Vertical foreign direct investment, welfare, and employment

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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).](image)

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, i.e., to do FDI. This literature has now reached a certain degree of maturity. It distinguishes between horizontal FDI (Markusen, 1984;
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 faces 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 and is at the heart of the policy debate in Europe. 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 necessarily imperfect competition on product markets. Furthermore, according to the eclectic paradigm of Dun-
ning (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, and there would be no case for FDI as intermediate or primary inputs could then easily be imported.

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 and exit 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. 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. Zhang and Markusen (1999) have discussed 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 departs 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. More importantly, we thereby contrast our results to those of Zhang and Markusen (1999) because we are interested in changes in labor demand for fixed wages, in particular in the home country of FDI. Our paper models therefore the impact of vertical FDI on European labor markets which are characterized by a large degree of wage inflexibility. Second, we consider also the case that market entry is not possible, at least in the short
Third, we conduct an explicit welfare analysis for all cases. The effects of FDI will be determined by comparing the FDI regime under which FDI is possible and profitable with a closed economy 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, i.e., 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 (closed economy 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. 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. Our benchmark is the case where firms are not allowed to go multinational.
Table 1: Game structure without market entry

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The specific model we employ is similar to models used in the so-called new trade literature. We assume a linear demand function

$$Y = s(a - p),$$

(1)

with $a, s > 0$. 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 $f$, since setting up a plant in another country is likely to be more costly than doing so next to the headquarters. Marginal costs of a multinational firm are $c_m$. 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.\(^1\) It is important, however, that firms can make use of lower marginal costs only by FDI and not by importing an intermediate or primary input.

Let $y_h(y_m)$ denote the equilibrium output of a national (multinational) firm.

\(^1\)We will be more explicit on the labor requirements in different stages of production in Section 4.
The f.o.c.'s yield

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

and equilibrium profits of

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

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 \( h \).

Differentiating (3) establishes the following lemma:

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

\[ \frac{\partial \Pi_m}{\partial m} < \frac{\partial \Pi_h}{\partial m}. \quad (4) \]

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 wants to move production to the home country if \( V(m) := \Pi_m(m) - \Pi_h(m - 1) < 0 \). If \( V(m + 1) = \Pi_m(m + 1) - \Pi_h(m) \geq 0 \) 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

\[^2a - c_m > n(c_h - c_m) \] 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.
the following no-switching conditions hold:\footnote{A similar equilibrium concept is employed in Mills and Smith (1998) and Elberfeld (2003) to study technology choice.}

\[ V(m^*) \geq 0 > V(m^* + 1) \]  \hspace{1cm} (5)

Ignoring the integer constraint on the number of firms, these conditions imply that the equilibrium number of national firms satisfies the no-switching condition exactly:

\[ V(m^*) = 0 \]  \hspace{1cm} (6)

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

\[ V(m) = s \left[ \frac{2n(a - c_h)(c_h - c_m)}{(n + 1)^2} + n(n + 2)(c_h - c_m)^2 \right] - \frac{2n(c_h - c_m)^2 m}{(n + 1)^2} - f. \]  \hspace{1cm} (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\footnote{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 \( m^* \).}

\[ m^* = \frac{n}{2} - \frac{(n + 1)^2 f/s - 2n(a - c_h)(c_h - c_m)}{2n(c_h - c_m)^2}. \]  \hspace{1cm} (8)

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

\[ f \geq \frac{ns(c_h - c_m)(2(a - c_h) + n(c_h - c_m))}{(n + 1)^2} =: f(a, c_h, c_m, s, n) \]  \hspace{1cm} (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

\[
f \leq \frac{ns(c_h - c_m)(2(a - c_h) - n(c_h - c_m))}{(n + 1)^2} =: f(a, c_h, c_m, s, n),
\]

(10)
multinational firms will be dominant and the equilibrium number of multinational firms is \( m^* = n \).

