Multinationals do not export jobs, and other related results

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Abstract

We develop a simple model of multinational firms, in which firms engage in production abroad to take advantage of cheap labour. There are gains from multinational firms beyond the standard gains from trade. The model makes two empirically testable predictions. First, firms with more foreign employment also have more domestic employment; multinationals are not net exporters of jobs. Second, the expansion of multinational activity will increase the overall size of the firm. We find that both predictions hold empirically, using a sample of the largest multinational firms. In addition, the presence of multinational firms raises welfare relative to when they are absent, although the proportional gain is not large.

Keywords: Multinational firms; comparative advantage.
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1 Introduction

Multinational firms play an important role in the modern economy. Although perhaps not as big and powerful as they are sometimes made out to be (see De Grauwe and Camerman (2002)), they have undeniably captured the attention of the popular press. In addition, some of the numbers associated with multinational firms are truly large. For example, in 2015 the 100 largest multinational firms (as measured by their foreign assets) had total assets worth $12 trillion, total sales of $7 trillion, and employed a total of 14 million workers. Because of their size and importance, an important and policy-relevant question is whether multinational firms "export jobs". That is, whether by shifting some of their production process abroad, they reduce employment at home. A closely related question is whether a multinational firm that expands its foreign operations becomes larger as a result. This may affect the degree of competitiveness and the varieties available for consumption in the market, and hence the welfare of consumers.

This paper seeks to address both questions, from both a theoretical and empirical perspective. First, we develop a simple model of the multinational firm, in which firms may engage in production abroad to take advantage of cheap labour. This has been referred to in the literature as vertical foreign direct investment (FDI). The model allows for the separation of fixed and variable production costs across countries, in the framework of the Krugman (1980) model of trade under monopolistic competition. We assume one factor of production, and the co-existence of multinational and national firms in a model without firm heterogeneity. The simple model enables us to compare the welfare implications of multinational firms versus trade in final products alone. Allowing for multinational firms results in a modest welfare gain for both trading partners. Although multinational firms are larger than the domestic firms they have replaced, implying a smaller number of varieties available for consumption (and leading to fears over the homogenization of the high street (New Economics Foundation (2007))), this is more than outweighed by the gain from increased productivity of multinational firms.

The model makes two key predictions. First, firms which expand their foreign activities also expand their domestic activities. That is, domestic and foreign employment are complements, and multinational firms are not net exporters of jobs. This prediction is driven by a key assumption we make, that multinational firms incur an additional fixed headquarters cost when expanding their foreign activities. This additional cost may be thought of as the cost of coordinating activities at a distance. The second main

prediction of the model is that firms which expand their international activities become larger as a result. This suggests that expanding into foreign production may be a strategy for firms to gain an advantage over their competitors. We take both predictions to data on the largest multinational firms in the world, and confirm both predictions of the model, especially when we control for unobserved heterogeneity across firms and the endogeneity of firms' employment decisions.

There has of course been much academic literature on multinational firms. Recent surveys include Antras and Yeaple (2014) Bernard et al (2017). The modern literature originated from the literature on international trade under imperfect competition, and can be divided into several different strands. First, there is what Brainard (1993, 1997) refers to as the proximity-concentration hypothesis. Here, firms engage in multinational behaviour in order to avoid transport costs and tariff barriers, and to benefit from scale economies at the plant level; an early exemplar of this literature is Krugman (1983). This strand of the literature relates to horizontal FDI. Second, there is the factor proportions hypothesis, where multinational firms are incorporated into a model of trade with factor endowments differences and imperfect competition (see Markusen (1984), Helpman (1984, 1985), Helpman and Krugman (1985)). Here, multinational firms emerge in response to differences in factor prices across countries, and takes the form of vertical FDI. Third, there is the literature on the advantages that multinational firms possess, which means that firms prefer to internalise their production rather than outsource it to other firms in arms-length transactions (Ethier (1986), Antras (2003), Antras and Helpman (2004))[1]. This paper is most closely related to the second strand of the literature, on vertical FDI. We depart from the standard formulation by adopting a simpler, one-factor setup, which allows us to explicitly derive the gains from multinational firms, and the implications for firm size and firm activities. In addition, we assume a fixed number of multinational firms, so that they make potentially positive profits in equilibrium. This requires a different solution method to the standard approach, which we describe in detail.

In the model, firms may find it profitable to produce abroad, because of technological differences across countries. Therefore, the paper is related to the literature on technological differences across countries in models of trade under imperfect competition, for instance Ricci (1997), Chung (2007) and Soo (2016). Also similar in approach to that taken in the present paper is Lo (2005, 2014), who also develops models of multinational firms based on technological differences across countries. Compared to this work, the present paper allows for the simultaneous existence of both

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[1] See Appendix A for a discussion of the distinction between "multinational firms" and "offshoring".

multinational and national firms, which turns out to have large implications for the predictions of the model. For instance, the co-existence of domestic and multinational firms means that wages are unaffected by the presence of multinational firms[2]. The model in this paper also yields testable predictions which we take to the data.

On the empirical side, there has also been much work on the relationship between a multinational firm's domestic and foreign activities. Slaughter (2013) argues that US firms' expansion abroad is complementary to their US operations, and also creates jobs in other US firms. On the other hand, Simpson (2012a, 2012b) finds that UK multinational firms tend to substitute foreign workers for domestic workers, especially in low-skill-intensive sectors. These are similar to the findings of Bernard and Jensen (2007) for US multinationals. In other related work, Amiti and Wei (2009) show that offshoring has positive effects on productivity in the US. Gorg et al (2008) find similar results for Irish firms. Keller and Yeaple (2009) find positive spillover effects of FDI on the productivity of other firms in the sector in the US, while Girma et al (2015) find similar results for Chinese firms.

The next section outlines the theoretical model, starting with the case of trade in goods alone, and then allowing for multinational firms. Section 3 discusses the empirical evidence. The final section provides some concluding comments.

2   The model

The starting point of the model is the Krugman (1980) model of international trade under monopolistic competition. Let there be two countries, $j = H,F$ for Home and Foreign, one factor of production, labour, and one sector, which is comprised of a continuum of differentiated varieties i. The utility function of the representative consumer is:

$$U = \int_0^n c(i)^\theta di, \qquad\qquad 0 < \theta < 1. \qquad\qquad (1)$$

Where the two countries differ from each other, is in the production functions of each variety. Suppose that production of a variety requires two activities: headquarters activities, represented by a fixed cost in production, and assembly activities, represented by a variable cost. Assume without loss of generality that Home is a developed country and Foreign a less developed country, so that (1) Home has a comparative advantage in producing headquarters services and Foreign in producing

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[2] Since multinational firms make profits in equilibrium, if the workers of these firms also own the firms, their total income will be higher than that of workers in national firms.

assembly services, and (2) Home has an absolute advantage in both activities. Then the production functions in the two countries will take the following form:

$$l_{ij} = \alpha_j + \beta_j x_{ij}. \tag{2}$$

As discussed above, throughout the paper we will use the following assumptions on parameter values:

Assumption 1: $\alpha_H < \alpha_F$, $\beta_H < \beta_F$, $\alpha_H/\beta_H < \alpha_F/\beta_F$.

Consider first the case of autarky. The solution of the model follows the procedure which has been well-established since Krugman (1980). We obtain the profit-maximising price and output of the representative firm given free entry and exit, and the equilibrium number of varieties produced in each country:

$$p_{ij} = \frac{\theta}{\lambda}\left(c_{ij}\right)^{\theta-1} = \frac{\beta_j w_j}{\theta}, \qquad x_{ij} = \frac{\alpha_j\theta}{\beta_j(1-\theta)}, \qquad n_j = \frac{L_j(1-\theta)}{\alpha_j}. \tag{3}$$

Given symmetry across varieties, per capita consumption of each variety in each country is:

$$c_{ij} = \frac{x_{ij}}{L_j} = \frac{\alpha_j\theta}{\beta_j(1-\theta)L_j}. \tag{4}$$

Hence utility under autarky is:

$$U_j^A = n_j c_{ij}^\theta = \left(\frac{\theta}{L_j}\right)^\theta (1-\theta)^{1-\theta}\left[\frac{L_j}{\alpha_j}\left(\frac{\alpha_j}{\beta_j}\right)^\theta\right]. \tag{5}$$

Autarkic utility depends on the size of the labour force, technology, and the substitutability between varieties in consumption. Note that given Assumption 1, if the two countries have the same labour force, Home consumers would enjoy a higher level of utility in autarky than Foreign consumers, because of Home's absolute advantage in both fixed and variable costs.

