5a) $\pi\ (e,c) = \text{Max}_{L,I}\ F(L,I,e,c) - w'\ L - p'\ I$

which Diewert (1973) theorem (2.20) demonstrates has the following properties

(p1) linearly homogeneous in e and c
(p2) concave and continuous in e and c
(p3) strictly increasing in e,c[18]
(p4) bounded from above

No assumptions are made regarding the complementarity or substitutability of e and c.

(a3) $\pi_{ec}>0$, $\pi_{ec}<0$ or $\pi_{ec}=0$

[17] In a WOS, a MNC is the residual claimant and therefore the MNC must provide all non-contractable goods. Under a TP, the local firm is the residual claimant and the MNC has no incentive to provide e.

[18] Diewert (1973) proved that the restricted profit function is non-decreasing in e and c. Because the production function is assumed to be strictly increasing in e and c, the restricted profit function can easily be shown to be strictly increasing in e and c. Let L^0, I^0 be the solution to $\text{MAX}_{\{L,I\}}\ F(L,I,e^0,c^0) - w'\ L - p'\ I$ and let L^1, I^1 be the solution to $\text{MAX}_{\{L,I\}}\ F(L,I,e^1,c^0) - w'\ L - p'\ I$ with $e^0<e^1$. Then we have the following:

The cost of providing managerial resources for the MNC, R(e), and for the local firm, S(c), are assumed to have the following standard properties:

(a4) $R(0)=R'(0)=S(0)=S'(0)=0$
(a5) $R'(x), S'(x) > 0$ for all $x>0$, $R''\geq 0$, $S'' \geq 0$

This fully characterizes the production process, all that remains of the MNC's problem is the division of collaboration's profits between it and its local partner. The model assumes a linear sharing rule as it has a number of nice features. First, such a sharing rule is characterized by two constants, α and β, the optimal value of which is endogenously chosen by the MNC. The MNC and local firm share of profits are defined in (6a) and (6b) respectively.

(2.6a) $\alpha + \beta\, \pi(e,c)$
(2.6b) $-\alpha + [1-\beta]\, \pi(e,c)$

Each constant has a very simple interpretation in the present context. The lump sum portion of the contract, α, corresponds to technology payments, and the slope parameter, β, corresponds to the MNC's ownership share. Most importantly, as is shown in Appendix B, the same incentives can be achieved with this relatively simple sharing arrangement as can be achieved with a more complicated non-linear sharing rule.

The model also assumes that in a JV, e and c are determined in accordance with a non-cooperative Nash equilibrium with each party performing its most proficient managerial task and

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$F(L^0,I^0,e^0,c^0) - w' L^0 - p' I^0 < F(L^0,I^0,e^1,c^0) - w' L^0 - p' I^0 \leq F(L^1,I^1,e^1,c^0) - w' L^1 - p' I^1$. The proof that the restricted profit function is increasing in c is identical.

(a6) the Nash equilibrium is unique.[19]

Competition among local firms ensures that all rents remain with the MNC. The optimal JV contracting problem for the MNC is ...

(2.7) $\Pi^*_{M,JV} = \text{Max}_{\{\alpha,\beta\, e,c\}} \alpha + \beta\, \pi(e,c) - R(e)$

subject to

(2.7a) $\beta\, \pi_e(e,c) = R'(e)$
(2.7b) $[1-\beta]\, \pi_c(e,c) = S'(c)$
(2.7c) $[1-\beta]\, \pi(e,c) - \alpha - S(c) \geq 0$

where (2.7a), (2.7b) and (2.7c) are the MNC's incentive constraint, the local firm's incentive constraint and the local firm's participation constraint.

Problem (2.7) defines the maximum profits that a MNC can earn under a JV. In order to determine entry mode, this value must be compared to a WOS and a TP. Profits for the WOS, the local firm's profits under a TP, and the MNC's profits under a TP are defined in (2.8), (2.9) and (2.10) respectively.

(2.8) $\Pi^*_{M,WOS}(\gamma_m) = \text{Max}_{\{e,c\}}\, \pi(e,\gamma_m c) - R(e+c)$
(2.9) $\Pi^*_{L,TP}(\gamma_l) = \text{Max}_{\{e,c\}}\, \pi(\gamma_l\, e, c) - S(e+c) - \alpha$
(2.10) $\Pi^*_{M,TP}(\gamma_l) = \text{Max}\, \{0, \Pi^*_{L,TP}(\gamma_l)\}$

2.3 THEORETICAL IMPLICATIONS

The model produces a number of interesting theoretical results regarding joint equity ventures, the only entry mode yet to be analyzed by theoretical economists. In

[19] The assumptions above are sufficient for existence and the following condition is sufficient for uniqueness $|\pi_{ec}| \leq |\pi_{cc}|, |\pi_{ee}|$. A proof is provided in Appendix A.

order to simplify the analysis, we write the JV contracting problem as a Lagrangean.[20, 21]

$$(2.11)\ \Pi^*_{M,JV} = \text{Max}_{\{\alpha,\beta,e,c\}}\ \alpha + \beta\ [\pi(e,c)] - R(e) + \lambda\,[\beta\,\pi_e(e,c) - R'(e)] + \mu\,[\,[1-\beta]\,\pi_c(e,c) - S'(c)] + \eta\,[\,[1-\beta]\,\pi(e,c) - \alpha - S(c)]$$

Proposition 1: With two missing markets, ownership must be shared if each party is expected to contribute managerial effort.

Proof: From the participation constraint we can see that $\pi(e,c)$ must be positive. If this were not the case then α would be negative and the MNC would earn negative profits from the JV. Given that $\pi(e,c)$ is positive, by our earlier assumption both e and c must also be positive. If $\beta = 1$, we can derive a contradiction from the local firms incentive constraint, because with $\beta = 1$ this constraint can only be satisfied for c=0. Similarly, we can derive a contradiction with $\beta = 0$.

This represents a key advantage of employing bi-lateral moral hazard to model collaboration between MNCs and local firms. Not only does the approach make intuitive sense, it also explains the use of joint equity ventures, a frequently employed entry mode ignored in prior examinations of the subject.

Proposition 2: Joint equity ventures arise when neither collaborator is proficient at both managerial tasks.

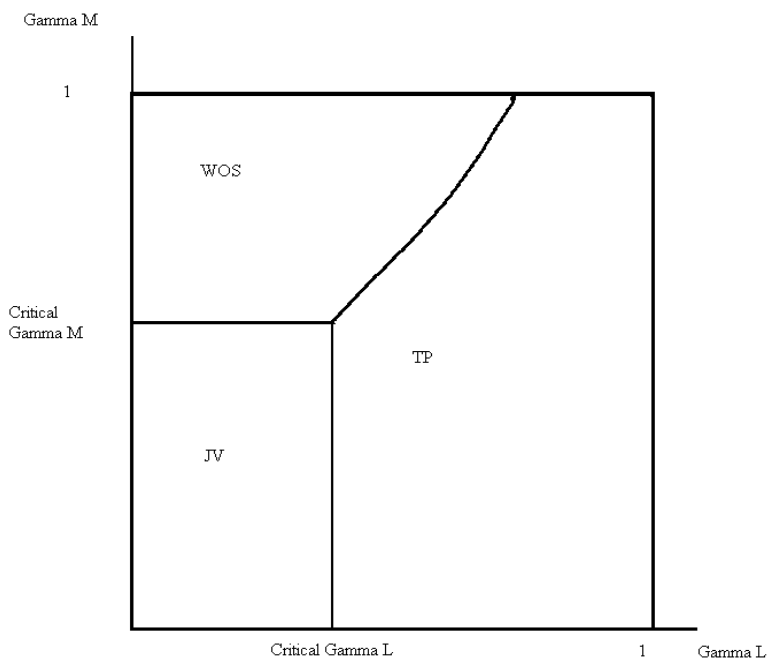
Proof: A MNC will enter via a JV when $\Pi^*_{M,JV} \geq \Pi^*_{M,WOS}(\gamma_m)$ and $\Pi^*_{M,JV} \geq \Pi^*_{M,TP}(\gamma_l)$. The envelope theorem and (p3) ensure that $\Pi^*_{M,WOS}(\gamma_m)$ and $\Pi^*_{M,TP}(\gamma_l)$ are strictly increasing in γ_m and γ_l respectively. Therefore, because π is continuous, there exists a critical pair (γ_m^*, γ_l^*), such that for all $(\gamma_m, \gamma_l) \leq (\gamma_m^*, \gamma_l^*)$ the MNC will enter via a JV.

[20] The problem is solved in a more complete manner in Appendix C.

[21] Rather than employing a Lagrangean, the participation constraint could be solved for α as a function of β, and the incentive constraints could be simultaneously solved for $c(\beta)$ and $e(\beta)$. The problem could then be set up as an unconstrained maximization problem with β as the only remaining choice variable. This is the approach taken by Eswaran and Kotwal (1985).

A multinational will choose to enter via joint equity ventures when it lacks the skills necessary to navigate the local economy and the local firm lacks the skills needed to implement the MNC's technology. JVs are formed when each partner needs the other. Similar propositions can be proven describing the conditions under which MNCs will form a wholly owned subsidiary and license technology. Figure 2.1 solves the model for

Figure 2.1: Contract Outcomes and Skill Parameters



the case of a Cobb-Douglas production function with constant marginal cost of providing unobservable inputs.[22] When both parties are inefficient at performing their counterpart's task, a MNC forms a JV, but as the skill of the MNC (local firm) rises, all else fixed, the MNC is more likely to enter via a WOS (TP).

[22] Eswaran and Kotwal produce a similar figure.

Frequently for nationalistic reasons, developing countries have sought ways of gaining access to advanced MNC technology while minimizing the number of firms with foreign equity. While Section V will discuss the impact of several of these policies, note that Figure 2.1 suggests a simple alternative to the heavy-handed policies frequently adopted. Namely, by improving the scientific and technical capabilities of local firms, the government can increase the likelihood that local firms are sufficiently skilled and MNCs choose to enter in an arm's length fashion.

Proposition 3: The marginal social benefit of technology transfer is greater than the marginal social cost in all joint equity ventures.

Proof: This follows immediately from the MNC's incentive constraint and the fact that the ownership share is between zero and one.

This proposition points to the fundamental problem created by bi-lateral moral hazard.[23] Since the linear contract studied here produces the exact incentives as a more general non-linear contract, this difficulty is even more problematic. To a developing country, the marginal social value of MNC effort devoted to technology transfer is at least equal to the marginal impact of effort on profits.[24] The need to share profits has driven a wedge between this and the MNC's marginal cost of effort, condemning LDCs to realize insufficient benefit from technology transfer from MNCs. This model shows that while MNCs recognize this, they cannot credibly offer to devote more effort to the transfer of technology. This proposition also demonstrates precisely why it is so important to distinguish JVs from WOSs. The incentive structure is very different in

[23] Notice, there is an identical problem regarding local firm managerial effort as well.
[24] The marginal social value will be greater than this value if there are technology spillovers.

these two modes of operation and without considering this fact, policy will likely be misguided.

Proposition 4: Ownership share is simultaneously determined with all other choice variables.

Proof: In Appendix C the following expression for the optimal ownership share is derived.

$$(2.12)\quad \beta^{*} = \frac{\pi_{e}^{2}[[1-\beta^{*}]\pi_{cc} - S'']}{\pi_{c}^{2}[\beta^{*}\pi_{ee} - R''] + \pi_{e}^{2}[[1-\beta^{*}]\pi_{cc} - S'']}$$

Where (2.12) is evaluated at the optimal values of e, c, L and I.

While this expression and the incentive compatibility constraints can in principle be solved, no intuitive results can be derived without imposing more structure on the problem.[25] However the result is still of significance. First, this model warns that the frequent econometric practice of including foreign ownership share as an independent variable creates bias in the parameter estimates. Second, there are few theoretical or empirical assessments of the determinants of foreign equity share at the microeconomic level. Aswicahyono and Hill (1995) note this lack of empirical investigation.

This model, however, precisely derives an expression for the foreign ownership share and develops testable implications. For example, in related work Bhattacharyya and LaFontaine (1995) show that under fairly general specifications the optimal ownership share is determined by parameters of the production function and the cost of effort functions, and is independent of demand conditions. Aswicahyono and Hill

(1995) claim that the determinants of industry foreign share and firm level ownership share are one and the same. In contrast to this, with constant returns to scale technology, the model in this dissertation shows that that there is little reason to expect barriers to entry and scale economies, which are important determinants of the foreign share of industries, to impact the foreign equity share of particular enterprises.[26]

2.4 DETERMINANTS OF CRITICAL SKILL LEVELS AND ENTRY-MODE

Figure 2.1 demonstrates that MNCs choose entry mode by comparing the two collaborators' actual skill levels to certain critical levels. This section relates the predictions of the model in this regard to existing empirical findings. Characteristics of the production technology have a very important influence on the determination of the critical skill levels, (γ_m*, γ_l*). To derive concrete results, a Cobb-Douglas technology is assumed.[27] Therefore,

(2.13) $Y=[B^{\delta 1}e^{[1-\delta 1]}]^{\alpha 1}[L^{\delta 2}c^{[1-\delta 2]}]^{\alpha 2} [I]^{\alpha 3}$

Figure 2.2 varies $\alpha 2/\alpha 1$. In essence, this asks how the critical skill levels vary as "technological intensity" changes. High technology industries correspond to low values of $\alpha 2/\alpha 1$; the marginal product of technology is high relative to that of other inputs.

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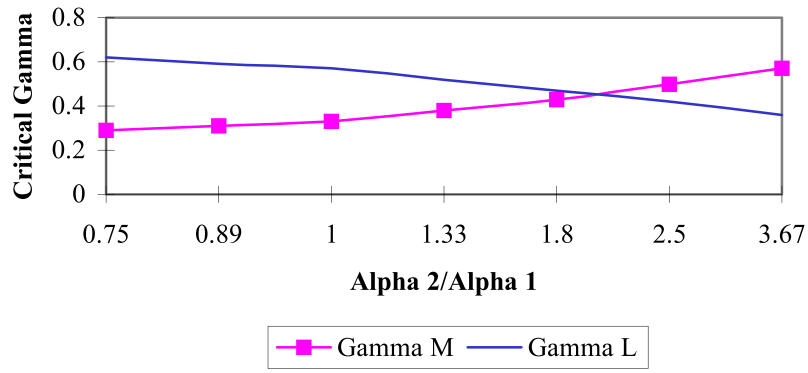
[25] For example, if the MNC's "technological asset" is based purely on its international marketing expertise, it can be shown that the foreign ownership share is an increasing function of the export percentage.

[26] We return to these issues in Chapter 4.

[27] Eswaran and Kotwal (1985) and Bhattacharyya and LaFontaine (1995) analyze this special case as well.

Figure 2.2: Dependence of Critical Skill Levels on Production Function Parameters

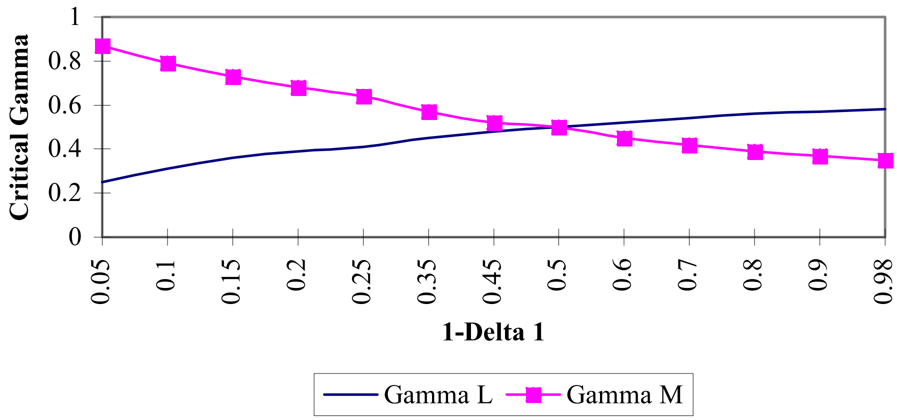


Because the critical level of γ_l is high and the critical level of γ_m is low as $\alpha 2/\alpha 1$ is low, the model predicts that MNCs are less likely to use arm's length exchanges in high technology industries. Caves (1996) and Contractor (1985) report a wealth of results that indicate TPs are less common in technology intensive industries.

Not only does the importance of technology influence the critical skill levels, but so does the nature of technology. This issue can be addressed by varying the parameter δ_1 in the sub-production function for effective technology (recall, effective technology = $B^{\delta 1}e^{[1-\delta 1]}$). For δ_1 near 0, effort is of paramount importance and the non-rival component of technology is relatively unimportant. Accordingly, Figure 2.3 indicates the critical γ_m is low which increases the probability of entry via a WOS. With complex or embodied

technology, a MNC is more likely to open a WOS and less likely to rely upon a TP. The opposite is the case if effort is redundant. This is consistent with Kogut and Zander's (1993) finding that codifiability makes it more likely that a technology will be licensed. Technological effort is less important when the agreement involves older technologies, is based purely on patent or copyright infringement or imparts only easily codified

Figure 2.3: Dependence of Critical Gamma's on Technology Production Function



information. Prior research indicates that TPs are much more likely with these sorts of technological assets.[28]

The discussion above relates studies of entry mode to the determinants of the critical skill levels. The model presented here also draws a connection between empirical findings and the determination of a particular MNC's ability to navigate the local environment. A MNC's prior experience obviously plays an important role in this regard. MNCs with substantial experience possess the skills necessary to successfully manage the complex environment in a developing country. They will therefore be more likely to choose a WOS or JV rather than a TP. There is a substantial volume of empirical literature that supports this implication of the model.[29]

"Cultural distance" also has an impact on the choice of entry mode. Ferrantino (1993) found that FDI from US firms was greater in English speaking countries.

