The effect of international firm mobility on wages and unemployment

Abstract

Although the increase in international firm mobility is well documented, its effects on macroeconomic aggregates and the labour market remain controversial. Multi-national enterprises (MNEs) benefit from an international outside option during wage bargaining, leading to a decrease in average wages. However, a strategic incentive to hire extra workers in a foreign (home) plant in order to reduce wages in the home (foreign) plant has an indirect positive effect on wages due to spillovers resulting from an increased demand for labour. In a framework of frictional unemployment, permitting MNEs leads to a decrease in unemployment. Abstracting from transport and plant fixed costs, MNEs lead to higher wages. Including transport and plant costs generally leads to lower wages, though the effects are small. The strategic hiring effect is important in mitigating the fall in wages.
1. Introduction

On 1st November 2006, the International Trade Union Confederation was formed in another attempt for the workers of the world to unite. When commenting on a possible merger of a British and a US union, the then joint general secretary of Britain’s largest union said: "Multinational companies are pushing down wages and conditions for workers the world over by playing one national workforce off against another."

Firms are now more mobile. Due to legal changes (such as the Single European Act), and technological changes (such as lower costs in providing parts maintenance and customer service from abroad) capital mobility has increased across the world (Eaton and Kortum, 2001). Trade unions have responded by increasing cooperation internationally, working through umbrella organisations such as the European Trade Union Confederation, but so far, cooperation in the area of transnational collective bargaining has not taken place. Indeed such cooperation is illegal in many OECD countries. Stole and Zwiebel (1996) show that within firms workers benefit from being in a single union if they are substitutes (where the labour revenue product function is concave), but that they benefit from bargaining for wages separately if they are complimentary (where the labour revenue product function is convex). Analogous to this is the case of a firm having several plants. Skaksen and Sorensen (2001), again using a partial equilibrium framework, show that if workers are complimentary then they may gain from FDI. In contrast, if workers

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are substitutes in two countries then workers lose from FDI. Firm mobility can improve the bargaining position of firms when a constant demand for labour is assumed, but it is important to understand the effect of firm mobility on wages and unemployment in general equilibrium. This paper addresses the question, what is the effect of increased firm mobility on wages and unemployment?

Although market size is the most important determinant of where multinational enterprises (MNEs) locate, labour market institutions have a significant impact on firm location (Bognanno et al., 2005). Despite MNEs advantage in bargaining, it is a stylised fact that MNEs pay higher wages (Conyon et al., 2002). However, controlling for plant size and education greatly reduces the foreign ownership wage premium (Lipsey and Sjoholm, 2004; Heyman et al., 2007). Girma and Gorg (2007) suggest that where multinationals pay more, it is due to higher productivity. Controlling for firm and individual characteristics, Braun (2009) finds that the trade union wage premium actually disappears in foreign firms. Using German data Braun and Scheffel (2007) estimate the effect of outsourcing on the union wage premium. They find that the wage premium is smaller for the low skilled in sectors affected by outsourcing while the wages of those not covered by collective agreements are unaffected. This supports the hypothesis that, ceteris paribus, multinational firms pay lower wages due to their advantage in bargaining.

In this paper, we present a new mechanism for how globalisation can affect labour markets. The model extends the new trade model of Markusen and Venables (1998) by including labour market frictions and union bargaining. In the presence of union bargaining firms have an incentive to hire workers abroad in order to improve their outside option during bargaining, increasing the demand for labour. This effect has been ignored in the partial equilibrium literature (see
Gaston and Nelson, 2002), where labour demand is typically constant. In addition, in the presence of frictional labour markets there is a possibility for the increased demand for labour to lead to both lower unemployment and higher wages.

The intuition for how the bargaining advantage of MNEs can lead to higher wages is as follows. In a two-country economy with a good sector characterised by Cournot competition; where there are no transport costs or labour market friction; firms pay workers their marginal product; and there are no plant fixed costs; firms are indifferent whether they operate as national firms or as MNEs. By extending the model to include a cost of transporting the good internationally and fixed costs in establishing a plant, each firm faces a trade-off between operating as a national firm (and thereby incurring the cost of transporting the good internationally), or operating as a MNE (and incurring the fixed cost of having an additional plant abroad). Extending the model further to include labour market frictions and plant level wage bargaining (in which workers are represented by a union), creates an extra incentive for a firm to operate as a MNE. Firms are motivated to become MNEs to reduce the outside option of workers in the wage bargain.

The general equilibrium effects of hiring extra workers to affect the wage bargain were examined before, in a setting of individual rather than union bargaining over wages. In a model in which labour is the only factor, Krause and Lubik (2007) show that accounting for intra-firm bargaining increases wages by about 20 per cent and decreases the number of unemployed workers by approximately 15%. In an unpublished version of a paper Cahuc et al. (2008) show that where both labour and capital are present accounting for intra-firm bargaining raises wages by about 20% and the number of unemployed workers decreases by 12%, if capital is held constant.
The strategic hiring incentive is important as an increased demand for labour increases labour market tightness. This improves the value of unemployment (which is the outside option for workers) by making it easier for unemployed workers to find a job, and decreases the outside option for firms by making it more difficult for firms to fill a vacancy. In addition, as there is a competitively traded good sector which uses a specific resource, drawing labour into the Cournot sector increases the resource/labour ratio in the competitive sector and increases wages in the competitive sector. This can increase wages in the Cournot sector as if wages are higher in the competitive sector; the value of unemployment increases for workers. This improves the value of alternative employment. Both the effect on the resource/labour ratio and the increase in labour market tightness serve to increase the bargaining position of workers. Counter-intuitively, the availability of an outside option to MNEs may actually raise wages for all workers.