2.1 Equilibrium with trade in final goods

Suppose trade in final goods is costless. The results for prices, output and number of varieties from the previous sub-section remain unchanged. It can be shown that Assumption 1 implies that:

$$\frac{p_{iH}}{p_{iF}} = \left(\frac{c_{iH}}{c_{iF}}\right)^{\theta-1} = \left(\frac{x_{iH}}{x_{iF}}\right)^{\theta-1} = \left(\frac{\alpha_H\beta_F}{\alpha_F\beta_H}\right)^{\theta-1} > 1, \tag{6a}$$

$$\frac{p_{iH}}{p_{iF}} = \frac{\beta_H w_H}{\beta_F w_F} \qquad \leftrightarrow \qquad \frac{w_H}{w_F} = \left(\frac{\alpha_H}{\alpha_F}\right)^{\theta-1}\left(\frac{\beta_F}{\beta_H}\right)^\theta > \frac{p_{iH}}{p_{iF}}. \tag{6b}$$

Since $\theta < 1$, Home-produced varieties are more expensive than Foreign-produced varieties, implying that Home firms are smaller than Foreign firms[3], but Home real (and nominal) wages are higher than Foreign real (and nominal) wages. Given symmetry across varieties produced in each country and no trade costs, free trade utility can be written as:

$$U_j^{FT} = \int_0^{n_H+n_F} c(i)^\theta di = n_{iH} c_{iH}^\theta + n_{iF} c_{iF}^\theta$$

$$= \left(\theta \mathbf{\Omega}_j^{FT}\right)^\theta (1-\theta)^{1-\theta} \sum_{j=H,F} \left[\frac{L_j}{\alpha_j}\left(\frac{\alpha_j}{\beta_j}\right)^\theta\right], \qquad (7)$$

Where $\mathbf{\Omega}_j^{FT} = 1/\left(L_j + \left(w_k/w_j\right)L_k\right)$ is the consumption share of an individual in country j, k indicates the trading partner, and the similarity to the autarkic utility (5) can be noted. Dividing free trade utility by autarkic utility gives the gains from trade:

$$G_j^{FT} = \frac{U_j^{FT}}{U_j^A} = \left[1 + \left(\frac{L_k}{L_j}\right)\left(\frac{\alpha_j}{\alpha_k}\right)^{1-\theta}\left(\frac{\beta_j}{\beta_k}\right)^\theta\right]^{1-\theta} > 1. \qquad (8)$$

The gains from trade are a function of the two trading partners' relative sizes, and the relative technologies. As is often the case in these types of models, a smaller country gains proportionally more than a larger country; however, because of Assumption 1, if the two countries have the same labour endowments, the Foreign country will experience larger gains from trade. This is shown in Figure 1. Intuitively, this is because Home has the technological advantage, so the effective labour endowment of Home is greater than that of Foreign.
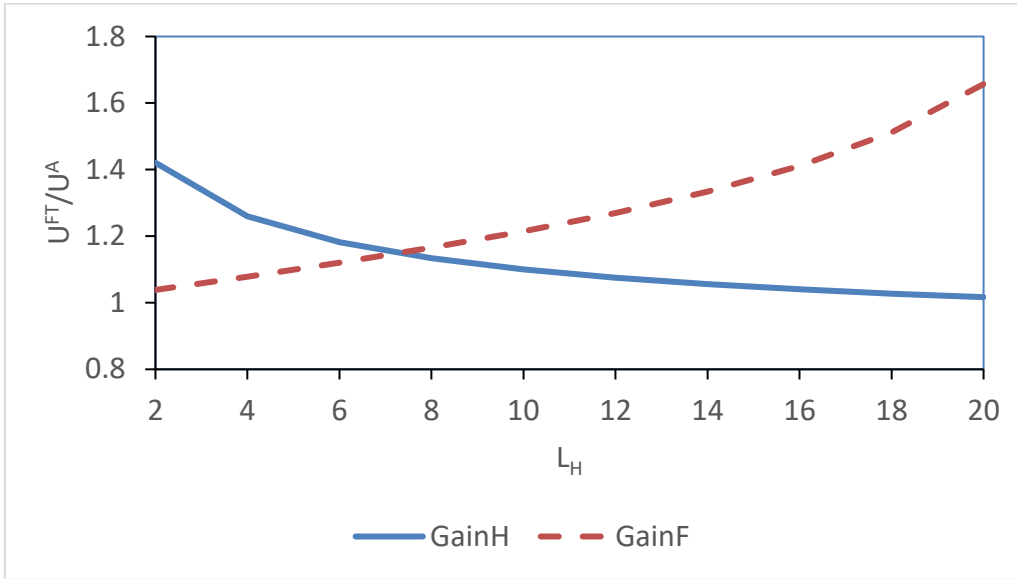
2.2   Multinational firms

Suppose that firms are able to separate the two activities involved in production across countries. Headquarters activities always have to be produced in the country of origin, while assembly activities can be produced abroad. Since Home has a comparative advantage in headquarters activities, and Foreign in assembly, Foreign firms have no incentive to separate their activities, whereas Home firms do. If assembly activities are produced abroad, then, following the discussion in Baldwin (2016), a multinational firm will employ Foreign workers at low Foreign wages, but use superior Home technology[4]. Even though firms are identical to each other in autarky or free trade,

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[3] This is not entirely satisfactory, since we would expect developed country firms to be larger on average than developing country firms. One possible way to get around this problem would be to allow firms to choose the production technology (e.g. a high fixed cost combined with a low marginal cost, versus a low fixed cost but a high marginal cost), and impose some restriction that results in developed country firms choosing the former, and developing country firms choosing the latter. This formulation is beyond the scope of the paper.

[4] This assumption is not necessary for the results below; we get the same qualitative results if we assume that the multinational firm employs Foreign workers using Foreign technology.

they may differ in their ability to coordinate activities across borders. Hence, suppose that each pre-existing Home firm has a probability $0 < \psi < 1$ of becoming a multinational firm. This implies that the number of multinational firms, $n_{MNE} = \psi n_H^A$, where n_H^A is the number of Home firms in autarky. This fixed number of multinational firms will have important implications for the solution of the model, since we can no longer invoke free entry and exit and the zero profit condition to pin down the size of each multinational firm.

Figure 1: Gains from trade in final goods alone.

Note: Parameter values assumed: $\alpha_H = 2$, $\alpha_F = 8$, $\beta_H = 1.5$, $\beta_F = 3$, $\theta = 0.8$, $L_H + L_F = 24$.

Further, suppose that for the Home firms which become multinational firms, each firm allocates a fraction $0 < \gamma < 1$ of their assembly activities abroad, there are no fixed costs of foreign production (an assumption used in Krugman (1983)), and that the separation also incurs an additional fixed cost at Home, equal to $\gamma \alpha_H$. This may be the cost of coordinating activities at a distance, and as discussed below, will be a crucial assumption in what follows[5]. Appendix B discusses the implications of allowing for an additional fixed cost in Foreign (for instance, to represent a fixed cost of setting up the factory abroad); this turns out not to affect the main results of the model. Then the profit function of the firm is:

$$\pi_{iMNE} = p_{iMNE} x_{iMNE} - (1 + \gamma) w_H \alpha_H - (1 - \gamma) w_H \beta_H x_{iMNE} - \gamma w_F \beta_H x_{iMNE}. \qquad (9)$$

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[5] This implies that fixed costs are a larger fraction of a multinational firm's total cost compared with a national firm. For simplicity we treat γ as exogenous, as if Samuelson's Angel (Samuelson (1949)) had descended from heaven to divide the multinational firm's activities in this way. Endogenising γ is left for future work.

