*Preliminary, Please do not quote*

# Competing to Invest in the Foreign Market

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**Abstract**

This paper studies foreign direct investment (FDI) under oligopoly in a three-country framework. We have in mind the competition of Airbus and Boeing, (or General Motors and Volkswagen) in China. Upstream production can be conducted in the home countries or in the host country, while final assembly is made in the home countries only. The Chinese government endogeneizes tariffs, while Airbus and Boeing choose domestic output and FDI in China. Wages and employment in Europe and the U.S. are bargained over between labor and management. We find that in equilibrium, 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 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 Chinese wage is sufficiently low. However, if the Chinese wage is sufficiently high, 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. If Boeing invests in China while Airbus does not, then: (i) Boeing's market share is higher than Airbus's; (ii) the tariffs facing Boeing is lower than that facing Airbus; (iii) the wages are lower in Boeing than in Airbus.

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## 1. Introduction

Since 1978, China's GDP growth rate has averaged more than 9.5 percent annually. With its accession to the WTO in 2001, China's GDP is projected to overtake that of Japan in 30 (?) years by a number of estimates. Given such a huge potential market, multinationals are flocking to China, to establish production and distribution facilities.[1] China is at present the second largest destination for FDI, next to the U.S.[2]

In this paper, we offer a model that illustrates such a phenomenon. We have in mind the competition of Airbus and Boeing, (or General Motors and Volkswagen, Kodak and Fuji Film, etc.) in China. Upstream production can be conducted in the home countries or in the host country, while final assembly is made in the home countries only. The Chinese government endogeneizes tariffs to maximize national welfare. Airbus and Boeing determine domestic output and FDI in China. Wages and employment in Europe and the U.S. are bargained over between labor and management.

We find that the 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 prod quo FDI--by undertaking FDI, the import tariffs in China can be reduced; (c) Strategic outsourcing—FDI drives down the union wages at home if the Chinese wage is sufficiently low. However, if the Chinese wage is sufficiently high, then the union wage can increase under FDI. In such cases, FDI competition benefits the multinationals, the

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[1] There are numerous reports. For stories of Airbus and Boeing, see for instance, "Airbus angles to compete with Boeing in China's skies," Wall Street Journal, Aug. 20, 2001, and China Daily, Aug. 28, 2001.

[2] See "Making it in China," U.S. News & World Report, Oct. 7, 2002.

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 is higher than Airbus's; (ii) the tariffs facing Boeing is lower than that facing Airbus; (iii) the wages are lower in Boeing than in Airbus.

In the literature of tax competition (e.g., Janeba, 1995, Haufler and Wooton, 1999), several host countries (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. The multinationals are played off by the host country.

Our model is also closely related to the so-called 'quid pro quo' FDI, see for instance, Bhagwati et al (1987, 92), Dinopoulos (1989, 1992), Wong (1989), Dinopoulos and Wong (1991), Blonigen and Feenstra (1996). This literature suggests that FDI may be induced by the threat of protection, and further, that FDI may be used as an instrument to defuse a protectionist threat. Blonigen and Feestra (1997) find strong statistical support for the hypothesis. However, the literature assumes a protection function, so that the level of protection decreases as FDI increases. This approach has been criticized as being 'a black box', because the details in the protection function are not clear.

Our contribution in the present paper is to *not* use a protection function. Instead, we assume that the Chinese government maximizes national welfare, which includes wage income, consumer surplus and tariff revenue (zero profits because no Chinese firms are involved). Thus, while the shortcomings of the protection function approach are avoided, the qualitative results of quid pro quo FDI are retained, in a setup of oligopolistic rivalry.

In addition, we find that outward FDI can either raise or reduce domestic wages, depending on the wage level in the host country. This is in stark contrast to Glass and Saggi (1999), and Zhao (2001), who show that outward FDI lowers wages in the home country by

shifting the demand of labor, or due to labor-management interactions. Leahy and Montagna (2000), and Skaksen and Sorensen (2001) also study the relationship between FDI and labor unions. The former analyzes the welfare effects on the host country, and the latter shows that home workers may lose or gain depending on the substitutability of the multinational activities. However, these papers include only one multinational firm.

In the present paper, our setup and focus are different. Under oligopolistic interactions in three countries, 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 outsourcing reduces the cost of production and increases domestic output and labor demand. 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.

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 equilibria under no FDI and FDI competition, section 6 looks into the case of unilateral FDI by one firm only, and finally, section 7 includes 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. Airbus and Boeing sell aircrafts only in China. 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, toilets, 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 buy the intermediate inputs except producing them inside the firm.