There have been relatively few general equilibrium models incorporating labour market matching frictions and MNEs. Dutt, et al. (2007) look at off-shoring and unemployment but ignore strategic hiring effects. In an extension of the Melitz (2003) model, Helpman et al. (2004) look at the choice faced by firms between exporting and establishing a foreign plant. Only the most productive firms open a foreign plant as they face a cost of entry. Eckel and Egger (2009) look at the effect of multinationals on wage bargaining and find that firm mobility leads to a rise in wages. Their model also extends that of Melitz (2003) to include MNEs, whereby MNEs may locate abroad due to the potential to save money in the wage bargain. However, there are no labour market matching frictions, and firms simply choose the number of workers so their marginal return equal wages. Wages rise due to MNEs having higher productivity, but they largely ignore unemployment.
The paper is organised as follows. In Section 2, we present the model and outline the equilibrium. Section 3 outlines details of the equilibrium and calibration. In Section 4, we present the results of the numerical analysis. Section 5 concludes.

2. The model

The model is an extension of the "new trade" model of Markusen and Venables (1998) by including labour market frictions, bargained wages, and discreet time. There are two countries, a home country $h$ and a foreign country $f$, and two homogeneous goods, $X$ and $Y$. The $Y$ sector good is traded competitively and the $X$ sector is characterised by Cournot competition. Countries are endowed with a continuum of two factors, labour ($L$), and resources ($R$). Firms use labour in production in both sectors and resources are only used in the competitively traded sector. It is useful to think of $Y$ as a competitively traded product which uses the resource land. A star is used to denote variables located in country $f$. So, $R$ is the resource endowment of country $h$ and $R^*$ is the resource endowment of country $f$. We only present equations for one country to avoid duplication.

Though labour is mobile between sectors, it is immobile between countries. The competitively traded good sector firms are small and produce in only one country (though they may sell their product in either country). In contrast, firms in the Cournot good sector may operate as national firms, which produce in only one country, or as MNEs and have production plants in both countries.

The competitively traded good is traded internationally without any cost of transportation. There is a cost to transport the Cournot good internationally. A firm in the Cournot sector can either operate as a national firm which has a plant in only one country (and which may export abroad), or as a multinational enterprise
(MNE), which has a headquarters in its home country but a manufacturing plant in both countries. It is possible for national firms and MNEs to coexist. As with the model of Markusen and Venables (1998), costs (with the exception of vacancy posting costs, \( \phi \), which were not present in the model of Markusen and Venables (1998)) are measured in terms of labour used. As in Markusen and Venables (1998), the utility of the representative consumer is given by \( U = X^{\delta} Y^{1-\delta} \), where \( Y_c \) is the amount of the competitively traded good consumed in the country, \( X_c \) is the total amount of the Cournot good consumed in the home country, and \( \delta \) is the elasticity of substitution between good \( X \) and \( Y \).

The budget constraint, that national income equals national expenditure, is given by

\[
Υ = P(X_c) X_c + P(Y_c) Y_c, \quad (1)
\]

where \( P(X_c) \) is the price of the Cournot good in the home country, \( P(Y_c) \) is the price of the competitively traded good, and \( \Upsilon \) is the national income of the home country. By maximising utility subject to the budget constraint, the product demands are

\[
X_c = \frac{\delta \Upsilon}{P(X_c)}, \quad Y_c = \frac{(1 - \delta) \Upsilon}{P(Y_c)}. \quad (2)
\]

The indirect demand equations for \( X_c \) and \( Y_c \) are given by

\[
P(X_c) = \frac{\delta \Upsilon}{X_c}, \quad P(Y_c) = \frac{(1 - \delta) \Upsilon}{Y_c}.
\]

The price index for the economy is defined as

\[
P(X_c, Y_c) = P(X_c)^{\delta} P(Y_c)^{1-\delta},
\]

which was calculated by inserting Eq. (2) into the utility function, which gave an
indirect utility function in terms of prices and nominal income, and then rescaling. The price index is normalised such that

\[ P(X_c, Y_c) = 1 \]

so all values presented in this paper are in real terms.

The labour market is characterised by frictional unemployment. If a firm posts a vacancy this period, there is a probability that it will fill this vacancy and have a worker next period. There is a cost, \( \phi \), to posting a vacancy. Country \( i \) has a continuum of measure \( L \) workers. There is a Cobb-Douglas matching technology \( su^\rho v^{1-\rho} \), which gives the total number of matches between unemployed workers (the mass of workers looking for a job) with vacancies, where \( u \) is the mass of unemployed workers in the home country, \( v \) is simply the total sum of the vacancies posted by the different firms operating in the home country, and \( \rho \) and \( s \) are parameters.

Labour market tightness is defined as

\[ \theta = \frac{v}{u}. \]  

(3)

Dividing the matching function by \( v \) we get the intensive matching function

\[ q(\theta) = s \left( \frac{u}{v} \right)^\rho = s\theta^{-\rho}. \]  

(4)

If a firm posts a vacancy this period, the probability that it fills the vacancy this period (and so have a worker available to work next period) is given by \( q(\theta) \). This term is increasing in \( u \) so the more unemployment there is the easier it is for a firm to find a worker. A firm can enter the labour market by posting a vacancy at cost \( \phi \).
The exogenous probability that the job-worker pair is destroyed is given by $\lambda$. As firms may be large, it is important to distinguish between job destruction due to the separation of a worker from the firm, $\tilde{\lambda}$, and the probability of firm destruction, $\eta$. Exogenous firm destruction is necessary to prevent multiple solutions in the steady state. $\lambda$ is defined such that $\lambda = \eta + \tilde{\lambda} - \tilde{\lambda}\eta$.