For it to be worthwhile for a firm to switch from being a national firm to being a multinational firm, equation (9) must be non-negative for $x_{iMNE} = x_{iH}$, which corresponds to $w_H/w_F \geq \theta/(2\theta - 1)$. This inequality holds for sufficiently large values of θ, which is what we will assume. There are several unusual features of the multinational equilibrium. First, since the assembly process uses both Home and Foreign workers, the equilibrium price of x_{iMNE} is:

$$p_{iMNE} = \frac{\beta_H[(1-\gamma)w_H + \gamma w_F]}{\theta}. \tag{10}$$

From whence it can be established that $dp_{iMNE}/d\gamma < 0$; the larger the fraction of assembly activities produced abroad, the lower the (relative) price of the multinational's output. In general, multinational prices are always lower than those of domestic Home firms, and may also be lower than those of domestic Foreign firms if γ is sufficiently large. Because some Home firms and all Foreign firms remain as national firms, the relative wages and prices are unchanged, and remain as they are in equations (6a) and (6b)[6].

Since we assume a fixed number of multinational firms, there is no additional entry or exit of multinational firms. Multinational firms, having chosen their profit-maximising price following (10), will produce the quantity that is determined by their demand curve given the fixed number of multinational firms. Hence, to solve for the size of each multinational firm, from (3), (6a) and (10), we have:

$$\frac{p_{iMNE}}{p_{iH}} = \frac{(1-\gamma)w_H + \gamma w_F}{w_H} = \left(\frac{x_{iMNE}}{x_{iH}}\right)^{\theta-1}. \tag{11}$$

From this, we obtain:

$$x_{iMNE} = \Phi\left[\frac{\alpha_H\theta}{\beta_H(1-\theta)}\right] = \Phi x_{iH} > x_{iH}, \tag{12}$$

where $\Phi = \left[\frac{(1-\gamma)w_H + \gamma w_F}{w_H}\right]^{\frac{1}{\theta-1}} > 1$ since $0 < \theta < 1$ and $w_H > w_F$, and $d\Phi/d\gamma > 0$. Φ may be thought of as a scaling factor for how big a multinational firm is, relative to a domestic Home firm. For sufficiently large values of γ, multinational firms are also larger than domestic Foreign firms. Substituting into the profit function (9) shows that for profits to be non-negative (and hence for the number of multinational firms n_{MNE} to be an equilibrium), it must be that:

$$x_{iMNE} \geq \frac{(1+\gamma)w_H}{[(1-\gamma)w_H + \gamma w_F]}\left[\frac{\alpha_H\theta}{\beta_H(1-\theta)}\right], \tag{13}$$

or:

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[6] Technically, this plays a role similar to the assumption of a homogeneous goods sector in other models: it pins down the relative wage.

$$(1-\gamma)w_H + \gamma w_F \le (1+\gamma)^{\frac{\theta-1}{\theta}} w_H. \qquad (14)$$

We assume that this inequality is satisfied. Multinational firms may earn supernormal profits, and these profits are uniformly distributed to consumers in Home. This is in line with Coeurdacier and Rey (2012), who show that although the home bias in equities is decreasing, it remains an important feature of the structure of firm ownership. By making this assumption, we avoid issues relating to the distribution of income, which may have additional welfare implications beyond those discussed below. Nevertheless, the presence of profits which are distributed only to Home consumers means that the overall distribution of income is skewed towards Home (and away from Foreign), and this will have implications for the distribution of gains from multinational firms across the two countries.

The following results can be shown, assuming $\alpha_H > \beta_H$ (i.e. the fixed cost is sufficiently large relative to the variable cost):

$$\frac{dx_{iMNE}}{d\gamma} > 0, \qquad \frac{dl^H_{iMNE}}{d\gamma} > 0, \qquad \frac{dl^F_{iMNE}}{d\gamma} > 0. \qquad (15)$$

That is, as the fraction of assembly activities produced in Foreign rises, the firm's output rises, as does its employment of both Home and Foreign workers, l^H_{iMNE} and l^F_{iMNE}. That is, the model predicts that multinational firms do not "export jobs": more employment abroad is consistent with more employment at home. Hence we can state:

Result 1: There is a positive association between domestic and foreign employment of a multinational firm.

In our empirical analysis, we only have data on firms' revenues, not output. We can calculate total revenue of a firm as follows:

$$p_{iH}x_{iH} = \frac{w_H\alpha_H}{1-\theta}, \qquad p_{iF}x_{iF} = \frac{w_F\alpha_F}{1-\theta}, \qquad p_{iMNE}x_{iMNE} = \frac{\alpha_H w_H}{1-\theta}\boldsymbol{\Phi}^\theta. \qquad (16)$$

A multinational firm's revenue is increasing in its share of foreign assembly activities γ. Once again, multinational firms headquartered in Home earn more revenue than domestic Home firms, and for sufficiently large values of γ, also earn more revenue than domestic Foreign firms. Hence:

Result 2: The more activities a firm performs abroad, the larger will be the firm.

Note the direction of causality here. Firms are ex ante identical to each other; it is the act of becoming a multinational firm that makes firms larger. In the next section, we

take Results 1 and 2 to the data. Before that, it is worth noting the key assumption required to obtain Result 1. This is the additional fixed cost associated with becoming a multinational firm. Absent this additional cost, it is immediately obvious that Result 1 will not hold, since the rest of the model implies substitution between domestic and foreign employment of assembly workers. On the other hand, inspection of equation (16) makes it clear that the multinational firm's total revenue does not depend on the presence of this additional fixed cost.

2.3 The welfare implications of multinational firms and trade patterns

To obtain the welfare implications of allowing for multinational firms, we first have to solve for the number of each type of firm. Assume that we have an internal solution (i.e. all three types of firms exist in equilibrium). Start from the labour market clearing conditions for the two countries:

$$L_H = n_H(\alpha_H + \beta_H x_H) + n_{MNE}[(1 + \gamma)\alpha_H + (1 - \gamma)\beta_H x_{iMNE}], \qquad (17a)$$

$$L_F = n_F(\alpha_F + \beta_F x_F) + n_{MNE}(\gamma \beta_H x_{MNE}). \qquad (17b)$$

These conditions, when combined with the assumption that $n_{MNE} = \psi n_H^A$, allows us to solve for the number of national and multinational firms in equilibrium:

$$n_H = \frac{(1-\theta)L_H}{\alpha_H}\{1 - \psi[(1-\theta)(1+\gamma) + \theta(1-\gamma)\Phi]\}, \qquad (18a)$$

$$n_{MNE} = \frac{\psi(1-\theta)L_H}{\alpha_H}, \qquad (18b)$$

$$n_F = \left(\frac{1-\theta}{\alpha_F}\right)\{L_F - L_H \psi \gamma \theta \Phi\}. \qquad (18c)$$

There are fewer domestic firms in both countries than when there are no multinational firms, since some labour in each country is now employed by multinational firms. In fact, since each multinational firm employs more workers than the domestic Home firm it replaced, the total number of firms is reduced in the presence of multinationals. In addition, equations (18a) and (18c) show the conditions for an internal solution. From equation (18a), Home domestic firms exist ($n_H \geq 0$) provided the fraction of Home firms which are multinational, ψ, is not too large. Foreign domestic firms exist ($n_F \geq 0$) provided Foreign is not too small relative to Home.