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[28] Contractor (1985), and Oman (1989) and Davidson and McFetridge (1984, 1985) all find this to be true.
[29] Yu (1990), Caves (1996), and Gomes-Casseres (1989) all present evidence of this result.

Davidson and McFetridge (1985) found that US MNCs preferred direct investment to licensing when the host country was predominantly Catholic or Protestant. Finally, Kogut and Singh (1988) found that cultural dissimilarities were likely to lead MNCs to enter the US by joint venture rather than acquisition. The model presented in this paper would interpret these results as examples where similarities or differences between the MNC's home country and the host country impact the skills of the MNC relative to local firms. Similarities between home and host countries increase γ_M and increase the probability of entry by a WOS. Dissimilarities have the exact opposite effect.

2.5 CONCLUSION

The model presented in this chapter offers one clear advantage over most existing theoretical work in the area of FDI. It endogenously determines entry mode allowing for traditional FDI, joint equity ventures, and arm's length transfers. Also in contrast to earlier models, this research shows that licensing fees and royalty payments should be employed in conjunction with joint ventures. MNCs will use these instruments to ensure that they maintain their share of the rents earned based on their technological assets while also maintaining their partner's incentives. Additionally, the model is consistent with a number of stylized facts regarding both the types of technology that are likely to be transferred under alternative contract types as well as the types of MNCs that are likely to engage in different types of contracts. In particular, experienced MNCs are less likely to need to provide ownership equity to local firms as an incentive mechanism.

This model also points to the important role played by local firm skills. If local firms possess particular skills, MNCs will actually seek them out and willingly form partnerships. Alternatively, if local firms are sufficiently skilled they will be able to access MNC technological assets through technology purchase agreements. This should be of particular interest to those governments that seek to minimize the presence of foreign owned firms. Finally, although this model assumes that all rents remain with the MNC, if skilled local firms also have a degree of bargaining power, they will be able to maintain an increased share of the rents generated by these technological assets.

CHAPTER 3: PUBLIC POLICY, ENTRY MODE AND TECHNOLOGY TRANSFER

3.1 INTRODUCTION AND LITERATURE REVIEW

The interaction between public policy and the benefits derived from FDI by LDCs has drawn much recent attention. In particular, two seemingly contradictory questions have been asked in connection with developing economies. First, some researchers have examined policies that attract and increase the benefit of inward FDI. Second, economists have analyzed policies that minimize the social cost of FDI in industries that fall short of the perfectly competitive paradigm. The first branch of research focuses on the acquisition of advanced technology possessed by MNCs, while the second is primarily concerned with the imperfection of the markets in which MNCs operate. Because each line of inquiry ignores the very sort of market failure that leads to firms becoming multinational in the first place, neither approach is entirely satisfactory and the conclusions may not be robust.

The first approach has examined both the role of policy in attracting new multinationals (Wheeler and Mody (1992)) and increasing the benefits from existing subsidiaries. Wang and Blomstrom (1992) and Kokko and Blomstrom (1995) consider that technology transfer to developing countries may be a costly process. Therefore, they suggest policies that focus on education, contract security and competition to either reduce such transfer costs or increase the benefits MNCs may expect to receive. While the authors' conclusions are likely correct, because they do not examine precisely the market failures which render such transfers costly, the results fail to demonstrate the subtle yet important unintended consequences of public policy.

The second strand of literature is built upon the presumption that MNCs are creatures of market imperfection. That is to say MNCs always and everywhere operate in imperfectly competitive markets, behind non-optimal tariffs, or in industries with non-clearing factor markets. Understandably, given this basis, attention has been focused on minimizing the negative impact of MNCs in such environments. Such literature prescribes instruments such as local content policies, export promotion schemes or profit taxation in order to attenuate the social costs created by the interaction of MNCs with pre-existing distortions.

A frequent theme of the second strand of literature is that although policies such as local content regulation and export promotion policies may not generally achieve their stated goals, they may have some use when applied selectively to MNCs. For example, while Grossman (1981) demonstrates that local content regulation may actually stifle the domestic intermediate goods industry and hurt the exportable sector, Lahiri and Ono (1998) argue that local content policies directed at foreign nationals can generally be used to increase host country welfare by spurring competition and encouraging the entry of relatively efficient MNCs. In addition, while Herander and Thomas (1986) show that export promotion policies may fail to improve overall trade balance, Rodrik (1987) argues that such policies may be beneficial when applied to foreign owned firms. The author shows that such policies mitigate the social cost of MNCs that operate behind non-optimal tariffs. Chao and Yu (1996) reach a similar conclusion. In a surplus labor model, Beladi and Chao (1993) show that the influx foreign investment can increase unemployment. A profit tax on MNCs can limit this negative impact. Finally, due to capital market imperfections, Batra (1986) finds that the transfer of technology alone (i.e., without any accompanying physical capital) through MNCs can lower employment and real income in developing countries. He, too, proposes a profit tax to limit such a negative outcome.

Each of the above policies proposes to limit a possible negative impact of FDI by controlling the size and quantity of foreign investments. While MNCs may chase a particular sort of market imperfection, prior analysis ignores the fact that MNCs owe their very existence to an entirely different set of market failures. Broadly defined these are market failures in the transfer of technology based assets. Given the presence of these market failures, such policies may alter not only the number of foreign firms but also alter the behavior of those that still enter a particular market. A full understanding of the impact of these frequently employed policies necessitates an analysis of the impact these policies have on MNC behavior given the type of market failures modeled in this dissertation.

3.2 IMPACT OF POLICY ON ENTRY MODE AND TECHNOLOGY TRANSFER

A number of factors must be considered in this analysis of government policy. First, due to moral hazard, the JV equilibrium is not necessarily constrained Pareto optimal.[30] In fact, in the joint venture equilibrium there are two types of externalities. Neither collaborator considers the marginal impact of e or c on its partner's share of the profits - the profit sharing externality. Neither does either partner consider the impact of its own choice of unobservable resources on its partner's contribution - the Nash

[30] Greenwald and Stiglitz (1986) and Arnott and Stiglitz (1987) demonstrate this principle. As long as goods subject to moral hazard are sensitive to policy instruments, through cross-price effects for example, there will be room for policy induced Pareto improvements. Below, it is shown that these observations apply to this model.

externality. Second, as is done elsewhere, this model assumes policies are applied selectively to firms with foreign ownership. Finally, although no attempt is made to derive optimal policy interventions,[31] the insights below have important implications regarding the conclusions drawn from the existing literature discussed above.

As in other models based on incentive contracts and unobservable factors of production, any positive or negative impact of public policy on MNCs occurs through the impact of said policies on the incentive compatibility and participation constraints. The first key feature to notice about this model is that any policy which eases the incentive compatibility constraints and raises profits in joint ventures will have an additional effect. The policy will alter the desired entry mode. Using the notation developed in Chapter 2, consider the following propositions.

Proposition 5: Policies which increase (decrease) the profitability of JVs increase the critical level of local skills (γ_l*) necessary for entry via TP. Further, a policy which simultaneously increases the profitability of JVs and decreases the profitability of WOSs will increase the critical level of MNC skills (γ_m*) necessary for entry via WOS.

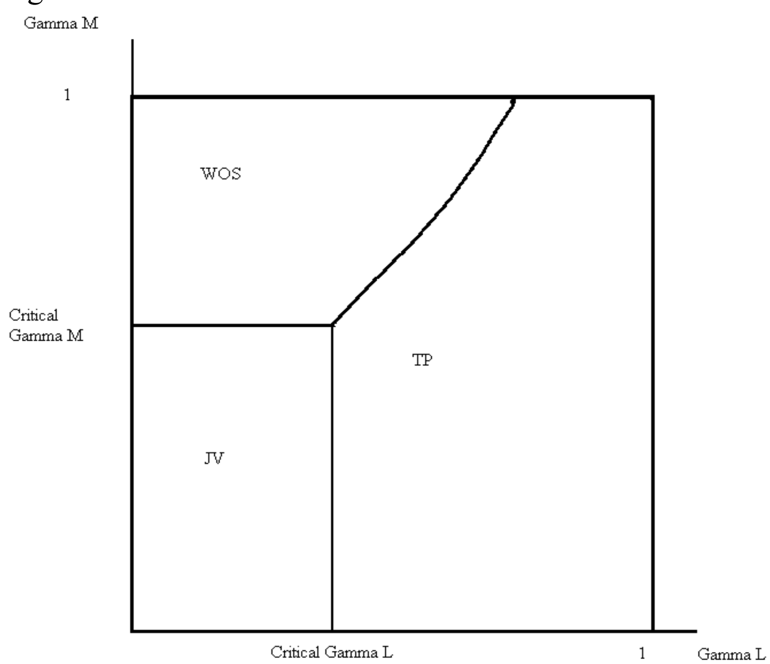
Proof : Let $\Pi^*_{M,JV}$ equal the unrestricted JV profit, then clearly if $\Pi^0_{M,JV}$ equals the restricted JV profits (i.e., after the additional policy instrument has been imposed), $\Pi^*_{M,JV} \leq \Pi^0_{M,JV}$. Recall, that $\Pi^*_{M,TP}$ is increasing in γ_l and the critical γ_l* is determined by $\Pi^*_{M,TP} = \Pi^0_{M,JV}$. Identical logic can be used to prove the second half of the proposition. The key is that both increasing JV profitability relative to unrestricted WOS profits and decreasing WOS profits relative to the unrestricted environment impact γ_m in the same fashion.

The essence of this proposition is that when governments get their interventions right and create Pareto improvements in existing JVs - by acting to *increase* the

[31] No attempt is made because policies directed at foreign firms can alter both the desired levels of inputs and the desired entry-mode. Policies which improve the profitability of joint ventures may also cause MNCs to choose JVs rather than WOSs. This will introduce distortions through second best constraints where there were none originally. It is impossible to weigh these costs against the gains from improved

profitability of joint ventures - they also increase the likelihood that future MNC entrants will choose to enter via a JV. Referring to Figure 2.1, which is included here for convenience, policies which increase the profitability of JVs and decrease the profitability of WOSs shift the horizontal line up and the vertical line to the right, increasing the probability that a MNC enters via a joint venture. To the extent that encouraging MNCs

Figure 2.1: Contract Outcomes and Skill Parameters



to engage in joint equity operations is an independent goal[32], the government will experience a type of policy spillover benefit.

The remainder of this chapter examines five policy interventions. Following the example of Greenwald and Stiglitz (1987) and Arnott and Stiglitz (1986), the first

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behavior of existing JVs without introducing specific assumptions regarding the distribution of firms over the skill variables.

intervention involves a quota on an input which is a complement to unobservable inputs and the second a per-unit subsidy. The final three interventions examined are export promotion policies, revenue taxation of foreign-owned firms and traditional local content requirements.[33]

3.2.1 OBSERVABLE INPUT QUOTAS

In order to see that restrictive policies may actually improve JV profits, consider the following highly stylized model of a local content restriction. Assume L and I are locally purchased inputs and imported inputs respectively and suppose that all foreign owned firms are required to purchase a minimum quantity of (all) local inputs, $L - L_{min} \geq 0$. Substitute this constraint (assuming it binds) into the production function and re-write the problem as[34]

$$\text{(3.1) } \max_{\{\beta,I,e,c\}} F(L_{min},I,e,c) - w L_{min} - p I - R(e) - S(c) + \mu_1 [\beta F_e(L_{min},I,e,c) - R'(e)] + \mu_2 [[1-\beta] F_c(L_{min},I,e,c) - S'(c)]$$

Standard intuition regarding the effect of additional constraints on maximization problems fails. Differentiating with respect to L_{min} and using the Envelope Theorem gives the marginal impact of increasing the quantity restriction.

$$\text{(3.2) } \{F_L(L_{min},I,e,c) - w\} + \{\mu_1 \beta F_{eL}(L_{min},I,e,c)\} + \{\mu_2 [1-\beta] F_{cL}(L_{min},I,e,c)\}$$

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[32] If management cooperation through joint ventures enhances technology spillovers to local firms, governments may prefer such policies.
[33] The adjective "traditional" is used only to distinguish the frequently employed practice of specifying a percentage of inputs that must be purchased locally from the rather unusual quota in Policy 1.
[34] Notice the random variable is eliminated. This is done so that uncertainty does not create an option value that the constraint will bind and distort input choices. Alternatively it could have been assumed that

The first term in {} will be negative given that the constraint is binding, but the signs of the second and third term are indeterminate in general.[35] A sufficient condition for JV profits to increase is that the quantity forcing of locally purchased goods eases the incentive compatibility constraints ($F_{eL}>0$ and $F_{cL}>0$) and these gains are sufficient to offset the loss created by using locally purchased goods in such a large quantity that their marginal value product is less than their marginal cost.[36] This insight is generalized and formalized in the following proposition. Suppose there exists an observable good L_1, on which a quantity restriction may be placed. Equation (3.3) is total profits from a JV. Totally differentiating this expression gives Equation (3.4).

$$(3.3)\quad \prod\nolimits_{JV}^{*}(\bar{L}_1) = F(\bar{L}_1,\ L(\bar{L}_1)_2,..L(\bar{L}_1)_n, I(\bar{L}_1), e(\bar{L}_1),\ c(\bar{L}_1)\,) - w_1\,\bar{L} - \sum\nolimits_{i\neq 1} w_i L(\bar{L}_1)_i - p\, I(\bar{L}_1) - R(e(\bar{L}_1)),\ S(c(\bar{L}_1))$$

$$(3.4)\quad \frac{\partial \prod_{JV}^{*}}{\partial \bar{L}_1} = [F_{L_1} - w_1] + \sum\nolimits_{i\neq 1}[F_{L_i} - w_i]\frac{\partial L_i}{\partial \bar{L}_1} + \sum\nolimits_{j}[F_{I_{ij}} - p_j]\frac{\partial I_j}{\partial \bar{L}_1} + [F_e - R_e]\frac{\partial e}{\partial \bar{L}_1} + [F_c - S_c]\frac{\partial c}{\partial \bar{L}_1}$$

Proposition 6: Quantity restrictions on observable inputs may be used to increase JV profits unless all unobservable inputs are insensitive to changes in observable inputs or the impacts are such precisely offset one another. Mathematically, such quantity restrictions may be used to increase JV profits unless $[F_e - R_e]\frac{\partial e}{\partial \bar{L}} + [F_c - S_c]\frac{\partial c}{\partial \bar{L}} = 0$. Further, quantity restrictions which raise JV profits necessarily increase the provision of at least one unobservable good.

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the random term was additively separable, with a mean of zero. This would be the case if the firm occasionally received kick-backs from or paid bribes to bureaucrats.

[35] Note that this derivation also shows that profits of WOSs, which are not subject to incentive compatibility constraints, will be diminished by this policy.

[36] In fact, it is easy to see that the increased provision of an unobservable good is a necessary condition for a quantity restriction on observable inputs to have a positive impact on JV profits.

Proof: Evaluating Equation (3.4) at the unconstrained equilibrium, the first term and each of the terms within the summation operators are equal to zero. Because both $[F_e - R_e]$ and $[F_c - S_c]$ are positive (see Proposition 3), as long as unobservable inputs are sensitive to the policy variable, profits can be increased. Clearly, at least one of e and c must increase in order to increase profits.

This result is not surprising. Profits can be increased as long as unobservable inputs are sensitive to the amount of at least one observable input. Except in the unlikely event where the changes in unobservable goods resulting from the quantity restriction are opposite in sign and of the appropriate magnitude to cancel each other out, the initial joint venture equilibrium is not constrained Pareto efficient. Finally, If $\frac{\partial e}{\partial \bar{L}}$ and $\frac{\partial c}{\partial \bar{L}}$ are both positive (negative), it is easy to see that a quantity minimum (maximum) should be used.

In a WOS, because the MNC takes sole ownership and equates, at the margin, the benefits and costs of technology transfer and monitoring of locally purchased goods, the impact on entry mode is evident.

Proposition 7: Well designed quantity restrictions - those that increase profits in JVs - applied selectively to foreign owned firms will increase the probability that MNCs choose to enter via a JV.

Proof: These quantity restrictions cannot increase the profits of a WOS and are not applied to local firms which engage in TPs. These facts and Proposition 5 imply the conclusion.

The chief weakness of the quantity restrictions analyzed above is that they are rather esoteric. It is hard to imagine that policy makers in developing countries have the capabilities or knowledge regarding individual foreign owned operations to design quantity restrictions which manage to balance the second-order gains achieved through increased provision of management activities against the first-order losses imposed by employing inputs in a non-optimal fashion. However, there are alternative policy instruments which can be employed to improve resource allocation in JVs.

3.2.2 PIGOUVIAN TAXES (SUBSIDIES) ON OBSERVABLE INPUTS

In order to examine the use of taxes and subsidies to ease the incentive compatibility constraints, assume that the government subsidizes foreign owned firms' purchases of a particular imported input, I_1, at a rate "t" and collects a lump sum tax T from these firms. The analysis assumes all changes in taxes are revenue neutral and are in the neighborhood of an initial equilibrium with t=T=0.

Proposition 8: Starting at the no tax equilibrium, the introduction of a small tax or subsidy on an observable imported input will increase JV profits unless

$$[F_e - R_e]\frac{\partial e}{\partial t} + [F_c - S_c]\frac{\partial c}{\partial t} = 0.$$

Proof: See Appendix D.

