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Competing to Invest in the Foreign Market

Laixun ZHAO **Kobe University**
OKAMURA Makoto **Hiroshima University**

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Laixun Zhao* Makoto Okamura**

Kobe University Hiroshima University

Abstract This paper analyzes foreign-direct-investment (FDI) competition in a three-country framework: two Northern countries and one Southern country. We have in mind the competition of Airbus and Boeing (or GM and Volkswagen) in a developing country. The host-country government endogeneizes tariffs, while Airbus and Boeing choose domestic output and FDI. Wages and employment in the home countries are bargained over between labor and management. We find that in the unique equilibrium, both Airbus and Boeing compete to undertake FDI in the developing country. This arises because the host country can play off the multinational corporations, which in turn stems from three factors: (a) Oligopolistic rivalry; (b) Quid prod quo FDI, which reduces tariffs; (c) Strategic outsourcing—FDI drives down the union wages at home if the host-country wage is sufficiently low. However, if the host-country wage is sufficiently high, then the union wage increases under FDI. In such cases, FDI competition benefits the multinationals, the labor unions as well as the host country. If Boeing undertakes FDI while Airbus does not, then: (i) Boeing's market share and profits are higher than Airbus's; (ii) the tariff facing Boeing is lower than that facing Airbus.

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Author addresses:

*: *Corresponding author*. Research Institute for Economics & Business, Kobe University, Kobe 657-8501, Japan, zhao@rieb.kobe-u.ac.jp, Fax: 81-78-803-7059.

**: Dept. of Economics, Hiroshima University, Hiroshima, Japan, okamuram@hiroshima-u.ac.jp.

1. Introduction

Developing countries are taking over as the most attractive destinations for foreign direct investment (FDI) in recent years. In 2003, China, the U.S. and India ranked 1, 2, 3 as the largest FDI host countries. A **UNCTAD** survey (UNCTAD/PRESS/PR/2005/03105/09/05) shows that both experts and transnational corporations answer that the five most attractive business locations for the years 2005-2006 are in the following order: China, USA, India, Russia and Brazil. Such large emerging markets in the developing countries offer new opportunities to firms from developed countries, in terms of huge pools of both final consumers and cheap workers. China in particular, with its accession to the WTO in 2001, trade and investment restrictions are expected to decrease substantially. Given the potential market of more than 1.3 billion people and near unlimited labor supply at low wages, multinationals vie each other to establish production and distribution facilities there. Feenstra (1999) states that FDI in China is one of the most important multinational activities, which will have fundamental effects on the patterns of world trade and investment.

While the potential in such emerging markets is large, a priori the net effects of the multinational activities on both the host and home countries are unclear. The purpose of this paper is to investigate such effects. Given that both the multinational firms and the emerging markets are big players, we adopt a game-theoretic framework. Specifically, we have in mind the competition of large multinationals, say Airbus and Boeing (or General Motors and Volkswagen, Kodak and Fuji Film, etc.) in a large developing country, say China (or India, or Russia).[1]

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[1] Other examples are, "Airbus angles to compete with Boeing in China's skies," *Wall Street Journal*, Aug. 20, 2001, "Airbus wants to … not only in selling aircraft but also working with China's aviation industry, citing **the production of wings** of Airbus 320 in China," *China Daily*, Mar. 2, 2002, and "Boeing, Airbus face off in China," *The Seattle Times*, Nov. 2, 2002. Regarding FDI in China, Branstetter and Feenstra (2002) show that FDI inflows reflect political openness and state ownership there; Cheng and Kwan (2000) and Lardy (1995) find that large regional market, good infrastructure, and preferential policy are important determinants of FDI in China; Feenstra and Hanson (2003) examine the organization of export processing operations of foreign MNEs in China and test the property rights model. Benkard (2000) conducts a dynamic analysis of the market for wide-bodied aircraft. Baldwin and Krugman (1987), Klepper (1990), and Neven and Seabright (1995) adopted simulations to analyze the competitive interactions of Airbus and Boeing. Irwin and Pavcnik (2001) examined the interactions of Airbus and Boeing, and found that the future entry of Airbus' A-380 could reduce the market share of Boeing 747 by 14 percent, using commercial aircraft data from 1969 to 1998.

Since the purpose of such FDI is to take advantage of cheap labor (i.e., outsourcing) and to capture the potential large consumer markets in the emerging economies, we assume that upstream production can be conducted in the home countries or outsourced to the host country, while final assembly is made in the host countries only (Our analysis can be straightforwardly extended to a reverse setup of the upstream and downstream productions above). The host government endogeneizes tariffs, while Airbus and Boeing determine domestic output and FDI. Wages and employment in the home countries (called Europe and the U.S. respectively) are bargained over between labor and management. Thus, the model incorporates not only the interactions of multinationals, labor unions and the government, but also intermediate and final productions, as well as the choice between exporting and FDI.

We find that the unique Nash equilibrium is the case when both Airbus and Boeing compete to undertake FDI in China. This arises because the host country can 'play off' the multinational corporations, which in turn is due to three factors: (a) Oligopolistic rivalry between Airbus and Boeing; (b) Quid pro quo FDI--by undertaking FDI, the import tariffs in China can be reduced; (c) Strategic outsourcing to erode the labor union's power—FDI drives down the union wages in the source countries if the Chinese wage is sufficiently low (as in rural areas).

However, if the Chinese wage is sufficiently high (as in Shanghai, Shenzhen and other coastal cities), then the union wage can increase under FDI. In such cases, FDI competition benefits the multinationals, the labor unions as well as the host country. In addition, if Boeing invests in China while Airbus does not, then: (i) Boeing's market share and profits are higher than Airbus's; (ii) the tariff facing Boeing is lower than that facing Airbus. These findings seem to fit well with the current FDI situation in China and some other developing countries.

In the literature of tax competition (e.g., Janeba, 1995, Haufler and Wooton, 1999), several host (usually less developed) countries compete to lower taxes to attract FDI from multinationals. In a sense, the multinationals can play off the host countries. In the present paper, the opposite is true.