To obtain utility in the presence of multinational firms, first note that since goods prices are equalised across countries and preferences are homothetic, we can define the consumption share of an individual in each country as:

$$\Omega_H^{MNE} = \frac{w_H L_H + n_{MNE}\pi_{iMNE}}{w_H L_H + n_{MNE}\pi_{iMNE} + w_F L_F}\left(\frac{1}{L_H}\right), \qquad (19a)$$

$$\Omega_F^{MNE} = \frac{w_F L_F}{w_H L_H + n_{MNE}\pi_{iMNE} + w_F L_F}\left(\frac{1}{L_F}\right) = \frac{1 - \Omega_H^{MNE} L_H}{L_F}. \tag{19b}$$

The key difference between equations (19a) and (19b) lies in the fact that multinational firms can make positive profits, which are distributed to Home consumers, thus implying that $\Omega_H^{MNE} > \Omega_H^{FT}$, and $\Omega_F^{MNE} < \Omega_F^{FT}$. Utility in the presence of multinational firms is:

$$U_j^{MNE} = \int_0^{n_H + n_F + n_{MNE}} c(i)^\theta di = n_{iH}c_{iH}^\theta + n_{iF}c_{iF}^\theta + n_{iMNE}c_{iMNE}^\theta$$

$$= \frac{\left(\theta\Omega_j^{MNE}\right)^\theta}{(1-\theta)^{\theta-1}}\left\{
\begin{array}{c}
\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right) - \left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right)\psi[(1-\theta)(1+\gamma) + \theta(1-\gamma)\Phi] \\
+ \left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{L_F}{\alpha_F}\right) - \left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{L_H}{\alpha_F}\right)\psi\gamma\theta\Phi \\
+ \left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right)\psi\Phi^\theta
\end{array}
\right\}. \tag{20}$$

Although this is a cumbersome expression, it is not difficult to interpret. The first line in the curly brackets is the welfare from consumption of Home national varieties, the second line is the welfare from consumption of Foreign national varieties, and the third line is the welfare from consumption of multinational varieties. In addition, there are similarities between it and utility under trade in goods alone. Hence welfare in the presence of multinational firms relative to exporting firms only is:

$$G_j^{MNE} = \frac{U_j^{MNE}}{U_j^{FT}} = \left(\frac{\Omega_j^{MNE}}{\Omega_j^{FT}}\right)^\theta\left\{1 + \frac{L_H\left[\begin{array}{c}\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{\psi}{\alpha_H}\right)\Phi^\theta - \left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{\psi\gamma\theta}{\alpha_F}\right)\Phi \\ -\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{1}{\alpha_H}\right)\psi[(1-\theta)(1+\gamma)+\theta(1-\gamma)\Phi]\end{array}\right]}{\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right)+\left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{L_F}{\alpha_F}\right)}\right\}. \tag{21}$$

This time, the first term of the first line in square brackets is the gain from multinational varieties, the second term of the first line is the loss from the reduced number of Foreign varieties, and the second line is the loss from the reduced number of Home varieties. Equation (21) is difficult to sign analytically. However, if the love-for-variety parameter θ is sufficiently large (as assumed above), then $G_j^{MNE} > 1$. That is, the presence of multinational firms leads to a welfare gain relative to the case without multinationals. The reason for this is intuitive. Because multinational firms are larger than the domestic Home firms they have replaced, there are fewer varieties of the good available for consumption. This is offset by the productivity gain from multinational firms. Provided θ is sufficiently large, the loss from fewer varieties is outweighed by the gain in productivity, leading to an overall welfare gain.

We can establish that $dG_j^{MNE}/dL_H > 0$, $dG_j^{MNE}/dL_F < 0$, $dG_j^{MNE}/d\psi > 0$, and $dG_j^{MNE}/d\gamma > 0$. That is, the gain from multinational firms is larger the larger is the

Home country, the smaller is the Foreign country, the larger the fraction of multinational firms, and the larger the fraction of foreign activities. These are as we may expect: the larger the role of multinational firms in the global economy, the greater will be their effect on welfare.

Figure 2: Welfare with multinational firms relative to trade in goods.
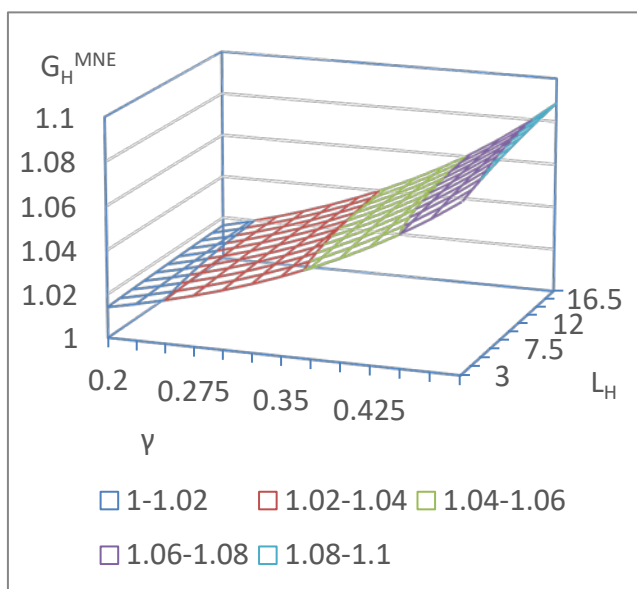
Figure 2a: Home welfare as a function of γ
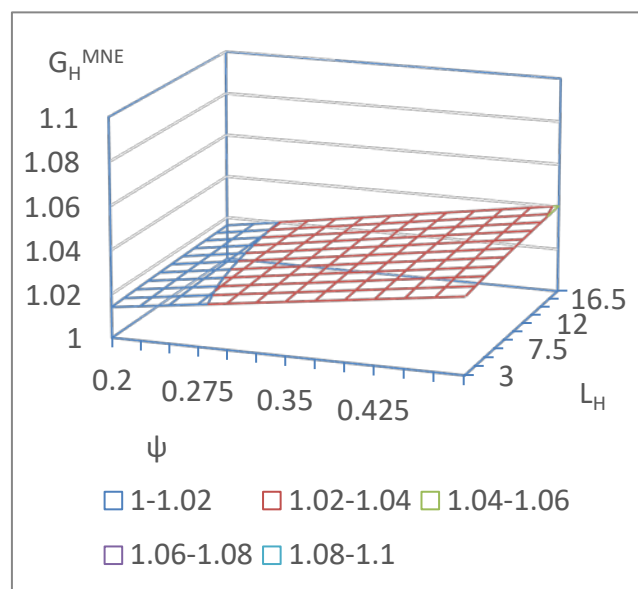
Figure 2b: Home welfare as a function of ψ

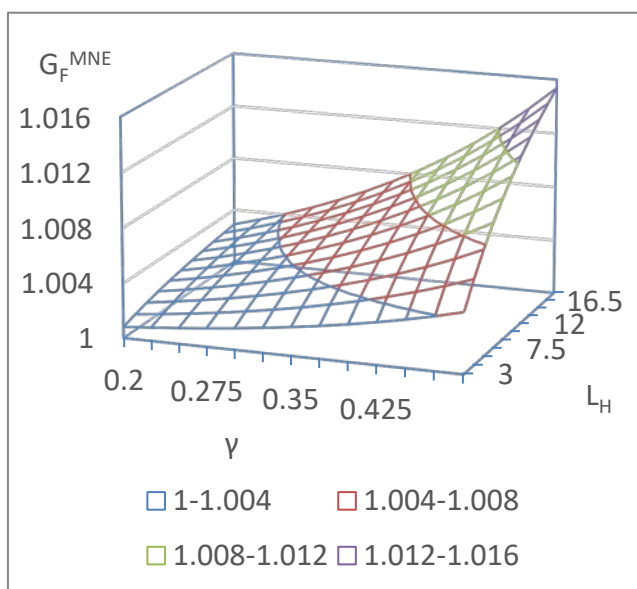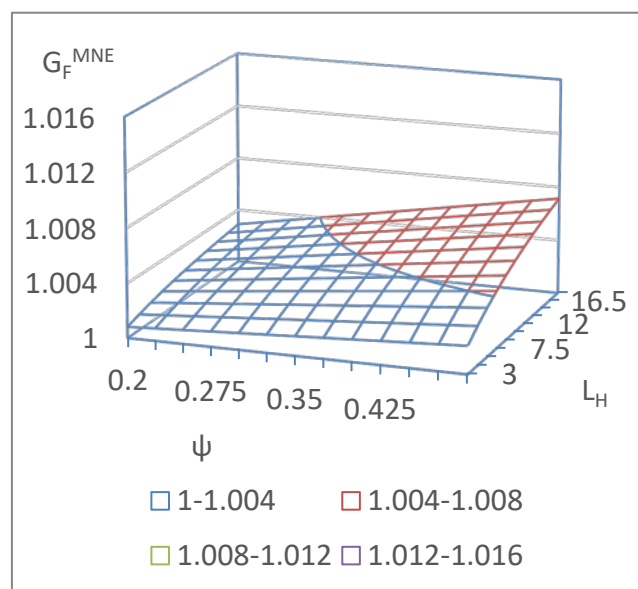Figure 2c: Foreign welfare as a function of γ