Since

\[
\overline{f} - f = \frac{2n^2s(c_h - c_m)^2}{(n + 1)^2} > 0,
\]

(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

\[
\frac{\partial m^*}{\partial n} = \frac{1}{2} - \frac{f/s(n^2 - 1)}{2n^2(c_h - c_m)^2} < \frac{1}{2}
\]

(12)
An increase in the number of firms decreases profits of multinational firms more 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 $m\hat{a}$ 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

$$\frac{\partial \Pi_{m}}{\partial f} = \frac{a - c_{m} + (n - m)(c_{h} - c_{m})}{n(c_{h} - c_{m})} - 1 > 0. \quad (13)$$

The expression in (13) is positive, since we have assumed $a - c_{m} > n(c_{h} - c_{m})$ to ensure that national firms are viable (see fn. 1). To understand this result, note that increasing $f$ has two effects. A higher $f$ increases directly the cost of FDI which makes FDI less attractive. On the other hand, an increase in $f$ lowers the number of firms that go for FDI. This increases the profits of international firms, by Lemma 1. Thus, the inequality (13) states that the positive indirect effect of higher FDI costs on international firms’ profits dominates the negative direct effect. Aggregate consumption is

$$Y = (n - m)y_{h} + my_{m} = s\frac{n(a - c_{m}) - (n - m)(c_{h} - c_{m})}{n + 1}. \quad (14)$$

Due to linear demand, consumer surplus can be determined as

$$CS = \frac{Y^{2}}{2s} = s\frac{(n(a - c_{m}) - (n - m)(c_{h} - c_{m}))^{2}}{2(n + 1)^{2}}. \quad (15)$$

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 closed economy regime, the aggregate welfare effect of vertical FDI is ambiguous if market entry and exit are not possible. The welfare effect is negative if relatively few multinational firms are active in equilibrium.

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

$$W(m) = CS(m) + m\Pi_m(m) + (n - m)\Pi_h(m).$$  

(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

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

(17)

and negative otherwise. This shows ambiguity. To see that the welfare effect of FDI is negative if allowing FDI encourages only a few firms to go multinational, observe that

$$\frac{\partial W}{\partial h}(h = n) = \frac{ns(c_h - c_m)}{(n + 1)^2}n(a - c_h) > 0.$$  

(18)

This shows that an increase in the number of national firms increases welfare if only relatively few multinationals are active. □

To obtain a clearer picture of the welfare properties of the model, note that welfare is convex in $h$. Taken together with Proposition 1, this implies the following relation between the exogenous variables and welfare: If we start from a parameter configuration for which all firms are national, but one firm is indifferent with respect to going for FDI (equation (9) applies with equality), any small change in a parameter which makes FDI more attractive decreases
welfare. Therefore, small increases in the two market size parameters \( a \) and \( s \) as well as an increase in the variable cost advantage of foreign production \((c_h - c_m)\) lead to a fall in welfare. The same holds for a reduction in FDI specific fixed costs \( f \). Due to the convexity of the welfare function, however, large changes of these parameters may improve welfare.

Figure 2: Equilibrium welfare as a function of the FDI specific fixed costs \( f \) when \( c_h = 2, c_m = 0, a = 100, s = 1 \) and \( n = 40 \).

Figure 2 depicts welfare as a function of FDI specific fixed costs \( f \) in a concrete example. It shows that social welfare is non-monotonic in \( f \). Aggregate welfare declines with the emergence of multinational firms and increases the more multinationals are active. National and multinational firms coexist in the interval \([f, \bar{f}]\). Welfare is lower in the FDI than in the closed economy regime, as long as the switch leads to a mixed industry structure. However, this need not be the case. In particular, if FDI is productive, i.e., \( f \) is small and \( m^* \) is large, FDI may be welfare increasing. This holds, for instance, if the parameter values are \( c_h = 2, c_m = 0, a = 100, s = 1, n = 48 \) and \( f \) is such that \( m = 47 \).

The possibly negative welfare result is due to business stealing which leads to rent dissipation. Firms undertake investments to capture a larger share of
profits. However, a firm’s vertical FDI causes the output all other firms to fall, thereby creating a negative externality. If this effect is larger than the positive effect on consumer surplus plus the additional profits of the investing firms, welfare will be lower in the presence of FDI.

