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Walter Elberfeld, Georg Götz, and Frank Stähler

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# Vertical foreign direct investment, welfare, and employment

Walter Elberfeld[1], Georg Götz[2], and Frank Stähler[3]

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[1]Staatswissenschaftliches Seminar, Universität zu Köln, Albertus-Magnus-Platz, D-50923 Köln, Germany, e-mail: elberfeld@wiso.uni-koeln.de

[2]Corresponding author, Department of Economics, University of Vienna, BWZ - Brünnerstr. 72, A-1210 Vienna, Austria, e-mail: georg.goetz@univie.ac.at, Tel/Fax: Tel +431 4277 374 -66/-98

[3]Department of Economics, University of Kiel, Wilhelm-Seelig-Platz 1, D-24098 Kiel, Germany, e-mail: fstaehler@econ-theory.uni-kiel.de

**Abstract**

This paper shows that vertical foreign direct investment will reduce prices but the aggregate welfare effect is unambiguously positive only under free market entry. Using a standard model of imperfect competition, we develop this result by considering two different cases. In the first case, the total number of firms is fixed, and we show that national and multinational firms may coexist. In the second case, we allow for market entry, and we focus on situations in which either only national or only multinational firms are active. Furthermore, we discuss impact effects on labor demand. We show that a decline in foreign wages increases domestic employment.

**JEL-Classification**: F12, F15.

Keywords: Vertical foreign direct investment, multinational enterprises, imperfect competition, welfare, labor demand.

# 1 Introduction

The era of globalization can be characterized by an ongoing integration of factor and commodity markets. One key observation is that aggregate world trade grows faster than world GDP. But integration does not only take place by commodity trade. Another important observation is that foreign direct investment (FDI) adds more to globalization than trade does. Figure 1 shows that the sales of foreign affiliates have outnumbered world exports for two decades. These sales are based on FDI, and their magnitude emphasizes how important FDI has become for the world economy.

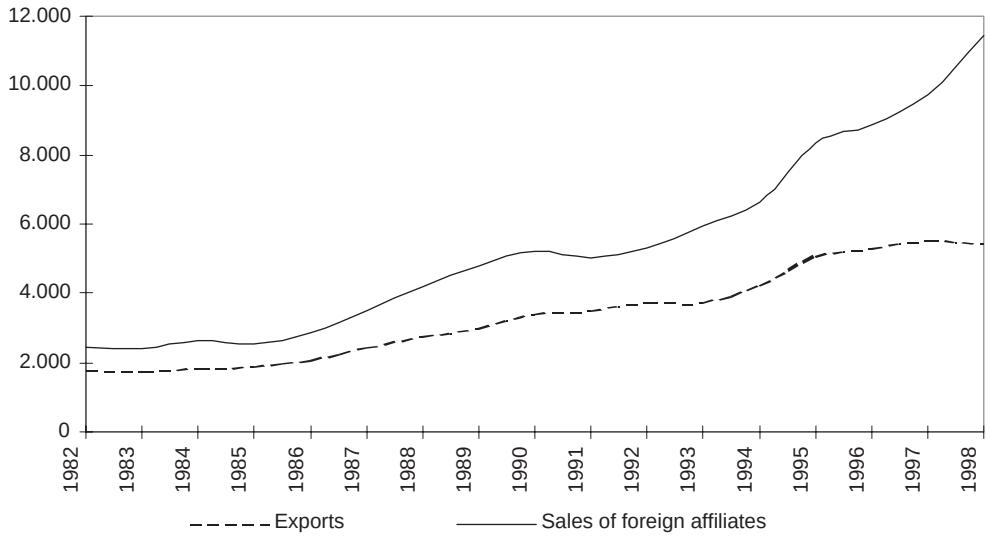


Figure 1: World exports and sales of foreign affiliates in billions of US Dollars (Source: United Nations, *World Investment Report*, various editions).

These empirical figures have found their counterpart in the international economics literature. Among other things, this literature studies the role of multinational firms which are supposed to set up production plants in foreign countries, that is to do FDI. This literature has now reached a certain degree of maturity. It distinguishes between horizontal FDI (Markusen, 1984;

Horstmann and Markusen, 1992; Brainard, 1993; Markusen and Venables 1998, 2000; De Santis and Stähler, 2000) and vertical FDI (Helpman, 1984; Helpman and Krugman, 1985). Horizontal FDI is dominant among industrialized countries which do not differ substantially in production possibilities and per capita endowment with factors of production. In this case, firms set up an additional production plant in another country, and this plant then serves this country's market which was served by exports before. The intention is to be closer to the market and to avoid trade costs which are associated with exports. Hence, horizontal FDI replaces trade, and the domestic market will still be served by a production plant in the domestic country. The trade-off a potential multinational firm has to consider is that FDI saves variable costs but implies additional fixed costs to set up a production plant in the other country.

Although empirical evidence suggests that horizontal FDI dominates (Brainard, 1997, Blonigen, 2001, Markusen and Maskus, 2000), vertical FDI becomes more important.[1] Vertical FDI takes place between countries which differ substantially in factor endowment and production possibilities. Usually, one country is able to host the headquarters of an oligopolistic industry producing a high skilled labor intensive commodity. Vertical FDI may occur if the production process can be split into a part which requires high skilled labor and a part which requires low skilled labor. In this case, it may be profitable to move the production process requiring low skilled labor to the other country if labor costs in this country are sufficiently low. FDI is, then, complementary to trade. Typically, vertical FDI is important in industries which require substantial fixed investments in terms of skilled labor. These investments can be, for instance, in research and development or in the development of special product designs. Therefore, in many cases vertical FDI takes place in industries with substantial economies of scale, implying neces-

[1]For example, the *Economist* expects that global FDI will shrink in the next five years whereas FDI to poor countries is expected to remain by and large constant. See "The cutting edge", The *Economist* of February 24th 2001, Vol. 358, No. 8210, p. 90.

sarily imperfect competition on product markets. Furthermore, according to the eclectic paradigm of Dunning (1977), multinational firms will themselves invest abroad if ownership and internalization advantages are dominant and hence they are not interested in selling licenses to foreign firms. Otherwise, firms could simply alter their boundaries and buy instead of make certain inputs.