2.1. Workers value functions

We assume that all agents in the economy are risk neutral. Workers in a country may work for one of four types of firm. They may work for

- a competitively traded good sector firm based in their home country,
- a Cournot sector national firm based in their home country,
- a Cournot sector MNE firm headquartered in their home country, or
- a Cournot sector MNE firm headquartered in the foreign country.

Different types of firms may pay different wages. The value to a worker of having a job depends on the wages and future value of employment, which depends on firm type. The probability of unemployment is determined exogenously and is independent of firm type. The value to workers of employment is

$$W^k_i = w^k_i + \beta(\lambda U' + (1 - \lambda)W^{k'}_i), \quad k = Y, M, N, \quad i = h, f, \quad (5)$$

where $w^k_i$ is the wage, $U'$ is the value of being unemployed next period, $\beta$ is the discount rate. The value of having a job is increasing in the wage, the value of continuing to have a job next period, and due to the risk of unemployment it is increasing in the value of being unemployed. Subscript $i$ denotes the nationality of the firm the worker is employed by, and is only relevant if the worker is employed
by a multinational firm. The superscript $k$ denotes the type of firm, $Y, N, M$, the worker is working for. Superscript $Y$ denotes a competitively traded good sector firm, $M$ denotes a Cournot sector MNE and $N$ denotes a Cournot sector national firm.

Unemployed workers do not participate in the product market. They do gain some utility, $z$, which is the utility a worker receives from non-market activities. We consider this as home production, which the agent does not sell on the market. The value of being unemployed is

$$U = z + \beta ((1 - \theta_q(\theta)) U' + \theta_q(\theta) E(W')).$$

(6)

$\theta_q(\theta)$ is the probability that a worker finds a job this period. The value of being unemployed is increasing in the value of $z$. Also, as the expected value of having a job next period, $E(W')$, is greater than the value of unemployment next period, the value of unemployment is increasing in $\theta_q(\theta)$. This means that with a tighter labour market, and lower unemployment, the value of unemployment is higher as it makes it easier for the worker to find a job. As an unemployed worker does not know what type of firm he will work for next period, $E(W')$ is simply a weighted average of the values of being employed in the various types of firms and is given by

$$E(W') = \frac{\bar{v}^Y}{v} W^Y + \frac{\bar{v}^N}{v} W^N + \frac{\bar{v}^M}{v} W^M + \frac{\bar{v}^f}{v} W^f,$$

where $v$ is the total number of vacancies in the country, and $\bar{v}^k_i$ are the total number of vacancies posted in the home country by a country $i$ headquartered firm, and where $k = Y, M, N$. The expected wage is defined as

$$E(w) = \frac{\bar{w}^Y}{v} w^Y + \frac{\bar{w}^N}{v} w^N + \frac{\bar{w}^M}{v} w^M + \frac{\bar{w}^f}{v} w^f.$$
2.2. Competitively traded good sector firms

In the competitively traded sector, firms are small with one worker per firm. Therefore the mass of workers, $L^Y$, and the mass of firms in the competitively traded sector are identical. Competitively traded good sector firms consider themselves too small to affect the market. The firms use resources and one unit of labour. As the resource is freely traded and not subject to any frictions, all the resource is used each period, so $R = L^Y \hat{R}$. The amount of resources used by an individual firm is given by $\hat{R}$. Competitively traded good sector firms only have one worker and there are no competitively traded good sector MNEs. The value this period of a filled job to an entrepreneur in the competitively traded sector is given as

$$J^Y = P(Y_c) y - w^Y - r\hat{R} + \beta (1 - \lambda) J^{Y'} ,$$

(7)

where the production technology is given by $y = \hat{R}^{1-\alpha}$, and $r$ is the rental rate of resources in the home country, $w^Y$ is the wage and $\alpha$ is the labour elasticity of $Y$ sector output. A lower value of $\alpha$ increases the effect that drawing labour from the competitively traded sector has on wages. Maximising the above for $\hat{R}$ and using the fact that all firms in the competitively traded sector act symmetrically, we get that

$$r = (1 - \alpha) P(Y_c) \left( \frac{L^Y}{R} \right)^{\alpha} .$$

(8)

Similarly, the total amount of the competitively traded good produced in the economy is

$$Y = (L^Y)^\alpha R^{1-\alpha} .$$

(9)
The value of posting a vacancy in the competitively traded sector is

\[ V^Y = -\phi + (1 - \eta) \beta (q(\theta) J^Y + (1 - q(\theta)) V^Y), \]  

(10)

where \( \phi \) is the real cost of posting a vacancy and is paid by the firm to some agency in their own country who has the same consumption preferences as anyone else in that country. \( q(\theta) \) is the probability that the firm will fill the vacancy. When a firm decides to post a vacancy they take \( \theta \) as given. While the cost of posting a vacancy is constant in real terms, the cost of filling a vacancy is increasing in labour market tightness and decreasing in unemployment. As a firm is deemed to exist from the moment it posts a vacancy, there is a possibility, \( \eta \), that the firm will expire before it even manages to hire a worker.