Our model can explain for the phenomenon of ‘quid pro quo’ FDI, see for instance, Bhagwati et al (1987, 92), Wong (1989), Dinopoulos and Wong (1991), and Dinopoulos (1992). This literature suggests that FDI may be used as an instrument to defuse a protectionist threat, which Blonigen and Feenstra (1997) subsequently find strong statistical support. However, the literature assumes a reduced-form protection function, so that the level of protection falls as FDI rises. This approach has been criticized as being ‘a black box’, since the details in the protection function are not clearly explained.

In the present paper we do not use a protection function. Instead, we assume that the Chinese government maximizes an objective function, which includes a wage premium, consumer surplus and tariff revenue (zero profits because no Chinese firms are involved). Thus, the essential results of quid pro quo FDI are generated under oligopolistic rivalry: FDI provides employment incentives for the host country to reduce import barriers, creating scope for mutual gains for both the host country and the multinationals.

Our results indicate that outward FDI can raise domestic wages, when the wage level in the host country is sufficiently high. This is in contrast to Glass and Saggi (1999), who show that outward FDI lowers wages in the home country by shifting out the demand for labor. Recently, Leahy and Montagna (2000) analyzes the welfare effects on the host country, and Lommerud, Meland and Sorgard (2003) show that trade liberalization can induce FDI because the firm uses FDI to battle with the union. Haaland and Wooton (2002, 2003) examine how country risks related to labor markets and industry affect the decisions of multinationals in location selection.

Perhaps the part on FDI and unions is more closely related to Skaksen and Sorensen (2001), who use a CES production function with several inputs, and allow the firm to produce one of the inputs overseas. They find that under Leontief technology, the union always gains from the firm becoming a multinational; On the other hand, with perfect substitutes, the union always loses. Skaksen (2004) extends the analysis in a general equilibrium model with sector-specific capital, under potential and realized outsourcing. However, their results essentially hinge on production technology. All

interactions occur within one multinational firm, i.e., between management and labor. Possible interactions across firms (as found in Irwin and Pavcnik, 2001), and those between the multinationals and the host government are not modeled.

In contrast, the present paper focuses on oligopolistic interactions in three countries, with the host government playing an active role. We show that if the wage in the host country is sufficiently high, outward FDI can benefit not only the firm but also the labor union, as well as the host country. This arises because FDI increases domestic final output and labor demand by reducing the cost of production and intensifying oligopolistic competition. However, if the host-country wage is sufficiently low, then strategic outsourcing arises—FDI not only avoids high union wages at home, but also drives them down. Thus, the paper complements the recent literature on outsourcing, for instance, Feenstra and Hanson (1996), McLaren (2000), Baldwin and Ottaviano (2001), and Yeaple (2003). In addition, the paper is in spirit related to Markusen and Venables (1999), who establish circumstances in which FDI is complementary to local industries by raising their productivity in developing countries, and show how FDI may lead to the establishment of local industrial sectors.

The rest of the paper is organized as follows. Section 2 sets up the basic model, section 3 presents a benchmark case of no FDI by either Airbus or Boeing, section 4 investigates FDI competition, section 5 compares the cases of no FDI and FDI competition, section 6 looks into the case of unilateral FDI by one firm only, and finally, section 7 provides concluding remarks.

2. The Basic Setup of the Model

Consider a world consisting of three countries: China, Europe and the U.S. Europe is home to Airbus and the U.S. is home to Boeing. For simplicity, we assume that Airbus and Boeing sell aircrafts only in China, aiming to capture the empirical evidence that multinationals go there for the

potential market.[2] The variables denoted with *x* or A are related to the productions of Airbus, those denoted with *y* or B are related to the productions of Boeing, and those denoted with C are related to the productions in China.

Production consists of two processes. One is the production of an intermediate input, the other is combining the intermediate input and labor to produce the final output. Examples of the intermediate input are: aircraft doors, chairs, luggage cabinets, lavatories, landing gear, and wings, etc. An example of the final output is the whole aircraft including the engine. Airbus and Boeing do not sell intermediate inputs to each other and there is no other source to purchase the intermediate input except producing it inside the firm.

For simplicity, we assume that labor is the only factor needed to produce the intermediate input, according to the following input requirement function:

$$\phi(m) = m^2 / 2 . \qquad (1)$$

That is, *m* units of the intermediate input require $m^2 / 2$ units of labor.[3] To produce the final output, both the intermediate input and labor are needed. We assume a one-to-one-to-one relationship among the intermediate input, assembly labor input and the final output, by a proper choice of units. Thus, the total amount of labor required to produce *m* units of the final output is $m + m^2 / 2$.

Labor is unionized in both Airbus and Boeing. Both wages and employment are determined through negotiations. In other words, bargaining is efficient.[4] The unions in Airbus and Boeing have Stone-Geary type utility functions:

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[2] Allowing sales of the final product in other countries affects only the level of welfare. As will become clear later, the trade-off mechanism between employment shift and employment expansion of FDI competition remains and so do the main qualitative results in the paper. But the model can be straightforwardly extended to cover sales elsewhere.

[3] We could also assume a decreasing marginal cost function, which would make our story stronger. However, corner solutions would arise.

[4] The amount of FDI the multinationals undertake may change if a different form of bargaining is adopted, such as in the case when only wages are bargained while employment decision is left to the firm, or in the monopoly union model in which the union can determine the wage unilaterally. Nevertheless, positive FDI still emerges in equilibrium.

$$u_A(x, w_A) = (x + x_A^2/2)(w_A - w_0), \tag{2a}$$

$$u_B(y, w_B) = (y + y_B^2/2)(w_B - w_0), \tag{2b}$$

where terms $x_A^2/2$ and $y_B^2/2$ indicate respectively the amount of labor needed to produce the intermediate input in each firm's home country, *x* and *y* are labor used for final assembly, w_A and w_B are respectively the negotiated union wages in Europe and the U.S., and w_0 is the (outside) reservation wage or unemployment compensation, which is assumed to be identical in Europe and the U.S. for simplicity.