In the theoretical literature the main focus of FDI models under imperfect competition has been on horizontal FDI. However, the relevance of vertical FDI has also become very clear after the NAFTA has been launched and after the former communist countries in Eastern Europe were able to attract FDI. In both cases, substantial differences in variable costs, in particular in labor costs, could be observed, leading to vertical FDI within industries. A basic difference between both cases is the different impact on labor markets. NAFTA affected labor markets which are by and large competitive in North America so that vertical FDI altered the wage structure within economies. On the contrary, due to dominant collective wage bargaining, wages in Western Europe are not that flexible so that vertical FDI in Europe triggered structural employment effects.

In this paper, we will develop a model which takes into account all the mentioned features of vertical FDI. First, we acknowledge that firms deciding on vertical FDI typically face substantial fixed costs. This feature opens the avenue to imperfect competition and strategic interactions among firms. We will show that consumers will always benefit from vertical FDI. However, vertical FDI may reduce profits and even aggregate welfare if market entry is not possible. It improves aggregate welfare unambiguously under free market entry despite a possible increase in industry concentration. Second, we will argue that the reduction in variable costs achieved by vertical FDI implies additional fixed costs. In order to have a plant run in the foreign country, more coordination and supervision is necessary than in the home country. These fixed costs will decide on the profitability of vertical FDI. Third, we

will consider labor market impacts in some depth. We will not model the labor market explicitly but we will simply demonstrate how vertical FDI will change labor demand in the home country for given factor prices, reflecting the discussion in Europe, where the labor market is to a large extent characterized by wage bargaining between unions and employers, and unemployment seems to be persistent. Hence, it is clear that the effects of vertical FDI on employment have been at the heart of the debate in Europe. We will demonstrate that the labor market effects are not as clear as expected at first glance. In particular, we will show that vertical FDI alters aggregate production and hence also the demand for high-skilled labor.

There is one clear predecessor to this paper. In a recent article, Zhang and Markusen (1999) discuss which countries are able to attract vertical FDI. Their analysis is based on a two country general equilibrium model. The headquarters of firms in an oligopolistic industry can exist only in the developed country but the developing country may host production plants employing low-skilled labor. The industry performance is determined by Cournot behavior of firms and free entry, leading to zero profits in equilibrium, and perfect competition on all other factor and commodity markets. Due to the complexity of the model, the model is solved by numerical simulations. Because size matters under imperfect competition, Zhang and Markusen conclude that small, skilled labor scarce countries are hardly able to attract FDI, leading to a development trap.

Our paper departures from this approach in several respects. First, we do not consider general equilibrium effects but we are interested in the change in industry performance. Hence, our model will be less complex but can be solved analytically. Second, we consider also the case that market entry is not possible, at least in the short run. Third, we conduct an explicit welfare analysis for all cases. Fourth, we do not assume flexible wages in order to determine changes in labor demand. The effects of FDI will be determined by comparing the *FDI regime* under which FDI is possible and profitable

with a *trade regime* under which FDI is not possible or banned. Accordingly, the structure of the paper is as follows. Section 2 will introduce the model and will investigate the impact of vertical FDI on consumers' surplus, profits and aggregate welfare if the number of active firms is fixed. This scenario may well reflect the case of an industry to which market entry is not possible in the short run due to technological or institutional barriers to entry. Section 3 will do the same job for endogenous market structures, that is, if market entry is possible, at least in the long run. Section 4 will determine the labor market effects for both cases. Section 5 concludes the paper.

# 2 Industry structure and welfare without entry

This section assumes that the number of active firms is fixed but that a firm may choose to be either a national or multinational firm if FDI is allowed (FDI regime). National firms serve the market by a plant next to their headquarters; multinational firms serve the market by a plant set up in the foreign country. We will then compare this case with the case that FDI is banned (trade regime), and hence only national firms exist. Since setting up a plant in the foreign country is observable by rivals, we assume the following game structure: in the first stage, firms decide whether to set up a production plant in the foreign country (and thereby closing down production in the home country) or to continue to produce in the home country. Since setting up a plant in another country is likely to be more costly than doing so next to the headquarters, some additional fixed costs have to be covered in case of vertical FDI. In the second stage, all firms compete in the usual Cournot fashion. As usual, the subgame-perfect equilibrium is determined by backward induction. Table 1 shows this game structure, and the benchmarking case is given if firms are not allowed to be of the multinational type in stage 1. The specific model we employ is similar to models used in the so-called new

Table 1: Game structure without market entry

| | |
|---|---|
| *Stage 1* | Firms decide on their type |
| *Stage 2* | Firms determine production |

trade literature. We assume a linear demand function

$$Y = s(a - p), \tag{1}$$

with $a, s > 0$ where $s$ denotes the size of the market. Eq. (1) gives the behavior of an integrated world market, and this function can be derived from utility maximization of identical consumers with quasi linear utility functions. Concerning the industry structure, we distinguish two types of firms. $h$ will denote the number of national firms producing at home with constant marginal costs $c_h$ where $a > c_h$. $n$ is the number of all active firms in the industry, so that $m = n - h$ is the number of multinational firms. Vertical FDI implies additional fixed costs of size $f$ and marginal costs of $c_m$. Obviously, $c_h > c_m$ should hold for potential profitability of vertical FDI. In this setting, it makes no difference whether the skill-intensively produced good is an intermediate (as in Zhang, Markusen, 1999) or the final good using an intermediate which is produced with low-skilled labor since $c_h$ and $c_m$ give the total marginal costs for both production stages. We will be more explicit on the labor requirements in different stages of production in Section 4.

Let $y_h(y_m)$ denote the equilibrium output of a national (multinational) firm. The f.o.c.'s yield

$$y_h = s\frac{a - c_h - m(c_h - c_m)}{n+1}, \quad y_m = s\frac{a - c_m + (n-m)(c_h - c_m)}{n+1}, \tag{2}$$

and equilibrium profits of

$$\Pi_h = s\frac{(a - c_h - m(c_h - c_m))^2}{(n+1)^2}, \quad \Pi_m = s\frac{(a - c_m + (n-m)(c_h - c_m))^2}{(n+1)^2} - f, \tag{3}$$

where $f$ denotes the additional fixed costs to move the revelant part of the production from the home to the foreign country. We assume that $a - c_m > \max\{n(c_h - c_m), \sqrt{f}(n+1)\}$ which ensures that all firms make positive profits, irrespective of $h$.[2]

Differentiating (3) demonstrates the following lemma:

**Lemma 1** *Both $\Pi_h$ and $\Pi_m$ are decreasing in $m$. Moreover,*

$$\frac{\partial \Pi_m}{\partial m} < \frac{\partial \Pi_h}{\partial m}. \tag{4}$$

Lemma 1 states that a firm, if it moves its production to the foreign country, creates a negative externality for all other firms. The externality arises, because outputs are strategic substitutes and the reduction in the firm's variable costs due to the move of the production to the foreign country increases production of this firm.