Figure 2d: Foreign welfare as a function of ψ

Note: Parameter values assumed: $\alpha_H = 2$, $\alpha_F = 8$, $\beta_H = 1.5$, $\beta_F = 3$, $\theta = 0.8$, $L_H + L_F = 24$. In Figures 2a and 2c, we also assume $\psi = 0.2$, and in Figures 2b and 2d, we also assume $\gamma = 0.2$.

Figure 2 presents the gain from multinational firms relative to trade in goods for the two countries as a function of γ and L_H (Figures 2a and 2c), and as a function of ψ and L_H (Figures 2b and 2d), holding world endowment of labour $L_H + L_F$ constant. Clearly, the gains are increasing in all three parameters for both countries. A few comparisons may be made. First, an increase in the share of multinational firms ψ has a smaller impact than an increase in the fraction of assembly activities performed abroad γ on the gains from multinational firms for both countries. The channel through which the two parameters operate is very different. An increase in γ increases the size of the multinational firm, while keeping the number of multinational firms unchanged. On the other hand, an increase in ψ increases the ratio of multinational firms to domestic Home firms, while keeping the size of the multinational firm unchanged.

A second comparison that can be made is between the gains to Home and Foreign. Noting that the vertical axis has a smaller scale in Figures 2c and 2d compared to Figures 2a and 2b, Home gains much more than Foreign does from multinational firms. This is because multinationals make supernormal profits, which are distributed to Home consumers, thus raising their income. Foreign consumers therefore have a smaller share of world income, which reduces their (still positive) gain from the multinational firms.

Finally, a comparison can be made between Figure 2 and Figure 1. It is clear that the gains from allowing for multinational firms relative to free trade are smaller than the gains from free trade relative to autarky. This is perhaps not surprising. Moving from autarky to free trade (with or without multinational firms) enlarges the market, leading to gains from increased variety, whereas introducing multinational firms actually reduces the total number of varieties available. In addition, recall that the welfare effects of multinational firms arise without factor price adjustments (c.f. Helpman and Krugman (1985) Chapter 12); they exist because of the shift towards a more efficient means of production.

The pattern of trade may be described as follows. Home and Foreign domestic firms export a fraction of their output in the usual Krugman (1980) manner, depending on the relative incomes of the two countries. Multinational firms export headquarters services and part of the product from Home to Foreign, and import the other part of the product. Viewed in this manner, if overall trade is balanced, then the model predicts that the developed Home country will run a deficit in trade in goods, which is balanced by its trade surplus in headquarters services. Hence, the model provides

one potential explanation for the large deficit in goods trade of countries like the US and UK (and, conversely, the large trade surpluses of countries like China).

3   Empirical evidence

The data which we use comes from the UNCTAD World Investment Report, which presents data for the 100 largest non-financial multinational firms in the world (ranked by foreign assets), and the 100 largest non-financial multinational firms from developing countries (50 largest from developing countries before 2004). Although the World Investment Report has been published since 1991, early data was often incomplete. The sample we use thus starts from 2000 and ends in 2015 for developing country firms and 2016 for world firms. One year of data is missing: 2014 for world firms, and 2013 for developing country firms. A few firms – the largest developing country firms – appear in both samples; in these cases the duplicates are dropped, and never exceeds ten firms in any given year[7]. Variable definitions are provided in the Methodological Notes to the World Investment Report (UNCTAD (2017)).

Table 1: The 10 largest multinational firms from all countries and developing countries, 2015.

All firms		Developing countries	
Firm	Foreign Assets	Firm	Foreign Assets
Royal Dutch Shell	288,283	CK Hutchison	118,250
Toyota	273,280	China Nat. Offshore Oil Corp	66,673
General Electric	257,751	Hon Hai (Foxconn)	64,040
Total	236,719	Samsung Electronics	62,294
BP	216,698	Petronas	47,912
Exxon Mobil	193,493	China Shipping Corp	43,076
Chevron	191,933	Vale	35,338
Volkswagen	181,826	China Minmetals Corp	35,165
Vodafone	166,967	America Movil	34,480
Apple Computer	143,652	Tata Motors	30,589

Note: Foreign assets are in US$millions.

It may seem incongruous to use data on multinational firms from both developed and developing countries, given our theoretical model which predicts multinational firms emerging only in developed countries. However, almost all the firms in the sample from

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[7] There is entry and exit of firms from the sample in each year. Firms which exit the sample tend to be the smaller firms in the previous year. However, we do not have data on firms which exit the sample, so we are not able to estimate a Heckman selection model. Therefore our results may be interpreted as being conditional on remaining in the sample. Tables 2 and 3 report the number of firms in the sample, so the magnitude of this effect can be assessed.

developing countries are from countries which are not the poorest countries in the world. For instance, in 2015, of the 100 firms from developing countries, 18 were from China, 14 from Hong Kong, 10 from Singapore, 8 from India, 7 apiece from South Korea and Mexico, 6 apiece from Brazil, South Africa, and Taiwan, and 5 from Malaysia, with the remaining 13 from a variety of countries. By the same token, it is instructive to identify the largest firms in our sample, for both groups of countries; this is shown in Table 1 for 2015. Perhaps unsurprisingly, since the sample is based on foreign assets, the list is dominated by petrochemical and mining firms, with many of the other firms being involved in electronics or motor vehicles.

Results 1 and 2 in Section 2 above provide two testable hypotheses. Result 1 states that there is a positive association between domestic and foreign employment by a multinational firm. Result 2 states that a firm which expands its foreign employment, will experience more revenues. We therefore estimate the following equations separately, where each observation is a firm i in year t:

$$\ln DE_{it} = \delta_i + \delta_t + \delta_1 \ln FE_{it} + v_{it}, \tag{22}$$

$$\ln TR_{it} = \kappa_i + \kappa_t + \kappa_1 \ln FE_{it} + \varepsilon_{it}, \tag{23}$$

where DE_{it} is the firm's domestic employment, TR_{it} is total revenue of the firm, FE_{it} is the firm's foreign employment, $\kappa_i, \delta_i, \kappa_t$ and δ_t are firm and year fixed effects, and ε_{it} and v_{it} are the error terms. The inclusion of the firm and year fixed effects means that we can control for unobserved heterogeneity across firms and across time, and that the coefficients are identified through within-firm, across-time variation in the data.

Foreign employment is likely to be simultaneously determined with domestic employment, and with total revenue. Hence, in addition to the standard fixed effects estimator, we also perform some Instrumental Variables-Generalized Method of Moments (IV-GMM) estimation[8]. Limitations in the data mean that we are constrained in the choice of instruments we can use. We therefore instrument foreign employment with lagged foreign revenues and foreign assets. These instruments are likely to be highly correlated with the instrumented variable. For the instruments to be valid, the identifying assumption is that past values of foreign revenues and assets would affect current domestic employment and total revenue only through their effect on current foreign employment. We perform the standard IV specification tests to test the validity of the instruments. Figure 3 shows the distribution of total revenues over

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[8] IV-GMM is efficient in the presence of heteroscedasticity of unknown form, whereas the conventional IV estimator is not.

time. There is convergence of firm sizes, which may be explained by firms from developing countries, which are on average smaller, growing more rapidly on average than firms from developed countries[9].

