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Export versus FDI under Duopoly with Unemployment and Exchange Rates

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Developing a duopoly model with unemployment caused by a rigid wage, this paper examines whether FDI benefits both the host and source countries. We show that in contrast to the full employment case this win-win FDI is possible since the employment-creating effect of FDI can dominate the negative effect of profit-shifting. Then, we examine the effect of exchange rates, which are one of the most influential factors of exports/FDI, and find that appreciation of the host country's currency monotonically increases the above win-win possibility of FDI.

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1 Introduction

Foreign direct investments (FDIs) and multinational firms have been playing a growing role in the contemporary world economy. For instance, UNCTAD (2014, p.2) provides evidence reporting that 'global FDI flows rose by 9 per cent in 2013 to \$1.45 trillion, up from \$1.33 trillion in 2012 ... FDI inflows increased in all major economic groupings- developed, developing, and transition economies.' The increased importance of FDI has generated a number of studies that theoretically and/or empirically examine the determinants and consequences of FDI.¹⁾

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1) Markusen (1995, 2002, 2011) and Blonigen (2005) provide a comprehensive survey

While this paper belongs to this strand of literature, we pay special attention to the implications of unemployment and exchange rates for FDI, both of which have received small attention particularly in the theoretical literature.²⁾ Specifically, by constructing a duopoly model that incorporates unemployment in the host country and exchange rates, we seek the condition under which a source firm chooses FDI instead of exports, and the host country gains from FDI. The reasons for allowing for unemployment and exchange rates are as follows. For one thing, employment effects in the host country are significant as the existing empirical literature finds out.³⁾ As compared with the empirical literature that suggests a significant effect of FDI on employment, the theoretical literature mostly overlooks it by assuming full employment. For another thing, exchange rates are empirically shown to be an important determinant of FDI. In a seminal work, Froot and Stein (1991) demonstrate that appreciation of the host country's currency increases inward FDI.⁴⁾ Takagi and Shi (2011), moreover, empirically find a positive relationship between the Japanese yen appreciation and Japan's FDI outflows. These studies clearly suggest the relevance of unemployment and exchange rates in studying the determinant and consequence of FDI not only at the theoretical level as well as at the empirical level. With these motivations in mind, this paper provides a simple theory

on the theoretical and empirical literature, respectively. See, furthermore, Antlas and Yeaple (2014) for a more updated review.

- 2) Unemployment and exchange rates are a macroeconomic variable, and so we need a macroeconomic model in order to endogenize them. However, we simply assume that exchange rates are exogenous and unemployment is caused by an exogenously high wage because a full macroeconomic model makes our focus less transparent.
- 3) Table A1 in Kingombe (2002) summarizes the results of the empirical studies published by 2000 whereas more recent papers are summarized in Table 2 in Hoang and Binh (2014). Both of these papers find that most empirical evidence suggests a positive employment effect of FDI.
- 4) Empirical studies of FDI determinants including Froot and Stein (1991) are comprehensively reviewed in Blonigen (2005).

that is capable of discussing the effect of FDI. Making use of a duopoly model with unemployment and exchange rates, we establish two results. First, FDI can be win-win in the sense that it improves both the source firm's profit and the host country's welfare, which never holds in the full employment model. Second, while an appreciation of the host country's currency reduces the incentive to FDI of the foreign firm, but it monotonically increases the above possibility of win-win FDI. These theoretical predictions may provide a sound support for the empirical evidence above.

As mentioned earlier, the theoretical literature on FDI in the presence of unemployment is much smaller than the empirical literature. To our knowledge, Brander and Spencer (1987) are the first to examine the implication of unemployment for FDI in a foreign monopoly model. Their model is extended to an oligopoly model by Lahiri and Ono (1998a, b, 2003a, b) to consider the effects of FDI policies, e.g., local content requirement. Dei (1990), Horstmann and Markusen (1992) and Brainard (1997), on the other hand, explore the choice between exports and FDI in a duopoly model with full employment, commonly showing that FDI is chosen if the fixed cost associated with FDI is small relative to a trade barrier such as transport costs and import tariffs. Our model is similar to the model of these predecessors, but we ignore trade costs and fixed costs of FDI, and introduce exchange rates instead in order to isolate the implication of exchange rates.