Firms may decide to produce either at home or abroad. If the number of multinational firms is $m$, a multinational firm does not have an incentive to move production to the home country if $V(m) := \Pi_m(m) - \Pi_h(m-1) > 0$. If $V(m) \leq 0$, a multinational firm wants to move production to the home country. If $V(m+1) = \Pi_m(m+1) - \Pi_h(m) > 0$ and $m$ multinational firms are active, a national firm can improve its profits by moving production abroad. In equilibrium, changing the location of production should be unprofitable for either type of firm. Thus, a number of multinational firms $m^*$ constitutes an equilibrium if the following no-switching conditions hold:[3]

$$V(m^*) \geq 0 > V(m^* + 1) \tag{5}$$

Ignoring the integer constraint on the numbers of firms, these conditions imply that the equilibrium number of national firms satisfies exactly the

[2] $a - c_m > n(c_h - c_m)$ guarantees that the output of a national firm is positive, $a - c_m > \sqrt{f}(n+1)$ guarantees that the market is profitable if only multinational firms are active.

[3] A similar equilibrium concept is employed in Mills and Smith (1998) and Elberfeld (2001) to study technology choice.

no-switching condition:

$$V(m^*) = 0 \tag{6}$$

The function $V(m)$ describes the individual incentive for a national firm to undertake vertical FDI:

$$V(m) = s[\frac{2n(a-c_h)(c_h-c_m) + n(n+2)(c_h-c_m)^2}{(n+1)^2} - \frac{2n(c_h-c_m)^2 m}{(n+1)^2}] - f. \tag{7}$$

Eq. (7) says that the individual incentive to invest in FDI is decreasing in the number of multinational firms. This means that (6) has at most one solution. Solving this equation yields[4]

$$m^* = \frac{n}{2} - \frac{(n+1)^2 f/s - 2n(a-c_h)(c_h-c_m)}{2n(c_h-c_m)^2}. \tag{8}$$

This is only true if an interior solution exists, that is, if $0 < m^* < n$. Vertical FDI will not occur if the rhs in (8) is smaller or equal than zero, i.e. if

$$f \geq \frac{ns(c_h-c_m)(2(a-c_h) + n(c_h-c_m))}{(n+1)^2} =: \overline{f}(a, c_h, c_m, s, n) \tag{9}$$

If the fixed cost disadvantage of a multinational firm is sufficiently large, national firms will be dominant and no multinational firm can realize the same profits. In this case, the equilibrium number of multinational firms is $m^* = 0$. On the contrary, if the rhs in (8) is larger or equal than $n$, i.e. if

$$f \leq \frac{ns(c_h-c_m)(2(a-c_h) - n(c_h-c_m))}{(n+1)^2} =: \underline{f}(a, c_h, c_m, s, n), \tag{10}$$

multinational firms will be dominant and the equilibrium number of multinational firms is $m^* = n$.

[4]If the integer constraints on the numbers of firms are taken into account, the equilibrium number of multinational firms is the largest integer number equal or smaller than $m^*$. For simplicity, we will ignore the integer constraint and will use $m^*$.

Since

$$\overline{f} - \underline{f} = \frac{2n^2 s(c_h - c_m)^2}{(n+1)^2} > 0, \tag{11}$$

a range of fixed costs exists which supports coexistence. Eq. (11) proves the following lemma:

**Lemma 2** *If market entry and exit are not possible, multinational and national firms may coexist.*

The intuition for Lemma 2 can be demonstrated as follow. Take, for instance, $f = \overline{f}$, and reduce $f$, so that multinational production will become profitable. An increase in the number of multinationals will decrease the profits of multinational firms more than the profits of national firms (see Lemma 1). Therefore, a small change in $f$ induces only a small increase in the number of multinational firms so that we obtain coexistence of both firm types for a sizeable range of parameters.

Apart from the negative effect of an increase in $f$ on the number of multinational firms, (8) implies that $m^*$ decreases with $c_m$ and increases with $c_h$, $a$ and $s$. The effects of increases in the various cost parameters are intuitive. If market size increases (measured by an increase in $a$ or $s$), the output of each firm increases. As a result, vertical FDI becomes more attractive because multinational firms are better able to realize economies of scale. An increase in $n$ by $k$ firms increases the number of multinational firms by less than $k/2$ firms because differentiating $m^*$ with respect to $n$ yields

$$\frac{\partial m^*}{\partial n} = \frac{1}{2} - \frac{f/s(n^2-1)}{2n^2(c_h - c_m)^2} < \frac{1}{2}. \tag{12}$$

An increase in the number of firms decreases profits of multinational firms faster than those of national firms. To restore the equilibrium conditions, the number of national firms must increase relative to the number of multinational ones.

We now turn to the welfare analysis. Since we assume quasi-linear preferences, welfare and welfare changes can be measured by the sum of industry profits and consumers' surplus. If FDI is profitable and both types of firms coexist, profits of both national and multinational firms increase with increasing costs of FDI, i.e. with increasing $f$. This result is obvious for national firms. They profit from the fall in $m^*$ which is implied by an increase in $f$ (see equation (8)). The same holds for multinational firms. If one takes $\partial m^*/\partial f$ into account, the derivative of the profit function (3) reads

$$\frac{\partial \Pi_m}{\partial f} = \frac{a - c_m + (n-m)(c_h - c_m)}{n(c_h - c_m)} - 1 > 0. \tag{13}$$

The first term on the rhs must be larger than 1 in order to ensure that small firms are profitable. Aggregate consumption is

$$Y = (n-m)y_h + my_m = s\frac{n(a-c_m) - (n-m)(c_h - c_m)}{n+1}. \tag{14}$$

Due to the quasi linear structure of preferences, the consumer surplus can be determined as

$$CS = \frac{Y^2}{2s} = s\frac{(n(a-c_m) - (n-m)(c_h - c_m))^2}{2(n+1)^2}. \tag{15}$$

Obviously, consumers are always better off by vertical FDI since lower marginal costs of some suppliers for a fixed number of firms in the whole industry will reduce equilibrium prices. To obtain the effect on total welfare, we need to aggregate the two opposing effects which leads to the following proposition.