Figure 3: Distribution of total revenues, 2005, 2010 and 2015.

kernel = epanechnikov, bandwidth = 0.3347
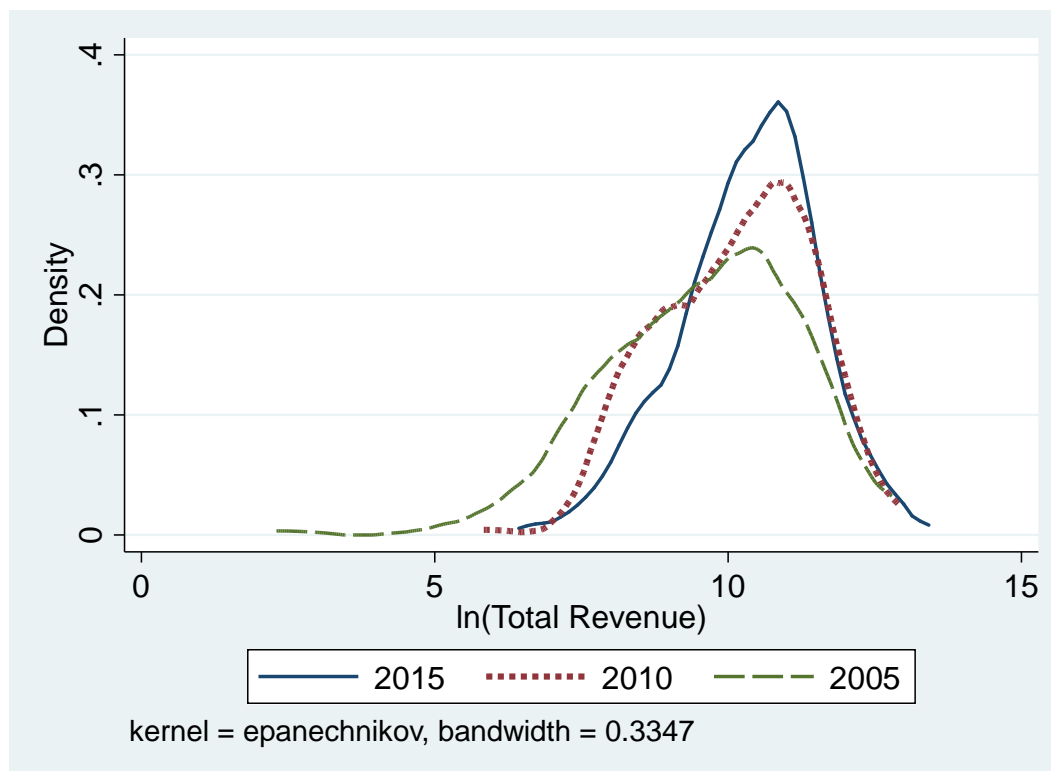
3.1 Foreign and domestic employment

We use our data to ask the following question: Do multinational firms export jobs? That is, does increasing foreign employment imply a reduction in domestic employment? Figure 4 presents a first answer to this question: unambiguously, no. In fact, quite the opposite: there is a positive correlation between firms' employment abroad, with their employment at home (the correlation coefficient is 0.44, with a p-value of 0.000, while the best-fit line implies that a 1 percent increase in foreign employment is associated with a 0.58 percent increase in domestic employment).

Although Figure 4 is suggestive, it does not control for firm-specific or time-specific characteristics, so the correlation observed may be due to some firm characteristics. We therefore turn to more formal econometric analysis. Table 2 presents the results of

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[9] Across the full sample, the average annual growth rate of total revenues for firms from developed countries is 5.8 percent, while for firms from developing countries it is 11.0 percent.

estimating equation (22). Columns (1) and (2) report the fixed effects results, without and with year fixed effects, columns (3) and (4) report the IV-GMM results, and columns (5) and (6) report the first stage of the IV-GMM regressions. Since the IV-GMM estimates entail the use of lags as instruments, we lose many observations; for consistency, we report results for the same sample across specifications. The conventional fixed effects estimates do not yield a statistically significant relationship between domestic and foreign employment. However, the IV-GMM results are positive and highly significant, confirming the result in Figure 4 and Result 1 from the model, that foreign employment has a positive effect on domestic employment. Since the main variables are in logs, there is a simple interpretation of the size of the coefficients: for the IV-GMM results, a 1 percent increase in foreign employment will increase domestic employment by 0.4 to 0.5 percent. The IV-GMM coefficients are much larger than the fixed effects coefficients, which may indicate that the IV-GMM approach is able to overcome the attenuation bias associated with the endogeneity of foreign employment.

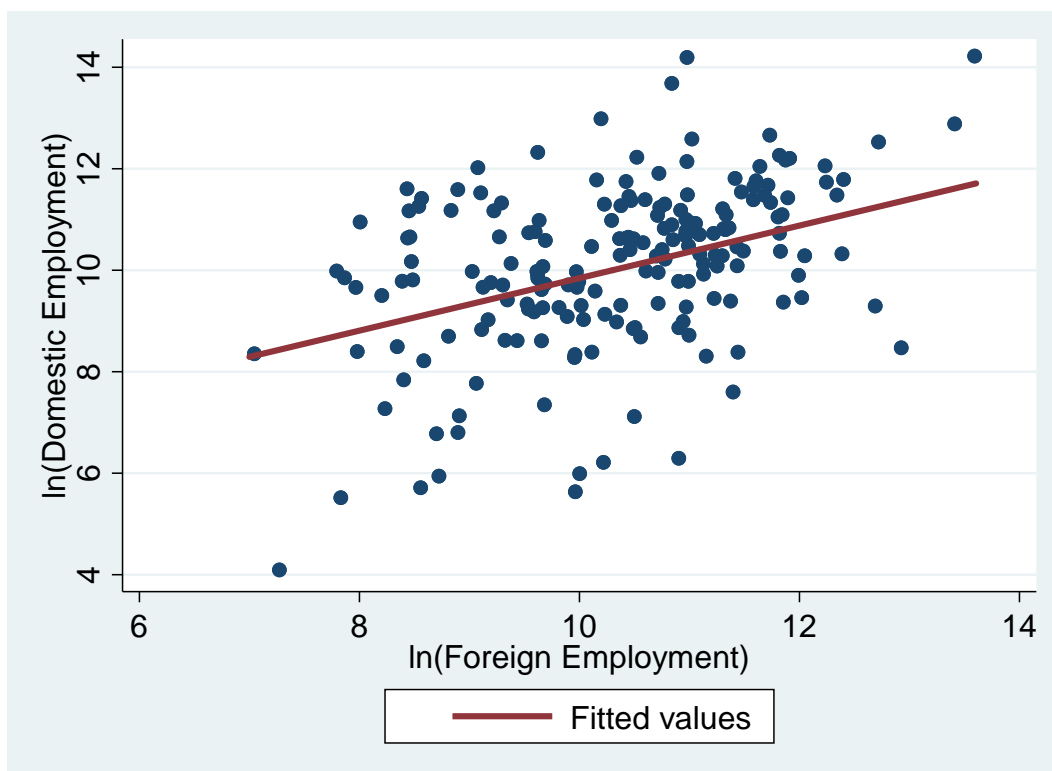Figure 4: Correlation between domestic and foreign employment, 2015.

Table 2: Foreign and domestic employment.