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 adjustments in the industry structure into account. Consequently, we augment the game of the last preceding section by an entry stage.

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 entry entails a sunk investment \( g > 0 \). 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 (forthcoming), who employs a similar framework.
Table 2: Game structure with entry and exit

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<thead>
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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 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 (forthcoming) 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

\[
\Pi_h(h, m) = s \left( \frac{(a - c_h - m(c_h - c_m))^2}{(h + m + 1)^2} \right) - g = 0, \\
\Pi_m(h, m) = s \left( \frac{(a - c_m + h(c_h - c_m))^2}{(h + m + 1)^2} \right) - g - f = 0.
\]

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 (forthcoming) shows that for \( D < 2 \) and \( T_h > T_m \) quite different outcomes are possible. The results
range from non-existence of a pure strategy 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 large markets imply a pure strategy equilibrium in which only one type of firms is active.\(^5\) 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

\[ h^* = \frac{a - c_h}{\sqrt{g/s}} - 1, \quad m^* = 0. \quad (20) \]

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

Since profits - ignoring the integer constraint - 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

\[ p^h = a - h^*y_h/s = \sqrt{g/s} + c_h. \quad (21) \]

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

\[ h^* = 0, \quad m^* = \frac{a - c_m}{\sqrt{(f + g)/s}} - 1, \quad (22) \]

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

\[ p^m = a - m^*y_m/s = \sqrt{(f + g)/s} + c_m. \quad (23) \]

\(^5\)This result derives immediately from the conditions underlying Proposition 2. For both large \( s \) and large \( a \) they are likely to be satisfied.
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 (22) with (20), given 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 closed economy regime.

Proof: The decline in price (which is equivalent to an increase in welfare due to the zero profit conditions (19)) will be proved by contradiction. Welfare will decline by vertical FDI if \( p^m > p^h \) which requires that

\[
c_h - c_m < \sqrt{(f + g)/s} - \sqrt{g/s} \quad \Leftrightarrow \quad f > f' := s(c_h - c_m)(c_h - c_m + 2\sqrt{g/s}). \tag{24}
\]

\( f' \) 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

\[
f < f' = s(c_h - c_m)(c_h - c_m + 2\sqrt{g/s}). \tag{25}
\]

This condition shows that welfare decreasing vertical FDI is never possible since (24) and (25) are contradictory.

It is clear from (22) that \( m^* \) will be the larger the smaller is \( f \). Hence, if \( f \) is sufficiently small, \( m^* \) will be larger than \( h^* \) according to (20) because of \( c_m < c_h \). Eq. (25) 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

\[
m^* = \frac{a\sqrt{s} - \sqrt{s}c_h - \sqrt{g}}{\sqrt{g} + \sqrt{s}(c_h - c_m)} \tag{26}
\]
As $h^*$ can be written as

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

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 the 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, by moving from the closed economy regime to the situation where FDI is possible, rent dissipation cannot occur. Since price falls, if firms go for FDI, welfare must increase.

Note that the critical fixed cost $f'$, which triggers FDI, is the larger the larger the market size parameter $s$, the cost difference $c_h - c_m$ and/or the fixed cost $g$ is. Hence, the welfare increasing switch to multinational production is more likely to occur if both market size and cost differentials are sufficiently large. Furthermore, multinational production is the more attractive the larger the firm-specific fixed cost $g$ is. The reason is that a large $g$ requires that firms are large in size which makes multinational production more profitable.

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. In this section we address this issue, but we still use the partial equilibrium model. We assume
that changes in the industry do not cause changes in factor prices. Thus, we analyze how labor demand changes in a particular industry due to FDI without taking into account 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. 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 sticky. For continental Europe, this assumption seems to be more appropriate than the assumption of perfect competition on factor markets as in Zhang and Markusen (1999).

In order to evaluate the factor market effects of FDI, we specify the cost functions explicitly. Focusing on the labor market, 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 country 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

\[
g = w^S \varepsilon + w^U (\eta + \rho).
\]  

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

6To 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)).