The free entry condition \( V^Y \leq 0 \) determines the number of \( Y \) sector firms in the economy. In the steady state, this holds with equality where there are a positive number of competitively traded good sector firms. Due to the nature of the Cobb-Douglas production function, in the steady state there is always a positive number of competitively traded good sector firms operating in the home country whenever \( R > 0 \). This, combined with Eq. (10) leads to

\[ J^Y \leq \frac{\phi}{\beta (1 - \eta) q(\theta)}, \]  

(11)

with equality in the steady state if \( R > 0 \). The firm has a value due to the barrier to entry caused by the cost of labour market frictions.

2.3. Cournot sector firms

Good \( X \) is a homogeneous good and firms producing good \( X \) act according to Cournot competition, taking the price index as numeraire. Cournot sector firms are aware of their effect on the price of the good but take the actions of the
other firms, the price index, national income, and the labour market as given.

Firms in the Cournot sector can operate as either national firms or MNEs. In the model of Markusen and Venables (1998), firms operate as MNEs in order to avoid the shipping cost, though at the cost of operating an extra plant. In this model, there is the added motivation of possibly reducing labour costs by improving the firms bargaining position. The superscripts \( N \) and \( M \) designate whether the firm is a national firm or a multinational respectively. Technology in the Cournot sector is increasing returns to scale. Firms need a minimum number of plant workers, \( G \), and headquarter workers, \( F \), before they can produce and sell their goods. It takes one worker to produce one unit of the good. As in the model of Markusen and Venables (1998), iceberg trade costs, \( \tau \), are in terms of the number of workers needed to transport the good. This ensures transport costs are a proportion of marginal costs. The nationality of a MNE is defined by the location of its headquarters, which is where it employs \( F \) headquarter workers. Cournot sector firms are large and hire a continuum of workers, allowing the use of the law of large numbers. Therefore, the probability that a worker separates from the firm is the proportion of workers separating from the firm at the end of the period. The number of workers employed in non-production activities and transport activities has an important effect on productivity in the Cournot sector and therefore the wage. By opening a second plant to gain an advantage in wage bargaining, MNEs may divert workers to non-production activities. This may reduce productivity and wages can fall. Firms do not switch from being a national firm to a MNE or vice versa. The firm makes its decision as to what type of firm it will be when it forms.

\( X_c \) equals total amount of the Cournot good supplied to the home country (the
The value of a national firm producing in the home country is

\[ V^N(H^N) = \max_{v^N, X^N_h, X^N_{h^*}} \left\{ P(X_e) X^N_h + P(X^*_e) X^N_{h^*} - w^N(H^N) H^N - \phi v^N \right\} \]

subject to

\[ P(X_e) = \frac{\delta Y}{X_e}, \quad P(X^*_e) = \frac{\delta Y^*}{X^*_e}, \]

\[ H^{N^*} = \left(1 - \lambda\right) H^N + q(\theta) v^N, \]

and

\[ H^N = F + G + X^N_h + (1 + \tau) X^N_{h^*}, \]
where $v^N$ represents the vacancies posted and $H^N$ represents the number of workers hired by the national firm. The value of the firm is simply the revenue minus the wage bill and cost of posting vacancies, plus the discounted probability of the value of the firm next period. Eq. (15) shows that $F$ headquarter non-production staff and $G$ plant non-production staff are required in order to produce the good. As can be seen, the firm discounts the future due to both impatience and as there is the probability that the firm will exit at the end of the period.

The first order conditions for $X^N_h$ and $X^N_*$ show that marginal revenue in the home and foreign markets must be equal. That is

$$\frac{\delta \Upsilon (X_c - X^N_h)}{X^2_c} = \frac{\delta \Upsilon^* (X^*_c - X^N_*)}{(1 + \tau) X^2_c}$$  \hspace{1cm} (16)

Using Eqs. (15) and (16), the amount of the Cournot good supplied by national firms to their domestic and foreign markets are given by the equations

$$X^N_h = \frac{(1 + \tau)^2 \Upsilon (X^*_c)^2 X_c + (H^N - F - G) X^2_c X^*_c (1 + \tau)}{(1 + \tau)^2 \Upsilon (X^*_c)^2 + X^2_c X^*_c (1 + \tau)},$$

and

$$X^N_* = \frac{-(1 + \tau) (X^*_c)^2 X_c + X^*_c (H^N - G - F) \Upsilon (X^*_c)^2}{(1 + \tau)^2 \Upsilon (X^*_c)^2 + X^*_c (1 + \tau) \Upsilon (X^*_c)^2}.$$

It is ambiguous as to whether $X^N_h$ is increasing or decreasing in $\tau$. A decrease in $\tau$ means there are more workers available for production which could lead to an increase in $X^N_h$. However, it also means it is cheaper to export. $X^N_*$ is strictly decreasing in $\tau$. Using these equations, the revenue of a national firm is given by

$$REV^N = \frac{\delta \{[(1 + \tau) \Upsilon X^*_c - \Upsilon X^*_c]^2 + \Upsilon (H^N - F - G)(X_c + (1 + \tau) X^*_c)\}}{(1 + \tau)^2 \Upsilon (X^*_c)^2 + X^*_c (1 + \tau) \Upsilon (X^*_c)^2},$$  \hspace{1cm} (17)

which is simply the revenue of the national firm as $REV^N = P(X_c) X^N_h + P(X^*_c) X^N_*$. \vspace{1cm}
It is quite clear that revenue increases with the number of employees hired by the firm, and is decreasing in the number of non-production workers \((F + G)\) required. The first order condition for vacancies (using the assumption that next period the firm will remain a national firm) leads to the condition for the optimal number of employees

\[
\frac{\partial V^N (H^N)}{\partial H^N} = \frac{\phi}{\beta (1 - \eta) q(\theta)}.
\]

Similar to the case for the commodity sector, Eq. (11), the firm posts vacancies until the discounted nominal benefit of having an extra worker next period is equal to the nominal cost of filling a vacancy.