The intuition and the basic details from the discussion of quantity restrictions continue to hold. As long as unobservable inputs are sensitive to some policy instrument, through cross-price effects, the initial equilibrium will not be constrained Pareto efficient. Pareto improving policies will increase the provision of one or both unobservable inputs. Also, it can be seen that if the cross-price effects from input I_1 are both positive (negative), then the government should impose a subsidy (tax) in order to increase JV profits. Finally, this policy will have no impact on WOS profits. Any additional costs or savings will be offset by the change in the lump sum tax. Given this and the fact that locally owned firms are not subject to this scheme, Proposition 5 ensures that this policy will also increase the probability that a MNC will prefer to enter via a JV.

This option has much greater practical relevance because it shows that incentive schemes used to attract investors such as duty draw-backs of inputs and tariff-free importation of capital goods have an additional benefit. To the extent that these inputs are complementary to the MNC technological asset, such incentive schemes motivate MNCs to increase efforts devoted to technology transfer. The benefits of these policies are not without limit. Eventually, the cost of over-employing observable inputs outweighs the gain of employing unobservable inputs at a point nearer their marginal cost.[37]

While these results are intriguing, it is even more interesting to compare the results above to the policies such as export promotion programs, local content regimes, and profit taxation.[38] The only impact of these policies in earlier models is the deterrence of MNC entry. This limits the welfare costs created by MNCs given tariffs and other pre-existing distortions. These policies will encourage some MNCs to look to other countries; others will still enter and their behavior will be affected by the policies. Since host governments frequently seek out foreign investors so that the developing country can gain access to advanced technology, the impact of these policies on technology transfer is of particular interest. In order to derive concrete results regarding unobservable inputs, this model follows Eswaran and Kotwal (1985) and Bhattacharyya and Lafontaine (1995) and analyzes the case of Cobb-Douglas production technology

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[37] The incentive compatibility constraints will still bind and therefore the marginal value of the unobservable inputs in the JV will still exceed the marginal cost of supplying them.

and constant marginal cost of providing managerial efforts. Derivations and proofs are contained in Appendix D.

3.2.3 EXPORT PROMOTION POLICIES

In order to capture the impact of export promotion policies we must explicitly introduce the price of output sold , P_D^{Out} to our model.[39] Following Rodrik (1987), the impact of an export requirement is modeled as a reduction in the "effective" price realized by the JV. Given a tariff jumping motive for choosing local production over trade, output is sold at a higher price domestically than on the world market, $P_D^{Out} > P_F^{Out}$. Therefore if the export performance requirement dictates that foreign firms must export a fraction, μ, of their output, the effective price (P_E^{Out}) equals a weighted average of the domestic and world prices ($P_E^{Out} = \mu * P_F^{Out} * (1-\mu) * P_D^{Out}$). Clearly, with a positive export performance requirement, $P_E^{Out} < P_D^{Out}$.

Export promotion policies never increase the profitability of foreign owned firms.[40] Given this, Proposition 5 guarantees these policies increase likelihood that MNCs choose to allow local firms to "go it alone" by exchanging technology in an arm's length fashion.

Proposition 8: Given Cobb-Douglas technology and constant marginal cost of providing managerial inputs and a tariff hopping motive for foreign investment, binding export promotion policies will discourage the use of joint ventures, diminish profits, and lead to lower provision of unobservable inputs.

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[38] Rodrik (1987) and Chao and Yu (1996) recommend an export promotion scheme, Lahiri and Ono (1998) and Batra (1986) support a profit or revenue based tax, and Lahiri and Ono (1998) recommend local content restrictions.

[39] Equation 6 needs to be amended as follows: Max $_{\{L,E\}}$ P_D^{Out} F(I,L,e,c;B,δ)-wL-pI.

[40] Standard properties of the profit function ensure that this is true for WOSs and it is easy to prove this property continues to hold for JVs.

Proof: Changes in export performance requirements have the same impact as changes in the price of output. The effects of changes in P^{Out} are analyzed in Propositions D1 and D2 of Appendix D.

Using data from a recent survey of Japanese executives in MNCs, Mody, Dasgupta and Sinha (1999) found that these executives both perceived export promotion policies to be a significant barrier to FDI and acted on these beliefs. Since export promotion policies have a negative impact on entry decisions, MNCs must believe that there is something to be gained by producing locally for the local market. As export promotion policies erode these gains, they erode the incentive for MNCs to transfer technology as well.

Export growth is frequently prescribed to promote competition and spur the adoption of new technology. In this model, firms are perfectly competitive and there is only a single time period. This essentially assumes away the traditional gains. However, this model sharpens the focus on the adverse impact on the incentive compatibility constraints. Before analyzing local content requirements, note that the impact of sales and revenue taxes is the same as the export promotion policy.

3.2.4 SALES AND REVENUE TAXATION

Proposition 9: Given Cobb-Douglas technology and constant marginal cost of providing managerial inputs, revenue or sales taxes will have the exact same impact as the export promotion policy. Namely these taxes will diminish profits earned by foreign firms, discourage the use of JVs, and decrease the supply of unobservable inputs.

Proof: See Appendix D Propositions D1 and D2.

3.2.5 TRADITIONAL LOCAL CONTENT REQUIREMENTS

Local content regulation generally dictates a minimum percentage of inputs which must be purchased locally. For simplicity, assume that I and L are scalars and represent imported inputs and locally purchased inputs respectively. This gives

$$(3.5)\ \pi\,(e,c) = \text{Max}_{\{L,I\}}\ [[\ F(L,I,e,c)\text{-}wL\text{-}pI] + \lambda\ [\frac{L}{L+I} \geq \phi\ ]$$

where ϕ is the percentage of inputs that must be purchased locally. Notice the constraint can be re-written

$$(3.5a)\ \pi\,(e,c) = \text{Max}_{\{L,I\}}\ [[\ F(L,I,e,c)\text{-}wL\text{-}pI] + \lambda\ [\ \rho\ L - I \geq 0\ ]$$

where $\rho = \frac{1-\phi}{\phi}$ is the required ratio of domestic inputs to imported inputs.

Proposition 10: With Cobb-Douglas production technology and constant marginal cost of providing unobservable inputs, binding local content policies will reduce JV profits, reduce WOS profits, and decrease the amount of unobservable resources in all firms with foreign ownership. Further, local content policies will decrease the probability that MNCs choose to form joint ventures.

Proof: See Appendix A, Propositions A3 and A4.

Binding local content policies act like a subsidy on locally purchased inputs and a tax on imported inputs. The discussion of quantity and tax instruments involved only a single input as this was sufficient to show the JV equilibrium was not constrained Pareto optimal. Greenwald and Stiglitz (1986) and Arnott and Stiglitz (1987) show that the optimal policy involved varying the rate of taxation or subsidy across all goods depending on their degree of substitutability or complementary with unobserved inputs. It is unlikely that a local content policy is an approximation of an optimal intervention. In a many goods model, this would require that all locally purchased inputs be equally complementary with all unobserved inputs and all imported inputs be equal substitutes for all unobserved inputs. Policies aimed at easing the incentive constraints require a delicate touch and not an overbearing hand.

3.3 CONCLUSION

The hallmark of a good policy intervention is that the policy is targeted explicitly at easing incentive compatibility constraints. Perhaps their blunt and heavy handed nature is the hallmark of frequently used policies in LDCs. As another example of such policies consider the impact of a legal limit to the foreign ownership percentage. Obviously, this would eliminate the possibility that a foreign corporation will enter via a WOS. In terms of Figure 2.1, the only relevant constraint is the vertical line. Since there are MNCs which would prefer to enter via a WOS, this policy introduces shirking behavior where before there was none. There is a clear negative impact on technology transfer. Developing countries that seek to promote technology spillovers by forcing MNCs to enter via shared equity or force MNCs to take a smaller equity stake than the MNC would otherwise find optimal, need to be aware of this effect of their policy.

Table 3.1 summarizes and compares the results of our analysis of the widely used policies to the first two policies. The distinction between good and bad policy interventions is stark. The quantity and price instruments in Table 3.1 are employed in such a fashion that they ease the incentive constraints. The policies achieve this result by promoting the use of inputs that increase the marginal value of non-contractible inputs.

Table 3.1: Policy Comparisons

Policy	Probability of JV	Technology Transfer in JV	Technology Transfer in WOS
Quantity Instrument*	Increases**	Increases**	Increases**
Price Instrument*	Increases**	Increases**	Increases**
Export Promotion	Decreases	Decreases	Decreases
Sales Tax	Decreases	Decreases	Decreases
Local Content %	Decreases	Decreases	Decreases

*The effects assume the instrument is employed appropriately.
** These results are independent of functional form.

The supply of these non-contractible goods is increased accordingly.

Given developing countries quest for advanced technology and the fact that the original equilibrium was not constrained Pareto optimal, any intervention which achieves this will be welcomed by all parties. The good news is that there are significant benefits to getting interventions right. However, a frequent complaint among developing nations is that local entrepreneurs have not realized any spillover benefits from MNCs and in fact MNCs transfer little technology to their local facilities. This too can be easily explained in the context of this model.

For example, Thee and Pangestu (1996) studied technological capabilities in the Indonesian manufacturing sector. They lament that “ the [industrial technological capabilities] of even foreign-controlled JVs have not achieved international best practice.” Despite relative openness to FDI since the late 1960’s, Indonesia has employed restrictions to ownership percentage, export promotion policies and local content policies. Each of these can diminish the incentive to commit managerial effort to the implementation of technology. This model suggests that the low capabilities of many affiliates may be the result of policy makers’ failure to get certain key interventions right, rather than malfeasance on behalf of MNC executives. It is possible for LDC governments to simultaneously promote technology transfer and to promote the establishment of joint ventures. However, many of the policies which prior research has urged LDCs to adopt can have deleterious effects on each of these goals.

While it is possible for governments to engage in Pareto interventions, this will only be necessary if the firms are unable to undertake such actions on their own.[41] Arora (1996) examines one such possible intervention. Multinational firms bundle sales of inputs that are complementary to effort in arm's length technology. Such an approach is beneficial because it promotes the provision of an unobservable resource as well. In fact, the model presented in Arora can be viewed as a special case of the model analyzed in this dissertation. There are two reasons why LDC governments may still find a need for interventions. First, the difficulty of observing and enforcing compliance to more complex contracts in a developing country environment may hinder private Pareto improving actions. Second, the LDC government may choose to use these instruments to capture some of the rents earned by the multinational.[42]

[41] I thank Dan Vincent making this observation.
[42] I owe Arvind Panagariya for making this comment.

CHAPTER 4: DETERMINANTS OF FOREIGN OWNERSHIP SHARE AT AGGREGATE AND MICRO LEVEL

4.1 INTRODUCTION

The model developed in Chapter 2 provides testable implications regarding the determination of foreign ownership at the plant level. Ownership is granted to provide an incentive to contribute managerial resources. Therefore, theory predicts that foreign ownership share varies directly with the importance of MNC's contribution and inversely with the importance of the local partner's contribution. Further, as an experienced MNC (local firm) is fully capable of performing all managerial tasks, foreign ownership percentage varies directly (inversely) with MNC (local firm) experience. Some of these characteristics should certainly be the same throughout an industry. However, one must be careful not to confuse the determination of plant or firm level foreign ownership shares with the share of industrial output produced by foreign owned firms in a given industry. While the latter issue has been extensively studied[43], the former remains virtually unexamined.[44]

Aswicahyono and Hill (1995) may claim that "the link between the determinants of MNC shares in a given industry and the MNC's equity share in its subsidiaries is a powerful one," but this actually remains an untested proposition. Evidence does

[43] Dunning (1993) provides a survey of the literature on inter-industry variations in foreign investment. See also Caves (1974) for developed countries and Lall and Mohammed (1983) for developing nations. Aswicahyono and Hill (1995) find that many of these propositions are in general true for Indonesia, the country considered in this research.

[44] Empirical studies such as Yu (1990), Gomes-Casseres (1989, 1990), Kogut and Singh (1988) and Beamish and Banks (1987) have examined each of the entry modes discussed in this dissertation: wholly-owned subsidiaries, an equity joint ventures, and an arm's length exchange of proprietary assets. However, the dependent variable was categorical and did not specifially examine the ownership share. These results were discussed in Chapter 2 in relation to this model's consistency with certain stylized facts.

indicate that MNCs have a large presence in industries that demonstrate significant scale economies and other barriers to entry, however there is merely a strong presumption that these same factors are important at the micro level. This confusion may arise because the literature on MNC entry mode employs some of these same industry level characteristics, along with characteristics of the particular MNC and perhaps the recipient nation. These studies do not constitute the sort of evidence needed to make such strong claims. Although similar in logic to the model presented in this dissertation, prior studies of MNC entry mode have failed to recognize a few key theoretical implications and have employed indicator variables for various entry-modes rather than the continuous (although censored) percentage ownership variable analyzed here.

Before proceeding, it is important to note that this empirical model is quite similar to that employed by LaFontaine (1992) and Lafontaine and Shaw (1995) to examine whether risk, bi-lateral moral hazard, or capital market imperfections were the cause of franchising agreements in the US retail sector. However, the methodology employed here represents a significant improvement of this earlier approach in that obvious endogeneity issues are addressed.

The remainder of this chapter proceeds as follows. Section 3 presents the data, summarizes the results of Aswicahyono and Hill (1995) and conducts a similar analysis of inter-industry variation in foreign ownership share in the Indonesian manufacturing sector. Section 3 develops an empirical model of the determinants of foreign ownership at the plant level. This is a simplified version of the model developed and analyzed in earlier chapters. Section 4 presents the empirical results and Section 5 concludes.

4.2 DATA AND INDUSTRY LEVEL DETERMINANTS OF FOREIGN OWNERSHIP

The data employed in this chapter are drawn from two sources, each produced by the Indonesian Badan Pusat Statistik (Central Board of Statistics - BPS). Since 1975, BPS has conducted the Survei Tahunan Perusahaan Industri Sedang dan Besar (Annual Survey of Medium and Large Industrial Establishments - SI) to collect detailed data on output, input, value added, costs, location and ownership. All data are collected at the establishment or plant level and include establishments with twenty or more employees. For a more detailed discussion of the data, see Appendix E. The current work will focus on data for 1993-1995. This corresponds to the period for which foreign entries for each of the possible entry modes can be identified.[45] Such entries are identified by one of three conditions: an existing locally owned plant reports (for the first time) positive foreign equity, an existing locally owned plant reports (for the first time) paying management and royalty fees to a multinational[46] firm, or a plant begins operations with positive foreign equity or positive royalties or management fees. All export oriented foreign entries are include in the estimation.

In order to verify that the same forces drive aggregate foreign presence in Indonesia, attention is temporarily directed towards the industry level determinants of foreign presence. Aswicahyono and Hill (1995) use the same data as are employed in this dissertation, except they employ an earlier time period, 1985. Data are aggregated to the 5-digit ISIC level to analyze inter-industry variation in ownership shares.

[45] BPS began reporting data on royalties and management fees paid in 1992.
[46] Although the data field does not require that these fees be paid to non-Indonesian firms, conversations with officials at the Central Board of Statistics indicate that this was the intent of the question and highly likely to be the case.

Improvements to BPS data collection and certain policy changes indicate that further analysis using updated data is warranted.

Aswicahyono and Hill do not find that advertising or R&D shares are significant predictors of the foreign share of industry output, however they do find that the foreign share increases with other industry variables that are indicative of scale economies and entry barriers[47]. The authors also find that government regulation has a significant impact on the foreign share of industry output. They offer three pieces of evidence for this fact. A dummy variable for industries in which foreign investment is expressly prohibited deters foreign investment as does a large government share of industry output. Finally, results are sensitive to the exact definition of foreign share. If “foreign output” is defined to include only 100% foreign owned enterprises or foreign/private JVs, few if any conclusions can be drawn from the data. When “foreign share” is defined to include foreign/government JVs, except those in 5 industries in which the authors deem government to be the dominant partner[48], the authors demonstrate the results discussed above.

[47] Minimum Efficient Production Scale (MEPS) which equals the average output of all firms in the upper half of the output distribution relative to the average for the lower half of the distribution, the Four Plant Concentration Ratio (CR4), the Herfindahl Index, Non-Wage Value Added are all significant predictors of an increased foreign share of output.

[48] These industries are sugar, fertilizer, cement, basic metals and ship building.