This paper proceeds as follows. Section 2 presents a model, and derives the equilibrium outcome under export and FDI regimes. Section 3 considers the effect of exchange rates on the win-win possibility of FDI mentioned above. Section 4 concludes. Appendix 1 offers a detailed proof of the first main result, and Appendix 2 addresses the full employment case for comparison with the unemployment case in the main text.

2 Model

Suppose a domestic duopoly in which a Home firm (firm X) and a Foreign firm (firm Y) compete with a Cournot conjecture.⁵⁾ We modify the model in two ways. First, unemployment prevails in the Home labor market due to a highly fixed wage rate w . Second, we allow an exchange rate e , which measures the value of the Home currency in terms of the Foreign currency so that a rise (resp. fall) in e represents depreciation (resp. appreciation) of the Home currency.

Assuming that Good Z is a numeraire good, and that the amount of labor to produce it is denoted by $f(z)$, the profit is defined by $z - wf(z)$.⁶⁾ Profit maximization by price-taking firms leads to the first-order condition $1 - wf'(z) = 0$, from which the equilibrium output of Good Z is obtained as $z = f'^{-1}(1/w) \equiv \phi(w)$.

Domestic demand of the non-numeraire good is represented by a linear inverse demand function $p = a - x - y$, $a > w$, and producing one unit of this good requires one unit of labor. Then, the profit of the Home firm is defined by

$$px - wx = (a - x - y)x - wx. \quad (1)$$

The profit of the Foreign firm is defined in two ways as follows.⁷⁾

$$\frac{py}{e} - w^*y = \frac{(a - x - y)y}{e} - w^*y \quad \text{under exports} \quad (2)$$

$$\frac{py - wy}{e} = \frac{(a - x - y)y - wy}{e} \quad \text{under FDI}, \quad (3)$$

where w^* is the wage rate in Foreign. This completes describing the key ingredients of the model.

5) Dornbusch (1987) is the first to discuss some implications of exchange rates in a duopoly model. We basically follow his setting except for incorporating FDI and unemployment.

6) Note that the price of Good Z is one.

7) Note from Eqs. (2) and (3), e can be regarded as an iceberg transport cost by assuming that $e > 1$ units of good must be shipped in order to deliver one unit.

Let us begin solving the model with the export case where the Foreign firm chooses output to maximize (2). Then, each firm's first-order conditions for profit maximization are

$$a - w - 2x - y = 0, \quad \frac{a - x - 2y}{e} - w^* = 0,$$

and thus the Cournot equilibrium outputs are

$$x^E = \frac{a - 2w + ew^*}{3}, \quad y^E = \frac{a + w - 2ew^*}{3}, \quad (4)$$

where superscript E represents the exporting equilibrium. Substituting these into (2), the Foreign firm's equilibrium profit π_Y^E becomes

$$\pi_Y^E = \frac{1}{e} \left(\frac{a + w - 2ew^*}{3} \right)^2. \quad (5)$$

Home welfare is now computed. Since we have implicitly assumed a quasi-linear utility function, Home welfare is given by a sum of consumer surplus CS and national income I , each of which is derived as follows.

$$\begin{aligned} CS^E &\equiv \frac{(x + y)^2}{2} = \frac{1}{2} \left(\frac{2a - w - ew^*}{3} \right)^2 & (6) \\ I^E &\equiv \underbrace{px - wx}_{\text{(firm X's profit)}} + \underbrace{z - wf(z)}_{\text{(sector Z's profit)}} \\ &\quad + \underbrace{wx}_{\text{(labor income in firm X)}} + \underbrace{wf(z)}_{\text{(labor income in sector Z)}} \\ &= px + z = (a - x - y)x + \phi(w) \\ &= \frac{(a + w + ew^*)(a - 2w + ew^*)}{9} + \phi(w). & (7) \end{aligned}$$

Using (6) and (7), Home welfare in the export case is given by $W^E = CS^E + I^E$.