For simplicity, we assume that labor is the only factor needed to produce the intermediate input. The relation between labor and the intermediate input is:

$$c(y_B) = c(y_C) = c(x_A) = c(x_C) = \frac{1}{2}L^2 . \qquad (1)$$

Where $L$ is labor input, $x_A$ and $x_C$ are Airbus's production of the intermediate input in Europe and China respectively, $y_B$ and $y_C$ are the counterparts for Boeing in the U.S. and China respectively, $c(\cdot)$ is the cost of production, satisfying $c' > 0,\ \ c'' > 0$. That is, one unit of the intermediate input requires $\frac{1}{2}L^2$ units of labor.

And to produce the final output, the intermediate input and labor are needed. Assume a one-to-one relationship among the intermediate input, labor input and the final output, by a proper choice of units.

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

$$u(x, w_A) = (x + \frac{1}{2} x_A^2)(w_A - w_0), \quad (2a)$$

$$u(y, w_B) = (y + \frac{1}{2} y_B^2)(w_B - w_0), \quad (2b)$$

where terms $\frac{1}{2} x_A^2$ and $\frac{1}{2} y_B^2$ indicate the amount of labor needed to produce the intermediate input in each firm's home country, *x* and *y* are labor used for the production of the final outputs, $w_A$ 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

$$\pi_A = xp - (x + \frac{1}{2} x_A^2) w_A - \frac{1}{2} (x - x_A)^2 w_C - t_A x, \quad (3a)$$

$$\pi_B = yp - (y + \frac{1}{2} y_B^2) w_B - \frac{1}{2} (y - y_B)^2 w_C - t_B y, \quad (3b)$$

where in (3a), $x_A$ is Airbus's outputs of the intermediate input produced in Europe. Since the final product is *x*, the amount of intermediate input produced in China is $x - x_A$. Variable $t_A$ is an import tax 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 welfare function:

$$W = (x - x_A + y - y_B)w_C + U(x+y) - p(x+y) + t_A x + t_B y\,, \qquad (4)$$

where $(x - x_A + y - y_B)w_C$ is the wage income, $U(x+y) - p(x+y)$ is the consumer surplus, and $t_A x$ and $t_B y$ are tariff revenues. The Chinese wage $w_C$ is exogenously given.

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 welfare; 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 $y^B$. 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 indicate 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

$$G(x, w_A) = \pi_A u_A\,, \qquad (5a)$$

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

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. In this section, Airbus and Boeing are treated identically. It 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

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

$$\frac{\partial G}{\partial w_A} = (x + \frac{1}{2}x^2)\pi_A - (x + \frac{1}{2}x^2)u_A = 0\,. \tag{6b}$$

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:

$$p + yp' - (1+y)w_0 - t_B = 0\,, \tag{7a}$$

$$\pi_B - u_B = 0\,. \tag{7b}$$

Conditions (6a') and (7a) imply that the firm and the labor union first choose employment to maximize their joint rents—the sum of profits and union utility. And then conditions (6b') and (7b) state that the two players choose the negotiated wage at a level so that their net gains are equalized. Totally differentiating (6a') and (7a), we obtain the familiar comparative statics results on outputs, which are reported in Appendix 1.

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 welfare function and maximize it to obtain 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 quid pro quo FDI is a kind of lobbying by Airbus and Boeing.

In the absence of FDI, the Chinese government maximizes the following welfare function, choosing tariff rates $t_A$ and $t_B$.

$$W = U(x+y) - p(x+y) + t_A x + t_B y . \tag{8}$$

Substituting the equilibrium values of *x* and *y* obtained in the third stage into (8) and differentiating, we have

$$\frac{\partial W}{\partial t_A} = -(x+y)p'\frac{\partial (x+y)}{\partial t_A} + x + t_A \frac{\partial x}{\partial t_A} + t_B \frac{\partial y}{\partial t_A} = 0 , \tag{9a}$$

$$\frac{\partial W}{\partial t_B} = -(x+y)p'\frac{\partial (x+y)}{\partial t_B} + y + t_A \frac{\partial x}{\partial t_B} + t_B \frac{\partial y}{\partial t_B} = 0 . \tag{9b}$$

Rearranging to give respectively

$$x\Delta_{NI} - (x+y)dp' + (b+d)t_A - bt_B = 0\,, \tag{10a}$$

$$y\Delta_{NI} - (x+y)dp' + (a+d)t_B - at_A = 0\,. \tag{10b}$$

Where $a = p' + xp'' < 0$, $b = p' + yp'' < 0$, $d = p' - w_0 < 0$, and $\Delta_{NI} = (a+b+d)d > 0$.