**Proposition 1** *Compared to a trade regime, the aggregate welfare effect of vertical FDI is ambiguous if market entry and exit are not possible.*

Proof: Define welfare as a function of $m$:

$$W(m) = CS(m) + m\Pi_m(m) + (n-m)\Pi_h(m). \tag{16}$$

Substituting $m^*$ into $W(m)$ and solving $W(m) - W(0) > 0$ for $f$ yields that welfare effect of vertical FDI is positive if

$$\frac{(c_h - c_m)s(2(a - c_h) + (c_h - c_m)(2n^2 + 5n + 4))}{(n+1)^2(2n-3)} > f, \tag{17}$$

and negative otherwise. □

To obtain further insights into the welfare properties, we evaluate the case that FDI is quite costly and we calibrate $f$ such that the equilibrium number of multinational firms is 1:

$$f(m^* = 1) = \frac{(c_h - c_m)(2a + c_h(n-4) - c_m(n-2))ns}{(n+1)^2}. \tag{18}$$

The welfare effect of FDI for $f = f(m^* = 1)$ is:

$$W(m^* = 1) - W(0) = -s(c_h - c_m)A, \tag{19}$$

where $A := 2(n-2)(a - 4c_h + 3c_m) - 11(c_h - c_m)$.

A sufficient condition for (19) to be negative is that $n \geq 8$ and that domestic firms are viable if four multinational firms were active. To see this, insert $n = 8$ into $A$ and note that the sign of $A$ is certainly positive if we replace 11 by 12 and obtain a positive sign for the resulting expression $\tilde{A}$. $\tilde{A}$ can be written as $12(a - 5c_h + 4c_m)$. Note that the term in brackets determines whether the output of domestic firms is positive if four multinational firms were active (see (2)). Therefore, $A$ is positive and $W(1) - W(0)$ is negative if domestic firms were viable if four multinational firms were active. We conclude from this excercise that FDI is likely to decrease welfare if the equilibrium number of multinational firms is small unless the total number of firms is small and the marginal cost advantage of the multinational firms is very large.

Turning to the case, when FDI is more productive, i.e. $f$ is small and $m^*$ is large, note that FDI may be welfare increasing.[5]The reason is that the

[5]FDI is, for instance, welfare increasing if the parameter values are $c_h = 2, c_m = 0, a = 100, s = 1, n = 48$ and $f$ is such that $m = 47$.

function $W(m^*)$ is convex in $f$ because the respective second derivative reads $(n+1)^2(2n-3)/(4(c_h-c_m)^2n^2s)$. The resulting pattern can most easily be illustrated by means of an example.

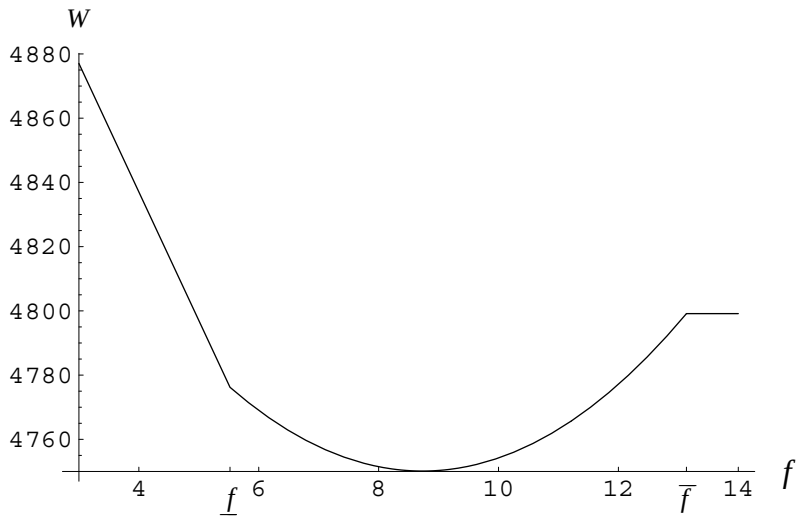


Figure 2: Welfare as a function of the FDI specific fixed costs $f$.

Figure 2 shows that aggregate welfare is non-monotonic in the fixed costs.[6] Aggregate welfare declines with the emergence of multinational firms and increases the more multinationals are active. The graph shows the behavior of aggregate welfare for levels of fixed costs which imply coexistence. As long as a switch leads to a mixed industry structure, welfare is lower than in the trade regime.

The reason for the negative welfare result is a rent dissipation effect. Firms undertake investments to capture a larger share of profits. If FDI should be welfare increasing, a rationalizing effect, realizing economies of scale, would be necessary. This is, however, prevented by the fact that exit does not occur. In the next section, we will show that this rationalizing effect implies welfare gains if entry and exit are possible.

[6]Figure 2 gives the results of a simulation using parameter values $c_h = 2, c_m = 0, a = 100, s = 1$ and $n = 40$.

# 3 Industry structure and welfare under free entry

In the last section we considered an industry in which market entry and exit were not allowed. If institutional barriers to entry do not exist, however, also technological barriers to entry may be overcome by potential entrants if the industry yields more than normal profits. On the contrary, if the industry suffers from losses, some firms will leave the market. In this section, we will take these long-run adjustment in the industry structure into account. Consequently, we assume the following three stage game: firms decide on market entry in the first stage, and those which have entered decide on their type in the second stage. Finally, all active firms compete in the usual Cournot fashion. We will then compare this case with the trade regime under which firms are not allowed to be of the multinational type in stage 2.

We will show that the possible adjustment to the profitability of the industry will imply substantially different results. In order to determine the equilibrium industry structure, we will assume that each firm, whether national or multinational, has to cover fixed costs of size $g$. These fixed costs are necessary to run the headquarters and the production plant in the home country, and firms decide on this investment in stage 1. As before, a multinational firm has to carry additional fixed costs $f$, and all firms which have entered in stage 1 decide on this investment in stage 2. Hence, $f$ is the difference in fixed cost of running a plant in the foreign country compared to running it in the home country. Since skilled labor is abundant in the home country but scarce in the foreign country, the headquarters will stay in the home country anyway. Table 2 summarizes the game structure employed in this section.

The main question in this section concerns the possible industry structure. It can be derived from Götz (2002), who employs a similar framework. To derive industry structure first define $T_h = c_h + \sqrt{g/s}$ and $T_m = c_m + \sqrt{(g+f)/s}$. $T_h$ and $T_m$ are the average costs realized by a national firm and a multinational

Table 2: Game structure with entry and exit

| | |
|---|---|
| *Stage 1* | Firms decide on market entry |
| *Stage 2* | Firms decide on their type |
| *Stage 3* | Firms determine production |

firm, respectively, in a free entry equilibrium in which only the respective type of firms is active. Furthermore, define $D \equiv (a/T_m) - (a/T_h)$.