Table 4.1: Output Shares by Ownership Group

Industry		Private 1985	Private 1995	Government* 1985	Government* 1995	For/Priv JV 1985	For/Priv JV 1995	For/Gov** JV 1985	For/Gov** JV 1995	Foreign 1985	Foreign 1995
31100	FOOD1	60.14	70.44	30.11	16.25	6.54	10.11	0.33	0.59	2.88	2.6
31200	FOOD2	69.89	66.21	10.62	5.35	18.81	25.01	0.08	0.13	0.6	3.3
31300	BEVERAGES	50.68	59.02	0.13	0.01	36.53	35.34	12.66	.	.	5.63
31400	TOBACCO & CIGARETTES	94.39	95.15	1.17	0.28	3.79	3.64	0.15	.	0.51	0.94
32100	TEXTILES	65.83	81.61	7.97	1.96	23.08	15.08	0.87	0.81	2.25	0.53
32200	CLOTHES EXCL FOOTWEAR	95.95	67.86	3.01	1.18	1.04	28.66	.	0.1	.	2.21
32300	TANNERIES AND LEATHER EXCL	82.99	80.75	8.1	3.45	0.32	15.13	.	.	8.58	0.68
32400	FOOTWEAR	51.63	51.4	6.44	0.62	41.94	43.02	.	.	.	4.95
33100	WOOD ETC.	81.85	87.61	3.33	0.88	13.76	10.58	0.2	.	0.86	0.93
33200	WOOD FURNITURE	86.17	87.03	10.37	0.63	3.46	11.34	.	.	.	1
34100	PAPER & PAPER PRODUCTS	64.94	57.57	16.02	7.07	19.04	35.32	.	.	.	0.04
34200	PRINTING & PUBLISHING	74.27	67.45	21.58	20.99	0.51	11.56	3.64	.	.	.
35100	INDUSTRIAL CHEMICAL	17.55	29.27	65.24	34.19	16.5	35.32	0.03	0.45	0.68	0.77
35200	OTHER CHEMICAL	51.48	48.27	4.93	4.23	33.99	44.5	6.57	.	3.04	3
35400	PRODUCTS OF PETROLEUM REF & COAL	100	53.1	.	.	.	15.15	.	7.8	.	23.94
35500	RUBBER & RUBBER PRODUCTS	66.2	69.4	9.44	6.64	15.36	16.14	0.05	0.49	8.95	7.34
35600	PLASTIC PRODUCTS	88.02	72.31	0.4	0.28	11.57	16.73	.	.	.	10.68
36100	PORCELAIN	88.98	76.64	1.98	2.27	9.04	20.17	.	.	.	0.92
36200	GLASS & GLASS PRODUCTS	29.96	77.64	3.92	5.09	66.13	17.28	.	.	.	.
36300	CEMENT AND CEMENT PRODUCTS	22.72	30.21	64	51.11	12.69	13	0.59	.	.	5.68
36400	CLAY PRODUCTS	86.79	87.52	4.4	2.69	8.81	9.78	.	.	.	.
36900	OTHER NON-METL MIN PRODUCTS	89.31	91.68	10.69	2.07	.	6.26	.	.	.	.
37100	IRON AND STEEL BASIC IND	21.24	30.56	72.69	42.9	6.08	26.51	.	.	.	0.03
37200	NON-FERROUS METAL BASIC IND	98.26	47.87	1.74	38.28	.	11.79	.	.	.	2.06
38100	FABRICATED METAL PRODUCTS EXCL	60.68	56.85	8.8	1.04	27.92	40.83	2.59	0.73	.	0.55
38200	MACHINERY EXCL ELECTRICAL	37.26	45.85	19.04	7.55	34.55	39.57	7.97	0.21	1.18	6.83
38300	ELEC MACH APPARATUS, APPLIANCES &	54.45	36.71	2.62	3.6	27.97	42.28	5.59	0.75	9.36	16.66
38400	TRANSPORT EQUIP	67.34	53.73	18.72	6.97	13.94	34.53	.	.	.	4.78
38500	PROFESSIONAL SCIENTIFIC EQUIP	72.37	50.18	0.09	.	27.54	25.76	.	.	.	24.05
39000	OTHER MANUFACTURING	65.03	45.99	1.07	0.02	33.9	51.06	.	.	.	2.93

Source: Unpublished BPS data

*Government sector includes sectors where government is dominant partner in the JVs.

** Excludes sectors where the government is deemed the dominant partner

Tables 4.1 and 4.2 present some summary information regarding the foreign presence in Indonesia. In 1986, Indonesia began a process of liberalizing its investment environment.[49] Table 4.1 shows the change in the structure Indonesian industry between 1985 and 1995 at the 3-digit ISIC.[50] The foreign share of industries has shown a dramatic response. Much of this has been channeled through foreign/private JVs. Until 1992, there was a prohibition on 100% foreign ownership, between 1992 and May 1994, 100% ownership was allowed provided the investor met certain qualifications regarding capital investment, export propensity, location, and future transfer of equity to Indonesian interests (phase-down requirements). In 1994, phase-down requirements were liberalized[51]and the other qualifications were eliminated. It is interesting to note that in the vast majority of industries, the private sector has maintained its share of production. It has only lost a considerable share to foreign firms in three of the relatively high-tech sectors.

Table 4.2 identifies start-up plants that are involved with foreign corporations. Zero-equity start-ups are identified as those plants that report a positive value for royalty payments and 0% foreign equity in their initial year of production.[52] The table contains

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[49] This process was gradual and intermittent from 1986-1992 and then followed by a big bang in May 1994. Pangestu (1996) provides a complete discussion of these issues.

[50] The data presented are output shares, where output is taken from the Backcast Data. There are no data on equity shares from this source, so these data were taken from the annual Industrial Survey. Those observations where a particular plant has data in the Backcast, but not the annual survey (i.e., years before BPS "found" the plant in question) the equity shares are assumed to be the same as the initial year the plant appears in the annual survey. For the present purposes, this seems to be an innocuous assumption. Further, Jammal (1993) discusses the misleading conclusions that can be drawn if only the raw Industrial Survey data are employed.

[51] Some of equity, the amount to be determined by the foreign investor, had to be transferred to national interests within 15 years.

[52] Although the questionnaire does not stipulate that these payments are made to foreign corporations, interviews with officials at BPS indicate that this is the intention.

Table 4.2: Frequency Distribution of Foreign Start-Ups and Total Plants by Equity Class

Year	Ownership Percentages				
	0%	1%-40%	41%-60%	61%-99%	100%
Start-Ups					
1992	12.12	9.1	28.79	37.88	12.12
1993	8.54	7.32	32.92	39.03	12.2
1994	16.96	8.93	16.97	26.79	30.36
1995	30.11	2.16	10.76	16.14	40.86
Total Plants					
1995	30.61	6.87	21.03	28.79	12.69

the percentages of foreign start-ups in each of the categories. For instance, in 1992, 12.12% of the start-up plants that were involved with foreign corporations did so in an arm's length fashion, while a further 12.12% were 100% foreign owned subsidiaries. The final row focuses on all plants operating in 1995 that are associated with foreign firms. In 1995, 30.6% of all "foreign" firms actually have no foreign equity investment. Only 12.7% are 100% foreign-owned subsidiaries. These numbers demonstrate the claim put forward in the introduction to this dissertation. Namely, theoretical models of FDI that implicitly or explicitly restrict their attention to 100% MNC owned subsidiaries fail to explain a significant proportion of MNC involvement in developing country markets.

Studies of inter-industry variation in ownership shares are conducted using industry aggregate statistics. Here observations for 336 5-digit ISIC industries are analyzed. Table 4.3 list the variables employed in the analysis and Table 4.4 replicates Aswicahyono and Hill's (1995) regressions for the more recent time period. As noted, some changes result from refinements to the data collection and to regulatory changes. In particular R&D, advertising, as well as skilled labor are directly measured.

Additionally, regulatory changes have necessitated a different definition of D1, the dummy variable for industries with direct restrictions on foreign ownership until the reforms of 1994[53]. In her study of the determinants of franchising agreements, LaFontaine (1992) measures risk as the number of failures in the industry. The impact of this variable is also considered.

Table 4.3: Variable Definitions

Variable	Definition*
FP_SHR	Output Share by Foreign Firms or Foreign/Private JVs
FPGS_SHR	Output Share by Foreign Firms, Foreign/Private JVs, or Foreign/Government JVs
M5ADVOUT	Avg. Advertising/Output:5-Digit Industry
M5RDOUT	Avg. R&D/Output:5-Digit Industry
M5SKLLF1	Avg. (Skill Labor)/(Total Labor):5-Digit Industry
M5NWGVA	Avg. Non-Wage VA per Worker:5-Digit Industry
GS_SHR	Output Share of Government Owned Plants: Excluding JVs
D1	Dummy: Direct Foreign Ownership Restriction
CR4_5D	Four Plant Concentration Ratio: 5 Digit Industry
MEPS_5D	Minimum Efficient Scale: 5 Digit Industry
AVGEXT_5	Avg. # Annual Exits '92-'94:5 Digit Industry

* Precise definitions are provided in Footnote 5.

The results clearly demonstrate that MNCs are drawn to industries with high entry barriers. The proxy for capital intensity (M5NWGVA), concentration (CR4_5D), and economies of scale (MES_5D) are highly significant in all specifications. This confirms many of the classic results in the literature. Advertising and R&D expenditures are thought to generate the intangible assets frequently possessed by MNCs. Although they have the proper sign, these variables are never significantly different from zero. This is an important distinction from the research on developed economies. Aswicahyono and Hill (1995) found a similar result with their proxies for

[53] A review of investment regulations indicates that the chief changes here are that the garment industry was opened to foreign ownership (1989) and the woods products industry was closed.

these variables. This result adds further credence to the opinion expressed in this work and Lall and Mohammed (1983) that there may be different motivations behind FDI in developed and developing nations.

As was discussed above, restrictions on foreign ownership in Indonesia were gradually eased between 1986 and 1992, and then virtually eliminated in 1994. In the highly regulated environment of the mid-1980's, Aswicahyono and Hill found that the small 100% foreign owned and foreign/private joint venture shares did not respond to

Table 4.4: Industry Level Analysis

	Independent Variable			
	FP_SHR	FP_SHR	FPGS_SHR	FPGS_SHR
INTERCEPT	-0.489***	-0.485***	-0.443***	-0.440***
	(0.143)	(0.144)	(0.147)	(0.148)
M5ADVOUT	1.367	1.344	1.284	1.266
	(2.421)	(2.426)	(2.484)	(2.489)
M5RDOUT	8.237	8.179	6.104	6.055
	(10.766)	(10.784)	(11.046)	(11.065)
M5SKLLF1	-0.131	-0.128	-0.140*	-0.138
	(0.081)	(0.082)	(0.084)	(0.084)
M5NWGVA	0.002***	0.002***	0.002***	0.002***
	(0.0005)	(0.0006)	(0.0006)	(0.0006)
GS_SHR	-0.442***	-0.441***	-0.343***	-0.342***
	(0.085)	(0.085)	(0.088)	(0.088)
D1	-0.067	-0.066	-0.069	-0.068
	(0.057)	(0.058)	(0.059)	(0.059)
CR4_5D	0.338***	0.332***	0.329***	0.325***
	(0.075)	(0.078)	(0.077)	(0.080)
MEPS_5D	0.347***	0.347***	0.324***	0.325***
	(0.064)	(0.064)	(0.065)	(0.066)
AVGEXT_5		-0.0003		-0.0003
		(0.001)		(0.001)
R2	0.20	0.20	0.17	0.17
n	336	336	336	336

Standard errors in parentheses
*** 1% significance, ** 5% significance, * 10% significance

the explanatory variables suggested in the literature. The current results indicate that this is no longer the case. Further, as regulatory authorities have allowed exceptions to their direct prohibition of foreign ownership and then eliminated these restrictions in nearly all manufacturing industries[54], the impact of this layer of red tape has diminished. Whereas D1 was highly significant in the earlier study, it is not significantly different from zero here. However, the fact that multinationals remain deterred by the government share of output indicates that the domestic policy environment still matters for foreign investors. Finally, it cannot be said that MNCs avoid sectors of the economy with a high rate of business failures.

These results indicate that FDI in this developing economy generally responds to the same pressures as FDI in developed countries. An important exception is the impact of R&D and advertising intensity. It must be admitted, though, a subsidiary's expenditure on R&D and advertising may be a poor indicator of the MNC's assets in these areas. Aswicahyono and Hill (1995) claim that there is a close relationship between determinants of the foreign owned share of industries and the foreign owned share of firms. If this is true, foreign firms should demand a greater ownership percentage as the size of the project increases and when other indicators of economies of scale are present. This test can be incorporated in the modeling framework to be developed in the following section.

[54] In 1995, foreign ownership was prohibited only in the sawmill and milk products industries.

4.3 EMPIRICAL MODEL

The main hypothesis to be tested here is that bi-lateral moral hazard is the driving force behind the determination of equity share in foreign establishments. These arrangements are very similar to other forms of share contracts such as franchising agreements and sharecropping. Accordingly, similar competing explanations have been offered in each of these three areas. Contractor (1985) cites a number of reasons why arm's length exchange of MNCs' proprietary assets may not be feasible. Risk sharing and the implicit insurance provided with a share contract is one alternative explanation. In the case of a MNC, the profitability of its technological asset is not guaranteed given the new cultural and institutional environment in an LDC. Local firms may be unwilling to bear the risk of these projects. To the extent that this explanation of equity sharing is true and to the extent the MNCs are less risk averse, foreign ownership percentage should be higher for plants in riskier industries. Additionally, if Aswicahyono and Hill (1995) are correct, barriers to entry and measures of scale economies lead to higher foreign ownership percentage. Conversely, Chapter 2 demonstrated that under fairly general circumstances ownership percentage is independent of scale. This is clearly testable.

The theoretical discussion in Chapter 2 was motivated by the observation that both MNCs and their local partners contribute managerial resources to joint ventures. It is commonly believed that MNCs are sought out for two broad types of resources:[55] technological expertise and international marketing expertise. Similarly, local firms provide knowledge of the local economy and local distribution networks. Appendix H

[55] Caves (1996) provides a review.

presents a version of the model developed in Chapter 2 which is quite similar to Aitken, Hanson and Harrison (1994). The important distinction is that in this dissertation the simultaneity of the ownership and export orientation decisions is modeled. The novel insight in this dissertation is that the value of MNC marketing expertise is greater in export oriented firms which increases the incentive for a MNC to take an ownership stake. It has long been recognized that MNC owned firms face a lower marginal cost of exporting.

To allow a role for managerial resources, it is assumed that production costs and international marketing costs are decreasing functions of the amount of unobservable managerial resources provided by the MNC. Likewise, it is assumed that production costs and domestic marketing costs are a decreasing function of unobservable managerial resources provided by the local partner. Ownership provides the incentive to contribute these managerial resources. As in Chapter 2 and following Eswaran and Kotwal (1985), the incentive compatibility constraints can be solved simultaneously to give e and c as functions of the ownership percentage. This leaves multinationals with two key choice variables: ownership percentage and export orientation.

For the purpose of the empirical estimation let $y_1^* =$ PCT_FOR=foreign ownership percentage and let $y_2^* =$ PCT_EXP=percentage of goods exported. Assume the solution to the model presented in Appendix H can be represented according to the following empirical model.

(4.1) $y_{1i}^* = \beta_1 y_{2i} + x_{1i}' \gamma_1 + u_{1i}$

(4.2) $y^*_{2i} = \alpha_2 y_{1i} + x'_{2i}\gamma_2 + u_{2i}$

Where u_{1i} and u_{1i} ~ $N(0, \Sigma_{12})$ and $\Sigma_{12} = [\begin{matrix} \sigma_{11} & \sigma_{12} \\ \sigma_{12} & \sigma_{22} \end{matrix}]$.

The first thing to be noticed is that in the case of an arm's length entry, the foreign ownership percentage will equal zero and in the case of a WOS, the foreign ownership percentage will equal 1. If y^*_{1i} equals the latent value of foreign ownership percentage, let y_{1i} equal the observed value with the following rule.

$$
\begin{aligned}
&y_{1i} = 0 \ \text{ if } y^*_{1i} < 0 \\
(4.3)\quad &y_{1i} = y^*_{1i} \ \text{ if } 0 < y^*_{1i} < 1 \\
&y_{1i} = 1 \quad \text{else}
\end{aligned}
$$

(4.4) $y^*_{2i} = y_{2i}$

Additionally, note that y^*_{2i} depends on the observed, y_{1i}, rather than the latent value of the foreign ownership percentage, y^*_{1i}. The reason for this is obvious. Because of the incentive compatibility constraints, the marginal cost of exporting will depend on the realized foreign ownership share. Likewise the higher the realized value of export share, the greater the value of MNC management effort and the greater the chosen value of

y_{1i}. While theoretically appealing, this leads to certain empirical difficulties. Namely, there will not be a unique reduced form and the usual estimation approach is not applicable.[56] However, the parameters of this model can be consistently estimated via the two-stage methodology proposed by Blundell and Smith (1994). For details of the estimation procedure and asymptotic distribution of the estimates see Appendix F. Essentially, the equation for y_{2i},(4.2), is estimated via instrumental variables and then the portion of exports not explained by foreign ownership, $\tilde{y}_{2i} = y^{*}_{2i} - \alpha_2 y_{1i}$, where α_2 is the IV estimate, is substituted for y^{*}_{2i} and the IV residual, $\hat{u}_{2i}$, are include in the standard maximum likelihood estimation of (4.1). The basic estimating equation is (See equation (F3a) in Appendix F.)

$$(4.5) \quad y^{*}_{1i} = \beta^{*}_{1}\hat{\tilde{y}}_{2i} + x'_{1i}\gamma^{*}_{1} + \rho^{*}_{1}\hat{u}_{2i} + \hat{\varepsilon}^{*}_{1i}$$

Finally, notice that the discussion in Chapter 2 and model in Appendix H provide insights regarding the choice of exogenous variables. In general, the foreign ownership percentage is affected by three types of variables: indicators of MNC skill and experience, indicators of the local counterparts skill and experience and indicators of marginal cost reductions due the provision of managerial resources. In particular, Figures 2.1-2.3 indicate that the foreign ownership percentage will be an increasing function of the MNC's experience and a decreasing function of the local firm's

[56] When the model is endogenous in the latent variables a unique reduced forms exists an the model can

experience. An experienced local firm will be able to perform all managerial tasks capably. Therefore since there is little to be gained by the MNC performing these tasks, there is little need for the MNC to take a large ownership stake. As MNC managerial contributions are relatively more important, there will be greater production cost savings associated with their provision of managerial talent and an increased incentive for it to take a substantial ownership stake.