The envelope condition for hiring, combined with the first order condition for \(X^N_h\) and \(X^N_h^*\) leads to

\[
\frac{\partial V^N (H^N)}{\partial H^N} = \frac{1}{\partial w^N} (1 - \lambda) \frac{q(\theta)}{\partial H^N} + \frac{\partial \REV^N}{\partial H^N}.
\]

(18)

The benefit of having an extra worker comprises of a strategic hiring effect, the benefit of not needing to incur the expenses of replacing the worker, an effect on revenue, minus the wage of the worker. \(\frac{\partial w^N}{\partial H^N}\) is a strategic hiring effect. Due to Cournot competition and the concave labour revenue product function, adding one more worker affects the wage of the other workers. The value of a start-up national firm in the \(X\) sector is

\[
V^N (0) = \max \{ -\phi v^N + (1 - \eta) \beta V^N (H^N) \}
\]

subject to

\[
H^N = q(\theta) v^N.
\]
As with firms that are already operating, we get the condition that

$$\frac{\partial V^N(H^N)}{\partial H^N} = \frac{\phi}{\beta (1 - \eta) q(\theta)}.$$ 

New firms posting vacancies aim to have the same number of workers as other firms that are already operating.

Due to the free entry condition, $V^N(0) \leq 0$, with equality if $n > 0$. This free entry condition determines the number of national firms in the economy. Using Eq. (14), this leads to

$$V^N(H^N) \leq \frac{\phi H^N}{\beta (1 - \eta) q(\theta)}$$

with equality in the steady state when $n > 0$. This is very similar to Eq. (11) and shows an equal value per filled job for the two types of firm. This is as both types of firm only hire in one country, they face identical hiring costs, and due to the free entry condition, when $n > 0$ vacancies are posted for both types of firm so the value of a filled job is the same in each firm.

**Proposition 1.** If only national firms operate in the Cournot sector ($m = 0$) an increase in transport costs ($\tau$) reduces the number of national firms ($n$)

An increase in $\tau$ decreases the revenue of national firms. Intuitively, as more workers are necessary to perform the non-production function of transporting the good, there are fewer workers available for production. This reduction of the value of the firm requires a reduction in $n$ in order to maintain $V^N(H^N) = \frac{\phi H^N}{\beta (1 - \eta) q(\theta)}$.

**Proposition 2.** If $m = 0$ an increase in $(F + G)$ reduces $n$ but a change in the ratio $\frac{F}{G}$ has no effect.

As can be seen from Eq. (15), the terms $F$ and $G$ only enter the value function for national firms additively. So keeping $F + G$ constant, but changing $\frac{F}{G}$ has no
direct effect on national firms. Therefore it has no effect when \( m = 0 \). Similar to Proposition 1, an increase in \( F + G \) decreases the revenue of national firms as less workers are available for production. This reduction of the value of the firm requires a reduction in \( n \) in order to maintain \( V^N (H^N) = \frac{\phi H^N}{\beta (1 - \eta) q(\theta)} \).

### 2.3.2. MNEs

The problem of the MNE is slightly more involved as the MNE has workers in both countries. Both plants produce the same good and the workers in both plants are substitutes. The value of a Cournot sector firm that operates as a multinational is given by

\[
V^M (H^M_h, H^M_\ast_h) = \max_{v^M_h, v^M_\ast_h, X^M_h, X^M_\ast} \left\{ \begin{array}{l}
P(X_c) X^M_h + P(X^*_c) X^{M*}_h \\
- w^M_h (H^M_h, H^{M*}_h) H^M_h \\
- w^{M*}_h (H^M_h, H^{M*}_h) H^{M*}_h - \phi (v^M_h + v^{M*}_h) \\
+ (1 - \eta) \beta V^M (H^{M'}_h, H^{M'*}_h)
\end{array} \right\},
\]  

subject to

\[
H^{M'}_h = (1 - \tilde{\lambda}) H^M_h + q(\theta) v^M_h,
\]  

\[
H^{M'*}_h = (1 - \tilde{\lambda}) H^{M*}_h + q(\theta^*) v^{M*}_h,
\]  

\[
H^M_h = F + G + X^M_h,
\]  

and

\[
H^{M*}_h = G + X^{M*}_h.
\]

As can be seen from Eq. (23), the firm needs at least \( F + G \) workers in the home plant to fulfill headquarter services and plant services. As \( G \) is the minimum number of people required for each plant, a lower value of \( G \) makes it easier for a firm to open a plant abroad. Also, a lower value of \( F \) makes it easier for the firm
to move its headquarters. The envelope conditions for hiring is given as

\[-H_h^M \frac{\partial w_h^M}{\partial H_h^M} - w_h^M - H_h^M \frac{\partial w_h^M}{\partial H_h^M} + \phi \left( \frac{1 - \lambda}{q(\theta)} \right) + \frac{\partial \text{REV}_h^M}{\partial H_h^M} = \frac{\phi}{(1 - \eta) \beta q(\theta)},\]

and

\[-H_h^M \frac{\partial w_h^M}{\partial H_h^M} - w_h^M - H_h^M \frac{\partial w_h^M}{\partial H_h^M} + \phi \left( \frac{1 - \lambda}{q(\theta^*)} \right) + \frac{\partial \text{REV}_h^M}{\partial H_h^M} = \frac{\phi}{(1 - \eta) \beta q(\theta^*)}, \quad (25)\]

where \( \text{REV}_h^M = P(X_h^M)X_h^M + P(X_h^*)X_h^*, \) \( \frac{\partial \text{REV}_h^M}{\partial H_h^M} = \frac{\delta \lambda (X_h^M - X_h^*)}{X_h^*}, \) and \( \frac{\partial \text{REV}_h^M}{\partial H_h^M} = \frac{\delta \lambda^* (X_h^* - X_h^M)}.\)