Combining the above yields

$$(x-y)(p' - w_0) - (t_A - t_B) = 0\,. \tag{11}$$

Thus, under symmetry, we obtain

$$x = y, \quad t_A = t_B = t\,. \tag{12}$$

***Proposition 1****: In the absence of FDI, the equilibrium tariff rates are positive if* $xp'' \le -(p' + xp'' - w_0)$.

***Proof:*** Substituting (12) into either (10a) or (10b) to obtain

$$t_A = t_B = -(p' + 2xp'' - w_0)x\,. \tag{13}$$

Because $p' + xp'' = \dfrac{\partial(p + xp')}{\partial y} < 0$, expression (13) is positively signed if

$xp'' \le -(p' + xp'' - w_0)$. QED

Proposition 1 implies that if the demand curve is not too convex, then the tariffs the Chinese government charges on Airbus and Boeing are always positive.

Substituting (12) into (6a') and (10a) to give respectively

$$p + xp' - (1+x)w_0 - t = 0, \tag{14a}$$

$$-2xp' + (a+b+d)x + t = 0, \tag{14b}$$

which can be combined to define:

$$f(x) \equiv p + 2(p' + xp'' - w_0)x - w_0. \tag{15}$$

Function *f(x)* determines the equilibrium level of *x* when neither firm undertakes FDI. Since $x = y$ in equilibrium, then $p = p(2x)$. Differentiating (15) yields

$$f'(x) = 4p' - 2w_0 + 4(2p'' + xp''')x. \tag{16}$$

A sufficient condition for (16) to be negative is $p' + 2xp'' + x^2P''' \le 0$, 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 (16) 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 tariffs facing both firms decrease while the union wages can increase or decrease compared to the case of no FDI.

If both firms produce a portion of the intermediate input in China, then $x$, $w_A$ and $x_A$ are negotiated in the Airbus bargaining game, and $y$, $w_B$ 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, we can obtain 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

$$p + xp' - (x - x_A)w_C - w_0 - t_B = 0, \tag{18a}$$

$$\pi_A - u_A = 0, \tag{18b}$$

$$(x - x_A)w_C - w_0 x_A = 0. \tag{18c}$$

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 (18c) says that the value of the intermediate input produced by Airbus in China should equalize that produced in Europe. It follows that if $w_C$ rises, then more intermediate input is produced in the home country, and if $w_0$ rises, more intermediate input is produced in the host country. Substituting (18c) into (18a) yields

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

where $\beta = \dfrac{w_0}{w_C + w_0}$.

The comparative static analysis is contained in Appendix 1, which is needed to solve the game in the second stage, which we turn to now. In the second stage, the Chinese government determines the tariffs. Using the equilibrium conditions (18a-c) for both firms, and $x_C = x - x_A$ and $y_C = y - y_B$, the Chinese welfare function becomes

$$W = \frac{1}{2}(x^2 + y^2)\beta^2 w_C + U(x+y) - p(x+y) + t_A x + t_B y \,. \qquad (20)$$

The first order conditions for $t_A$ and $t_B$ are respectively

$$\{\Delta_{II} + \beta^2 w_C(b+d+\beta w_0)\}x - (d+\beta w_0)(x+y)\,p' - b\beta^2 w_C y + (b+d+\beta w_0)t_A - bt_B = 0\,, \qquad (21a)$$

$$\{\Delta_{II} + \beta^2 w_C(a+d+\beta w_0)\}y - (d+\beta w_0)(x+y)\,p' - a\beta^2 w_C x + (a+d+\beta w_0)t_B - at_A = 0\,, \qquad (21b)$$

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

$$\{\Delta_{II} + \beta^2 w_C(a+d+\beta w_0)\}(x-y) + (a+b+d+\beta w_0)(t_A - t_B) = 0\,. \qquad (22a)$$

And from (19) and a similar condition for Boeing, we also have

$$(d+\beta w_0)(x-y) - (t_A - t_B) = 0\,. \qquad (22b)$$

Using (22a) and (22b) to give

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

which can be substituted back to (22a) and (22b) to show that in the equilibrium of FDI competition, we must have

$$x = y, \quad t_A = t_B = t\,. \tag{23}$$

Substituting (23) into (21a) to give

$$(\beta^2 w_C + a + d + \beta w_0)x - 2xp' + t = 0\,. \tag{24}$$

Equation (24) can be combined with (19) to define the following function

$$g(x) \equiv p + \{2p' + 2xp'' - (1-\beta)(2-\beta)w_0\}x - w_0 = 0\,. \tag{25}$$