7Similarly to our paper, Skaksen and Sørensen (2001) derive employment effects from a partial equilibrium model.
production are

\[ f = w^S \phi + w^M \rho_M - w^U \rho, \quad \rho_M \geq \rho. \quad (29) \]

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 administrative barriers to enter the host country which can be overcome only with skilled labor.

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.\(^8\)  Marginal costs read:

\[ c_h = w^S \gamma + w^U \delta \quad (30) \]

and

\[ c_m = w^S \gamma + w^M \delta. \quad (31) \]

Additionally, we assume that production requires less skilled labor than unskilled labor, \(i.e., \delta \geq \gamma\) because the part of production which is potentially relocated 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

\(^8\)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).
to the relocation of the stage requiring only unskilled labor. Depending on
the production process, this may be either stage 1 or stage 2. Our speci-
cation 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. Thus, our assumption of fixed
proportions seems to fit well and may well reflect the employment effects of
the drastic changes which result from moving a complete production stage
abroad via FDI.

Labor demand of national and multinational firms can be derived using Shep-
hard’s lemma. Demand for (domestic) skilled workers reads

\[ L^S = m(\phi + \varepsilon + \gamma y_m) + h(\varepsilon + \gamma y_h). \]  

(32)

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

\[ L^S = n\varepsilon + \gamma Y + m\phi. \]  

(33)

The demand for domestic unskilled worker amounts to

\[ L^U = n\eta + h(\rho + \delta y_h), \]  

(34)

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

\[ L^F = m(\rho M + \delta y_m). \]  

(35)

\( L^F \) is mentioned here for completeness only. It is clear that demand for for-
eign workers always increases if the number of multinational firms increases.

Turning to the domestic labor market, we analyze the employment effect of

\(^9\text{For instance, Brainard and Riker (1997) show that 'labor employed at different levels of development (...) are complementary' (p.2).}\)

\(^{10}\text{Marginal changes are considered by Brainard and Riker (1997) who analyze the employment effects of wage changes for the case of firms who already moved part of their value chain abroad. With respect to these marginal changes, they find that changes in wage in FDI host country hardly affects employment in the home country of the multinationals.}\)
changes in the two host country characteristics $\phi$ and $w^M$. These two variables are probably the most important ones both for the decisions of firms as well as for the public debate. The importance of the wage differential between domestic and foreign wages is obvious. Parameter $\phi$ is important because it depends crucially on the host country’s policy. Both the regulatory regime, i.e., the ease by which a foreign plant can be set up, and the quality of the host country infrastructure do affect $\phi$. Both $\phi$ and $w^M$ affect the profitability of vertical FDI. While lower values of $\phi$ imply smaller fixed costs of FDI, lower wages in the host country are associated with both lower variable and lower fixed costs.

As the effects of FDI on labor demand are sensitive to the entry conditions, we distinguish between no entry and free entry.

4.1 No Entry

For a given total number of firms, we obtain the following results with respect to employment effects.

**Proposition 4** If market entry and exit are not possible, an increase in FDI due to a fall in the fixed skilled labor requirement for FDI ($\phi$), (1) reduces the demand for unskilled labor in the home country; (2) increases the demand for skilled labor in the home country if the number of multinationals is ‘small’; (3) reduces aggregate employment in the home country if $\delta = \gamma$ and if, initially, $\rho = \phi$.

Part 1 of Proposition 4 is straightforward and rather intuitive. If FDI becomes more profitable due to a fall in $\phi$, the number of multinationals increases (i.e., $h$ falls) and as a consequence output $y_h$ of the domestic firms falls. Both effects imply (see eq. (34)) a decrease in demand for unskilled labor.

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. Obviously, this effect is most important if multinational firms make up for a large share of all firms. If \( m \), the number of multinationals, is small, demand for skilled work increases if \( \phi \) falls:

\[
\frac{d(L^s)}{d\phi} = \left( \frac{\partial Y}{\partial m} + \phi \right) \frac{\partial m}{\partial \phi} + m < 0 \tag{36}
\]

if \( m \) is close to 0. The reason is that aggregate output increases if the number of the low-cost firms, i.e., the number of multinationals, increases (\( \partial Y / \partial m > 0 \)), while the number of multinationals falls if \( \phi \) increases.