Airbus and Boeing can produce the intermediate input either in their home countries, or in China. Final assembly is done only in the home countries. Their profit functions can be written respectively as

$$\pi_A = xp(x+y) - (x + x_A^2/2)w_A - (x - x_A)^2 w_C/2 - t_A x, \tag{3a}$$

$$\pi_B = yp(x+y) - (y + y_B^2/2)w_B - (y - y_B)^2 w_C/2 - t_B y, \tag{3b}$$

where w_C is the Chinese wage, taken as exogenously given, and $p(x+y)$ is the inverse demand function. In (3a), since the final output is *x*, the amount of intermediate input produced in China is $x - x_A$. Variable t_A is an import tariff imposed by the Chinese government on Airbus. Corresponding variables and technology enter (3b), which is Boeing's profit function.

The Chinese government maximizes the following objective function:

$$W = \{(x - x_A)^2 + (y - y_B)^2\}w_C/2 + U(x+y) - (x+y)p(\cdot) + t_A x + t_B y, \tag{4}$$

where $\{(x-x_A)^2+(y-y_B)^2\}w_C/2$ can be considered as a wage premium from the intermediate production of Airbus and Boeing in China, because the Chinese workers' alternative is to work in local firms with lower wages, which are assumed to be zero without loss of generality, $U(x+y)-(x+y)p(\cdot)$ is the consumer surplus, and t_Ax and t_By are tariff revenues. Tariffs are imposed for shifting rents from foreign oligopolists and generating revenue.[5]

We consider a three-stage game. In stage 1, Airbus and Boeing decide simultaneously whether to undertake FDI or not; in stage 2, the Chinese government chooses t_A and t_B to maximize its objective;[6] and in stage 3, each firm bargains simultaneously with its labor union for wages and employment, i.e., w_A, x, x_A; w_B, y and y_B, taking the actions of the other firm and union as given. Thus, the amount of FDI is also determined in the third stage. It follows that the order of stages 1 and 2 can be reversed and the qualitative results of the model remain intact (see discussions in the concluding section). To ensure consistency, the game will be solved backwards.

We investigate sequentially three different cases: no FDI, FDI competition, and unilateral FDI. The wages, employment, tariffs, firm profits, union utility and welfare in the three cases will be compared. To save on notation, subscripts $_{NI}$, $_{II}$, and $_{I}$ will be used to denote respectively "no FDI", "FDI competition", and "unilateral FDI".

3. A Benchmark Case: No FDI

We look at the third stage first, in which the firms and the unions negotiate for wages and employment through efficient Nash Bargaining. The Nash products can be written respectively as

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[5] In practice, the commercial aircraft industry in many countries is state-owned or partially so. The government would "reward" one of the foreign rivals for good behavior by directing the state-owned airlines to purchase its products. In such a case, an import quota is substituted for the tariff. And our results on quid pro quo FDI would carry through more straightforwardly.

[6] After its accession to the WTO, China must impose an identical tariff rate on different countries. However, China did impose different tariff rates on different countries before the accession. In any case, in the present paper, we find that in equilibrium, China imposes an identical tariff rate on both Airbus and Boeing.

$$G(x, w_A) = \pi_A u_A, \tag{5a}$$

$$H(y, w_B) = \pi_B u_B. \tag{5b}$$

Airbus and its union negotiate over *x* and w_A, to maximize (5a), and simultaneously, Boeing and its union bargain over *y* and w_B, to maximize (5b), taking the tariff rates as given, which are determined in a prior stage by the Chinese government. We assume all workers are unionized in Europe and the U.S. Since final output is only produced at home, if bargaining breaks down, union workers become unemployed and the firms produce zero outputs. This outcome is the threat-point of the bargaining game, when the unions and the firms obtain zero utility and zero profits respectively. Also, in this section, Airbus and Boeing are treated identically. It thus suffices to focus on Airbus only.

In the absence of FDI by either firm, $x = x_A$ and $y = y_B$. Substituting into (5a) and (5b), we find that the equilibrium satisfies the following first order conditions

$$\partial G / \partial x = (w_A - w_0)(1+x)\pi_A + [p + xp' - (1+x)w_A - t_A]u_A = 0, \tag{6a}$$

$$\partial G / \partial w_A = (x + x^2/2)\pi_A - (x + x^2/2)u_A = 0. \tag{6b}$$

Rearranging to yield:

$$p + xp' - (1+x)w_0 - t_A = 0, \tag{6a'}$$

$$\pi_A - u_A = 0. \tag{6b'}$$

Analogously, the bargaining game in Boeing satisfies similar first order conditions.

Condition (6a') implies that the firm and the labor union first choose employment to maximize their joint rents—the sum of profits and union utility. And then condition (6b') states that

the two players choose the negotiated wage at a level so that their net gains are equalized. Totally differentiating (6a') and (6b'), we obtain the familiar comparative statics results on outputs, which are reported in Appendix 1 (A1).

Next we turn to the second stage of the game, in which we substitute the equilibrium values of all variables (obtained in the 3rd stage) into the Chinese government's objective function and maximize it to find the equilibrium tariff rates. Lobbying activities within China are not considered because the Chinese political system is different from democracies in the West. One could argue that FDI competition is a kind of lobbying by Airbus and Boeing to reduce tariffs, the essence of quid pro quo FDI in the literature.

From (4), in the absence of FDI, the Chinese government maximizes the following function, choosing tariff rates t_A and t_B.

$$W = U(x+y) - (x+y)\,p(x+y) + t_A x + t_B y\,. \tag{7}$$

Substituting the equilibrium values of *x* and *y* obtained in the third stage into (7) and differentiating, we have

$$\frac{\partial W}{\partial t_A} = -(x+y)\,p'\frac{\partial (x+y)}{\partial t_A} + x + t_A\frac{\partial x}{\partial t_A} + t_B\frac{\partial y}{\partial t_A} = 0\,, \tag{8a}$$

$$\frac{\partial W}{\partial t_B} = -(x+y)\,p'\frac{\partial (x+y)}{\partial t_B} + y + t_A\frac{\partial x}{\partial t_B} + t_B\frac{\partial y}{\partial t_B} = 0\,. \tag{8b}$$

Rearranging to give respectively

$$x\Delta_{NI} - (x+y)dp' + (b+d)t_A - bt_B = 0\,, \tag{8a'}$$

$$y\Delta_{NI} - (x+y)dp' + (a+d)t_B - at_A = 0\,, \tag{8b'}$$

where $a = p' + xp'' < 0$, $b = p' + yp'' < 0$, $d = p' - w_0 < 0$, and $\Delta_{NI} = (a+b+d)d > 0$. From (6b') and the corresponding equation for Boeing, we have $(x-y)(p'-w_0) - (t_A - t_B) = 0$. And using (8a') and (8b'), we obtain the following symmetry of outputs and tariffs,

$$x = y, \qquad t_A = t_B = t\,. \tag{9}$$

It is straightforward to show that in the absence of FDI, the optimum equilibrium tariff rates are positive if $-xp''/p' \le (1-w_0)/p'$, i.e., a condition for goods *x* and *y* to be strategic substitutes.