Function *g(x)* determines the equilibrium *x* in the case when both firms undertake FDI. Noting that $p = p(2x)$, and differentiating (25) yields

$$g'(x) = 4p' - (1-\beta)(2-\beta)w_0 + 4(2p'' + xp''')x\,. \tag{26}$$

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

***Proposition 2****: The equilibrium outputs are larger in the case when both firms undertake FDI than in the case of no FDI.*

***Proof***: Subtracting (15) from (25) yields

$$g(x) - f(x) = \beta(3-\beta)w_0 > 0\,. \tag{27}$$

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

Final output increases due to three reasons. Firstly, the wage in the host county is lower than in the home countries; secondly, intermediate production exhibits increasing

marginal costs. FDI in China reduces the cost of intermediate production in both ways; and finally, oligopolistic rivalry makes both firms expand outputs more than in the case of a monopoly.

## 5. Equilibrium Comparison under Linear Demand

In this section, we compare the equilibrium 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

$$p = n - (x + y)\,. \tag{28}$$

Using (28), (15), (14a) and (7b), we obtain the equilibrium levels of the output of each firm, the tariffs, the negotiated employment and wages in the case of no FDI.

$$x_{NI} = \frac{n - w_0}{4 + 2w_0}, \tag{29a}$$

$$t_{NI} = \frac{(1 + w_0)(n - w_0)}{4 + 2w_0}, \tag{29b}$$

$$x_{NI} + \frac{x_{NI}^2}{2} = \frac{n - w_0}{4 + 2w_0} + \frac{(n - w_0)^2}{2(4 + 2w_0)^2}, \tag{29c}$$

$$w_{NI} = \frac{(1 + w_0)x_{NI} + w_0}{2 + x_{NI}} + \frac{w_0}{2}\,. \tag{29d}$$

And using (28), (25), (24a) and (18b) we also obtain the counterparts under FDI competition:

$$x_{II} = \frac{n - w_0}{4 + (2 - \beta)\beta w_C}, \tag{30a}$$

$$t_{II} = \frac{\{1 + (1 - \beta)\beta w_C\}(n - w_0)}{4 + (2 - \beta)\beta w_C}, \tag{30b}$$

$$x_{II} + \frac{(x_{II} - x_A)^2}{2} = x_{II} + \frac{(1 - \beta)^2 x_{II}^2}{2}, \tag{30c}$$

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

Next, we look into the effects of an increase in the wage in the host country. Differentiating (30a) yields

$$\frac{\partial x_{II}}{\partial w_C} = \frac{-x_{II}^2}{n - w_0} \frac{w_C + 3w_0}{(w_C + w_0)^3} < 0. \tag{31}$$

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

Differentiation of (30b) yields

$$\frac{\partial t_{II}}{\partial w_C} = \frac{-\beta / (w_C + w_0)}{\{4 + 2w_0 + \beta(\beta - 3)w_0\}^2} h(\beta), \tag{32}$$

where

$$h(\beta) = (6 + 2w_0)\beta - (5 + w_0) - w_0\beta^2 . \quad (33)$$

Function $h(\beta)$ has the following properties: $h'(\beta) > 0$ for all $0 \le \beta \le 1$; $h(\frac{1}{2}) < 0$; $h(1) > 0$. Thus there exists a unique $\tilde{\beta} \in (\frac{1}{2}, 1)$ such that $h(\tilde{\beta}) = 0$. If $\beta < \tilde{\beta}$, then expression (32) is positively signed; if $\beta > \tilde{\beta}$, then expression (32) is negatively signed. As a consequence, we can establish

***Proposition*** *3: If $w_C$ is sufficiently low compared to $w_0$ (i.e., $\beta > \tilde{\beta}$), then an increase in $w_C$ reduces the tariff imposed on imports; and if $w_C$ is close to or higher than $w_0$ (i.e., $\beta < \tilde{\beta}$), then the opposite arises.*

Let us gradually explain the intuition of Proposition 3, which has two parts. First, when $w_C$ is sufficiently low compared with $w_0$, an increase in $w_C$ does not cause large quantities of the intermediate production to be shifted to the home countries, while it raises the wage revenue in China. However, it also raises the cost of intermediate production, which reduces the final output and in turn the consumer surplus in China. To alleviate this loss in consumer surplus, a lower tariff is needed to reduce the cost of final production, which induces more final output and higher consumer surplus. Thus, when $w_C$ is sufficiently low compared with $w_0$, there is a substitution effect between $w_C$ and $t_{II}$ in maximizing the national welfare.