Let us turn to the other case in which the Foreign firm chooses FDI to maximize (3). Solving the first-order conditions for profit maximization, the equilibrium outputs, the Foreign firm's profit, Home's consumer surplus and national income are respectively obtained as follows.⁸⁾

8) Note that in this case the labor income paid by the Foreign firm wy contributes to the national income of Home.

$$x^F = y^F = \frac{a-w}{3}, \quad \pi_Y^F = \frac{1}{e} \left(\frac{a-w}{3} \right)^2 \quad (8)$$

$$CS^F = \frac{1}{2} \left[\frac{2(a-w)}{3} \right]^2, \quad I^F = \frac{(a+5w)(a-w)}{9} + \phi(w), \quad (9)$$

where superscript F refers to the FDI equilibrium. Home's welfare in the present case is given by $W^F = CS^F + I^F$.

Having derived the endogenous variables in each case, we proceed to obtaining the condition under which the Foreign firm prefers FDI to exports, and Home gains from FDI. This task is made by comparing the Foreign firm's profits and Home's welfare levels. It is easy to show that the Foreign firm chooses FDI

$$w^* > \frac{w}{e}. \quad (10)$$

This inequality simply states that FDI is chosen if marginal cost under FDI (w/e) is smaller than that under exports (w^*).

Let us turn to deriving the condition for FDI to be welfare-superior to exports. This is the case if and only if $W^F > W^E$, which is rewritten by

$$\begin{aligned} & \frac{1}{2} \left[\frac{2(a-w)}{3} \right]^2 + \frac{(a+5w)(a-w)}{9} + \phi(w) \\ & > \frac{1}{2} \left(\frac{2a-w-ew^*}{3} \right)^2 + \frac{(a+w+ew^*)(a-2w+ew^*)}{9} + \phi(w), \end{aligned}$$

from (6), (7) and (9). Rearranging this inequality, we have a quadratic inequality of w^* :

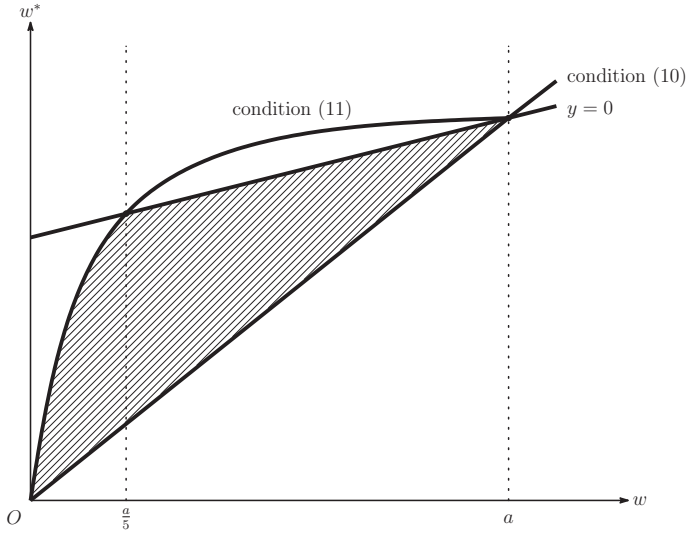
$$\frac{e^2 (w^*)^2 - 2aw + w^2}{6} < 0,$$

the solution of which is

$$w^* < \frac{\sqrt{2aw - w^2}}{e}. \quad (11)$$

Combining conditions (10) and (11), we have a combination of (w, w^*) such that FDI benefits both the Foreign firm and Home. This result is summarized in:

Proposition 1. *If (w, w^*) is inside the shaded area in Figure 1, FDI is*



win-win in the sense that it raises the Foreign firm's profit and Home's welfare relative to exports.

Proof. See Appendix 1. ||

The intuitions behind this result are as follows. From the viewpoint of the Foreign firm, FDI is more profitable than exports if exporting is more costly than FDI, i.e., $w^* > w/e$. In Figure 1, the Foreign firm finds it indifferent to choose either of exports and FDI if (w, w^*) is on the upward-sloping straight line, and it opts for FDI if (w, w^*) is above this line.