Substituting (9) into (6a') and (8a') to give respectively

$$p + xp' - (1+x)w_0 - t = 0\,, \tag{10a}$$

$$-2xp' + (a+b+d)x + t = 0\,, \tag{10b}$$

which can be combined to define:

$$f(x) \equiv p + 2(p' + xp'' - w_0)x - w_0 = 0\,. \tag{11}$$

Equation (11) determines the equilibrium level of *x* when neither firm undertakes FDI. Since $x = y$ in equilibrium, then $p = p(2x)$. Differentiating (11) yields

$$f'(x) = 4p' - 2w_0 + 4(2p'' + xp''')x\,. \tag{12}$$

A sufficient condition for (12) to be negative is $p' + 2xp'' + x^2 p''' \le 0$, and we assume this to be the case so that function *f(x)* is negatively sloped. For example, if $p''' \cong 0$ and the demand curve is not too convex, expression (12) is always negative.

4. Competing to Undertake FDI

In this section, we investigate the case in which both Airbus and Boeing undertake FDI in China. We show that the final production of both firms increases compared to the case of no FDI, due to three reasons that will become clear soon, under general demand conditions. For simplicity, we assume away the fixed costs of FDI. Analyses emphasizing fixed costs and transportation costs include for instance, Dei (1990) and Markusen and Venables (1998).

If both firms produce a portion of the intermediate input in China, then final assembly employment x, the union wage w_A and the home intermediate employment x_A are negotiated in the Airbus bargaining game, and similarly y, w_B and y_B are negotiated in the Boeing bargaining game. Substituting $x_C = x - x_A$ and $y_C = y - y_B$ into (5a) and (5b) and maximizing them, we can derive the first order conditions to determine x, w_A, x_A; and y, w_B and y_B. Since both firms undertake FDI, again it suffices to focus on the bargaining game in Airbus. We have

$$p + xp' - (x - x_A)w_C - w_0 - t_A = 0, \tag{13a}$$

$$\pi_A - u_A = 0, \tag{13b}$$

$$(x - x_A)w_C - w_0 x_A = 0. \tag{13c}$$

The first order conditions for the Boeing game can be obtained in a similar fashion, just replacing *x* with *y* and *A* with *B*.

Condition (13c) says that the marginal cost of the intermediate input produced by Airbus in China should equalize that produced in Europe, to minimize the total cost of intermediate production. It follows that if w_C rises, then more intermediate input is produced in the source country, and if w_0 rises, more intermediate input is produced in the host country. Substituting (13c) into (13a) yields

$$p + xp' - (1-\beta)w_0 x - w_0 - t_A = 0, \quad \beta = w_0/(w_C + w_0). \tag{14}$$

A similar condition can be derived for Boeing.

The comparative static analysis is contained in Appendix 1 (A2), which we now use to solve the game in the second stage; that is, the Chinese government determines the tariffs. Using first order conditions (13a-c) for both firms, and $x_C = x - x_A$ and $y_C = y - y_B$, the Chinese government's objective function becomes

$$W = (x^2 + y^2)\beta^2 w_C/2 + U(x+y) - p(x+y) + t_A x + t_B y. \tag{15}$$

The first order conditions for t_A and t_B are respectively

$$\{\Delta_{II} + \beta^2 w_C(b+d+\beta w_0)\}x - (d+\beta w_0)(x+y)p' - b\beta^2 w_C y + (b+d+\beta w_0)t_A - bt_B = 0, \tag{16a}$$

$$\{\Delta_{II} + \beta^2 w_C(a+d+\beta w_0)\}y - (d+\beta w_0)(x+y)p' - a\beta^2 w_C x + (a+d+\beta w_0)t_B - at_A = 0, \tag{16b}$$

where $\Delta_{II} = \{a+b+p'-(1-\beta)w_0\}\{p'-(1-\beta)w_0\} > 0$. Combining to yield

$$\{\Delta_{II} + \beta^2 w_C(a+b+d+\beta w_0)\}(x-y) + (a+b+d+\beta w_0)(t_A - t_B) = 0. \tag{17a}$$

And from (14) and a similar condition for Boeing, we also obtain

$$(d+\beta w_0)(x-y) - (t_A - t_B) = 0. \tag{17b}$$

Using (17a) and (17b) to give

$$\{2(d+\beta w_0) + \beta^2 w_C\}(a+b+d+\beta w_0)(x-y) = 0,$$

which can be substituted back into (17a) and (17b) to show that under FDI competition, we must have

$$x = y, \quad t_A = t_B = t\,. \tag{18}$$

Substituting (18) into (16a) to give $(\beta^2 w_C + a + b + d + \beta w_0)x - 2xp' + t = 0$, which can be combined with (14) to define the following equation

$$g(x) \equiv p + \{2p' + 2xp'' - (1-\beta)(2-\beta)w_0\}x - w_0 = 0\,. \tag{19}$$

Expression (19) determines the level of *x* in the case when both firms undertake FDI. Noting that $p = p(2x)$ under symmetry, and differentiating (19) yields

$$g'(x) = 4p' - (1-\beta)(2-\beta)w_0 + 4(2p'' + xp''')x\,. \tag{20}$$

It is negatively signed if $p' + 2xp'' + x^2 p''' \le 0$. We are now in a position to state:

Lemma 1 (output expansion): *The equilibrium final outputs are larger in the case when both firms undertake FDI than in the case of no FDI.*

Proof: Subtracting (11) from (19) gives rise to

$$g(x) - f(x) = \beta(3-\beta)w_0 > 0\,. \tag{21}$$

Thus, in figure 1, curve *g(x)* always lies above *f(x)*. QED

The output expansion effect of FDI arises due to three reasons. Firstly, the wage in the host county is lower than in the source countries; secondly, intermediate production exhibits increasing marginal costs. These two factors enable FDI in China to reduce the cost of intermediate production; and finally, the output expansion is larger under oligopolistic rivalry than if there were only a monopoly multinational firm.