**Proposition 2** *If $D \geq 2$, a unique equilibrium exists and in equilibrium all firms are multinational. If $T_h < T_m$, a unique equilibrium exists and in equilibrium all firms are national.*

**Proof:** The proof is identical to that of Proposition 1 in Götz (2002) and therefore omitted. □

The conditions employed in Proposition 2 guarantee that the no-switching condition mentioned above (see equation (5)) is satisfied in a situation in which the number of firms is active, which would emerge in a free entry equilibrium with only one type of firms. For general $h$ and $m$, these numbers are calculated from

$$\Pi_h(h,m) = s\frac{(a - c_h - m(c_h - c_m))^2}{(h+m+1)^2} - g = 0, \tag{20}$$
$$\Pi_m(h,m) = s\frac{(a - c_m + h(c_h - c_m))^2}{(h+m+1)^2} - g - f = 0.$$

Setting either $h$ or $m$ equal to 0, yields the zero profit numbers. If Proposition 2 applies, a single firm does not have an incentive to deviate from a 'candidate' equilibrium with only one type of firms. The respective technology is sufficiently superior in terms of a cost advantage. Götz (2002) shows that for $D < 2$ and $T_h > T_m$ quite different outcomes are possible. The results range from non-existence of equilibrium to equilibria with co-existence of different types as well as the occurrence of multiple equilibria. From the point of view

of our paper, the most important result, however, is that for large markets one almost always obtains equilibria in which only one type of firms is active.[7] Starting from an integrated world market, it seems to be justified to speak of a large market in this case. Therefore, we neglect the cases which arise if Proposition 2 does not apply for the remainder of the paper. We focus on equilibria in which either national firms or multinational firms are active. If only national firms are active, the equilibrium market structure is given by

$$h^* = \frac{a - c_h}{\sqrt{g/s}} - 1, m^* = 0. \tag{21}$$

Note that the market will be profitable for a national firm only if $\sqrt{g/s} < a - c_h \Leftrightarrow g < s(a - c_h)^2$. Otherwise, no national firm will be able to recoup its fixed costs.

Since profits are zero in equilibrium, we may measure welfare by the equilibrium price. For the case that only national firms are active, we find that the equilibrium price (denoted by the superscript $h$) is

$$p^h = a - h^* y_h / s = \sqrt{g/s} + c_h. \tag{22}$$

If only multinational firms are active, we find that the equilibrium market structure is

$$h^* = 0, m^* = \frac{a - c_m}{\sqrt{(f+g)/s}} - 1, \tag{23}$$

and the equilibrium price (denoted by the superscript $m$) is

$$p^m = a - m^* y_m / s = \sqrt{(f+g)/s} + c_m. \tag{24}$$

Two effects are of further interest. First, it is interesting how the number of active firms changes when FDI is possible and becomes profitable. Due to Proposition 2, this question boils down to comparing (23) with (21), given

[7] This result derives immediately from the conditions underlying Proposition 2. For both large $s$ and large $a$ they are likely to be satisfied.

that FDI is profitable. Second, a possible increase or decrease in industry concentration and lower variable cost will affect equilibrium prices and hence welfare. The following proposition answers both questions.

**Proposition 3** *The impact of vertical FDI on industry concentration is ambiguous. Despite this ambiguity, vertical foreign direct investment will reduce prices and increase welfare compared to a trade regime.*

Proof: The decline in price (which is equivalent to an increase in welfare due to the zero profit conditions (20)) will be proved by contradiction. Welfare will decline by vertical FDI if $p^m > p^h$ which requires that

$$c_h - c_m < \sqrt{(f+g)/s} - \sqrt{g/s} \Leftrightarrow f > f' := s(c_h - c_m)(c_h - c_m + 2\sqrt{g/s}). \tag{25}$$

$f'$ denotes the critical size of fixed costs which would lead to equal prices with and without FDI. If we derive from the condition $T_h = T_m$ the restriction of $f$ such that all firms are domestic firms is no longer an equilibrium, we obtain

$$f < f' = s(c_h - c_m)(c_h - c_m + 2\sqrt{g/s}). \tag{26}$$

This condition shows that welfare decreasing vertical FDI is never possible since (25) and (26) are contradictory.
It is clear from (23) that $m^*$ will be the larger the smaller is $f$. Hence, if $f$ is sufficiently small, $m^*$ will be larger than $h^*$ according to (21) because of $c_m < c_h$. Eq. (26) has shown that $f'$ determines the size of fixed costs for which multinational production is as profitable as national production. For $f'$, the equilibrium number of multinational firms is

$$m^* = \frac{a\sqrt{s} - \sqrt{s}\,c_h - \sqrt{g}}{\sqrt{g} + \sqrt{s}\,(c_h - c_m)} \tag{27}$$

As $h^*$ can be written as

$$h^* = \frac{a - c_h - \sqrt{g/s}}{\sqrt{g/s}} \tag{28}$$

we obtain $m^* < h^*$ for $f = f'$ which shows that there is a range of fixed costs $f$ where the switch to the FDI scenario leads to an increase in concentration. □

The ambiguous effect on concentration is due to negative relation between $f$ and the number of multinational firms. As $f$ falls $m^*$ increases. Although multinational firms have to bear higher fixed costs than domestic firms, their equilibrium number may be larger. This is due to the lower marginal costs of the multinational firms leading to higher demand. The effect on welfare is clear-cut. Due to entry, there are no excess profits. Thus, profit stealing cannot occur. As prices fall when firms go for FDI, welfare must increase.