Next, we look at the case when $w_C$ is sufficiently high. An example is to start at $w_C = w_0$. An increase in $w_C$ causes intermediate production to be moved out of China. Because $w_C$ enters the welfare function linearly while intermediate production does quadratically, the wage revenue falls. Intermediate production, final production and consumer surplus all fall. Thus, from the point of welfare maximization, a higher tariff is needed to increase the tariff revenue to make up for all these losses.

Now, we are in a position to compare the equilibrium values of the tariffs, union wages and employment under no FDI and FDI competition. Conditions (29b) and (30b) give

$$t_{NI} - t_{II} = \frac{(n - w_0)\{(3 + w_0)\beta^2 w_C + 2(1-\beta)w_0\}}{(4 + 2w_0)\{4 + (2-\beta)\beta w_C\}} > 0\,, \qquad (34)$$

which can be stated as,

***Proposition 4****: The tariffs are lower under FDI competition than under no FDI.*

Proposition 4 is 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 welfare. As a result, FDI defuses the protectionist threat and reduces the tariffs the Chinese government imposes.

From (29c) and (30c) we obtain the difference in employment as

$$\Delta E = x_{II} + \frac{(1-\beta)^2 x_{II}^2}{2} - (x_{NI} + \frac{x_{NI}^2}{2}) = x_{II} - x_{NI} + \frac{(1-\beta)x_{II} + x_{NI}}{2}\{(1-\beta)x_{II} - x_{NI}\}\,. \qquad (35)$$

A sufficient condition for it to be positive is

$$(1-\beta)x_{II} - x_{NI} \geq 0 . \tag{36}$$

Substituting in relevant variables, (36) can be reduced down to

$$w_C \geq \frac{4w_0}{w_0 - 4} . \tag{36'}$$

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 (36'), we have $w_0 \geq 8$. This implies two things: firstly, the Chinese wage should not be too low. Otherwise most of the intermediate production will be shifted to China and union employment in the home countries will be reduced; secondly, because the Chinese wage is lower than the home-country reservation wages, the latter should not be too low either.

It is certainly possible that if the host-country wage is very low, then the decrease of home employment in intermediate production is so large that total union employment decreases. To see this, consider the case that $w_C = 0$. Substituting into (35) to yield

$$\Delta E = \frac{-(n - w_0)}{8(2 + w_0)^2}\{n - (5 + 2w_0)w_0\} < 0 . \tag{37}$$

Since the term in braces represents the magnitude of the demand function and hence is positive, expression (37) is negatively signed. That is, when the Chinese wage is sufficiently low, union employment in the home countries decreases under FDI competition.

From the discussions above, we have

***Proposition 5****: The union employment in the home countries can increase (decrease) under FDI competition if the reservation wage in the home countries and the wage in the host country are sufficiently high (low), with the latter lower than the former.*

Next, comparing (29d) and (30d) yields

$$w_{II} - w_{NI} = \frac{(2+x_{NI})\{(1+w_0)x_{NI}+w_0\} - \{2+(1-\beta)^2 x_{II}\}\{x_{II}+w_0+(1-\beta-\beta^2/2)w_0\}}{(2+x_{NI})\{2+(1-\beta)^2 x_{II}\}}. \quad (38)$$

Expression (38) has the same sign as its numerator, which can be simplified to

$$Num = \frac{3\beta w_0(n-w_0)\ \{w_C - \frac{2w_0}{3}\}}{2(w_C+w_0)[4+(2-\beta)(1-\beta)w_0]} + \frac{(2+w_0)\beta x_{NI} x_{II}}{w_C+w_0}\{w_C - \frac{(w_0-2)w_0}{2(w_0+1)}\}. \quad (38')$$

The sign of (38') depends on the two expressions in curled braces. Because the following inequality holds

$$0 \ < \ \frac{(w_0-2)w_0}{2(w_0+1)} \ < \ \frac{2w_0}{3} \ < \ w_0, \quad (39)$$

we can establish

***Proposition 6****: i. If* $w_0 > w_C \geq \frac{2w_0}{3}$*, then (38') is positively signed and the union wage is higher under FDI competition than under no FDI; ii. If* $w_0 > \frac{w_0-2}{2(w_0+1)} \geq w_C$*, then (38') is*

*negatively signed and the union wage is lower under FDI competition than under no FDI; iii.* *If* $w_0 > \frac{2w_0}{3} > w_C > \frac{w_0 - 2}{2(w_0 + 1)} > 0$ *, then the sign of (38') is ambiguous.*