In discussing the effect of FDI on Home welfare, it is convenient to note that FDI has two conflicting effects. First, if the Foreign firm chooses FDI, the Foreign firm's output increases and the Home firm's output decreases.⁹⁾

9) Subtracting the output under exports from that under FDI yields $x^F - x^E = (w - ew^*)/3 < 0$ and $y^F - y^E = -2(w - ew^*)/3 > 0$ if FDI is chosen, i.e., $w < ew^*$.

In other words, FDI negatively affects Home welfare by shifting the profits from Home to Foreign. Second, FDI has a positive effect on Home welfare since employment is created by FDI.¹⁰⁾ The strictly concave locus in Figure 1 depicts the relative magnitude of these two effects. When w^* is so small that (w, w^*) is below this locus, the employment-creating effect dominates the profit-shifting effect, leading to a welfare gain of Home. As briefly demonstrated in Appendix 2, this possibility no longer exists in the full employment case because the employment-creating effect is absent.

3 Effect of Exchange Rate

The previous section has established the existence of a win-win possibility of FDI, which contrasts with the full employment situation. We devote this section to examining how exchange rates affect this possibility. This question is not only theoretically interesting but also practically important since even a small change in exchange rates has a considerable impact particularly on the countries employing a floating exchange rate. Our result is:

Proposition 2. *The win-win possibility of FDI monotonically rises as the host country's currency appreciates.*

Proof. Noting that the shaded area in Figure 1 is equal to

$$\begin{aligned} & \int_0^{\frac{a}{5}} \left[\frac{\sqrt{2aw - w^2}}{e} - \frac{w}{e} \right] dw + \int_{\frac{a}{5}}^a \left(\frac{a+w}{2e} - \frac{w}{e} \right) dw \\ &= \frac{1}{e} \int_0^{\frac{a}{5}} \left[\sqrt{2aw - w^2} - w \right] dw + \frac{4a^2}{25e}, \end{aligned}$$

which obviously decreases with e . To put it another way, the win-win set

10) The difference between the amounts of labor under FDI and exports is $(x^F + y^F) - x^E = (a - ew^*)/3 > 0$.

increase as e falls, i.e., the Home currency appreciates.||

Appreciation of the host country's currency has a conflicting effect on the world welfare. First, from the point of view of the Foreign country, appreciation of the host country's currency makes FDI less attractive because it reduces the profit from FDI by raising the cost of employing Home labor, w/e . This is also confirmed in Figure 1; when e declines, the slope of the straight line shifts up, and that the area where FDI is chosen becomes smaller.

The effect on Home welfare is, by contrast, more complicated. As mentioned right above, if the Home currency appreciates, the Foreign firm prefers exports more to FDI, and increases its export. While the Home firm contracts output, total supply and consumer surplus of Home increases since the output expansion of the Foreign firm is much larger than the reduction in the Home firm's output. This contributes to a welfare improvement of Home. However, the Foreign firm's shift from FDI to exports induced by the appreciation of the Home currency has a negative effect on the Home national income because decreased FDI leads to increased unemployment. Appreciation of the Home currency has these competing effects, but the former positive effect dominates the latter negative effect, thereby resulting in a welfare improvement of Home. This is checked by looking at Figure 1 in which the strictly-concave locus that depicts condition (11) shifts up as e falls.¹¹⁾

Summarizing the foregoing arguments, appreciation of the Home currency (fall in e) increases Home's gains from FDI, but decreases Foreign's gains from FDI. The above proposition states that the net effect on the win-win possibility becomes positive since the positive effect on the host

11) Note that the right-hand side of (11) is decreasing in e .

country dominates the negative effect on the source country.

Remark. As noted in Footnote 7, one can regard e as an iceberg transport cost rather than an exchange rate. This case should be discussed separately since transport costs considerably affect the FDI decision in reality. If we suppose that e stands for a transport cost, a reduction in it has two opposite effect on world welfare. When the transport cost falls, the Foreign firm expands output and the Home firm contracts output, but Home consumer surplus increases because total output increases. However, transport cost reductions lead the Foreign firm to choose exporting, which, in turn, has a negative effect on Home welfare by increasing unemployment. According to Proposition 2. the former positive effect of trade cost reductions dominates the latter negative effect, resulting in world welfare gains.