Though similar to the envelope condition for national firms Eq. (18) a crucial difference is that hiring workers in one plant also lowers the wage bill in the second plant. This is shown by the appearance of the terms \( \frac{\partial w_h^M}{\partial H_h^M} \) and \( \frac{\partial w_h^M}{\partial H_h^M} \) in the envelope conditions. This makes the strategic hiring effect stronger for MNEs and is why, ceteris paribus, they hire more workers than national firms.

As MNEs do not export, we can take the amount of the Cournot good supplied to each market directly from the constraints (23) and (24). Similar to the national firm case the value of a start-up national firm in the Cournot sector is

\[V^M(0, 0) = -\phi (v_h^M + v_h^M) + (1 - \eta) \beta V^M (H_h^M, H_h^M).\]

Due to the free entry condition, \( V^M(0, 0) \leq 0, \) with equality in the steady state if \( m > 0. \) Using Eqs. (21) and (22), this leads to

\[V^M (H_h^M, H_h^M) \leq \frac{\phi}{1 - \eta) \beta} \left( \frac{H_h^M}{q(\theta)} + H_h^M \frac{q(\theta^*)}{q(\theta^*)} \right), \quad (26)\]

with equality when \( m > 0. \) This is somewhat different from Eq. (11) and Eq. (19) in that the undiscounted value of the firm is equal to the cost of hiring the full complement of workers in both countries, rather than in just one country.
2.4. Wage bargaining

When bargaining wages workers wish to maximise the surplus of being employed, \( W^k_i - U \). Due to the cumbersome nature of the equations, it is useful to substitute out all the elements agents take as given during the wage bargain. These are taken as given as agents either consider themselves too small to affect these variables, or cannot commit to future variables. Setting \( W^k_i = U \), and rearranging for wages, leads to a variable (that can be interpreted as a reservation wage, \( \omega^k_i \)) that only includes variables taken as given by agents. The subscript \( i \) refers to the nationality of the firm the worker is working for, and is only relevant if the worker is employed by a MNE. Thus we can define

\[
\omega^k_i = z + \beta \left( (1 - \lambda - \theta q(\theta)) U' - (1 - \lambda) W^k_i + \theta q(\theta) E(W') \right),
\]

(27)

\[
k = Y, N, M, \quad i = h, f.
\]

(28)

From this, it is easy to show that

\[
W^k_i - U = w^k_i - \omega^k_i, \quad k = Y, N, M.
\]

(29)

The term \( \omega^k_i \) is useful as it summarises the external labour market influences on the wage bargain. This reservation wage is increasing in \( \theta q(\theta) \) and decreasing in unemployment, so when the labour market is tight workers have a higher reservation wage. It is increasing in the average value of employment in the economy and \( z \). It is decreasing however in \( W^k_i \), as workers are willing to accept a lower wage this period in anticipation of bargaining a higher wage next period.

2.4.1. Competitively traded sector

As is standard in the literature, we model wage bargaining by Nash bargaining. In the competitively traded good sector, there is only one worker per firm, and as
bargaining takes place at the firm level, union bargaining and individual bargaining are equivalent, as shown by Cahuc and Wasmer (2001). This is as the labour revenue product function is linear because the good is traded competitively. The Nash product takes the form

$$\max_{\omega^Y} \left\{ [W^Y - U]^\gamma [J^Y]^{1-\gamma} \right\}$$

where $\gamma$ is the bargaining power of workers. This leads to

$$\gamma J^Y = (1 - \gamma) [W^Y - U]. \quad (30)$$

Using Eqs. (7), (11), and (29) we get the wage for the competitively traded sector as

$$w^Y = \gamma \left( \alpha P(Y_c) \left( \frac{R}{L^Y} \right)^{1-\alpha} + \phi \frac{(1 - \lambda)}{q(\theta)} \right) + (1 - \gamma) \omega^Y.$$

This is a weighted average of the total benefit of the match and the reservation wage. The value of not needing to post the vacancy again, $\phi \frac{(1 - \lambda)}{q(\theta)}$, is increasing in labour market tightness, which serves to increase the wage.

### 2.4.2. Cournot sector national firms

Cournot sector firms are large, and a union negotiates wages on behalf of all workers in the firm. Although sectoral and centralised bargaining is common in European countries, even in these countries firm level bargaining plays a significant role in increasing wages above that agreed at a sectoral level (see for example Dell’Aringa and Lucifora, 1994; Card and De la Roca, 2006; Plasman et al., 2006; Braun and Schiffel, 2007). If negotiations break down, the firm sacks all the workers. Due to the free entry condition, this means the outside option for the firm is zero. When modelling, the choice of outside option can depend on the motivation agents have
on reaching an agreement, and can be either the income streams that agents receive
during a dispute or their best alternative if negotiations break down (Binmore et 
al., 1986). As there is no strike pay provided by unions, and firms have no revenue 
if there is a dispute, the outside options given are appropriate for both motivations.