Unfortunately, there are no data on the foreign partner in the database. However, $x_{1i}^{'}$ will contain variables indicative of the local partner's skill and experience (age and prior exporting experience) as well as production cost savings from the MNC provision of managerial effort (Non-Wage Value added per worker, % Skilled Labor, % Loans Foreign and industry dummies) and production cost savings from local firm provision of managerial effort (% inputs purchased locally, crony industries, regulated industries). Notice that this model interprets these included exogenous variable as indicating the relative importance of providing managerial effort to the supervision of supply and distribution networks, the supervision of international financial arrangements, the supervision of embodied technology transfer and the supervision of local regulatory requirements. Finally, variables suggested by alternative theories (risk, size and concentration) will be included. Additionally, $x_{2i}^{'}$ will include exogenous variables that affect the relative costs and benefits of exporting (prior experience exporting, NTBs, and tariffs, as well as industry dummies). Table 4.5 contains summary statistics and definitions for the key variables included in the empirical analysis.

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be estimated according to Amemiya (1979) or Nelson and Olsen (1978).

Table 4.5: Variable Definitions and Summary Statistics

Variable	Label	N	Mean	Std Dev
PCT_FOR	Percent Foreign Owned	880	25.09318	38.03002
PCT_EXP	Percent Export	880	70.24773	32.58653
Y2TILDA	PCT_EXP: Adjusted According to Blundell and Smith (1994)	880	66.92695	32.3319
SKLLF1	Total Skilled labor/Total Labor	880	45.3505	30.59768
NWAGEVA	Non-wage Value Added per Employee	880	13399.77	36054.04
PCT_LNF	% Loans Foreign	880	10.29977	28.61467
EXPLSTYR	Dummy=1 iff Exported in Previous Year	880	0.539773	0.498699
AGE	Plant age	880	10.32614	10.88441
CRONY	Crony Industry Dummy (Basri and Hill (1996))	880	0.085227	0.279378
D1	Ownership Prohibition (Aswicahyono and Hill (1995))	880	0.236364	0.42509
D2	Government Dominated Industry (Aswicahyono and Hill(1995))	880	0.022727	0.149117
PCT_COMD	% of Commodities Purchased Domestically	880	74.47587	36.99001
PCT_SPRD	% of Spare Parts Purchased Domestically	880	76.92241	39.834
AVGEXT5D	Avg # Annual Exits Previous 5 Years 5 Digit Industry	880	39.01409	66.5817
CR4_5D	Four Plant Concentration Ratio 5 Digit Industry	880	0.37799	0.247791
MES_5D	Minimum Efficient Scale 5 Digit Annual: 5 Digit Industry	880	1.861351	0.124884
OUT_BKR	Real Output	880	24985934	69753584
U2HATIV	First Stage Residual Values	880	-3.54E-14	27.38243

4.4 RESULTS

The results of both a standard 2-limit Tobit and the two stage approach which corrects for possible endogeneity bias resulting from the inclusion of export percentage indicate substantial support for the proposition that bi-lateral moral hazard is a driving force behind the determination of ownership at the plant level. In fact, little if any support for alternative theories is found. Results indicate that the determination of

Table 4.6: Standard 2-Limit Tobit

	Standard 2-Limit Tobit				
	(1)	(2)	(3)	(4)	(5)
PCT_EXP	0.6465***	0.6456***	0.6548***	0.6437***	0.6223***
	(0.1493)	(0.1491)	(0.1495)	(0.149)	(0.1486)
INTERCEPT	19.1745	19.5049	6.54	73.7819	20.9396
	(26.3553)	(26.309)	(30.7979)	(73.6935)	(26.183)
SKLLF1	0.0444	0.0343	0.0391	0.0399	0.0367
	(0.1748)	(0.1749)	(0.1748)	(0.1748)	(0.1742)
NWAGEVA	0.205**	0.2048**	0.2039**	0.2103**	0.2879***
	(0.0975)	(0.0973)	(0.0972)	(0.0975)	(0.1107)
PCT_LNF	0.7752***	0.7743***	0.7646***	0.7666***	0.797***
	(0.1271)	(0.1268)	(0.1271)	(0.127)	(0.12750
EXPLSTYR	-68.5691***	-68.1443***	-67.7167***	-68.2113***	-66.4362***
	(8.9062)	(8.8953)	(8.8937)	(8.8904)	(8.9092)
AGE	-1.4429***	-1.4107***	-1.3573***	-1.39***	-1.2461
	(0.4943)	(0.4931)	(0.4948)	(0.4928)	(0.4992)
CRONY	-28.7391	-28.0752	-29.9111	-26.2716	-28.016
	(19.2804)	(19.2448)	(19.3605)	(19.3286)	(19.2228)
D1	-73.0255	-73.6809	-75.1133	-71.8135	-73.543
	(39.5839)	(39.5557)	(39.3906)	(39.6571)	(39.2875)
D2	-70.9436	-71.5268	-79.4875	-70.1458	-63.9781
	(53.3264)	(53.1155)	(54.1193)	(52.8668)	(53.7922)
PCT_COMD	-0.4423***	-0.4283***	-0.4302***	-0.4323***	-0.4437***
	(0.1236)	(0.1243)	(0.1242)	(0.1244)	(0.1243)
PCT_SPRD	-0.3888***	-0.3938***	-0.3843***	-0.3912***	-0.3915***
	(0.0977)	(0.0977)	(0.0982)	(0.0977)	(0.0973)
AVGEXT5D		-0.143	-0.0904	-0.1165	-0.1511
		(0.1523)	(0.1653)	(0.1558)	(0.152)
CR4_5D			18.8632		
			(23.2511)		
MES_5D				-28.9079	
				(36.7224)	
OUT_BKR					-0.0166
					(0.0106)
Pseudo-R^2	0.444596	0.444767	0.444126	0.444254	0.451703

All Regressions Include Industry Dummies Standard errors in parentheses
*** 1% significance, ** 5% significance, * 10% significance

Table 4.7: Two Stage 2-Limit Tobit

	Two Stage 2-Limit Tobit				
	(6)	(7)	(8)	(9)	(10)
PCT_EXP	2.9542***	2.9806***	2.9682***	2.9452***	3.2162***
	(0.9209)	(0.9288)	(0.9255)	(0.9251)	(0.9983)
INTERCEPT	-174.582***	-176.566***	-178.347***	-164.376**	-196.274***
	(60.449)	(60.7706)	(61.1327)	(71.0396)	(63.8511)
SKLLF1	0.155**	0.1472**	0.1488**	0.1485**	0.1456**
	(0.0742)	(0.0734)	(0.0737)	(0.0739)	(0.071)
NWAGEVA	0.1359**	0.1354**	0.1355**	0.1368**	0.2048***
	(0.0597)	(0.0595)	(0.0596)	(0.0600)	(0.0714)
PCT_LNF	0.4682***	0.465***	0.4642***	0.4673***	0.4594***
	(0.1285)	(0.1284)	(0.128)	(0.1289)	(0.1313)
EXPLSTYR	-64.54***	-64.2467***	-64.1529***	-64.275***	-62.7422***
	(17.9849)	(18.0572)	(17.9719)	(17.8883)	(18.8994)
AGE	0.4025	0.4476	0.4484	0.4213	0.8064
	(0.5128)	(0.5099)	(0.5103)	(0.5217)	(0.4916)
CRONY	-4.9784	-4.2609	-4.7915	-4.333	-1.4132
	(8.3646)	(8.2718)	(8.4232)	(8.3628)	(7.6869)
D1	-40.2035***	-40.364**	-40.8232***	-40.4663**	-37.0503**
	(15.7272)	(15.7172)	(15.8405)	(15.7577)	(14.9966)
D2	-55.3833***	-55.7365***	-57.593***	-55.7866***	-46.1869**
	(20.2919)	(20.3235)	(20.9511)	(20.3997)	(18.9216)
PCT_COMD	-0.2933***	-0.2824***	-0.2835***	-0.2851***	-0.2817***
	(0.0861)	(0.0844)	(0.0846)	(0.0854)	(0.0859)
PCT_SPRD	-0.256***	-0.2577***	-0.2563***	-0.2591***	-0.2437***
	(0.0727)	(0.0732)	(0.073)	(0.0735)	(0.0722)
AVGEXT5D		-0.0988	-0.0872	-0.0947	-0.1029
		(0.0686)	(0.072)	(0.0708)	(0.0668)
CR4_5D			4.2521		
			(9.1856)		
MES_5D				-4.9544	
				(15.4716)	
OUT_BKR					-0.0144
					(0.0422)
Pseudo R^2	0.437947	0.438068	0.437663	0.437881	0.451157

All Regressions Include Industry Dummies
Standard errors in parentheses
*** 1% significance, ** 5% significance, * 10% significance

ownership share at the micro-level and the determination of ownership share at the aggregate level are two very different questions. Results are in Table 4.6 and Table 4.7.[57]

There are several clear results. The need for adequate supervision of supply and distribution networks is a driving force behind the determination of ownership percentage. PCT_EXP, PCT_COMD, and PCT_SPRD consistently have the appropriate sign and are highly significant. Secondly, there is little if any support for any of the competing theories. The measures of risk, barriers to entry and scale are never significant and add little or no explanatory power to the regressions. Also, these variables frequently have the wrong sign. For example, the inverse relation between measured risk and foreign ownership percentage would have to indicate that the local firm is less risk averse than the MNC if the risk-sharing hypothesis were true. Real output also has an apparently wrong sign. An alternative interpretation of this result would be that the most skilled plants are most able to grow and this same skill renders the plant capable of engaging in TPs or taking a majority position in a JV. Finally, correcting for endogeneity bias provides evidence that MNCs are granted ownership shares to provide technological expertise and Indonesian partners are sought out for their connections with regulatory agencies and industry cronies.

The methodology employed above is amenable to answering both whether export percentage is endogenous and whether the system is endogenous in observable

[57] For censored dependent variables, pseudo-R^2 is defined by Laitila (1993). This measure can be interpreted as the proportion of the variance of the dependent variable explained by the right hand side variables. The measure can decrease with the inclusion of additional dependent variables. Laitila (1993) notes that Monte Carlo simulations indicate that this is likely to happen with the inclusion of irrelevant variables.

or latent variables. Blundell and Smith (1994) show that endogeneity can be determined through a test of significance on the parameter ρ_1, which is associated with the IV residual $\hat{u}_{2i}$. Notice that this is a test that the error terms in the equations for y^*_{2i} and y^*_{1i} are uncorrelated. Further, Blundell and Smith (1994) show that a test of whether the system is endogenous in the latent or observed variables can easily be devised. If the system is endogenous in the latent variables, a unique reduced form for y^*_{2i} exists. Namely,

(4.6) $y^*_{2i} = x_i'\pi_2 + v_{2i}$.

Therefore, the predicted value of $\hat{y}^*_{1i}$ estimated from (4.5) should have no explanatory power. This can be tested by estimating (4.7) by OLS and testing whether $\delta_1 = 0$.

(4.7) $y^*_{2i} = x_i'\pi_2 + \delta_1 \hat{y}^*_{1i} + v_{2i}$

These results presented in Table 4.8 strongly indicate both that export percentage and foreign ownership percentage are jointly determined and that the system is endogenous in the observed variables.

Table 4.8: Endogeneity Tests*

	Two Stage 2-Limit Tobit Endogeneity Tests				
	(6)	(7)	(8)	(9)	(10)
δ_1	0.7722	0.7411	0.8230	0.7576	0.4537
	(4.173)	(3.994)	(4.439)	(4.081)	(2.575)
ρ_1	-2.9656	-2.9921	-2.977	-2.9566	-3.2444
	(-3.212)	(-3.213)	(-3.209)	(-3.186)	(-3.233)

* (T-Statistics)

4.5 CONCLUSIONS

Taken as a whole, these results indicate several significant conclusions. First and foremost, ownership does appear to be employed as an incentive mechanism. Consistent with the model based on bi-lateral moral hazard developed in this dissertation, ownership is used to provide incentives to both the MNC and its local partner. Further, the micro and macro determinants of ownership share are very different. Also, notice that these results indicate that ownership and performance variables are endogenously determined. Certainly, studies such as Aitken and Harrison (1994), which regress the probability a firm is an exporter on "exogenous" variables such as an indicator of foreign ownership, produce biased and inconsistent results. Further, the results in this chapter indicate that care must be taken in correcting for this bias. The incentive constraints ensure that the system is endogenous in observable rather than latent variables. As such, traditional techniques are inappropriate and Blundell and Smith (1994) show that these approaches may lead to overcorrections.

There are two significant caveats to these results. First, the analysis in this chapter has been based on exporting firms. This was necessitated because in order to produce consistent estimates at the first stage, Blundell and Smith (1994) must assume that the second endogenous variable is drawn from an uncensored distribution. Estimation following the approach suggested by Amemiya (1974) suggests that these results are robust. However, a full maximum likelihood estimation of the model developed in this chapter would be a worthwhile extension. Secondly, the maximum likelihood estimation is based on the assumption of normality. The violation of this assumption may create significant biases.

CHAPTER 5: POLICY IMPLICATIONS.

The empirical results presented in Chapter 4 can be seen as strong evidence that MNCs are indeed creatures of imperfection. Multinationals do operate in industries that fall well short of the perfectly competitive paradigm. However, market failures of an entirely different sort play an important role isn the interactions between MNCs and their local partners. Because MNCs use ownership as an incentive to both themselves and their local partners, incentive constraints play an important role in the ultimate performance of MNC affiliates. For this reason, great care must be taken when enacting public policy aimed at minimizing the social costs associated with non-competitive industries. As was clearly demonstrated in Chapter 3, policies that other researchers have proposed to attenuate such costs have the unintended consequence of distorting the incentives faced by MNCs and diminishing the incentive to transfer technology.

This should be carefully noted by policy makers and economic researchers alike. LDC governments may have bad policies to blame for the disappointing performance of foreign owned firms. One of the recent puzzles in empirical work in the area of FDI has been the lack of any plant-level evidence of spillovers from FDI.[58] This dissertation suggests a likely culprit and a fruitful line of future research. Namely, the interaction between good and bad policies and realized benefits - both internal and spillover - of FDI.

Finally, it cannot be forgotten that the theory presented in Chapter 3, which was supported by the plant-level empirical results in Chapter 4, indicate that there is room

[58] See Haddad and Harrison (1993) and Aitken and Harrison (1999).

for Pareto improving public policy. Countries that get their interventions right can enjoy increased levels of technology transfer at no additional cost.

APPENDIX A: NON-RESTRICTIVE NATURE OF LINEAR CONTRACTS

Proposition A1: Without loss of generality, the optimal sharing rule can be represented by a linear contract.

Proof: (Following Bhattacharyya and LaFontaine (1995) and Romano (1994))

Recall the contracting problem…

(A1) $\text{Max}_{\{\omega(.),\, e,c\}}\ E\ \{\omega(\Theta\ \pi\ (e,c))\ \text{-}R(e)\}$
Subject to
(A2) $\partial\ E\ \{\omega(\Theta\ \pi\ (e,c))\}/\partial e = R'(e)$
(A3) $\partial\ E\ \{\Theta\ \pi\ (e,c) - \omega(\Theta\ \pi\ (e,c))\}/\partial c = S'(c)$
(A4) $E\ \{\Theta\ \pi\ (e,c) - \omega(\Theta\ \pi\ (e,c))\} - S(c) \geq 0$

Let $\omega^*(.)$, e^*, c^* be a solution to this problem. These solutions must satisfy the incentive constraints

(A5) $\partial\ E\ \{\omega^*(\Theta\ \pi\ (e^*,c^*))\}/\partial e = R'(e^*)$
(A6) $\partial\ E\ \{\Theta\ \pi\ (e^*,c^*) - \omega^*(\Theta\ \pi\ (e^*,c^*))\}/\partial\ c = S'(c^*)$

The choices of e and c are independent of Θ and hence π (e,c) is independent of Θ.

Therefore, note the following

(A7) $\partial\ E\ \{\Theta\ \pi\ (e^*,c^*)\}/\partial\ c = \pi_c\ (e^*,c^*)$

and re-write (A6)

(A8) $\pi_c\ (e^*,c^*)\text{-}\partial\ E\ \{\omega^*(\Theta\ \pi\ (e^*,c^*))\}/\partial\ c = S'(c^*)$

Again, since e and c, and hence π (e,c), are independent of Θ, let

(A9) $E\ \{\omega(\Theta\ \pi\ (e,c))\}= \psi\ (\pi\ (e,c))$

and re-write the incentive constraints at the optimum.

(A10) $\psi'(\pi\ (e^*,c^*))\ \ \pi_e(e^*,c^*)= R'(e^*)$
(A11) $\pi_c\ (e^*,c^*)\text{-}\ \psi\ '(\pi\ (e^*,c^*))\ \pi_c\ (e^*,c^*) = S'(c^*)$

Now consider and alternative contract.

(A12) $\alpha + \beta \pi (e,c)$

where $\beta = \psi'(\pi(e^*,c^*))$.

Clearly, this contract satisfies the incentive constraints at the optimal choices. Also since α has no impact on the incentives of either party, it is free to adjust to satisfy the participation constraint. Finally, the standard assumptions regarding the production function and cost of effort functions ensured a unique equilibrium (See Appendix B, Part 1), therefore this contract produces the exact results as the general sharing rule.

APPENDIX B. EXISTENCE AND UNIQUENESS OF THE NASH EQUILIBRIUM SOLUTION WITH A LINEAR CONTRACT

Proposition B1: In addition to the standard properties of the production function and cost of effort functions assumed in the text, two additional assumptions are sufficient for the existence and uniqueness of the contracting problem. Namely, $|\pi_{ec}| \leq |\pi_{cc}|, |\pi_{ee}|$ and the Nash solutions for unobservable inputs are continuous functions of the ownership share: $c^*(\beta)$ and $e^*(\beta)$ are continuous in β.