4 Conclusion

Incorporating unemployment into a simple duopoly model, we have shown an interesting possibility that FDI can increase welfare of both the source country and the host country. The key behind this finding lies in the employment-creating effect of FDI, which has seemingly been overlooked in the theoretical literature on FDI. Our finding may well explain rapid growth of FDI over the last few decades. In addition, we have demonstrated that appreciation of the host country's currency monotonically increases this possibility.

We have chosen the simplest partial equilibrium model so as to focus on the implications of unemployment and exchange rates. There are, of course, a number of open questions. In this conclusion, we mention only two of them. First, it is arguably most interesting to reconsider our results in a context of tariff-jumping FDI. In a companion paper, we have shown the validity of our results in the presence of import tariffs. Another

promising direction is to reexamine our arguments by taking into account general equilibrium effects. One natural strategy for this purpose is to apply Neary's (2009) general oligopolistic equilibrium model, which has received increasing attention in trade theory. These tasks are left as future research agenda.

Appendix 1: Proof of Proposition 1

It is evident from Eq. (10) that FDI is more profitable than exports if and only if (w, w^*) is above the straight line in Figure 1, whose slope of $1/e$.

Condition (11) is satisfied if and only if (w, w^*) is below the strictly concave locus in Figure 1. In what follows, some detailed properties of this locus are obtained. Let us denote the right-hand side of (11) by

$$F(w, e) \equiv \frac{\sqrt{2aw - w^2}}{e}.$$

Then, we know that $F(0, e) = 0$ and $F(a, e) = a/e > 0$. Differentiating $F(\cdot)$ with respect to w yields

$$F_w(w, e) \equiv \frac{\partial F(w, e)}{\partial w} = (a - w) (2aw - w^2)^{-\frac{1}{2}},$$

and thus we have $F_w(0, e) = \infty$ and $F_w(a, e) = 0$. Furthermore, this function is strictly concave in w because the second derivative of $F(\cdot)$ becomes

$$F_{ww}(w, e) \equiv \frac{\partial^2 F(w, e)}{\partial w^2} = -a^2 (2aw - w^2)^{-\frac{3}{2}} < 0,$$

for any $w \in [0, a]$. Finally, from the assumption that $a > w$, the locus of $F(w, e)$ is always above the straight line that illustrates condition (10).

Appendix 2: The Full Employment Case

This appendix briefly addresses the case of full employment. For simplicity, one unit of labor is assumed to produce one unit of good Z so that

the wage rate in Home is one. Then, the equilibrium variables in the export regime are obtained as

$$x^E = \frac{a - 2 + ew^*}{3}, \quad y^E = \frac{a + 1 - 2ew^*}{3}$$

$$CS^E = \frac{1}{2} \left(\frac{2a - 1 - ew^*}{3} \right)^2 \quad (12)$$

$$\pi_X^E = \left(\frac{a - 2 + ew^*}{3} \right)^2, \quad \pi_Y^E = \frac{1}{e} \left(\frac{a + 1 - 2ew^*}{3} \right)^2, \quad (13)$$

and Home welfare is measured by $W^E = CS^E + \pi_X^E$. The equilibrium variables in the FDI case are

$$x^F = y^F = \frac{a - 1}{3}, \quad CS^F = \frac{1}{2} \left[\frac{2(a - 1)}{3} \right]^2 \quad (14)$$

$$\pi_X^F = \left(\frac{a - 1}{3} \right)^2, \quad \pi_Y^F = \frac{1}{e} \left(\frac{a - 1}{3} \right)^2. \quad (15)$$

Comparing the Foreign firm's profits in (13) and (15), FDI yields a larger profit if and only if $w^* > 1/e$, i.e., marginal cost of exporting (w^*) is higher than that of FDI ($1/e$). In contrast, a few manipulations allow us to know that $W^E > W^F$ holds for any parameter. In other words, it is impossible for FDI to be welfare-superior to exports in the present case of full employment.

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