The union wishes to maximise the surplus of the state of employment over 
unemployment for the members of the union. The union only bargains over wages 
and not over employment. There are criticisms over this right-to-manage approach 
(a discussion is given in Cahuc and Zylberberg, 2004), such as it does not lead to 
Pareto efficient outcomes. However, there are two reasons why in this case it is 
appropriate. The first is that, due to labour market frictions, workers and firms 
take the number of workers in the firm as given. The firm cannot hire more workers 
this period and in the previous period posted vacancies anticipating the wage, and 
so has no incentive to reduce the number of workers. The second reason is that 
there is no commitment mechanism. Firms and unions renegotiate wages each 
period, so though it is possible to bargain over the number of vacancies the firm 
posts, the firm may renege on hiring these workers next period. In addition, it 
would be difficult to understand what benefit current members gain from future 
hiring.

Wages are found by maximising the Nash product

$$\max_{w^N} \left\{ \left[ H^N (W^N - U) \right]^\gamma \left[ V^N (H^N) \right]^{1-\gamma} \right\},$$

which leads to

$$H^N (1 - \gamma) [W^N - U] = \gamma V^N (H^N). \quad (31)$$
Substituting Eqs. (13), (19), and (29) into Eq. (31) leads to
\[
w^N = \gamma \left( \frac{\text{REV}^N}{H^N} + \phi \left( \frac{1 - \tilde{\lambda}}{q(\theta)} \right) \right) + (1 - \gamma) \omega^N.
\]

This is similar to the wage for the commodity sector in that it is a weighted average of the total benefit of the match continuing and the reservation wage. It is interesting to note that in the steady state the wages of those working for Cournot sector national firms and competitively traded good sector firms are equal. This follows from the free entry condition, that workers in both types of firm have the same outside option, and neither type of firm can continue production abroad if bargaining breaks down.

The strategic hiring effect for national firms is given as
\[
\frac{\partial w^N}{\partial H^N} = \frac{\gamma}{(H^N)^2} \left[ H^N \frac{\partial \text{REV}^N}{\partial H^N} - \text{REV}^N \right].
\]

In equilibrium, this is equal to zero as national firms set employment so that average revenue per worker equals marginal revenue.

2.4.3. Cournot sector MNEs

Calculating wages for the case of MNEs is more complicated. This is as having a plant abroad improves the MNEs’ bargaining position. If negotiations break down in one plant, it can continue producing in its plant in the other country, so long as this plant currently has sufficient workers for both headquarter and plant functions. This is in contrast with Eckel and Egger (2009) where the firm does not face labour market frictions and can immediately increase the number of workers in the other plant. We assume that unions only represent the workers in one plant of one country, so there is no international cooperation between unions. Again, in contrast with Eckel and Egger (2009), but in keeping with the literature on
intrafirm bargaining (Stole and Zwiebel, 1996; Krause and Lubik, 2007; Cahuc et al., 2008) we assume non-simultaneous bargaining. The assumption does not qualitatively affect the results of the model. The firm treats each bargaining unit (plant) as the marginal production unit. Due to the concave labour revenue product function, the firm benefits from dividing workers into different bargaining units.

Wages in the foreign plant. Wages are calculated by maximising the Nash product,

\[
\max_{\hat{w}_h^{M*}} \left\{ \left( H_h^{M*} (W_h^{M*} - U^*) \right)^\gamma [V^M (H_h^M, H_h^{M*}) - V^M (H_h^M, 0)]^{1-\gamma} \right\}, \tag{32}
\]

which leads to

\[
H_h^{M*} (1 - \gamma) [W_h^{M*} - U^*] = \gamma [V^M (H_h^M, H_h^{M*}) - V^M (H_h^M, 0)]. \tag{33}
\]

\(V^M (H_h^M, 0)\) is the outside option for the firm. Variables that are different if negotiations breakdown in the foreign plant, compared to when the firm operates as normal (revenue, wages and vacancies), are designated with a hat symbol. As workers are split between two countries, workers bargain with management over the marginal, rather than the total, benefit of that production unit continuing to produce. We assume that if negotiations break down in the foreign plant then the firm sacks all the workers in the foreign plant. However, if the firm still has workers working in the domestic plant the firm operates similarly to a national firm for one period. These workers receive the wage