5. Comparisons under Linear Demand

We now compare the values of the final output, tariffs, union wages, employment, utility and firm profits, respectively under no FDI and under FDI competition. In order to obtain explicit expressions, we shall make use of the following linear demand function wherever necessary

$$p = n - (x + y), \quad n > 0, \tag{22}$$

where as usual, *n* represents the market size, which is taken as given here.

Using $f(x) = 0$ in (11), and (22), we obtain the levels of the output of each firm, the tariffs, the negotiated employment and wages in the case of no FDI.

$$x_{NI} = (n - w_0)/(4 + 2w_0), \tag{23a}$$

$$t_{NI} = (1 + w_0)(n - w_0)/(4 + 2w_0), \tag{23b}$$

$$E_{NI} = x_{NI} + x_{NI}^2/2, \tag{23c}$$

$$w_{NI} = \{(1 + w_0)x_{NI} + w_0\}/(2 + x_{NI}) + w_0/2. \tag{23d}$$

Using (19) and (22) we also obtain the counterparts under FDI competition:

$$x_{II} = (n - w_0)/\{4 + (2 - \beta)\beta w_C\}, \tag{24a}$$

$$t_{II} = \{1 + (1 - \beta)\beta w_C\}x_{II}, \tag{24b}$$

$$E_{II} = x_{II} + (x_{II} - x_A)^2/2, \tag{24c}$$

$$w_{II} = \{[1+(1-\beta-\beta^2/2)w_0]x_{II} + w_0\}/[2+(1-\beta)^2 x_{II}] + w_0/2\,. \qquad (24d)$$

Differentiating (24a) yields

$$\partial x_{II}/\partial w_C = -(2-\beta)\beta x_{II}^2/(n-w_0) < 0\,. \qquad (25)$$

That is, an increase in the Chinese wage raises the cost of intermediate production and in turn reduces the final output.

Now, we compare the values of the tariffs, firm profits, union utility, wages and employment under no FDI and FDI competition. Conditions (23b) and (24b) give rise to

$$t_{NI} - t_{II} = \beta\{(3+w_0)\beta w_C + 2w_0\}x_{II}/(4+2w_0) > 0\,, \qquad (26)$$

which can be stated as,

Lemma 2: *The tariffs are lower under FDI competition than under no FDI.*

Lemma 2 represents the effect of quid pro quo FDI. In the present model, through FDI, Airbus and Boeing bring wage income to China. The Chinese government takes this into consideration when choosing tariffs to maximize its objective. As a result, FDI defuses the protectionist threat and reduces the tariffs the Chinese government imposes.

We now turn to the changes in union employment in the home countries, which include those for both intermediate and final production. By Lemma 1, final production is always higher under FDI competition than under no FDI (the output *expansion effect* of FDI competition). However, FDI also has an employment *shift effect*, because some intermediate production is shifted to the host country. If the expansion effect dominates the shift effect, then total employment goes up. From (23c) and (24c) we obtain the difference in employment as

$$E_{II} - E_{NI} = x_{II} - x_{NI} + [(1-\beta)x_{II} + x_{NI}]\{(1-\beta)x_{II} - x_{NI}\}/2. \quad (27)$$

A sufficient condition for it to be positive is $(1-\beta)x_{II} - x_{NI} \geq 0$. Substituting in relevant variables, it can be reduced down to

$$w_C \geq 4w_0/(w_0 - 4). \quad (28)$$

That is, the Chinese wage should not be too low. Otherwise most of the intermediate production will be shifted to China, and as a consequence union employment falls. If we restrict the Chinese wage not to be higher than the reservation wages in the home countries, i.e., $w_C \leq w_0$, combined with (28), we have $w_0 \geq 8$, i.e., the home-country reservation wage should not be too low either.

What happens if the host-country wage is very low? Let us consider a special case, $w_C = 0$. Substituting into (27) to give

$$E_{II} - E_{NI} = -(n - w_0)\{n - (5w_0 + 2w_0^2)\}/[2(2 + w_0)^2] < 0. \quad (29)$$

Since the parameter *n* measures the size of the Chinese market, we assume it is large enough such that $n - (5w_0 + 2w_0^2) > 0$. Then expression (29) is negatively signed; that is, union employment is lower under FDI competition than under no FDI if the host country wage is sufficiently low. This arises because most of the intermediate production is shifted to the host country under FDI competition, but not under no FDI.

From (28), (29) and the explanations following them, we can state

Proposition 1: *The union employment in the source countries is higher (lower) under FDI competition than under no FDI if the reservation wage in the source countries and the wage in the host country are sufficiently high (low).*

Proposition 1 basically arises from the *shift effect* and the *expansion effect* of FDI. If the former dominates, then employment in the source countries decreases. Note that in Skaksen and Sorensen (2001), FDI could also raise employment, but due to the complementarity of inputs, instead of due to FDI competition as in the present model.