Proof: The proof proceeds in two stages. The first stage derives the Nash solutions for unobservable inputs taking ownership share as given. The second determines the optimal ownership share.

Stage 1.

First re-state the contracting problem. Noting that e and c are constrained only to be real numbers and that the MNC and local firm determine their provisions of efforts according to non-cooperative Nash behavior.

(B1) $\Pi^*_{M,JV} = \text{Max}_{\{e,c\}}\ \alpha + \beta^*\pi(e,c) - R(e)$

$\Pi^*_{L,JV} = \text{Max}_{\{e,c\}}\ -\alpha + [1-\beta]^*\pi(e,c) - S(c$

Subject to

(B2) $\beta\,\pi_e(e,c) = R'(e)$

(B3) $[1-\beta]\,\pi_c(e,c) = S'(c)$

(B4) $[1-\beta]\,\pi(e,c) - \alpha - S(c) = 0$

Proposition B2: The properties of the restricted profit function and the assumed properties of the cost of effort functions are sufficient for the existence of the Nash Equilibrium.

Proof:

a. Because π (e,c) is concave and continuous in e and c and R(e) and S(c) are each convex and continuous, $\Pi^*_{M,JV}$ and $\Pi^*_{L,JV}$ are concave and continuous in e and c respectively.

b. Because π (e,c) is bounded from above while R(e) and S(c) are not, there exists a pair (e^{MAX}, c^{MAX}), such that the optimal choices $e^{MAX} \geq e^*$ and $c^{MAX} \geq c^*$.

c. Because R'(0)=S'(0)=0 and $\pi_e > 0$ and $\pi_c > 0$, $e^* \geq 0$ and $c^* \geq 0$.

d. Therefore without loss of generality, an alternative problem can be defined where e and c are restricted to [0, e^{MAX}] and [0, e^{MAX}].

e. The Nash solution to the alternative problem exists by Fudenberg and Tirole (1993) Theorem 1.2.

Proposition B3: $|\pi_{ec}| \leq |\pi_{cc}|, |\pi_{ee}|$ are sufficient conditions for the uniqueness of the Nash equilibrium.

Proof: First, note the definitions of the reaction functions for each party (e=M(c) for the multinational and c=L(e) for the local firm).

(B5) $$\beta \pi_e (M(c),c) = R'(M(c))$$
$$[1-\beta] \pi_c (e, L(e)) = S'(L(e))$$

The proof proceeds by showing that a necessary condition for multiplicity of equilibria can never be satisfied. As can be seen from Figure B2, which is a plot of the reaction functions in the case $\pi_{ec} \geq 0$, two necessary conditions for multiple equilibria are clearly

(B6) $M^{-1}{}'(c) \geq L'(c)$ and
$M^{-1}{}'(c) \leq L^{-1}{}'(c)$.

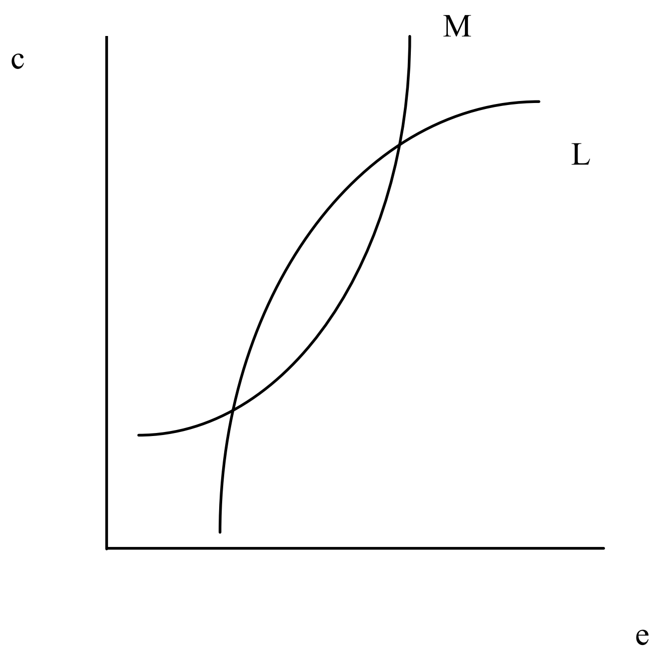
It is straightforward to derive the slopes of the reaction functions

$$\text{(B7)}\quad \frac{\partial M^{-1}(c)}{\partial c} = \frac{R_{ee} - \beta\pi_{ee}}{\beta\pi_{ec}}$$

$$\frac{\partial L(c)}{\partial c} = \frac{[1-\beta]\pi_{ec}}{S_{cc} - [1-\beta]\pi_{ee}}$$

Three cases must be considered: $\pi_{ec} = 0$, $\pi_{ec} \geq 0$, and $\pi_{ec} \leq 0$. When $\pi_{ec} = 0$, the reaction functions are horizontal and vertical and the equilibrium is unique.

Figure B1: Plot of Reaction Functions



Now consider $\pi_{ec} \geq 0$. Using the facts that $R_{ee} \leq 0$ and $S_{cc} \leq 0$ and $|\pi_{ec}| \leq |\pi_{cc}|, |\pi_{ee}|$, it can be shown that

(B8) $\dfrac{\partial M^{-1}(c)}{\partial c} > 1 \ \forall c$

$\dfrac{\partial L(c)}{\partial c} < 1 \ \forall c$

Therefore the necessary condition $M^{-1}{'}(c) \leq L^{-1}{'}(c)$ for multiple equilibria cannot be satisfied. The same technique can also show that the case where $\pi_{ec} \leq 0$ also fails to satisfy a necessary condition for multiple equilibria.

Stage 2

Note that the Nash equilibrium has been solved conditional on the value of β. Therefore the solution to stage 1 gives us c*(β) and e*(β). After substituting the participation constraint, write the MNC's problem as

(B9) $\Pi^{*}_{M,JV} = \text{Max}_{\{\Gamma\}} \ \pi\,(e^*(\beta), c^*(\beta)) - R(e^*(\beta)) - S(c^*(\beta))$

Following Eswaran and Kotwal (1985), the assumption is made that c*(β) and e*(β) are continuous in β, so a solution to this problem exists for $\beta \in [0,1]$.

APPENDIX C: DETAILED SOLUTION

(C1) $\Pi^{*}_{M,JV} = \text{Max}_{\{\alpha, \beta, e,c\}}\ \alpha + \beta\ [\pi (e,c)] - R(e) + \lambda [\beta \pi_e (e,c) - R'(e)]$
$+ \mu [[1-\beta] \pi_c (e,c) - S'(c)] + \eta [[1-\beta] \pi (e,c) - \alpha - S(c)]$

(C2) FOC α: $1 - \eta = 0$ => The participation constraint is binding therefore and the lump sum transfer adjusts to ensure the local firm earns no rents. Explicitly ...

(C3) $[1-\beta] \pi (e,c) - \alpha - S(c) = 0$

the remaining FOCs give us

(C4) FOC e : $\lambda [\beta \pi_{ee} - R''(e)] + \mu\ [1-\beta] \pi_{ce} + \eta\ [1-\beta] \pi_e + [\beta \pi_e (e,c) - R'(e)]= 0$
(C5) FOC c : $\beta \pi_c + \lambda \beta \pi_{ec} + \mu [[1-\beta] \pi_{cc} - S''(c)] + \eta\ [[1-\beta] \pi_c (e,c) - S'(c)] = 0$
and
(C6) FOC β: $\lambda\ \pi_e - \mu\ \pi_c + \pi(e,c)[1-\eta]= 0$

By equation (C2), the last term equals 0, so this is simplified to

(C7) FOC β: $\lambda\ \pi_e - \mu\ \pi_c = 0$

Proposition C1: The multipliers associated with the incentive compatibility constraint are positive.

Proof: Since π_e and π_c are each strictly positive, (C7) indicates that either both or neither of the constraints bind. Suppose that neither is binding ($\lambda = \mu = 0$). (C4) and (C5) imply $\pi_e - R'(e) = 0$ and $\pi_c - S'(c) = 0$ which cannot be satisfied for the same value of β. Therefore both $\lambda > 0$ and $\mu > 0$.

Given that the incentive compatibility constraints bind, re-write (C4) and (C5).

(C8) FOC e : $\lambda [\beta \pi_{ee} - R''(e)] + \mu\ [1-\beta] \pi_{ce} + \eta\ [1- \beta] \pi_e =0$
(C9) FOC c : $\beta \pi_c + \lambda \beta \pi_{ec} + \mu [[1-\beta] \pi_{cc} - S''(c)] + \eta\ [[1-\beta] \pi_c (e,c) - S'(c)] = 0$

Turning attention to the optimal ownership share.

Proposition C2: Following Bhattacharyya and Lafontaine (1995), the optimal ownership share is a non-linear function of the profit function and the disutility of effort functions.

Proof : The incentive compatibility constraints =>

(C10) $$\beta = \frac{R'(e)/\pi_e}{R'(e)/\pi_e + S'(c)/\pi_c}$$

Now use (C8), (C9), and (C10) to eliminate λ and μ and find the optimal value of β as a function of the optimal values of e and c.

$$\text{(C11)} \quad \beta^* = \frac{\pi_e^2[[1-\beta^*]\pi_{cc} - S'']}{\pi_c^2[\beta^*\pi_{ee} - R''] + \pi_e^2[[1-\beta^*]\pi_{cc} - S'']}$$

Where (C11) is evaluated at the optimal e and c. In principle, (C11), and the incentive compatibility constraints can be solved for the optimal values of β, e and c.

APPENDIX D. POLICY ANALYSIS

All of the variables below are as defined in the text. For simplicity we let L and I be scalars.

$$\text{(D1)}\ y = A\,K^{\delta_1}\ M^{\delta_2}\ I^{\delta_3}; K = B^{[1-\varepsilon_1]}e^{\varepsilon_1}; M = L^{[1-\varepsilon_2]}c^{\varepsilon_2}$$

$$\text{(D2)}\ y = A\,B^{a_1}\ L^{a_2}\ I^{a_3}\ e^{a_4}\ c^{a_5}$$

$$\text{(D3) where } a1 = \delta_1[1-\varepsilon_1], a_2 = \delta_2[1-\varepsilon_2], a_3 = \delta_3, a_4 = \delta_1\varepsilon_1, a_4 = \delta_2\varepsilon_2.$$

$$\text{Note that given } \sum_{i=1}^{3}\delta_i = 1,\ \sum_{i=1}^{5}a_i = 1.$$

For future reference, define

(D4) $b1\text{-}a_4/x$, $b_2=a_5/x$ $x=[1-a_2-a_3]$, $z=[1-b_1-b_2]$.

Following Equation (5) in the text, define the restricted profit function (for a JV).

$$\text{(D5)}\ \pi\ (e,c) = MAX_{\{L,I\}}\ P_{Out}A\,B^{a_1}\ L^{a_2}\ I^{a_3}\ e^{a_4}\ c^{a_5}\ \text{-}\ w\,L\ \text{-}\ p\,I$$

Where P_{out}, w, and p are the unit prices of y, L and I respectively. Using standard techniques, derive (details available)

(D6) $\pi_{JV}(e,c) = D_{JV}\,e^{b1}\,c^{b2}$.

Where

$$\text{(D7)}\ D_{JV} = P_{Out}^{\frac{1}{x}}\ A^{\frac{1}{x}}\ B^{\frac{a1}{x}}[\overline{L}^{\frac{a2}{x}}\overline{I}^{\frac{a3}{x}}\ \text{-}\ w\,\overline{L}^{\frac{a2}{x}} - p\,\overline{I}^{\frac{a3}{x}}]$$

$$\overline{L} = \frac{a_2}{w}^{\frac{1}{x}}\ \frac{w\,a_3}{p\,a_2}^{\frac{a_3}{x}}$$

$$\overline{I} = \frac{a_3}{p}^{\frac{1}{x}}\ \frac{w\,a_3}{p\,a_2}^{\frac{-a_2}{x}}.$$

Using the same techniques, the following can be derived

(D8) $\pi_{WOS}(e,c) = D_{WOS}\,e^{b1}\,c^{b2}$ and

$\pi_{TP}(e,c) = D_{TP}\,e^{b1}\,c^{b2}$.

It is straightforward to verify that

(D9) $D_{WOS} = \gamma_M^{\ b2}\,D_{TP}$ and

$D_{TP} = \gamma_L^{\ b1}\,D_{TP}$

Let

(D10) $R(e) = r\, e$ and
$S(c) = s\, c.$

Now define the optimal JV contracting problem as in Equation (7).

$$\text{(D11)}\ MAX_{\{L,I\}}\ D_{JV}\ e^{b_1}\ c^{b_2} + \alpha - r\, e$$

subject to

$$\text{(D12)}\ b_1\ \beta\ D_{JV}\ e^{b_1}\ c^{b_2} - r = 0$$
$$b_2\,[1 - \beta\,]\,D_{JV}\ e^{b_1}\ c^{b_2} - s = 0$$
$$[1 - \beta\,]\,D_{JV}\ e^{b_1}\ c^{b_2} - \alpha - s\, c = 0$$

The first two constraints are the incentive compatibility constraints of the MNC and local firm respectively. The last one ensures the participation of the local firm. Using Equation (19), substituting the relevant derivatives from the functions above, and solving for β. We have the following (details are available) …

$$\text{(D13)}\ \beta^* = [1 + [\frac{b_2[b_1 - 1]}{b_1[b_2 - 1]}]^{\frac{1}{2}}]^{-1}$$

At this point note that the optimal ownership share, β^*, is determined solely by the parameters of the production function. Because government policy will obviously have no impact on these parameters, the effect of these policies on entry mode and equilibrium provision of effort can be analyzed by focusing only on the D_{JV}, D_{WOS}, and D_{TP} terms.

$$\text{(D14)}\ e^*_{TP} = D_{JV}^{\frac{1}{z}}\ \bar{e}_{JV}$$
$$c^*_{TP} = D_{JV}^{\frac{1}{z}}\ \bar{c}_{JV}$$

where

$$\bar{e}_{JV} = [\frac{b_1}{r}[\frac{b_2\, r}{b_1\, s}]^{b_2}]^{\frac{1}{z}}[\beta^{*[1-b_2]}[1-\beta^*]^{b_2}]^{\frac{1}{z}}$$
$$\bar{c}_{JV} = [\frac{b_2}{s}[\frac{b_2\, r}{b_1\, s}]^{-b_1}]^{\frac{1}{z}}[\beta^{*b_1}[1-\beta^*]^{[1-b_1]}]^{\frac{1}{z}}$$

The profit function for JVs is derived by substituting (D14) into (D6).

$$(D15)\ \pi^*_{JV} = D_{JV}^{\frac{1}{z}}\ \bar{e}_{JV}^{\ b_1}\ \bar{c}_{JV}^{\ b_2}$$

Similarly, derive the following expressions for WOSs and TPs.

$$(D16)\ e^*_{wos} = D_{WOS}^{\frac{1}{z}}\ \bar{e}_{WOS}$$

$$c^*_{WOS} = D_{WOS}^{\frac{1}{z}}\ \bar{c}_{WOS}$$

where

$$\bar{e}_{WOS} = [\frac{b_1}{r}[\frac{b_2}{b_1}]^{b_2}]^{\frac{1}{z}}$$

$$\bar{c}_{WOS} = [\frac{b_2}{r}[\frac{b_2}{b_1}]^{-b_1}]^{\frac{1}{z}}$$

$$\pi^*_{WOS} = D_{WOS}^{\frac{1}{z}}\ \bar{e}_{WOS}^{\ b_1}\ \bar{c}_{WOS}^{\ b_1}$$

$$(D17)\ e^*_{TP} = D_{TP}^{\frac{1}{z}}\ \bar{e}_{TP}$$

$$c^*_{TP} = D_{TP}^{\frac{1}{z}}\ \bar{c}_{TP}$$

where

$$\bar{e}_{TP} = [\frac{b_1}{r}[\frac{b_2}{b_1}]^{b_2}]^{\frac{1}{z}}$$

$$\bar{c}_{TP} = [\frac{b_2}{r}[\frac{b_2}{b_1}]^{-b_1}]^{\frac{1}{z}}$$

$$\pi^*_{TP} = D_{TP}^{\frac{1}{z}}\ \bar{e}_{TP}^{\ b_1}\ \bar{c}_{TP}^{\ b_1}$$

Proposition D1: A reduction in the producer price of output paid to foreign firms, P_{out}, will decrease profits and decrease the provision of all unobservable inputs.

Proof: Since $\bar{e}_i$ and $\bar{c}_i$ (i=TP, JV, and WOS) are independent of P_{out}, the effect of a change in prices can be determined by examining D_i. It is easy to show that $\frac{\partial D_i}{\partial P_{Out}} > 0$

Using (A14) - (A17), it is therefore easy to show $\frac{\partial \pi^*_i}{\partial P_{Out}} > 0$, $\frac{\partial e^*_i}{\partial P_{Out}} > 0$, and $\frac{\partial c^*_i}{\partial P_{Out}} > 0$.

Proposition D2: The value of γ_M that indicates the border between entry via a JV and WOS, γ_M^{Crit} is unchanged by changes in the producer price of output, P_{Out}.