As regards total employment, assumptions \( \delta = \gamma \) and \( \rho = \phi \) yield an unambiguous result. Since \( \phi \) is changed, the result holds only in the neighborhood of \( \rho = \phi \). These assumptions are sufficient, but not necessary to derive part three of Proposition 4, and they favor an increase in total employment. Under these assumptions, production requires as many skilled workers as unskilled workers (\( \delta = \gamma \)). Furthermore, according to the equality \( \rho = \phi \), supervision of a foreign plant requires the same number of skilled workers than the setting up of a domestic plant requires unskilled workers. In general, we would expect that the respective input coefficients for skilled labor are smaller. As Proposition 4 shows, the impact on employment is even negative with these assumptions favoring a positive outcome.

This 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
\[
\frac{\partial h}{\partial \phi} = \frac{(n + 1)^2 w^S}{2ns(w^U - w^M)2^2} > 0, \tag{39}
\]
where the last inequality follows from the assumption that unskilled labor is less expensive abroad than at home. Our result concerning total employment 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 and demand for skilled labor in the home country. \( L^S \) increases if \( w^M \) falls.

The effect on aggregate employment is unclear. Although it seems unlikely that FDI creates a positive employment effect, an increase in aggregate employment is theoretically possible.

### 4.2 Free Entry

When entry and exit are possible, the relation between domestic employment and \( \phi \), the fixed skilled labor requirement for FDI, 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.\(^{11}\) Note also that employment is equal to 11632.5 if \( \phi > 34.18 \), i.e., above the value which induces FDI. The first conclusion from this example is that the employment effects of FDI may be negative for all values of \( \phi \). This effect appears to be strongest for values of \( \phi \) for which multinational

\(^{11}\) The parameters used in the example are: \( w^S = 100, w^U = 90, w^M = 45, \varepsilon = 5, \gamma = 1, \rho_M = 1, \delta = 1, \rho = 1, a = 250, s = 100, \eta = 1. \)
production just becomes dominant, *i.e.*, for values close to but below the trigger value. As noted above, a fall in $\phi$ has two effects on employment. It increases employment by increasing the number of firms implying lower prices and higher output. At the same time labor demand decreases as all existing firms must now make smaller fixed investments. While either of these effects might dominate, Figure 3 shows that initially, *i.e.*, starting from large values of $\phi$, a reduction in this variable increases (skilled) labor demand which is mainly due to an increase in the number of firms. For small values of $\phi$ a further reduction may negatively affect employment.

The effect of a reduction in foreign wages, $w^M$, 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 closed economy regime can be compared. Figure 4 shows that employment may decline or increase as a consequence of FDI.\(^\text{12}\) As soon as $w^M \leq 73.5$

\(^{12}\)The parameters used in the example are: $w^S = 100, w^U = 75, \phi = 10, \varepsilon = 5, \gamma = 1, \rho_M = 1, \delta = 1, \rho = 1, a = 220, s = 100, \eta = 1$. 

24
the FDI regime applies. The employment effect of FDI is only positive if \( w^M \) is sufficiently small.

\[
L^S + L^U
\]

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

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

\[
n
\]

Figure 5: The relation between the number of firms and the foreign wage \( w^M \).
Figure 5 shows that the number of firms may fall substantially due to the switch to the FDI regime. As a consequence, labor demand declines even though demand for skilled labor might increase. Figure 6 shows that prices decline gradually when $w^M$ decreases implying a continuous increase in aggregate output. Again, however, demand for labor falls at the threshold value since production is moved abroad. As wages decline further, both the increase in aggregate output and the increase in the number of firms increase employment compared to the closed economy regime.