Proposition 6 has some interesting implications, which follow naturally from proposition 5. 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) and Zhao (2001), 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. (i). The intermediate production at home is reduced which in turn reduces union employment; (ii). The final production at home is increased due to lower cost of intermediate production, which increases the demand for labor. It turns out that when the Chinese wage is close to the reservation wages in the home countries, the second effect dominates the first one, 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, then FDI has an effect of strategic outsourcing, i.e., driving down the negotiated wages in the home countries. When the Chinese wage is sufficiently low, most intermediate production will be shifted to China, which results in a large reduction in union employment that cannot be compensated by the increase in final production. And it follows that union wages fall. That is, by undertaking FDI competition, Airbus and Boeing can drive down the negotiated wages at home.

Combining propositions 5 and 6, we can also establish

***Proposition 7****: If the wage in the host country is sufficiently low, then the negotiated wages and employment both decrease under FDI competition, as a consequence both union utility and firm profits are lower under FDI competition than under no FDI.*

Note that the equilibrium conditions in the third stage game (i.e. labor-management bargaining) state that the union and the firm always divide the net gains equally, regardless of if firms undertake FDI or not. It follows that firm profits must also be lower under FDI competition than under no FDI, if it is so for the union utility.

With regard to firm profits, proposition 7 is counter-intuitive. Conventionally speaking, if the wage in the host country is low, then the cost of intermediate production becomes low and firm profits should be high. However, in the present model, because of the following two factors, firm profits are lower under FDI competition when the host country-wage is low: (a) When the Chinese wage is sufficiently low, then most intermediate production is shifted to China and output increases; (b) duopolistic rivalry makes both firm enlarge outputs. As a consequence, final output increases and price decreases by too much, which results in lower total industry rents compared with the case of no FDI. Therefore, the firms and unions are better off under no FDI.

Next, we are interested in the conditions for union utility and firm profits to increase under FDI. Combining condition (36') and proposition 6, we obtain

***Proposition 8***: *If* $w_0 > w_C \geq \frac{2w_0}{3}$, $w_C \geq \frac{4w_0}{w_0 - 4}$, *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.*

In figure 2, area I satisfies proposition 8, in which both firm profits and union utility are higher under FDI competition than under no FDI.

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

***Proposition 9***: *The welfare of the host country is higher under FDI competition than under no FDI.*

***Proof***: Substituting relevant variables into (4), the welfare under no FDI and FDI competition can be written respectively as

$$W(x_{NI}) = U(2x_{NI}) - 2x_{NI}P(2x_{NI}) + 2t_{NI}x_{NI}\,, \tag{40a}$$

$$W(x_{II}) = w_C\beta^2 x_{II}^2 + U(2x_{II}) - 2x_{II}P(2x_{II}) + 2t_{II}x_{II}\,. \tag{40b}$$

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

$$\Delta W \equiv w_C\beta^2 x_{II}^2 + 2t_{II}x_{II} - 2t_{NI}x_{NI} = (x_{II} - x_{NI})\{n - w_0 - 2(x_{II} + x_{NI})\}\,. \tag{41}$$

It can be shown that

$$n - w_0 - 2(x_{II} + x_{NI}) = \frac{(n - w_0)\{2w_0(2 - 3\beta + \beta^2)(1 + w_0) + 4w_0\}}{(4 + 2w_0)(4 + 2w_C\beta - w_C\beta^2)} > 0 \,. \qquad (42)$$

Therefore, expression (41) is positively signed. And it follows that the welfare in the host country is higher under FDI competition than under no FDI. QED

Welfare increases because the wage income from FDI dominates any possible decrease in tariff revenue. In addition, consumer surplus also increases.

**5. Unilateral FDI (***Disregard for the moment***)**

In this section, we look into the case when only one firm (say Boeing) undertakes FDI in China, while Airbus does not. In this case, Boeing produces $y_C = y - y_B$ of the intermediate input in China, which is endogenously determined. Airbus's production in China is set to be null, that is, $x_C = x - x_A = 0$. We shall show that $y_C > 0$.