Proof: γ_M^{Crit} is determined by equating a MNC's profits under a WOS with a JV. After substituting the participation constraint, we have the following expression which implicitly defines γ_M^{Crit} …

$$(D18)\ D_{JV}^{\frac{1}{z}}\ \bar{e}_{JV}^{\ b_1}\ \bar{c}_{JV}^{\ b_1} - r\, D_{JV}^{\frac{1}{z}}\ \bar{e}_{JV} - r\, D_{JV}^{\frac{1}{z}}\ \bar{c}_{JV}$$
$$- [D_{WOS}^{\frac{1}{z}}\ \bar{e}_{WOS}^{\ b_1}\ \bar{c}_{WOS}^{\ b_1} - r\,[D_{WOS}^{\frac{1}{z}}\ \bar{e}_{WOS} + D_{WOS}^{\frac{1}{z}}\ \bar{c}_{WOS}]] \equiv 0$$

Now, substitute (D9) and simplify to derive.

$$(D19)\ D_{JV}^{\frac{1}{z}}\, G(\gamma_M^{Crit}) \equiv 0,$$

where $G(\gamma_M^{Crit}) \equiv 0$.

Now applying the implicit function theorem,

$$(D20)\ \frac{d\gamma_M^{Crit}}{d P_{Out}} = -\frac{[\partial\ D_{JV}^{\frac{1}{z}} / \partial P_{Out}]\ G(\gamma_M^{Crit})}{[\partial\ G(\gamma_M^{Crit}) / \partial \gamma_M^{Crit}]\ D_{JV}^{\frac{1}{z}}} = 0$$

In the case of binding local content requirements, the government specifies a minimum percentage of inputs which must be purchased locally.

Following (D5) and Equation (18a), derive the restricted profit function as follows

$$(D21)\ \pi^{*}_{JV,LC}(e,c) = MAX_{\{L,I\}}\ P_{Out} A\, B^{a_1}\ L^{a_2}\ I^{a_3}\ e^{a_4}\ c^{a_5} - w\,L - p\,I + \lambda\,[\rho\, L - I]$$

Where λ is the Lagrange multiplier and as defined in the text $\rho = \frac{1-\phi}{\phi}$. Let $\tilde{w} = w + p\rho$. We assume the constraint binds and substitute it into the maximization problem.

$$(D22)\ \pi^{*}_{JV,LC}(e,c) = MAX_{\{L,I\}}\ \rho^{a_3}\ P_{Out} A\, B^{a_1}\ L^{a_2}\ I^{a_3}\ e^{a_4}\ c^{a_5} - \tilde{w}\, L$$

Using methodology the same methodology, derive (details available)

(D23) $e^*_{JV,LC} = D_{JV,LC}^{\frac{1}{z}} \bar{e}_{JV}$

$c^*_{JV,LC} = D_{JV,LC}^{\frac{1}{z}} \bar{c}_{JV}$

where

$$D_{JV,LC} = \rho^{\frac{a_3}{x}} \tilde{w}^{\frac{-[a_2+a_3]}{x}} \tilde{L}$$

$$\tilde{L} = P_{Out}^{\frac{1}{x}} A^{\frac{1}{x}} B^{\frac{a_1}{x}} [1 - a_2 - a_3][a_2 + a_3]^{\frac{a_2+a_3}{x}}$$

$$\pi^*_{JV} = D_{JV}^{\frac{1}{z}} \bar{e}_{JV}^{b_1} \bar{c}_{JV}^{b_1}$$

(D24) $e^*_{WOS,LC} = D_{WOS,LC}^{\frac{1}{z}} \bar{e}_{WOS}$

$c^*_{WOS,LC} = D_{WOS,LC}^{\frac{1}{z}} \bar{c}_{WOS}$

where

$$D_{WOS,LC} = \gamma_M^{Crit} D_{JV,LC}$$

$$\pi^*_{WOS} = D_{WOS}^{\frac{1}{z}} \bar{e}_{WOS}^{b_1} \bar{c}_{WOS}^{b_1}$$

Proposition D3: Given Cobb-Douglas technology and constant marginal cost of unobservable inputs, binding local content requirements will decrease the profits of all foreign owned firms, and decrease the provision of all unobservable inputs.

Proof: Recall that β^* is determined solely by the parameters of the production function, and $\bar{e}_i$ and $\bar{c}_i$ are independent of ϕ, as can be seen from (A14) - (A16). Therefore, in order to examine the impact of ϕ, all that needs to be analyzed is $D_{i,LC}$. Because $D_{i,LC}$ is multiplicatively separable in $\tilde{w}$ and ρ,

(D25) $$\frac{d D_{JV,LC}}{d\phi} = [\frac{\partial D_{JV,LC}}{\partial \rho} + \frac{\partial D_{JV,LC}}{\partial \tilde{w}} \frac{\partial \tilde{w}}{\partial \rho}] \frac{d\rho}{d\phi}$$

(D26) $$\frac{\partial D_{JV,LC}}{\partial \rho} = \frac{a_3}{1 - a_2 - a_3} \frac{1}{\rho} D_{JV,LC}$$

$$\frac{\partial D_{JV,LC}}{\partial \tilde{w}} = \frac{a_2 + a_3}{1 - a_2 - a_3} \frac{1}{\tilde{w}} D_{JV,LC}$$

$$\frac{\partial \tilde{w}}{\partial \rho} = p$$

$$\frac{d\rho}{d\phi} = -\frac{1}{\phi} - \frac{1-\phi}{\phi^2}$$

Since $\frac{d\rho}{d\phi}$ <0 for $0 < \phi \leq 1$,

(D27) $\text{Sgn}\,\frac{d\,D_{JV,LC}}{d\,\phi}$

$$= \text{-Sgn}[\frac{a_3}{1-a_2-a_3}\frac{1}{\rho} - \frac{a_2+a_3}{1-a_2-a_3}\frac{1}{\tilde{w}}]$$

$$= \text{-Sgn}[\frac{\tilde{w}}{p\,\rho} - \frac{a_2+a_3}{a_3}]$$

$$= \text{-Sgn}[\frac{w}{p\,\rho} - \frac{a_2}{a_3}]$$

$$= \text{-Sgn}[\frac{1}{\rho} - \frac{a_2\,p}{a_3\,w}]$$

If the local content constraint is binding, then $\frac{L^*}{I^*} \leq \frac{1}{\rho}$. L^* and I^* are the optimal (unrestricted) choices of L and I. From the FOCs of the unconstrained problem, it must be $\frac{L^*}{I^*} = \frac{a_2\,p}{a_3\,w}$. Therefore, we know $\frac{d\,D_{JV,LC}}{d\,\phi} \leq 0$. Further, since $\bar{e}_i$ and $\bar{c}_i$ (i=TP, JV) are independent of ϕ (See A(14) -(A16)), $\frac{\partial\ \pi_i^*}{\partial\ \phi} \leq 0$, $\frac{\partial\ e_i^*}{\partial\ \phi} \leq 0$, and $\frac{\partial\ c_i^*}{\partial\ \phi} \leq 0$.

Proposition D4: The value of γ_M that indicates the border between entry via a JV and WOS, γ_M^{Crit}, is unaffected by changes in the local content requirements.

Proof: The proof is analogous to the proof of Proposition A2.

Turning to the analysis of a particular Pigouvian tax, assume that the government subsidizes foreign owned firms' purchases of a particular imported input at a rate "t" and collects a lump sum tax T from these firms. Further assume that all changes in taxes are revenue neutral and begin from an initial equilibrium with t=T=0. Equation (D28) is total JV profits. Totally differentiating this gives (D29).

$$\text{(D28)}\quad \prod\nolimits_{JV}^{*}(t) \;=\; F(L(t),\; I(t)_1, I(t)_2, ..\; I(t)_m, e(t),\; c(t)\,) \;-\; w\,L(t)$$

$$- [p_1 - t]\; I_1 \;-\; \sum\nolimits_{i>1} p_i I(t)_i \;-\; R(e(\overline{L})),\; S(c(\overline{L}))\; - T(t)$$

$$\text{(D29)}\quad \frac{\partial \prod_{JV}^{*}}{\partial\; t} = [F_{I_1} - p_1] + I_1 + \sum\nolimits_i [F_{L_i} - w_i]\frac{\partial\; L_i}{\partial\; t} + \sum\nolimits_{j>1} [F_{I_{ij}} - p_j]\frac{\partial\; I_j}{\partial\; t}$$

$$+ [F_e - R_e]\frac{\partial\; e}{\partial\; t} + [F_c - S_c]\frac{\partial\; c}{\partial\; t} - \frac{\partial\; T}{\partial\; t}$$

Again at the initial equilibrium, the first term and each term in the summations will equal zero. Because the tax / subsidy scheme is assumed to be revenue neutral, $t\, I_1 = T$ and therefore, $\frac{\partial\; T}{\partial\; t} = I_1$ starting at t=0.

Proposition D5: Starting at the no tax equilibrium, the introduction of a small tax or subsidy will increase JV profits unless $[F_e - R_e]\frac{\partial\; e}{\partial\; t} + [F_c - S_c]\frac{\partial\; c}{\partial\; t} = 0$.

Proof: Equation (D29) and preceding discussion.

APPENDIX E: DATA DESCRIPTION

As noted in the main body, there are two basic sources of data used in this dissertation: the annual Industrial Survey and the annual Backcast Data. Although, the number of questions asked has varied over time, in 1995 there were over 150 different variables with data on over 21,000 manufacturing establishments in the Industrial Survey (Survei Industri-SI) . This data set is intended as a census, however from 1975-1985 new plants were generally only added as existing respondents exited the survey.

By 1985, BPS recognized that their methodology was providing them with a distorted view of the manufacturing sector. Therefore, in conjunction with foreign experts BPS began creating what they call the Backcast Data[59]. The researchers conducted extensive door-to-door searches for all possible manufacturing establishments in order to create a Directory of Manufacturing Establishments. This has been continually used and updated in hopes of questioning nearly all establishments. Surveyors knew that they had not necessarily begun questioning plants in the initial year of production, so through a series of questionnaires and interviews, BPS constructed estimates for all years that a particular plant had been in operation for a subset of variables including input, output, value added, and employment. Additionally, obvious data entry problems were corrected. BPS publishes a revised version of the Backcast each year. Further, there is a plant identification number so the annual SI and Backcast can be merged.

For the purpose of this dissertation, the foreign ownership percentage (PCT_FOR) and the export percentage (PCT_EXP) were also cleaned to eliminate obvious data entry problems. One persistent problem with the data is that BPS does not employ a distinct code for missing data. Therefore a "0" can either mean a true "0" or it can mean a particular question was left unanswered. In the case of ownership, this is further exacerbated. If the responding plant failed to answer, BPS filled in zeroes for all ownership categories[60] and set domestic private ownership to "100." In the interest of correcting obvious data entry problems, two sorts of changes were made to the ownership data. First, whenever the sum of all ownership categories did not equal 100, the appropriate changes were made. This was generally done by inspection. Additionally, all foreign owned firms are required to register with the Indonesian Investment Coordinating Board (Badan Koordinasi Penanaman Modal - BKPM) and BPS collects data on plant registration status. Therefore, if a period of foreign ownership is interrupted by one or two years of reported 100% local ownership without the appropriate change to BKPM registration status, foreign ownership is set to its pre- and post-interruption value. Generally, these are the same. Indonesia's regulations were similarly used to clean the export data. Majority foreign owned plants which began operation in Indonesia between the mid-1970's and May of 1994 were required to meet certain performance requirements. Chiefly, that they be export oriented. Therefore, majority foreign owned plants which experience one or two year "interruption" in their export status prior to 1995 are assumed to have continued to meet their statutory obligations and an interpolated value is assumed. Again, generally the pre- and post-values are the same.

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[59] For an extensive review of the methodology and importance of employing these data, please see Jammal (1993).

[60] BPS enumerates the foreign ownership percentage, central government ownership percentage, local government ownership percentage and private domestic ownership percentage.

APPENDIX F: ESTIMATION METHODOLOGY

This section derives the properties of the two-stage conditional maximum likelihood estimator employed in the text. Following Blundell and Smith (1994), re-write (4.1) conditionally on u_{2i}.

(F1) $$y_{1i}^{*} = \beta_1 y_{2i}^{*} + x_{1i}'\gamma_1 + \rho_1 u_{2i} + \varepsilon_{1i}$$

Where $\rho_1 \equiv \frac{\sigma_{12}}{\sigma_{22}}$ and $\varepsilon_{1i} \equiv u_{1i} - \rho_1 u_{2i}$ which is independent of u_{2i}.

Let $\tilde{y}_{2i} = y_{2i}^{*} - \alpha_2 y_{1i}$, which is independent of ε_{1i}. Re-write (F1) as

(F2) $$y_{1i}^{*} = \alpha_2\beta_1 y_{1i} + \beta_1 \tilde{y}_{2i} + x_{1i}'\gamma_1 + \rho_1 u_{2i} + \varepsilon_{1i}$$

To implement (F1), estimate (4.2) via instrumental variables which gives $\hat{\alpha}_2$ and $\hat{\gamma}_2$ which are used to construct $\hat{\tilde{y}}_{2i}$ and $\hat{u}_{2i}$. For $y_{1i}^{*} > 0$, the relevant estimating equation is

(F3) $$(1-\alpha_2\beta_1)\, y_{1i}^{*} = \beta_1 \hat{\tilde{y}}_{2i} + x_{1i}'\gamma_1 + \rho_1 \hat{u}_{2i} + \hat{\varepsilon}_{1i}$$

with $\hat{\varepsilon}_{1i} = \varepsilon_{1i} + \beta_1(\tilde{y}_{2i} - \hat{\tilde{y}}_{2i}) + \rho_1(u_{2i} - \hat{u}_{2i})$

or after dividing through by $(1-\alpha_2\beta_1)$ ...

(F3a) $\quad y^*_{1i} = \beta^*_1 \hat{\tilde{y}}_{2i} + x'_{1i}\gamma^*_1 + \rho^*_1 \hat{u}_{2i} + \hat{\varepsilon}^*_{1i}$

Blundell and Smith (1994, 1989, 1986) show that standard Tobit ML on (F3a) provides consistent estimators for β^*_1, γ^*_1 and ρ^*_1.

Note the estimation problem can be written as

(F4) $\quad y^*_{1i} = \beta^*_1 \tilde{y}_{2i} + x'_{1i}\gamma^*_1 + \rho^*_1 u_{2i} + \varepsilon^*_{1i}$

subject to the standard two-limit Tobit observation rule (4.3).

Note that $\tilde{y}_{2i}$ and u_{2i} depend upon $\varphi = [\alpha_2, \gamma'_2]'$. Let $\Theta^* = [\beta^*_1, \gamma^{*\prime}_1, \rho^*_1, \sigma^{*2}]'$, where σ^{*2} is the variance of ε^*_{1i}. Further, let $\ell_N(\Theta^*, \varphi)$ be the log-likelihood function derived from (F4) and (4.3) conditional on $\mathbf{x}_i$ and u_{2i} for $i = 1 \ldots N$. Finally, let $\hat{\Theta}^*_N$ be the ML estimator for Θ^* based on the consistent IV estimate $\hat{\varphi}_N$. Blundell and Smith (1994) show (Theorem 3.1) that $\hat{\Theta}^*_N$ is a consistent estimator for Θ^* and (Theorem 4.1) asymptotically normally distributed with variance covariance matrix $V(\hat{\Theta}^*_N)$.

The following definitions are useful in the derivation of the variance-covariance matrix of the conditional ML estimate.

(F5) $$\Phi = \lim_{N\to\infty} N^{-1} E \frac{\partial^2 \ell_N(\Theta^*, \varphi)}{\partial \Theta^* \, \partial \Theta^{*\prime}}$$

$$\Psi = \lim_{N\to\infty} N^{-1} E \frac{\partial^2 \ell_N(\Theta^*, \varphi)}{\partial \Theta^* \, \partial \varphi'}$$

$$\mathbf{K} = \Phi^{-1} \Psi$$

Note that E is the expectations operator where all expectations are taken conditional on $\mathbf{x}_i$ and u_{2i}. Blundell and Smith (1994, Theorem 4.1) show that

(F6) $$V(\hat{\Theta}_N^*) = \Phi^{-1} + K\, VC_{IV}\, K'$$

where VC_{IV} is the variance-covariance matrix of the IV estimate. Explicit expressions for Φ and Ψ are given in Blundell and Smith (1986,1994).

First define

(F7) $$\overline{\mathbf{W}} = \begin{bmatrix} \mathbf{W} & \mathbf{0} \\ \mathbf{0}^* & l \end{bmatrix}, \text{ where } \mathbf{W}' = [\mathbf{w}_1, ..., \mathbf{w}_N], \mathbf{w}_i = [\hat{\tilde{y}}_{2i}, \mathbf{x}'_{1i}, \hat{u}_{2i}]',$$

$\mathbf{0}^*$ is a matrix of zeroes and $\mathbf{0}$ and l are vectors of zeroes and ones respectively. Following Amemiya (1979) $\mathbf{A}$ is defined for the two-limit Tobit in Appendix G. Therefore,

(F8) $$\Phi = \overline{\mathbf{W}}'\mathbf{A}\overline{\mathbf{W}}.$$

Also,

(F9) $$\Psi = \overline{\mathbf{W}}'\mathbf{A}\begin{bmatrix} \mathbf{I}_N \\ \mathbf{0} \end{bmatrix}\mathbf{Z}_2$$

where $$\mathbf{Z}_2 = \left[\begin{bmatrix} \beta_1 + \rho_1 & \mathbf{0}' \\ \mathbf{0} & \rho_1 \mathbf{I}_{k2} \end{bmatrix}\begin{bmatrix} \mathbf{y}'_1 \\ \mathbf{x}'_2 \end{bmatrix}\right]'.$$

Define $\varphi = [\alpha_2, \gamma'_2]'$, $\Theta_1 = [\beta_1, \gamma_1', \rho_1]'$ and $\Theta_1^* = [\beta_1^*, \gamma_1^{*\prime}, \rho_1^*]'$. Having already obtained the estimator $\hat{\Theta}_1^*$, it is still necessary to derive an estimator for the structural parameters, $\hat{\Theta}_1$. Given the conditions that identify Θ_1 from $\Theta_1^*, 1-\alpha_2\beta_1 > 0$, consider the following set of constraints linking Θ_1, Θ_1^* and φ.