# 4 Impact effects of vertical foreign direct investment on labor demand

So far we have investigated the effects of vertical FDI as it is common in a partial equilibrium welfare analysis. However, vertical FDI is also expected to affect employment patterns substantially, and this is possibly the main issue which troubles politicians in the home countries of vertical FDI. In this section we will address this issue, but we will still use the partial equilibrium model, and we will assume that changes in the industry do not cause changes in factor prices. Thus, we analyse how labor demand changes in a particular industry due to FDI, and we do not consider any effects on other sectors of the economy. However, any impact effect on labor demand translates into an effect on the level of economy wide employment if one adopts the "European" approach like Krugman (1995) and assumes rigid factor prices.[8] Even if factor prices adjust in the long run, the labor demand effects of our model seem to be important for employment at least for a transition period, when wages are

[8]To be exact, our impact effect equals the employment effect if labor is immobile across sectors in addition to rigid factor prices. Maurice Obstfeld seems to consider both of these features to be characteristic for Europe (see the general discussion following Krugman (1995)).

sticky. For continental Europe, this assumption seems to be more appropriate than the assumption perfect competition on factor markets as in Zhang and Markusen (1999).[9]

In order to evaluate the factor market effects of FDI, we specify the cost functions explicitly. Focusing on the labor market effects, the inputs we consider are the demand for skilled and unskilled labor. $w^S$ and $w^U$ denote wages of skilled and unskilled workers at home, respectively. The wage a multinational pays for unskilled labor in the foreign county is $w^M$. For simplicity, we assume that there are no skilled workers in the foreign country so that skilled labor services in multinational production are provided by mobile domestic skilled workers. Greek letters will denote input requirements.

The fixed costs of setting up production at home comprise

$$g = w^S\varepsilon + w^U(\eta + \rho). \tag{29}$$

Both skilled and unskilled labor enter $g$. $\varepsilon$ and $\eta$ are the input requirements for headquarters services. The fixed cost associated with a domestic production plant are captured by $w^U\rho$. Additional fixed costs of multinational production are

$$f = w^S\phi + w^M\rho_M - w^U\rho, \quad \rho_M \geq \rho. \tag{30}$$

With a foreign production plant, setup costs for foreign production replace setup costs for domestic production. We allow economies of scope ($\rho_M \geq \rho$) in the sense that locating production next to the headquarters at the same location reduces factor demand. $f$ includes also additional overhead costs $w^S\phi$ for supervision, monitoring and training of the foreign work force. We assume that these tasks require skilled labor. $\phi$ may also be affected by the costs of setting up business in the host country. Of particular importance are legal requirements for doing business.

[9]Similarly to our paper, Skaksen and Sørensen (2001) derive employment effects from a partial equilibrium model.

With respect to marginal costs, we assume that FDI transfers the technology completely so that the labor input requirements $\gamma$ and $\delta$ are identical in both countries. [10] Marginal costs read:

$$c_h = w^S\gamma + w^U\delta \tag{31}$$

and

$$c_m = w^S\gamma + w^M\delta. \tag{32}$$

Additionally, we assume that production requires less skilled labor than unskilled labor, that is, $\delta \geq \gamma$ because the part of production which is potentially outsourced should be intensive in unskilled labor. The cost advantage of multinational production is due to lower factor prices in the foreign country, i. e. $w^M < w^U$. This specification mirrors a two-stage production process. In stage 1, an intermediate product is manufactured. In stage 2, assembly of the intermediate products yields the final output. In this setup, FDI is equivalent to the outsourcing of the stage requiring only unskilled labor. Depending on the production process, this may be either stage 1 or stage 2. Our specification assumes fixed proportions among the inputs in both stages. Recent empirical research shows that the extent of substitution among the inputs in the home and the foreign country is limited.[11] Thus, our assumption of fixed proportions seems to fit well and may well reflect the employment effects of the drastic changes which result from outsourcing a complete production stage via FDI.[12]

[10] Empirically, it seems to be the transfer of technology and the potential technological spillovers associated with FDI, which makes FDI so attractive for developing countries (see, e.g., Findlay, 1978).

[11] For instance, Brainard and Riker (1997) show that 'labor employed at different levels of development (...) are complementary' (p.2).

[12] Marginal changes are considered by Brainard and Riker (1997) who analyse the employment effects of wage changes for the case of firms who already moved part of their value chain abroad. With respect to these marginal changes, they find that changes in wage in FDI host country hardly affects employment in the home country of the multinationals.

Labor demand of national and multinational firms can be derived using Shephard's lemma. Demand for (domestic) skilled workers reads

$$L^S = m(\phi + \varepsilon + \gamma y_m) + h(\varepsilon + \gamma y_h). \tag{33}$$

Using aggregate output $Y$ as defined in (14), $L^S$ can be written as

$$L^S = n\varepsilon + \gamma Y + m\phi. \tag{34}$$

The demand for domestic unskilled worker amounts to

$$L^U = n\eta + h(\rho + \delta y_h), \tag{35}$$

and demand for (unskilled) labor in the foreign country is

$$L^F = m(\rho_M + \delta y_m). \tag{36}$$

$L^F$ is mentioned here for completeness only. It is clear that demand for foreign workers always increases if the number of multinational firms increases. Turning to the domestic labor market, we analyse the employment effect of changes in the two host-country characteristics $\phi$ and $w^M$. The effect of both variables on the profitability of FDI is obvious. Lower values of $\phi$ imply smaller fixed costs of FDI and $\phi$ obviously depends upon the host-country policy. Both the regulatory regime, i.e. the ease with which a foreign plant can be set up, and the quality of the host-country infrastructure do affect $\phi$. The importance of the host-country wage level for both fixed and variable costs is obvious.

First, we consider the case of a given total number of firms. If FDI becomes more profitable due to a fall in $\phi$, the number of multinationals increases (i.e. $h$ falls), and demand for unskilled labor declines. The relation between $\phi$ and $L^S$ is more complicated. The increase in the number of multinationals will reduce prices, increase aggregate output and will therefore lead to increased demand for skilled labor. In addition, a greater number of multinational firms means that more firms make the fixed investment. There is a countervailing

effect, however. The fall in $\phi$ implies that existing multinationals must employ less skilled labor. The effect of $\phi$ on *aggregate* labor demand is unambiguous if $\delta = \gamma$ and $\rho = \phi$.[13] In this case, production and setting up a plant requires the same amount of skilled labor as unskilled labor. Lemma 3 demonstrates the negative impact on employment.

**Lemma 3** *An increase in FDI due to a fall in $\phi$ reduces aggregate employment.*

Proof: The result follows from

$$\frac{d(L^S + L^U)}{d\phi} = \frac{\partial(L^S + L^U)}{\partial h}\frac{\partial h}{\partial \phi} + m > 0 \tag{37}$$

because

$$\frac{\partial(L^S + L^U)}{\partial h} = \gamma\left(y_h + (h-1)s\frac{c_h - c_m}{n+1}\right) > 0, \tag{38}$$

and

$$\frac{\partial h}{\partial \phi} = \frac{(n+1)^2 w^S}{2ns(w^U - w^M)^2\delta^2} > 0. \qquad \square \tag{39}$$

This result is consistent with empirical findings by Blomström, Fors and Lipsey (1997) who find a negative effect on total domestic employment for US multinationals allocating labor-intensive production stages to affiliates in developing countries.