Dependent variable	(1) $\ln DE_{it}$	(2) $\ln DE_{it}$	(3) $\ln DE_{it}$	(4) $\ln DE_{it}$	(5) $\ln FE_{it}$	(6) $\ln FE_{it}$
Estimation Method	FE	FE	IV-GMM	IV-GMM	FE	FE
$\ln FE_{it}$	-0.038	-0.085	0.363	0.512		
	(0.123)	(0.133)	(0.104)**	(0.153)**		
$\ln FR_{it-1}$					0.215	0.225
					(0.041)**	(0.047)**
$\ln FA_{it-1}$					0.279	0.317
					(0.057)**	(0.057)**
R^2	0.00	0.03			0.25	0.26
$N \times T$	1,842	1,842	1,842	1,842	1,842	1,842
N	271	271	271	271	271	271
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
Hansen test			0.73	0.33		
Hansen p-value			0.39	0.57		
Kleibergen-Paap UnderID test			40.13	36.84		
K-P test p-value			0.00	0.00		
Kleibergen-Paap Weak ID test			77.33	52.64		

Notes: * significant at 5%; ** significant at 1%. Standard errors clustered by firm in parentheses. Columns (5) and (6) report the first stage results of the IV-GMM estimates in columns (3) and (4). Estimation method is by fixed effects in columns (1), (2), (5) and (6), and by IV-GMM in columns (3) and (4), in which $\ln FE_{it}$ is treated as endogenous and is instrumented with lagged foreign revenues $\ln FR_{it-1}$ and lagged foreign assets $\ln FA_{it-1}$. Since there is a single endogenous regressor, the Kleibergen-Paap Weak ID test is identical to the first-stage F-statistics. The Kleibergen-Paap Weak ID test statistics lies outside the 10% maximal IV size of the Stock-Yogo critical values in columns (3) and (4).

Table 2 also reports several diagnostic tests of the IV-GMM estimator. The Hansen test of overidentification is never rejected at any conventional significance levels, indicating joint validity of the instruments used. On the other hand, the Kleibergen-Paap underidentification test and the Kleibergen-Paap weak identification test strongly reject the null of under- and weak identification, respectively. The results in columns (5) and (6) of Table 2 also indicate that the two instruments used, lagged foreign revenues and lagged foreign assets, are both highly significantly (and positively) associated with foreign employment. Overall the diagnostic tests support the choice of instruments used.

3.2 Firm size and multinational activity

Figure 5 presents a scatter diagram of total revenues and foreign employment, for 2015. There is an unambiguous positive association between the two variables: on average, firms with more foreign employment have more total revenues. The correlation coefficient is 0.49, with a p-value of 0.000, and the best-fit line implies that a 1 percent increase in foreign employment is associated with a 0.46 percent increase in total revenues.

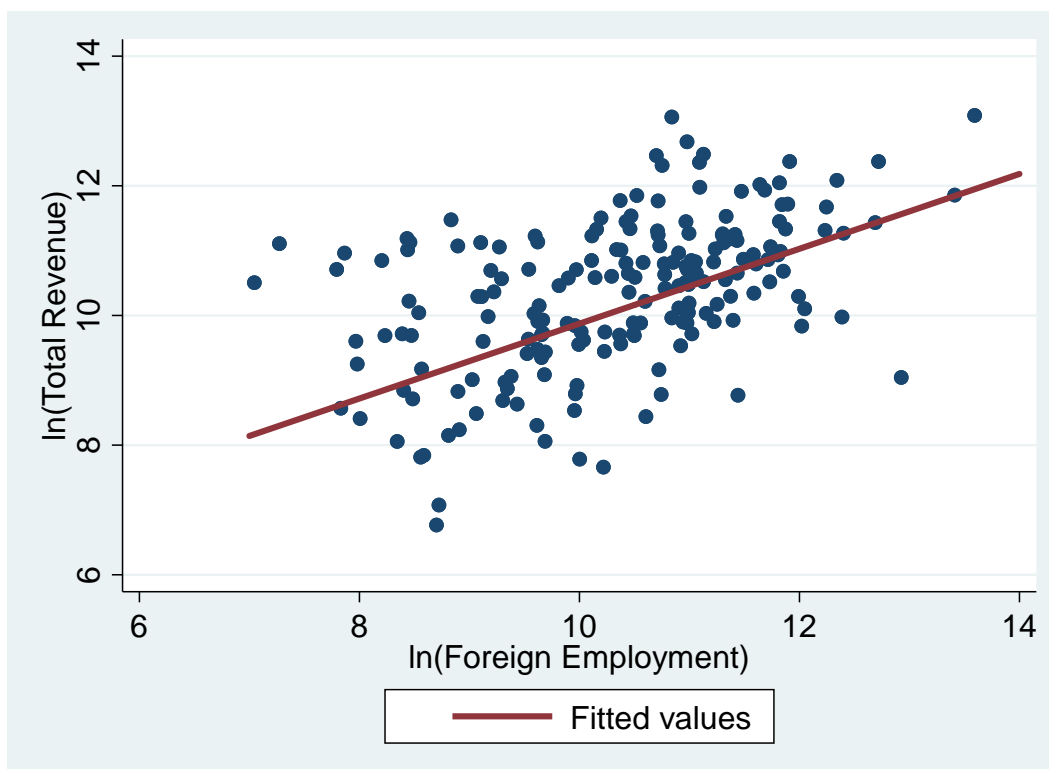Figure 5: Correlation between total revenue and foreign employment, 2015.

Table 3: Foreign employment and total revenues (dependent variable: $\ln TR_{it}$).

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable	$\ln TR_{it}$	$\ln TR_{it}$	$\ln TR_{it}$	$\ln TR_{it}$	$\ln FE_{it}$	$\ln FE_{it}$
Estimation Method	FE	FE	IV-GMM	IV-GMM	FE	FE
$\ln FE_{it}$	0.366	0.218	1.192	0.892		
	(0.050)**	(0.040)**	(0.105)**	(0.106)**		
$\ln FR_{it-1}$					0.212	0.222
					(0.041)**	(0.047)**
$\ln FA_{it-1}$					0.278	0.319
					(0.056)**	(0.057)**
R^2	0.23	0.53			0.24	0.25
$N \times T$	1,851	1,851	1,851	1,851	1,851	1,851
N	272	272	272	272	272	272
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
Hansen test			0.76	1.50		
Hansen p-value			0.38	0.22		
Kleibergen-Paap UnderID test			39.69	36.61		
K-P test p-value			0.00	0.00		
Kleibergen-Paap Weak ID test			76.69	53.44		

Notes: * significant at 5%; ** significant at 1%. Standard errors clustered by firm in parentheses. Columns (5) and (6) report the first stage results of the IV-GMM estimates in columns (3) and (4). Estimation method is by fixed effects in columns (1), (2), (5) and (6), and by IV-GMM in columns (3) and (4), in which $\ln FE_{it}$ is treated as endogenous and is instrumented with lagged foreign revenues $\ln FR_{it-1}$ and lagged foreign assets $\ln FA_{it-1}$. Since there is a single endogenous regressor, the Kleibergen-Paap Weak ID test is identical to the first-stage F-statistics. The Kleibergen-Paap Weak ID test statistics lies outside the 10% maximal IV size of the Stock-Yogo critical values in columns (3) and (4).

Turning to more formal econometric evidence, the results of estimating equation (19) are reported in Table 3. As with Table 2, columns (1) and (2) report fixed effects results without and with year fixed effects, columns (3) and (4) perform the same for IV-GMM results, and columns (5) and (6) report the first stage of the IV-GMM regressions. In columns (1) to (4), we find a positive and highly significant relationship between foreign employment and total revenues. This is supportive of Figure 5 and Result 2 from the theoretical model. The size of the IV-GMM coefficients indicate that a 1 percent increase in foreign employment will increase the total revenue of a firm by 0.9 to 1.1 percent. As before, the larger IV-GMM coefficients as compared with the fixed effects results may be indicative of the attenuation bias caused by the simultaneity between foreign and domestic employment. Similarly, the diagnostic tests and first stage regressions (columns (5) and (6)) are very similar to those reported in Table 2, since we employ the same instruments to instrument the same variable (although the sample size is slightly different from that in Table 2). All these diagnostics suggest that we can be confident in the instruments chosen. We conclude that the empirical evidence is supportive of the presence of a positive association between foreign employment and the total revenue of the firm.

3.3 Sensitivity and alternative specifications

For brevity we have only presented the main econometric results. There are many extensions that could be pursued in terms of data and methods, and results are available from the author upon request. On the data side, there are several ways in which the data could be sliced; for instance, whether the firm is from a developing country or not, and before and after the Great Recession of 2008. Results are broadly consistent across samples.