Next, we look into the union wages. Comparing (23d) and (24d) yields

$$w_{II} - w_{NI} = \frac{(2+x_{NI})\{x_{II} + w_0 + (1-\beta-\beta^2/2)w_0\} - \{(1+w_0)x_{NI} + w_0\}\{2+(1-\beta)^2 x_{II}\}}{(2+x_{NI})\{2+(1-\beta)^2 x_{II}\}}. \quad (30)$$

Expression (30) has the same sign as its numerator, which can be rewritten as

$$Num = \frac{3\beta w_0(n-w_0)\,(w_C - 2w_0/3)}{2(w_C+w_0)[4+(2-\beta)(1-\beta)w_0]} + \frac{(2+w_0)\beta x_{NI} x_{II}}{w_C+w_0}\{w_C - \frac{(w_0-2)w_0}{2(w_0+1)}\}, \quad (30')$$

whose sign depends on the two expressions in curled braces. Because the following inequality holds

$$0 \;<\; (w_0-2)w_0/[2(w_0+1)] \;<\; 2w_0/3 \;<\; w_0, \quad (31)$$

we can establish

Proposition 2: *(i). If* $w_0 > w_C \geq 2w_0/3$, *then (30') is positively signed and the union wage is higher under FDI competition than under no FDI; (ii). If* $(w_0-2)/[2(w_0+1)] \geq w_C$, *then (30') is negatively signed and the union wage is lower under FDI competition than under no FDI; (iii). If* $2w_0/3 \;>\; w_C \;>\; (w_0-2)/[2(w_0+1)] \;>0$, *then the sign of (30') is ambiguous.*

Proposition 2 has some interesting implications, which follow naturally from Proposition 1. Firstly, if the Chinese wage is close to the level of the reservation wages in the home countries, then the negotiated wage increases as a result of FDI competition. This is in stark contrast to the results in

the literature, for instance, Glass and Saggi (1999), who show that wages fall under outward FDI. In the present model, by using cheaper labor for intermediate production in China, FDI has two effects on employment, as analyzed in Proposition 1—the *expansion effect* and the *shift effect*. It turns out that when the Chinese wage is close to the reservation wages in the home countries, the expansion effect dominates the shift effect, which pushes up the demand for labor, and as a result, the negotiated wages rise in Airbus and Boeing.

Secondly, if the Chinese wage is much lower than the reservation wages in the home countries, most intermediate production will be shifted to China, which results in a large reduction of union employment in the host countries that cannot be compensated by the increase in final production (see Proposition 1). Thus FDI has an effect of *strategic outsourcing*; that is, by undertaking FDI competition, Airbus and Boeing can drive down the negotiated union wages at home.

Next, we are interested in the conditions for union utility and firm profits to increase under FDI. Combining condition (28') and Proposition 2 gives rise to

Proposition 3: *If* $w_0 > w_C \geq 2w_0/3$, $w_C \geq 4w_0/(w_0-4)$, *and* $w_0 \geq 8$, *then both the negotiated wages and employment are higher under FDI competition than under no FDI, and union utility and firm profits are also higher.*

Proposition 3 describes the case of `high' wages in the host country, which arises if Airbus and Boeing employ workers from big cities near the coastal areas in China. In figure 2, area I satisfies Proposition 3, in which both firm profits and union utility are higher under FDI competition than under no FDI. This is a case deserving more emphasis, because the labor union also benefits from outward FDI. As a consequence, FDI competition becomes the equilibrium.

Finally, we look into the objective function of the host country. We can establish

Proposition 4: *The host country is better off under FDI competition than under no FDI.*

Proof: Substituting relevant variables into (4), the objective function under no FDI and FDI competition can be rewritten respectively as

$$W(x_{NI}) = U(2x_{NI}) - 2x_{NI}P(2x_{NI}) + 2t_{NI}x_{NI}\,, \tag{32a}$$

$$W(x_{II}) = w_C\beta^2 x_{II}^2 + U(2x_{II}) - 2x_{II}P(2x_{II}) + 2t_{II}x_{II}\,. \tag{32b}$$

Since $x_{II} > x_{NI}$, then $U(2x_{II}) - 2x_{II}P(2x_{II}) > U(2x_{NI}) - 2x_{NI}P(2x_{NI})$. The difference $W(x_{II}) - W(x_{NI})$ is positive if the following expression is non-negative.

$$\tilde{W} \equiv w_C\beta^2 x_{II}^2 + 2t_{II}x_{II} - 2t_{NI}x_{NI} = (x_{II} - x_{NI})\{n - w_0 - 2(x_{II} + x_{NI})\}\,. \tag{33}$$

It can be shown that the last expression in (33) is

$$n - w_0 - 2(x_{II} + x_{NI}) = \{2w_0(2 - 3\beta + \beta^2)(1 + w_0) + 4w_0\}x_{NI}/(4 + 2w_C\beta - w_C\beta^2) > 0\,.$$

Therefore, equation (33) is positively signed. And it follows that the host country is better off under FDI competition than under no FDI. QED

Since $x_{II} > x_{NI}$, but $t_{II} < t_{NI}$, the tariff revenue may be lower under FDI competition than under no FDI. However, (33) demonstrates that the host country is better off because the wage income from FDI dominates any possible reduction in tariff revenue. In addition, consumer surplus increases from FDI. Thus FDI competition Pareto-dominates no FDI if the conditions given in Proposition 3 are satisfied. And we are left to show that FDI competition is superior to unilateral FDI.

6. Unilateral FDI

When only one firm (say Boeing) undertakes FDI in China, while Airbus does not ($x_C = x - x_A = 0$), then Boeing produces $y_C = y - y_B$ of the intermediate input in China, which is endogenously determined. We shall show that Airbus becomes worse off than Boeing.