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. Boeing and the labor union bargain to determine $x$, $x_B$ and $w_B$. Substituting $x_C = x - x_A = 0$ and $y_C = y - y_B$ into (5b) and maximizing, we obtain

$$p + yp' - (1 + \frac{y}{2})w_0 - t_B = 0, \qquad (40a)$$

$$\pi_B - u_B = 0, \qquad (40b)$$

$$y - 2y_B = 0. \qquad (40c)$$

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

$$W = \frac{1}{2}(y - y_B)^2 w_C + U(x+y) - p(x+y) + t_A x + t_B y \,. \qquad (42)$$

The Chinese government chooses $t_A$ and $t_B$ simultaneously to maximize (42), yielding the following first order conditions.

$$x\Delta_I - (x+y)(p' - \frac{w_0}{2})p' - \frac{byw_0}{4} + (b + p' - \frac{w_0}{2})t_A - bt_B = 0\,, \qquad (43a)$$

$$y\Delta_I - (x+y)dp' + \frac{yw_0}{4}(a+d) + (a+d)t_B - at_A = 0\,. \qquad (43b)$$

Where $\Delta_I = bd + (a+d)(p' - \frac{w_0}{2}) > 0$. In deriving the above, we have used condition (40c) and the comparative statics results (a6-a10) in the appendix. Combining them and using (41), we obtain

$$\frac{4(a+b+d)d + 4\Delta_I}{w_0}(t_A - t_B) = (a+b+d)dy + 2(x+y)p' - 2y\Delta_I\,. \qquad (44)$$

The long expression before $(t_A - t_B)$ on the LHS of (44) is positive.

Substituting the linear demand function in (28) into the first order conditions in the third stage of the game under unilateral FDI, i.e., (6a'), (6b'), and (40a-c), we have

$$t_A = n - w_0 - (2 + w_0)x - y\,, \qquad (45a)$$

$$t_B = n - w_0 - (2 + w_0/2)y - x\,. \qquad (45b)$$

Substituting these into (43a-b), straightforward calculations give

$$(\Delta_I + \alpha)x - (\Delta_I + \beta)y = -\frac{(n - w_0)w_0}{2} < 0, \qquad (46)$$

where $\alpha = \frac{1}{2}(w_0^2 + 3w_0 + 6)$, and $\beta = \frac{1}{2}(w_0^2 + 3w_0 + 5)$. Since $\Delta_I > 0$ and $\alpha > \beta > 0$, condition (46) implies that under unilateral FDI, $x < y$, i.e., the output of Airbus is less than that of Boeing. Thus we can state:

***Proposition 10:*** *If Boeing undertakes FDI while Airbus does not, then Boeing's output is higher than Airbus's.*

Proposition 10 arises because Boeing can take advantage of the lower wages in China by producing a portion of the intermediate input there. It also implies that the firm that undertakes FDI can increase its market share.

## 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 (7a) to obtain

$$\frac{\partial x}{\partial t_A} = \frac{2p' + yp'' - w_0}{\Delta_{NI}} < 0, \tag{a1}$$

$$\frac{\partial y}{\partial t_A} = -\frac{p' + yp''}{\Delta_{NI}} > 0, \tag{a2}$$

$$\frac{\partial x}{\partial t_B} = -\frac{p' + xp''}{\Delta_{NI}} > 0, \tag{a3}$$

$$\frac{\partial y}{\partial t_B} = \frac{2p' + xp'' - w_0}{\Delta_{NI}} < 0, \tag{a4}$$

$$\frac{\partial (x+y)}{\partial t_A} = \frac{\partial (x+y)}{\partial t_B} = \frac{p' - w_0}{\Delta_{NI}} < 0, \tag{a5}$$

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 (19) and totally differentiating it and also (19) itself, we get

$$\frac{\partial x}{\partial t_A} = \frac{2p' + yp'' - (1-\beta)w_0}{\Delta_{II}} < 0, \tag{a6}$$

$$\frac{\partial y}{\partial t_A} = -\frac{p' + yp''}{\Delta_{II}} > 0, \tag{a7}$$

$$\frac{\partial x}{\partial t_B} = -\frac{p' + xp''}{\Delta_{II}} > 0, \tag{a8}$$

$$\frac{\partial y}{\partial t_B} = \frac{2p' + xp'' - (1-\beta)w_0}{\Delta_{II}} < 0, \tag{a9}$$

$$\frac{\partial (x+y)}{\partial t_A} = \frac{\partial (x+y)}{\partial t_B} = \frac{p' - (1-\beta)w_0}{\Delta_{II}} < 0, \tag{a10}$$

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

## A3. Unilateral FDI

Substituting (40c) into (40a) and totally differentiating it and (6a'), we obtain