(F10) $\mathbf{q}(\Theta_1, \Theta_1^*, \varphi) = \mathbf{0}$,

where the number of constraints equals the number of elements of Θ_1 and Θ_1^*. The required estimator is uniquely defined by

(F10) $\mathbf{q}(\hat{\Theta}_1, \hat{\Theta}_1^*, \hat{\varphi}) = \mathbf{0}$.

Blundell and Smith (1994) show that the variance-covariance matrix of Θ_1^* and φ, $\mathbf{V}$ equals

(F11) $\mathbf{V} = \begin{bmatrix} \mathbf{I} & -\mathbf{K} \\ \mathbf{0} & \mathbf{I} \end{bmatrix} \begin{bmatrix} \Phi^{-1} & \mathbf{0} \\ \mathbf{0} & \mathrm{VC}_{\mathrm{IV}} \end{bmatrix} \begin{bmatrix} \mathbf{I} & \mathbf{0} \\ -\mathbf{K}' & \mathbf{I} \end{bmatrix}$

defining $\mathbf{Q} = \dfrac{\partial \mathbf{q}}{\partial \Theta_1'}^{-1} \left[\dfrac{\partial \mathbf{q}}{\partial \Theta_1^{*\prime}}, \dfrac{\partial \mathbf{q}}{\partial \rho'} \right]$, Blundell and Smith (1994) show that $\hat{\Theta}_1$ is asymptotically distributed according to

(F12) $\sqrt{N}(\hat{\Theta}_1 - \Theta_1) \xrightarrow{D} N(0, \mathbf{QVQ}')$

For the model considered here, the constraints linking Θ_1, Θ_1^* and φ can be expressed in the following manner (SEE F3 and F3a).

$$\begin{bmatrix} \hat{\beta}_1\left[1+\hat{\alpha}_2\hat{\beta}_1^*\right]-\hat{\beta}_1^* \\ \hat{\gamma}_1\left[1+\hat{\alpha}_2\hat{\beta}_1^*\right]-\hat{\gamma}_1^* \\ \hat{\rho}_1\left[1+\hat{\alpha}_2\hat{\beta}_1^*\right]-\hat{\rho}_1^* \end{bmatrix}=\mathbf{0} \text{ and}$$

$$\frac{\partial \mathbf{q}}{\partial \Theta_1'}^{-1}=\frac{1}{1-\alpha_2\beta_1}\mathbf{I},$$

$$\frac{\partial \mathbf{q}}{\partial \Theta_1^{*\prime}}=-\begin{bmatrix} \left[1-\alpha_2\beta_1\right] & \mathbf{0}' & 0 \\ \left[-\alpha_2\gamma_1\right] & \mathbf{I}_{k_1} & 0 \\ \left[-\alpha_2\rho_1\right] & \mathbf{0}' & 1 \end{bmatrix},$$

and

$$\frac{\partial \mathbf{q}}{\partial \rho'}=\frac{1}{1-\alpha_2\beta_1}\left[\beta_1\Theta_1,\mathbf{0}\right].$$

Therefore, $\mathbf{Q}=\left[\left[1-\alpha_2\beta_1\right]\mathbf{Q}_1,\beta_1\Theta_1,\mathbf{0}\right]$ where $\mathbf{Q}_1=-\begin{bmatrix} \left[1-\alpha_2\beta_1\right] & \mathbf{0}' & 0 \\ \left[-\alpha_2\gamma_1\right] & \mathbf{I}_{k_1} & 0 \\ \left[-\alpha_2\rho_1\right] & \mathbf{0}' & 1 \end{bmatrix}$.

APPENDIX G

This Appendix derives some basic equations for the standard two limit Tobit model, where the dependent variable is censored at 0 and 1. The following notation will be useful.

$$\Phi_i^0 = \int_{-\infty}^{\frac{-\beta' x_i}{\sigma}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

$$\phi_i^0 = \frac{1}{\sqrt{2\pi}} e^{\frac{-(\beta' x_i)^2}{2\sigma^2}}$$

$$\mathrm{z}_\mathrm{i}^0 = \frac{-\beta' x_i}{\sigma}$$

$$\Phi_i^1 = \int_{-\infty}^{\frac{1-\beta' x_i}{\sigma}} \frac{1}{\sqrt{2\pi}} e^{-\frac{t^2}{2}} dt$$

$$\phi_i^1 = \frac{1}{\sqrt{2\pi}} e^{\frac{-(1-\beta' x_i)^2}{2\sigma^2}}$$

$$\mathrm{z}_\mathrm{i}^1 = \frac{1-\beta' x_i}{\sigma}$$

Clearly, Φ_i^j and $\phi_\mathrm{i}^\mathrm{j}$ are the cumulative distribution function and probability density function of a standard normal random variable evaluated at z_i^j. Clearly, x_i and β are vectors of exogenous variable and parameters respectively.

Note the values of the following derivatives (see Maddala (1983, p. 153))

$$\frac{\partial \Phi_i^0}{\partial \beta} = -\frac{1}{\sigma}\phi_i^0 x_i, \qquad \frac{\partial \Phi_i^0}{\partial \sigma^2} = -\frac{1}{2\sigma^2}\phi_i^0 z_i^0$$

$$\frac{\partial \phi_i^0}{\partial \beta} = \frac{1}{\sigma}\phi_i^0 z_i^0 x_i, \quad \frac{\partial \phi_i^0}{\partial \sigma^2} = \frac{1}{2\sigma^2}\phi_i^0 [z_i^0]^2$$

and

$$\frac{\partial \Phi_i^1}{\partial \beta} = -\frac{1}{\sigma}\phi_i^1 x_i, \qquad \frac{\partial \Phi_i^1}{\partial \sigma^2} = -\frac{1}{2\sigma^2}\phi_i^1 z_i^1$$

$$\frac{\partial \phi_i^1}{\partial \beta} = \frac{1}{\sigma}\phi_i^1 z_i^1 x_i, \quad \frac{\partial \phi_i^1}{\partial \sigma^2} = \frac{1}{2\sigma^2}\phi_i^1 [z_i^1]^2$$

In the two limit Tobit considered in this dissertation, censoring of the dependent variable, y_i ,occurs at 0 and 1. Let Π_0 (Σ_0) be the product (sum) over the zero observations (i.e., $y_i = 0$), Π_* (Σ_*) be the product (sum) over the uncensored observation (i.e., $y_i = y_i^*$) and Π_1 (Σ_1) be the product (sum) over the observations which are censored at 1 (i.e., $y_i = 1$). The likelihood function and logliklihood function can be written as

$$\mathrm{L} = \Pi_0 \Phi_i^0 \; \Pi_* \frac{1}{\sigma}\phi\left(\frac{y_i - \beta' x_i}{\sigma}\right) \Pi_1 [1 - \Phi_i^1], \text{ and}$$

$$\log \mathrm{L} = \Sigma_0 \log(\Phi_i^0) + \Sigma_* \left[\log\left(\frac{1}{\sqrt{2\pi}}\right) - \frac{1}{2} \log(\sigma^2) - \frac{1}{2\sigma^2}(y_i - \beta' x_i)^2\right] + \Sigma_1 \log([1 - \Phi_i^1])$$

The first derivatives of log L are ...

$$\frac{\partial \log L}{\partial \beta} = -\Sigma_0 \frac{1}{\sigma}\frac{\phi_i^0}{\Phi_i^0} x_i + \Sigma_* [\frac{1}{\sigma^2}[y_i - \beta' x_i] x_i] + \Sigma_1 \frac{1}{\sigma}\frac{\phi_i^1}{[1-\Phi_i^1]} x_i$$

$$\frac{\partial \log L}{\partial \sigma^2} = -\Sigma_0 \frac{1}{2\sigma^2}\frac{\phi_i^0}{\Phi_i^0} z_i^0 + \Sigma_* [\frac{1}{2}[\frac{1}{\sigma^4}(y_i - \beta' x_i)^2 - \frac{1}{\sigma^2}]] + \Sigma_1 \frac{1}{2\sigma^2}\frac{\phi_i^1}{[1-\Phi_i^1]} z_i^1$$

The second derivatives are

$$\frac{\partial^2 \log L}{\partial \beta \partial \beta'} = -\Sigma_0 \frac{1}{\sigma^2}\left[\frac{\phi_i^0}{\Phi_i^0} z_i^0 + \left[\frac{\phi_i^0}{\Phi_i^0}\right]^2\right] x_i x_i' - \Sigma_* \frac{1}{\sigma^2} x_i x_i'$$

$$+ \Sigma_1 \frac{1}{\sigma^2}\left[\frac{\phi_i^1}{[1-\Phi_i^1]} z_i^1 - \left[\frac{\phi_i^1}{[1-\Phi_i^1]}\right]^2\right] x_i x_i'$$

$$\frac{\partial^2 \log L}{\partial {\sigma^2}^2} = -\Sigma_0 \frac{1}{4\sigma^4}\left[\frac{\phi_i^0}{\Phi_i^0}[z_i^0]^3 + [\frac{\phi_i^0}{\Phi_i^0}]^2 [z_i^0]^2 - 3\frac{\phi_i^0}{\Phi_i^0} z_i^0\right] + \Sigma_* [\frac{1}{2\sigma^4} - \frac{1}{\sigma^6}[y_i - \beta' x_i]]$$

$$+ \Sigma_1 \frac{1}{4\sigma^4}\left[\frac{\phi_i^1}{[1-\Phi_i^1]}[z_i^1]^3 - [\frac{\phi_i^1}{[1-\Phi_i^1]}]^2 [z_i^1]^2 - 3\frac{\phi_i^1}{[1-\Phi_i^1]} z_i^1\right]$$

$$\frac{\partial^2 \log L}{\partial \beta \partial \sigma^2} = -\Sigma_0 \frac{1}{2\sigma^2}\frac{\phi_i^0}{\Phi_i^0}\left[\frac{1}{\sigma}[z_i^0]^2 + \frac{1}{\sigma}\frac{\phi_i^0}{\Phi_i^0} z_i^0 - \frac{1}{\sigma}\right] x_i - \Sigma_* [\frac{1}{\sigma^4}[y_i - \beta' x_i] x_i]$$

$$- \Sigma_1 \frac{1}{2\sigma^2}\frac{\phi_i^1}{[1-\Phi_i^1]}\left[\frac{1}{\sigma} + \frac{1}{\sigma}\frac{\phi_i^1}{[1-\Phi_i^1]} z_i^1 - \frac{1}{\sigma}[z_i^1]^2\right] x_i$$

Following Amemiya (1979) define the following symbols

$$a_{11}(i) = \frac{1}{\sigma^2}\left[\left[\phi_i^0 z_i^0 + \left[\frac{[\phi_i^0]^2}{\Phi_i^0}\right] + \Phi_i^0\right] + \left[\phi_i^1 z_i^1 - \left[\frac{[\phi_i^1]^2}{[1-\Phi_i^1]}\right] + \Phi_i^1\right]\right],$$

$$a_{12}(i) = \frac{1}{2\sigma^3}\left[\left[\phi_i^0 [z_i^0]^2 + \left[\frac{[\phi_i^0]^2}{\Phi_i^0}\right] z_i^0 + \phi_i^0\right] + \left[\left[\frac{[\phi_i^1]^2}{[1-\Phi_i^1]}\right] z_i^1 - \phi_i^1 [z_i^1]^2 - \phi_i^1\right]\right], \text{ and}$$

$$a_{22}(i) = \frac{1}{4\sigma^4}\left[\left[\phi_i^0 [z_i^0]^3 + \left[\frac{[\phi_i^0]^2}{\Phi_i^0}\right][z_i^0]^2 + \phi_i^0 z_i^0 + 2\Phi_i^0\right] + \left[\left[\phi_i^1 [z_i^1]^3 - \frac{[\phi_i^1]^2}{[1-\Phi_i^1]}\right][z_i^1]^2 + \phi_i^1 [z_i^1] - 2\Phi_i^1\right]\right].$$

Let $\mathbf{A} = \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} \\ \mathbf{A}_{12} & \mathbf{A}_{22} \end{bmatrix}$ where $\mathbf{A}_{jk}$ are diagonal matrices with the ith - diagonal element equal to $a_{jk}(i)$.

Amemiya (1979) shows that the expected value of the matrix of second derivatives can be written as …

$$-\overline{\mathbf{X}}'\mathbf{A}\overline{\mathbf{X}}.$$

where $\overline{\mathbf{X}} = \begin{bmatrix} \mathbf{X} & \mathbf{0} \\ \mathbf{0}^* & l \end{bmatrix}$ and $\mathbf{X}' = [x_1, ..., x_N]$. $\mathbf{0}^*$ is a matrix of zeroes and $\mathbf{0}$ and l are vectors of zeroes and ones respectively.

APPENDIX H: EMPIRICAL MODEL

Now consider the following simplified version of the model presented in Chapter 2. This model is very similar to that presented in Aitken, Hanson and Harrison (1994). The important distinction is that in this dissertation, the ownership decision of the MNC is explicitly modeled using the insights developed in this dissertation regarding the role of bi-lateral moral hazard. Because Aitken, Hanson and Harrison (1994) have ignored the endogeneity of this decision, their empirical estimates are likely biased. Let total profits of a MNC's affiliate be ...

(H1) $\Pi(Q^F,Q^D,e,c;Q) = P^F*Q^F + P^D*Q^D - C(q^F,e,c)Q - m(c)\, Q^D - m(e)\, Q^F$

Q^F and Q^D are the quantities produced for the foreign and domestic markets with prices P^F and P^D respectively. Note that the total quantity produced is assumed to be fixed. Licensing restrictions in the Indian manufacturing sector lead Fikkert (1994) to make a similar assumption. In Indonesia, the country considered in this dissertation there are similar restriction placed on investors.[61] Further recall that Bhattachara and LaFontaine (1995) have show that the share parameter in bi-lateral moral hazard models, ownership percentage in this model, is independent of scale. Indeed, the excercises in Chapter 2 demonstrated that the relative importance of the MNC and local firm contributions is the driving force behind the determination of ownership percentage.

[61] Historically, all investors have needed government approval for capacity expansions. Further, foreign ownership has only been permitted if investments meet minimum capital requirements.

In order to account for the benefits of MNC and local managerial contributions, per unit production costs, $C(q^F,e,c)$, are allowed to be a decreasing function of MNC contributions, e, and local firm managerial contributions, c. Further, note that these costs increase as the export percentage, q^F, increases. This may be due to additional quality measures and more demanding specifications in international markets. Domestic, $m^D(c)$, and foreign, $m^F(e)$, marketing costs are assumed to be decreasing functions of respective managerial efforts. Note that for simplicity, managerial inputs are assumed to be "public" goods in that neither partner needs to make an allocation decision. A unit of managerial resources contributed by the MNC, for example, impacts both marketing and production costs.

Now, write the profits per-unit.

(H2) $\pi(q^F,e,c) = P^F*q^F + P^D*[1-q^F] - C(q^F,e,c) - m(c)\,[1-q^F] - m(e)\,q^F$

The MNC's maximization problem can therefore be written as ...

(H3) $\text{Max}_{\{\alpha,\beta,q^F,e,c\}}\ \alpha + \beta\ [\pi\,(q^F,e,c)*Q] - R(e) + \lambda\,[\beta\,\pi_e\,(q^F,e,c)*Q - R'(e)\,]$

$+\ \mu\,[\,[1-\beta]\,\pi_c\,(q^F,e,c)*Q - S'(c)] + \eta\,[\,[1-\beta]\,\pi\,(q^F,e,c)*Q - \alpha - S(c)]$

$+\ \varphi_0\,[\beta] + \varphi_1[1-\beta]$

This is similar to the problem examined in Chapter 2. There is one additional choice variable, q^F, and two additional constraints to explicitly account for the fact that the ownership share must lie between 0 and 1. Much of the formal analysis of this problem is the same as earlier and will not be repeated. For example, the lump sum portion of the contract will be adjusted to reduced the local partner to the reservation level of profits and the incentive constraints can be solved simultaneously to give e and c as functions of the ownership percentage. The two interesting variables for empirical research are the ownership percentage and the export percentage. The first order conditions for these choice variables are[62] ...

(H4) FOC q^F: $\pi_{qF}(q^F,e,c) + \lambda\,[\beta\,\pi_e\,(q^F,e,c)*Q] + \mu\,[\,[1-\beta]\,\pi_c\,(q^F,e,c)*Q = 0$

$$P^F - P^D - C_{qF}(q^F,e,c) + \lambda\,\beta\,m^F_e(e) - \mu\,[1-\beta]\,m^D_c(c) = 0$$

(H5) FOC β: $\lambda\ \pi_e - \mu\ \pi_c + \varphi_0 - \varphi_1 = 0$

$$\lambda\ [-C_e(q^F,e,c) - m^F_e(e)\ q^F] - \mu\,[-C_e(q^F,e,c) - m^D_c(c)\,[1-q^F]] + \varphi_0 - \varphi_1 = 0$$

Assume that the solution to this problem can be represented according to the empirical model in the main text. Notice that this problem indicates that the optimal value of β (q^F) depends on the chosen value of q^F (β). The incentive constraints ensure that this is the case. This means that the system of equations to be estimated is endogenous in the observed rather than latent values.

[62] For simplicity, it is assumed that $C_{e,qF}(q^F,e,c) = C_{c,qF}(q^F,e,c) = 0$.

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