Since Airbus does not undertake FDI, it follows that in the 3rd stage, the bargaining game in Airbus can still be modeled by maximizing (5a), and the first order conditions are identical to (6a') and (6b'). In Boeing, the union utility and firm profit functions can still be expressed as in (2b) and (3b) respectively. If bargaining breaks down in Boeing, the union utility goes down to zero. Boeing's profit also goes down to zero, because final assembly is done in the U.S. only. Boeing and the labor union bargain to determine y, y_B and w_B. Substituting $x_C = x - x_A = 0$ and $y_C = y - y_B$ into (5b) and maximizing, we obtain

$$p + yp' - (y - y_B)w_C - w_0 - t_B = 0, \tag{34a}$$

$$\pi_B - u_B = 0, \tag{34b}$$

$$(y - y_B)w_C - w_0 y_B = 0. \tag{34c}$$

Next we turn to the second stage of the game, in which the Chinese government chooses tariffs to maximize its objective. Again using $x_C = x - x_A = 0$ and $y_C = y - y_B$, the objective function under unilateral FDI by Boeing can be rewritten as (see also footnote 5):

$$W = (y - y_B)^2 w_C / 2 + U(x + y) - p(x + y) + t_A x + t_B y. \tag{35}$$

The Chinese government chooses t_A and t_B simultaneously to maximize (35), yielding the following first order conditions.

$$x\Delta_I - (x+y)(p'-w_0/2)p' - byw_0/4 + (b+p'-w_0/2)t_A - bt_B = 0, \qquad (36a)$$

$$y\Delta_I - (x+y)dp' + (a+d)yw_0/4 + (a+d)t_B - at_A = 0. \qquad (36b)$$

Where $\Delta_I = bd + (a+d)(p'-w_0/2) > 0$. In deriving the above, we have used condition (34a-c) and the comparative statics results (a7-a12) in the appendix. Combining them to obtain

$$(t_A - t_B)[4(a+b+d)d + 4\Delta_I]/w_0 = (a+b+d)dy + 2(x+y)p' - 2y\Delta_I. \qquad (37)$$

The long expression before $(t_A - t_B)$ on the LHS of (37) is positive.

Substituting the linear demand function in (22) into the first order conditions in the third stage of the game under unilateral FDI, i.e., (6a'), (6b'), and (34a-c), we have

$$t_A = n - w_0 - (2+w_0)x - y, \qquad (38a)$$

$$t_B = n - w_0 - (2+w_0/2)y - x. \qquad (38b)$$

Substituting these into (36a-b), straightforward calculations give

$$(\Delta_I + \alpha)x - (\Delta_I + \gamma)y = -(n-w_0)w_0/2 < 0, \qquad (39)$$

where $\alpha = (w_0^2 + 3w_0 + 6)/2$, and $\gamma = (w_0^2 + 3w_0 + 5)/2$. Since $\Delta_I > 0$ and $\alpha > \gamma > 0$, condition (39) implies that under unilateral FDI, $x < y$, i.e., the final output (market share) of Airbus is less than that of Boeing.

Due to the asymmetry in FDI activities of Airbus and Boeing, further calculations become very messy. What we do now is to simulate the model using numerical values for the exogenous

competitive wages in the home and host countries. We use three sets of values for (w_C, w_0) : (4,5), (6,8), and (8,10). All three sets of values yield identical results (see Table 1), which can be stated as:

Proposition 5: *If Boeing undertakes FDI while Airbus does not, then (i) Boeing's market share and profits are higher than Airbus's; (ii) the tariff rate facing Boeing is lower than that facing Airbus. Thus, the unique Nash equilibrium is FDI competition by both firms.*

Proposition 5 arises because Boeing can take advantage of the lower wages in China by producing a portion of the intermediate input there, and thus is able to expand output and market share. It also receives a lower tariff rate for exporting due to quid pro quo FDI. As a result, profits increase. Therefore, we can further conclude that in the first stage of the game, FDI competition is the unique Nash equilibrium, because both firms would unilaterally want to undertake FDI.

7. Concluding Remarks

In this paper, we have built a three-country model in which the government, multinational firms and labor unions are all involved. Production consists of two processes in intermediate and final outputs. And the firms can choose to export only or to export and undertake FDI simultaneously.

Many factors can explain to some extent for the recent FDI boom in China. We identified three, which are oligopolistic rivalry, strategic outsourcing and quid pro quo FDI. Each of these can cause firms to engage in FDI competition in the host country, in addition to the explanations of low wages, huge population and potential market size. In particular, we also found cases in which the firms, the labor unions and the host country are all better off under FDI competition.

It is worth noting that our qualitative results remain valid even if the structure of the model is altered somewhat. Consider the case of a two-stage game in which the Chinese government chooses tariffs in the first stage, and all other endogenous variables (including wages, employment, and FDI

decisions etc.) are determined simultaneously in the second stage. To show robustness, we need to prove that in equilibrium both Airbus and Boeing undertake FDI. Because the bargaining structure here is identical to those in section 4, first order conditions (13a)-(13c) still apply. Rewriting (13c) to obtain $x_C = w_0 x/(w_0 + w_C)$ and $x_A = w_C x/(w_0 + w_C)$. As long the firm produces positive output (i.e., $x > 0$), then $x_C > 0$ and $x_A > 0$. That is, each firm undertakes positive FDI in equilibrium.

In addition to intermediate goods, one could also incorporate final production in the host country. In this case the firm's payoff at the threat point becomes positive if bargaining with the union breaks down, while that of the union stays at zero. This again would reduce the negotiated union wage. Finally, introducing a local firm and endogenizing the wage rate in the host country would be another interesting extension. Then the impacts of FDI competition on the host country can be examined in more detail. All these constitute avenues for further research.

Finally, in the case of a quota instead of a tariff, our qualitative results on quid pro quo FDI would carry through more straightforwardly. Basically, the government tended to reward firms by allocating a larger market share to those following its plans and punishing those who obstruct such plans.

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Appendix 1

This appendix contains the comparative statics results in the third stage under cases of no FDI, unilateral FDI and FDI competition respectively.

A1. No FDI

Totally differentiating conditions (6a') and (6b') to obtain (under symmetry)

$$\partial x/\partial t_A = \partial y/\partial t_B = (2p' + yp'' - w_0)/\Delta_{NI} < 0, \tag{a1}$$

$$\partial x/\partial t_B = \partial y/\partial t_A = -(p' + yp'')/\Delta_{NI} > 0, \tag{a2}$$

$$\partial (x+y)/\partial t_A = \partial (x+y)/\partial t_B = (p' - w_0)/\Delta_{NI} < 0, \tag{a3}$$

where $\Delta_{NI} = [3p' + (x+y)p'' - w_0](p' - w_0) > 0$.