Many alternative econometric specifications could be explored. For example, using lagged foreign employment in columns (1) and (2) of Table 2 instead of current foreign employment, results in coefficients which are positive and often statistically significant. Estimating foreign employment as a function of domestic employment (i.e. the opposite of what is reported in Table 2) yields very similar results. Alternative estimation methods could also be used, for example Limited Information Maximum Likelihood (LIML) and Continuously Updated GMM Estimator (CUE), which have superior small sample properties when compared with the IV-GMM methods used in the main results. More ambitious would be to try and simultaneously estimate foreign and domestic employment in Table 2 (likewise total revenue and foreign employment in Table 3) using a three-stage-least-squares estimator.

4   Conclusions

In this paper we develop a simple model of vertical multinational firms in which firms engage in production abroad in order to benefit from lower wages. The model is an extension of the Krugman (1980) model of international trade under monopolistic competition, and yields two empirical predictions. First, a firm that expands its foreign activities also expands its domestic activities. Second the more activities that are produced abroad by a firm, the larger the firm becomes. Both predictions are confirmed using data on the largest multinational firms in the world. The model also generates the result that multinational firms yield a small but positive effect on global welfare.

The analysis in this paper can be extended on both the theoretical and empirical sides. On the theoretical side, the obvious extensions are to consider differences in factor intensities and factor endowments (Markusen and Venables (2000)), firm heterogeneity (Helpman et al (2004)), or richer patterns of comparative advantage (Soo (2017)). These extensions may also aid in endogenising some of the parameters which we currently take as exogenous. Similarly, on the empirical side, more detailed and richer data, for instance on the countries or activities which multinational firms engage in abroad, may yield a more nuanced picture of the activities and implications of multinational firms, and may help guide the development of models which are more useful for understanding multinational firms.

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Appendix A: Multinationals and offshoring: More than just semantics?

What is the difference between a multinational firm, and a firm which engages in offshoring? In some sense, the difference is merely semantic: offshoring is a more recent term than multinational firm. For instance, According to Google Books, the term "offshoring" experienced a quadrupling in use between 1996 and 1997, with a subsequent rapid increase, whereas there was no concurrent increase in the use of the term "multinational". As another example, in the Handbook of International Economics Volume 3 (published in 1995), there is no entry in the Index of either "offshoring" or "outsourcing", and two multi-page entries on "multinational enterprises" (both referring to Krugman's chapter). In Volume 4 (published in 2014), there are entries for both "offshoring" and "multinational firms".

On the other hand, it may be argued that the distinction between the two terms lies in the boundaries of the multinational firm (see Antras and Rossi-Hansberg (2009)). A multinational firm owns its foreign production facilities, whereas a firm which offshores part of its production, is engaged in arms-length transactions with its suppliers. In the paper, we abstract from issues surrounding the boundaries of the firm. Hence we make use of the term "multinational firm", and assume that all parts of the production process occur within the firm.

Appendix B: Allowing for a fixed cost in Foreign

Suppose that, in addition to the higher fixed cost at Home, becoming a multinational firm also incurs a fixed cost in Foreign, equal to $\gamma \alpha_H$. In this formulation, the fixed cost rises with the share of production carried out in Foreign. Then, the profit of the firm will be:

$$\pi_{iMNE} = p_{iMNE} x_{iMNE} - (1 + \gamma) w_H \alpha_H - (1 - \gamma) w_H \beta_H x_{iMNE}$$
$$- \gamma w_F \alpha_H - \gamma w_F \beta_H x_{iMNE}. \qquad (B1)$$

Since prices depend only on marginal costs and not on fixed costs, and since the multinational firm's output is a multiple of a domestic Home firm's output that does not depend on fixed costs, prices and output remain as in equations (10) and (12). Similarly, Results 1 and 2 are unaffected. What does change, is equation (13) setting the condition for which the assumed equilibrium is indeed an equilibrium. Now, we require:

$$x_{iMNE} \geq \frac{[(1+\gamma)w_H + \gamma w_F]}{[(1-\gamma)w_H + \gamma w_F]} \left[\frac{\alpha_H \theta}{\beta_H (1-\theta)} \right] \qquad (B2)$$

This is a more stringent requirement than equation (13); the addition of the fixed cost in Foreign makes it harder for a multinational firm to make non-negative profits and satisfy the participation constraint. The labour market clearing conditions are (17a) and:

$$L_F = n_F(\alpha_F + \beta_F x_F) + n_{MNE}(\gamma\alpha_H + \gamma\beta_H x_{MNE}). \tag{B3}$$

Hence the number of domestic Home firms is given by (18a), while the number of domestic Foreign firms is:

$$n_F = \left(\frac{1-\theta}{\alpha_F}\right)\{L_F - L_H\psi\gamma(1-\theta+\theta\Phi)\}, \tag{B4}$$

which is fewer than the case in the text, for the obvious reason: because multinational firms now use more labour in Foreign, there is less labour left for domestic Foreign firms. The expressions for the income shares of the two countries are given by (19a) and (19b), except that, because of the additional fixed cost, multinational firms' profits are lower, so $\boldsymbol{\Omega_H^{MNE}}$ is smaller, and $\boldsymbol{\Omega_F^{MNE}}$ is larger. Utility with multinational firms is given by:

$$U_j^{MNE} = \frac{\left(\theta\Omega_j^{MNE}\right)^\theta}{(1-\theta)^{\theta-1}}\left\{\begin{array}{c}\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right) - \left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right)\psi[(1-\theta)(1+\gamma)+\theta(1-\gamma)\Phi]\\+\left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{L_F}{\alpha_F}\right)-\left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{L_H}{\alpha_F}\right)\psi\gamma(1-\theta+\theta\Phi)\\+\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right)\psi\Phi^\theta\end{array}\right\} \tag{B5}$$

Where the only difference from equation (20) is in the second line showing the welfare from consumption of Foreign national varieties. Hence the gain from having multinational firms is:

$$G_j^{MNE} = \frac{U_j^{MNE}}{U_j^{FT}} = \left(\frac{\Omega_j^{MNE}}{\Omega_j^{FT}}\right)^\theta\left\{1 + \frac{L_H\left[\begin{array}{c}\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{\psi}{\alpha_H}\right)\Phi^\theta-\left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{\psi\gamma(1-\theta+\theta\Phi)}{\alpha_F}\right)\\-\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{1}{\alpha_H}\right)\psi[(1-\theta)(1+\gamma)+\theta(1-\gamma)\Phi]\end{array}\right]}{\left(\frac{\alpha_H}{\beta_H}\right)^\theta\left(\frac{L_H}{\alpha_H}\right)+\left(\frac{\alpha_F}{\beta_F}\right)^\theta\left(\frac{L_F}{\alpha_F}\right)}\right\}. \tag{B6}$$

Where again the only difference is that the smaller number of Foreign varieties reduces the gains from multinational firms. We therefore conclude that adding a fixed cost in Foreign has no material impact on the results in the text.

This setup could be further extended. For example, one could specify the fixed cost as consisting of a headquarters fixed cost and a plant fixed cost, so that

$$\alpha_H = \alpha_H^{HQ} + \alpha_H^P. \tag{B7}$$

Becoming a multinational firm may increase the headquarters cost for reasons explained in the text, but may reduce the plant fixed cost since part of the production

process is now done abroad. Then the total fixed cost of the multinational firm in terms of labour would be:

$$(1 + \delta)\alpha_H^{HQ} + (1 - \gamma)\alpha_H^P + \gamma\alpha_H^P \qquad (B8)$$

Where the first term is the headquarters cost including the additional cost of becoming a multinational and $\delta \neq \gamma$, the second term is the reduced plant cost in Home due to the reduced production being done at Home, and the third term is the fixed cost of opening a plant in Foreign. Provided the conditions specified in the text are met, these extensions have no material impact on the results in the text.