The effect of $w^M$ on aggregate employment is less clear. The reason is that foreign wages affect marginal costs. In addition to the indirect effect via the induced change in the number of multinational firms, lower values of $w^M$ imply an output expansion due to the reduction in marginal costs. Both of these effects yield unambiguously a negative relation between foreign wages

[13]Note that these assumptions are sufficient, not necessary to derive Lemma 3.

and demand for skilled labor in the home country. $L^S$ increases if $w^M$ falls. The effect on aggregate employment is unclear. While we consider it unlikely that increased FDI has a positive employment effect in this setting, we cannot theoretically exclude a positive employment effect.

Turning to the case in which exit and entry are possible, we first demonstrate that the relation between domestic employment and $\phi$ is not monotonic in general. Figure 3 shows that employment may first increase as $\phi$ falls below a threshold ($\phi \leq 34.18$) triggering FDI. Eventually employment falls as $\phi$ becomes small.[14] We have already demonstrated that increasing $\phi$, i.e. the fixed skilled labor requirement for FDI, has two effects on employment. It reduces employment by reducing the number of firms implying higher prices and lower output. At the same time labor demand increases as all existing firms must now make higher fixed investments. Figure 3 shows that either of these effects may dominate.

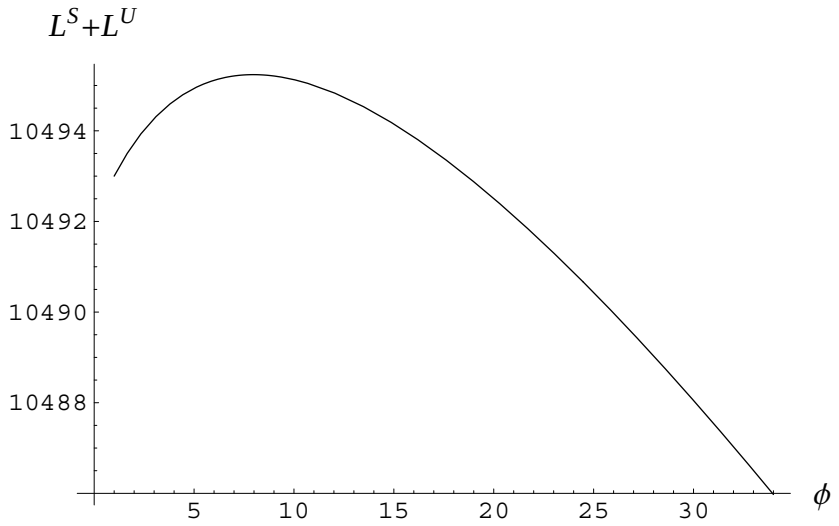


Figure 3: The relation between aggregate employment and $\phi$.

Two final points with respect to the impact of $\phi$ are worth mentioning. First, the employment effects of FDI may be negative for all values of $\phi$. This follows

[14]The parameters used in the example are: $w^S = 100, w^U = 90, w^M = 45, \varepsilon = 5, \gamma = 1, \rho_M = 1, \delta = 1, \rho = 1, a = 250, s = 100, \eta = 1$.

immediately from the employment level in the above example when there is only domestic production. In that case employment is equal to 11632.5. Second, a reduction in the cost of doing FDI need not benefit the domestic labor market as is immediately apparent from Figure 3.

The effect of a reduction in foreign wages on aggregate domestic employment can be divided into two parts. First, once multinationals are dominant, it increases total domestic employment because both fixed and marginal costs of multinational firms decrease and thus the number of firms and aggregate output increase. Second, employment levels under the FDI regime and the trade regime can be compared. Figure 4 shows that employment may decline or increase as a consequence of FDI.[15] As soon as $w^M \leq 73.5$ the FDI regime applies. The employment effect of FDI is only positive if $w^M$ is sufficiently small.

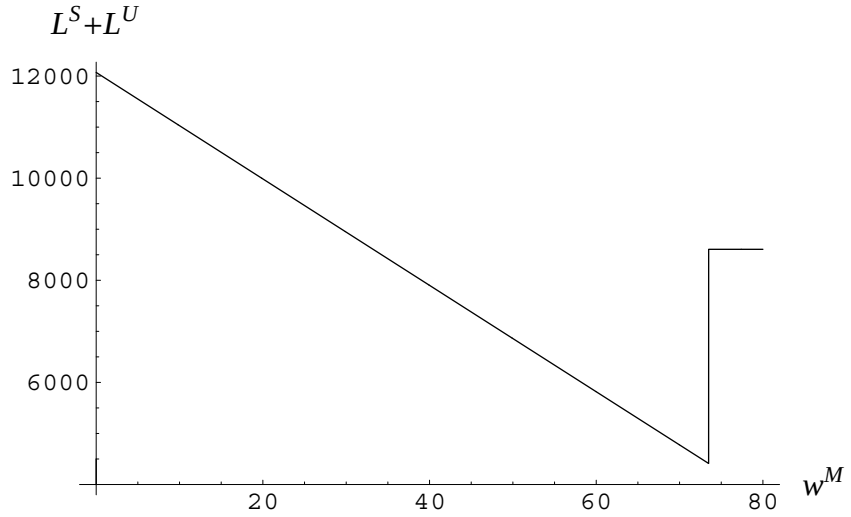


Figure 4: The relation between aggregate employment and the foreign wage $w^M$.

Figures 5 and 6 demonstrate that the market structure effects are the driving forces of labor demand.

[15]The parameters used in the example are: $w^S = 100, w^U = 75, \phi = 10, \varepsilon = 5, \gamma = 1, \rho_M = 1, \delta = 1, \rho = 1, a = 220, s = 100, \eta = 1$.