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

$$\frac{\partial y}{\partial t_A} = -\frac{p' + yp''}{\Delta_I} > 0, \tag{a12}$$

$$\frac{\partial x}{\partial t_B} = -\frac{p' + xp''}{\Delta_I} > 0, \tag{a13}$$

$$\frac{\partial y}{\partial t_B} = \frac{2p' + xp'' - w_0}{\Delta_I} < 0, \tag{a14}$$

$$\frac{\partial (x+y)}{\partial t_A} = \frac{p' - w_0/2}{\Delta_I} < 0, \tag{a15}$$

$$\frac{\partial (x+y)}{\partial t_B} = \frac{p' - w_0}{\Delta_I} < 0, \tag{a16}$$

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

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Figure 1

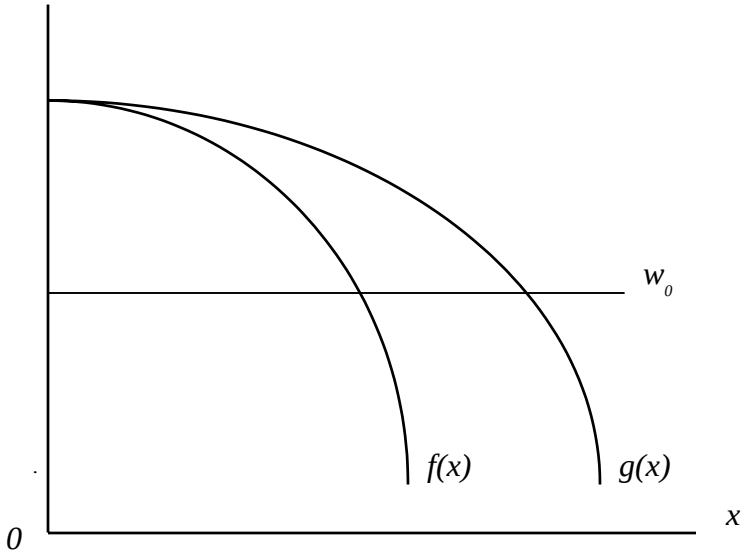
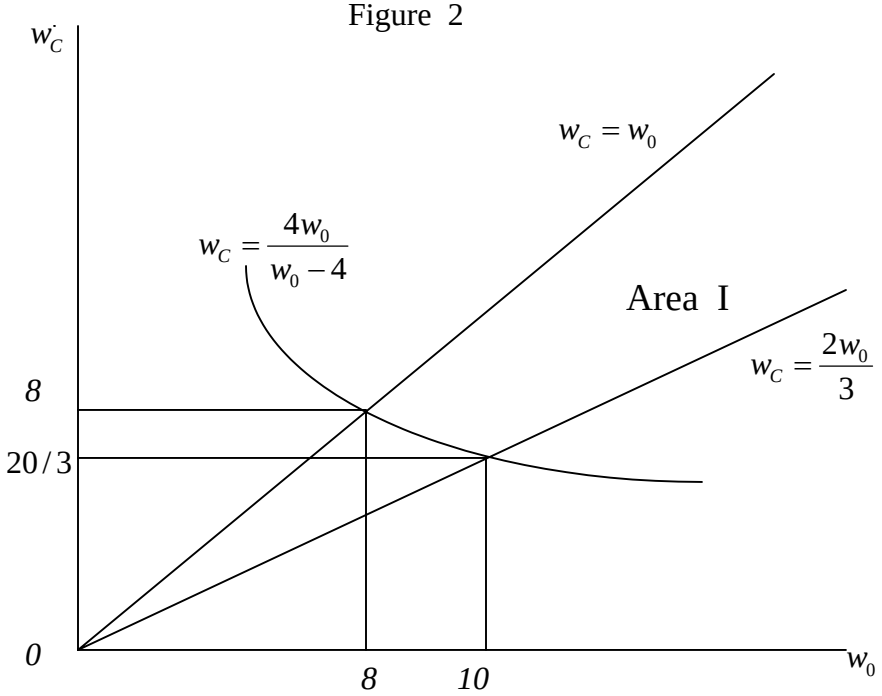



Figure 2



Airbus Angles to Compete with Boeing in China's Skies

By DANIEL MICHAELS, ZACH COLEMAN and GUY CHAZAN

Staff Reporters of THE WALL STREET JOURNAL (Aug. 20,2001)

Airbus opened a repair center in Beijing.

Three weeks after China approved a $2 billion order for 36 passenger jets from Boeing Co., rival Airbus is out to match it.

(China Daily 08/28/2001)

"In the next few years, we will increase investment as well as teach Chinese engineers and pilots with updated knowledge and technology," said Guy McLeod, acting president of Airbus China.

"China has the biggest potential airliner market in the world ...," he said.

Airbus is conducting cooperation with China in technological transfer concerning wings for

A320 airplanes, and is confident about its investment prospects in China, according to Airbus

sources.