A2. FDI Competition

Replacing *x* with *y* and *A* with *B* in (14) and totally differentiating it and also (14) itself yields

$$\partial y/\partial t_B = \partial x/\partial t_A = [2p' + yp'' - (1-\beta)w_0]/\Delta_{II} < 0, \tag{a4}$$

$$\partial x/\partial t_B = \partial y/\partial t_A = -(p' + yp'')/\Delta_{II} > 0, \tag{a5}$$

$$\partial (x+y)/\partial t_A = \partial (x+y)/\partial t_B = [p' - (1-\beta)w_0]/\Delta_{II} < 0, \tag{a6}$$

where $\Delta_{II} = \{p' - (1-\beta)w_0\}\{3p' + (x+y)p'' - (1-\beta)w_0\} > 0$.

A3. Unilateral FDI

Substituting (34c) into (34a) and totally differentiating it and (6a'), we obtain

$$\partial x/\partial t_A = (2p' + yp'' - w_0/2)/\Delta_I < 0, \tag{a7}$$

$$\partial y/\partial t_A = -(p' + yp'')/\Delta_I > 0, \tag{a8}$$

$$\partial x/\partial t_B = -(p' + xp'')/\Delta_I > 0, \tag{a9}$$

$$\partial y/\partial t_B = (2p' + xp'' - w_0)/\Delta_I < 0, \tag{a10}$$

$$\partial (x+y)/\partial t_A = (p' - w_0/2)/\Delta_I < 0, \tag{a11}$$

$$\partial (x+y)/\partial t_B = (p' - w_0)/\Delta_I < 0, \tag{a12}$$

where $\Delta_I = (p' + xp'')(p' - w_0/2) + (2p' + yp'' - w_0/2)(p' - w_0) > 0$.

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Figure 1

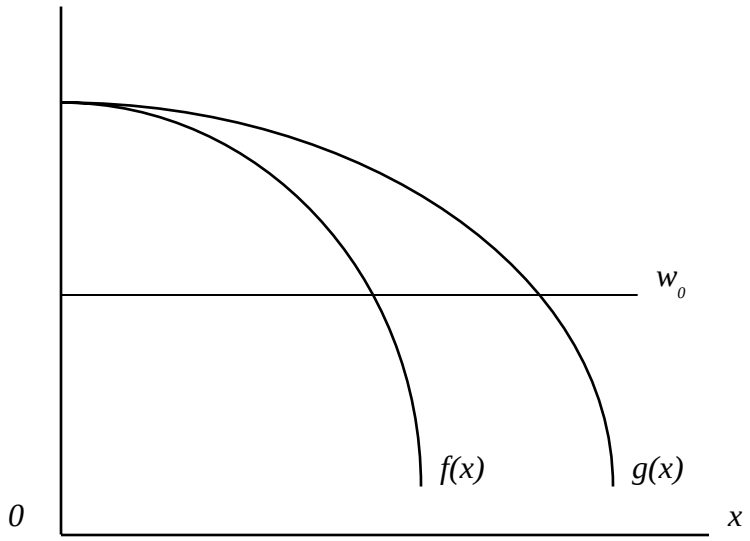

Figure 2

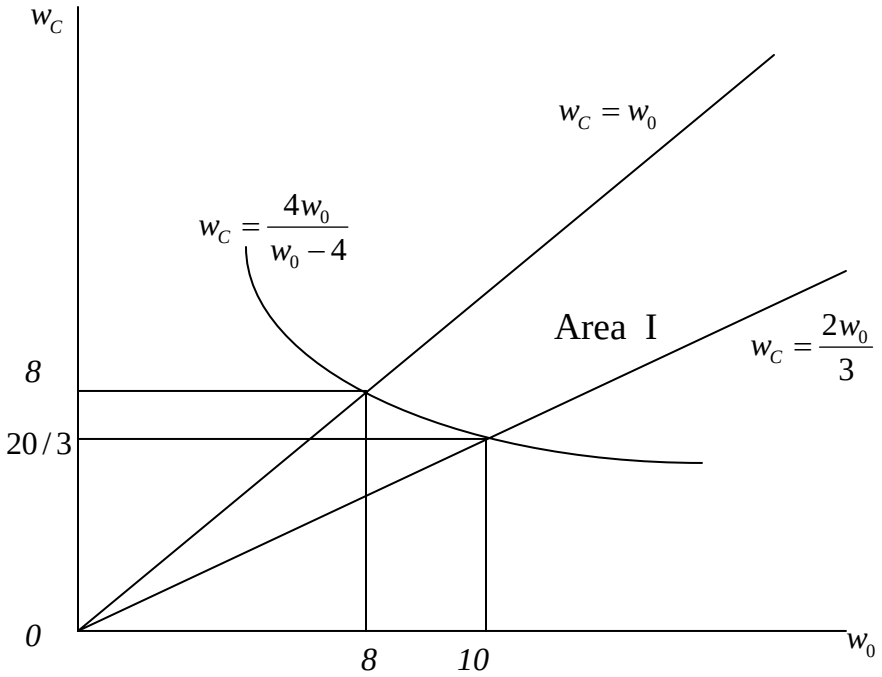

Table 1: FDI by Boeing but not Airbus

(w_C, w_0)	*(4, 5)*	*(6, 8)*	*(8, 10)*
x	$\frac{59627}{824453}$	$\frac{69085}{1356148}$	$\frac{7699}{181226}$
y	$\frac{124902}{824453}$	$\frac{164493}{1356148}$	$\frac{18549}{181226}$
t_A	$\frac{282162}{824453}$	$\frac{500805}{1356148}$	$\frac{70289}{181226}$
t_B	$\frac{237462}{824453}$	$\frac{394101}{1356148}$	$\frac{53989}{181226}$
π_A	$\frac{24887653903(n-5)^2}{4\times 679722749209}$	$\frac{23863686125(n-8)^2}{3678274795808}$	$\frac{355647606(n-10)^2}{65685726152}$
π_B	$\frac{16467204582(n-5)^2}{679722749209}$	$\frac{73442999133(n-8)^2}{3678274795808}$	$\frac{1108655181(n-10)^2}{65685726152}$

Note: the values of the variables x, y, t_A and t_B have been divided by a constant, $(n\text{-}w_0)$.