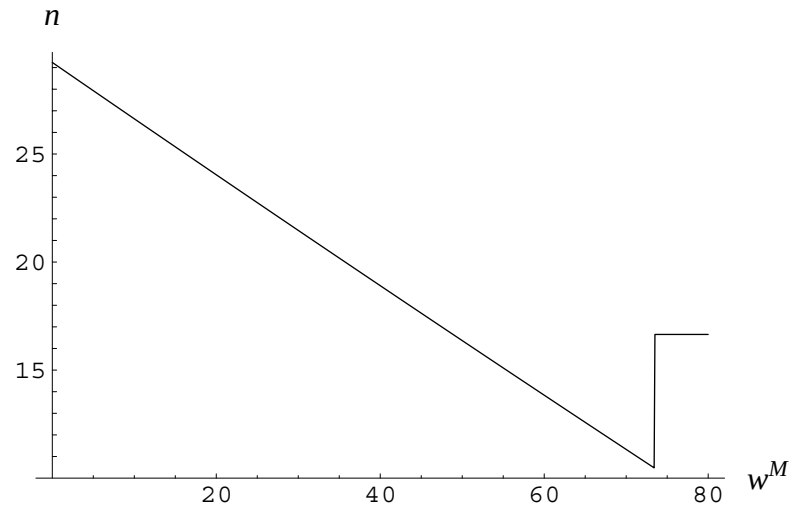


Figure 5: The relation between the number of firms and the foreign wage $w^M$.

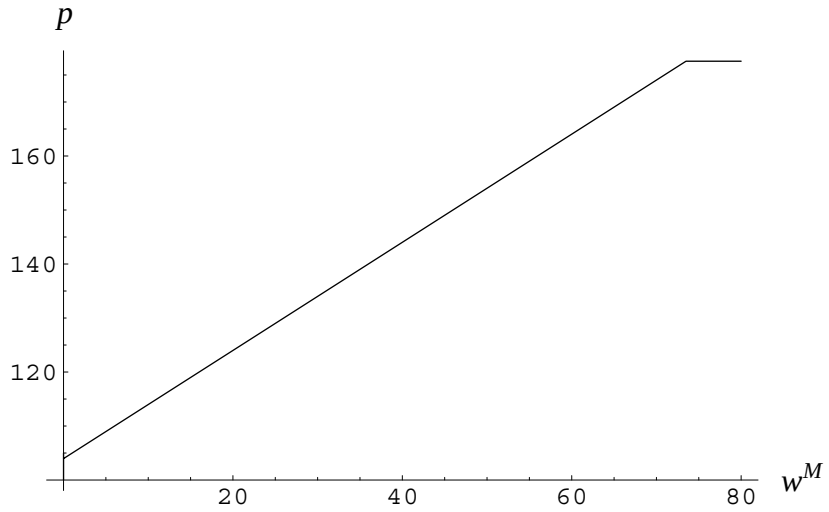


Figure 6: The relation between prices and the foreign wage $w^M$.

Figure 5 shows that the number of firms may fall drastically due to the switch to the FDI regime. Then, despite larger demand for skilled labor for FDI, labor demand declines. Figure 6 shows that prices decline gradually when $w^M$ decreases implying a continuous increase in aggregate output. As a consequence of declining foreign wages, in the example both the increase

in aggregate output and in the number of firms lead eventually to a positive employment effect compared to the trade regime.

Figure 4 shows that the aggregate employment effects of FDI are ambiguous. Here, two further remarks are warranted. First, employment need not be greater in the FDI regime than in situation without FDI even if $w^M = 0$. It is easy to find examples with a negative employment effect even in this case. Second, if $\rho = \phi$, the employment effect is negative if $w^M$ is close to the foreign wage which separates the FDI from the trade regime.[16] If $w^M$ is equal to the largest wage which guarantees that multinational firms are active, the number of multinational firms is equal to $m^*$ according to (27). In this case, aggregate output coincides under the trade regime ($TR$) and the FDI regime ($FR$) because the average costs of multinational and national firms coincide. Then, a regime switch induces the following changes in skilled labor and unskilled labor demand, respectively:

$$\Delta L^S \equiv L^S_{FR} - L^S_{TR} = m^*\phi - (h^* - m^*)\varepsilon, \tag{40}$$

and

$$\Delta L^U \equiv L^U_{FR} - L^U_{TR} = -(h^* - m^*)\eta - h^*(\rho + \delta y_h). \tag{41}$$

$h^*$ is determined by (28). If $\rho = \phi$ and since $m^* < h^*$, employment for both types of labor declines.

The above analysis has shown that, contrary to popular thinking, a decline in foreign wages increases employment if FDI occurs anyway. The reason is that low foreign wages make the domestic industry more competitive. Our results are similar to those of Skaksen and Sørensen (2001). They find that the employment effects will be positive once foreign wages are sufficiently small. Similar to our approach there exist complementarities between the different production stages in their model. Contrary to their model of a monopolist facing an isoelastic demand function, the employment effects in our model

[16] The respective value of $w^M$ is calculated like $f'$ (see (26)).

are not necessarily positive if foreign wages approach zero. The reason is that demand is bounded in our model. In our model industry structure, i.e. the number of firms, is also affected by the level of foreign wages. Therefore, our approach provides an additional channel for employment effects. It also shows how different types of labor are affected by changes in foreign wages.

# 5 Concluding remarks

The consequences of FDI are a hotly debated issue. We have presented a model which enabled us to address the welfare and labor market effects of vertical FDI. With one exception, the results depend crucially on the market entry regime. The exception concerns consumers. They will always gain when firms start multinational production and equilibrium prices decline. The effect on welfare depends upon whether firms are free to enter and exit, or not. If the number of firms is fixed, a switch to multinational production may lead to welfare losses because business stealing by multinational firms leads to rent dissipation. If the emerging industry structure is one of coexistence among domestic and multinational firms, welfare is likely to be lower than under the trade regime where FDI is banned. FDI may improve welfare if it is not costly and productive.

Results are different under free entry and exit. As soon as FDI is optimal for a single firm, it is also welfare improving. Free entry and, even more important, exit facilitate a rationalizing effect. Firms can then exploit economies of scale, and this rationalizing effect drives the unambiguously positive welfare effects of vertical FDI when also the number of active firms is determined endogenously.

As regards labor market effects, our results are in line with empirical findings. In the case without entry and exit, the demand for unskilled workers is likely to decline, but increases for skilled workers. Nevertheless, FDI is likely to reduce aggregate employment in this case. If entry and exit are possible,

employment effects depend crucially on both the productivity and the costs of FDI. FDI which is profitable, but does not sufficiently reduce the marginal cost leads to a decline in aggregate employment. If FDI reduces the marginal cost sufficiently, aggregate employment will rise. In this case, the reduction in marginal cost implies a substantial increase in aggregate production which is sufficient to increase aggregate employment. Note that once FDI occurs, a decline in foreign wages increases domestic employment. Taken together, we find a striking divergence of the welfare and the labor market effects of FDI for many parameter sets, especially in the free entry/exit case.

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