Here, two qualifications of the results from our above simulation are warranted. First, employment need not be larger in the FDI regime than without FDI even if $w^M = 0$. It is easy to find examples with a negative employment effect even in this case. Second, the employment effect is negative for both types of labor if $\rho = \phi$ and $w^M$ is close to the foreign wage which separates the FDI from the closed economy regime.\textsuperscript{13} 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 (26). In this case, aggregate output

\textsuperscript{13}The respective value of $w^M$ is calculated like $f'$ (see (25)).
coincides under the closed economy regime (CR) 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:

\[ \Delta L^S = L^S_{FR} - L^S_{CR} = m^* \phi - (h^* - m^*) \varepsilon, \]

(40)

and

\[ \Delta L^U = L^U_{FR} - L^U_{CR} = -(h^* - m^*) \eta - h^*(\rho + \delta y_h). \]

(41)

\( h^* \) is determined by (27). 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. Skaksen and Sørensen also model complementarities between the different production stages but they assume a monopolist facing an isoelastic demand function. Contrary to their results, the employment effects in our model 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 has 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 as they will always gain when firms start multinational production and equilibrium prices decline. The effect on welfare depends upon the possibility of entry and exit. 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 closed economy regime where FDI is banned. FDI may improve welfare if it is not costly and productive.

Results are different under free entry. As soon as FDI becomes profitable, it is also welfare improving. FDI entails a strong rationalizing effect, leading to a lower consumer price. This result holds, even if vertical FDI leads to an increase in industry concentration.

Our welfare results appear to be in line with what economists expect and why they are (mostly) in favor of 'globalization'. Our results regarding labor market effects indicate why people on the street who care more about jobs are much more critical of globalization. Our model reveals a striking difference between the employment and the welfare effects. In the no entry case, employment effects are likely to be positive only in cases in which welfare is negatively affected, namely if FDI is not very productive and the equilibrium number of multinationals is small. Then, only little rationalization occurs so that the layoff effects are marginal. The welfare effect can only turn positive if FDI becomes very productive and firms become multinationals, leading to a clearly negative effect on aggregate employment.

If entry and exit are possible, we obtain another case for disagreement between economists’ and popular perception of globalization. As noted above, the welfare effect is always positive with free entry and exit. The employment effect, however, will only be positive if FDI is very profitable, in particular due to low foreign wages. Therefore, we obtain the largest welfare gains and probably a positive employment effect in a situation which is sometimes called
'unfair' trade, for instance, by trade unions. Multinationals appear to face most opposition to a relocation of production if they move to countries with very low wages, a situation which is most likely to produce both positive welfare and employment effects! The important conclusion from our model is that once FDI occurs, a decline in foreign wages increases domestic employment. The corresponding reduction in marginal costs implies an increase in aggregate production which increases aggregate employment. The most drastic fall in domestic employment arises in a situation in which foreign wages are close to domestic wages (of unskilled workers), but sufficiently low to make FDI profitable. In this situation, even demand for skilled workers might decrease. The reason is a sharp fall in the number of active firms.

Our model contributes also to the discussion of the effect of vertical FDI on the relative demand for skilled and unskilled labor. In the case without entry and exit, demand for skilled labor increases, while demand for unskilled labor falls. Under free entry and exit, we generally expect that the number of skilled workers should increase due to FDI in our model. Demand for unskilled workers again decreases. These impact effects clearly indicate that vertical FDI contributes to an increased wage gap between skilled and unskilled workers. Inequity is likely to rise as a consequence. Since total employment may increase in this case, the increasing demand for skilled labor may even outnumber the decreasing demand for unskilled labor. If we were to draw any policy conclusion from our findings, the positive welfare results clearly demonstrate that countries should promote FDI and train unskilled labor instead of impeding FDI.

In the present paper we assumed that firms have a binary choice between producing an input abroad, via vertical FDI, or at home. However, in situations where arm’s length purchase of inputs is possible, importing the labor intensive fragment, might be attractive. Thus, the issue of trade in intermediate inputs under imperfect competition provides an interesting issues for

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14See Bhagwati, Hudec (1996) for a discussion of 'fair trade'.
further research.\textsuperscript{15}

\textsuperscript{15}For the effects of trade in intermediate inputs on wages under perfect competition, see e.g. Chapter 4 of Feenstra (2004).
References