\[
\hat{w}_h^M = \gamma \left( \frac{\hat{REV}_h^M}{H_h^M} + \phi \frac{(1 - \hat{\lambda})}{q(\theta)} \right) + (1 - \gamma) \omega_h^M. \tag{34}
\]
The derivation of this and the outside option of the firm and the wage are detailed in the Appendix. The wage is given as
\[ w_{h}^{M*} = \gamma \left( \frac{REV_{h}^{M} - \widehat{REV}_{h}^{M} + \gamma \widetilde{REV}_{h}^{M}}{(1 + \gamma) H_{h}^{M*}} + \phi \left( \frac{1 - \hat{\lambda}}{q(\theta^*)} \right) \right) + (1 - \gamma) \omega_{h}^{M*}, \tag{35} \]
where \( \widehat{REV}_{h}^{M} \) is the revenue of the firm if negotiations break down with workers in the foreign plant. It is interesting to note the difference between the wage equations for MNEs and for national firms. The inclusion of the term \( \widehat{REV}_{h}^{M} \) shows that the greater \( \widehat{REV}_{h}^{M} \) is, the lower is the wage for workers in the foreign plant. As there are \( G \) non-production workers in the foreign plant, a high value of \( G \) decreases the marginal revenue of the plant per worker. \( \widetilde{REV}_{h}^{M} \) is the revenue of the firm if wages negotiations break down in the home plant. This reduces the wage in the home plant. Due to the assumption of non-simultaneous bargaining \( \widehat{REV}_{h}^{M} \) has a positive effect on the wage in the foreign plant, as if foreign workers separate from the firm then the firm will renegotiate wages in the home plant having lost the ability to continue production abroad. It is also useful at this point to show
\[ \frac{\partial w_{h}^{M*}}{\partial H_{h}^{M*}} = \frac{\gamma}{(1 + \gamma) (H_{h}^{M*})^{2}} \left[ H_{h}^{M*} \left( \frac{\partial \, \widehat{REV}_{h}^{M}}{\partial H_{h}^{M*}} + \gamma \frac{\partial \, \widetilde{REV}_{h}^{M}}{\partial H_{h}^{M*}} \right) \right] + (1 - \gamma) \frac{\partial \omega_{h}^{M*}}{\partial H_{h}^{M*}}, \]
and
\[ \frac{\partial w_{h}^{M*}}{\partial H_{h}^{M}} = \frac{\gamma}{(1 + \gamma) H_{h}^{M*}} \left[ \frac{\partial \, \widehat{REV}_{h}^{M}}{\partial H_{h}^{M}} - \frac{\partial \, \widetilde{REV}_{h}^{M}}{\partial H_{h}^{M}} \right], \tag{36} \]
which can be inserted into the envelope condition, Eq. (25).

While it is ambiguous as to whether \( \frac{\partial w_{h}^{M*}}{\partial H_{h}^{M*}} \) is negative (though for a smaller \( F + G \) it is be more negative), \( \frac{\partial w_{h}^{M*}}{\partial H_{h}^{M}} \) is always negative as \( REV_{h}^{M} > \widehat{REV}_{h}^{M} \) and the labour revenue product function is concave.
Wages in the home plant. If negotiations break down in the home plant production may continue in the foreign plant. However this requires $H_h^{M*} > F + G$, as the foreign plant must perform headquarter operations as well as plant operations. A tilde over a variable signifies the value of that variable if negotiations break down with workers in the home plant.

Similar to before, the Nash product

$$\max_{w_h^M} \left\{ [H_h^M (W_h^M - U)]^\gamma [V^M (H_h^M, H_h^{M*}) - V^M (0, H_h^{M*})] \right\}, \quad (37)$$

is maximised, where $V^M (0, H_h^{M*})$ is the value of the firm if negotiations break down with workers in the home plant, leading to

$$H_h^M (1 - \gamma) [W_h^M - U] = \gamma [V^M (H_h^M, H_h^{M*}) - V^M (0, H_h^{M*})]. \quad (38)$$

We outline how we calculate the outside option in the Appendix. Due to non-simultaneous bargaining, if negotiations break down in the home plant, the firm and foreign plant union renegotiates wages, leading to

$$\tilde{w}_h^{M*} = \gamma \left( \frac{\overline{REV}_h^M}{H_h^{M*}} + \phi \left( 1 - \tilde{\lambda} \right) \frac{1}{q(\theta^*)} \right) + (1 - \gamma) \omega_h^{M*}. \quad (39)$$

From this we get the equilibrium wage in the home plant as

$$w_h^M = \gamma \left( \frac{\overline{REV}_h^M - \tilde{w}_h^{M*} + \gamma \overline{REV}_h^M}{(1 + \gamma) H_h^M} + \phi \left( 1 - \tilde{\lambda} \right) \frac{1}{q(\theta)} \right) + (1 - \gamma) \omega_h^M, \quad (40)$$

where $\overline{REV}_h^M$ is the revenue of the firm if negotiations with the home plant break down. If $H_h^{M*} < F + G$, then $\overline{REV}_h^M = 0$. Similar to when bargaining with the workers in the foreign plant, a higher $\overline{REV}_h^M$ results in a lower wage.

Again, the firm can operate as a national firm in the foreign country even if
negotiations with home workers breakdown. It is also useful to show

\[
\frac{\partial w^M_h}{\partial H^M_h} = \frac{\gamma}{(1 + \gamma) (H^M_h)^2} \left[ H^M_h \left( \frac{\partial \text{REV}^M_h}{\partial H^M_h} + \frac{\partial \text{REV}^M_h}{\partial H^M_*} \right) - \left( \text{REV}^M_h - \text{REV}^M_h - \gamma \text{REV}^M_h \right) \right],
\]

and

\[
\frac{\partial w^M_h}{\partial H^M_*} = \frac{\gamma}{(1 + \gamma) H^M_h} \left[ \frac{\partial \text{REV}^M_h}{\partial H^M_h} - \frac{\partial \text{REV}^M_h}{\partial H^M_*} \right].
\] (41)

\(\frac{\partial w^M_h}{\partial H^M_*}\) is always negative.

2.4.4. Effect of MNE wage on average wage

The following set of propositions highlight how MNEs affect the average wage, and impact on the term \(\omega^k_i\), \(k = Y, N, M\), \(i = h, f\).

**Proposition 3.** For a sufficiently low value of \(F\), MNEs on average pay lower wages than competitively traded good sector firms and national firms.

The average value of working in a MNE is given by \(\frac{H^M_h W^M_h + H^M_* W^M_*}{H^M_h + H^M_*}\). If \(H^M_h\) and \(H^M_*\) workers were to work in the competitively traded sector in their respective countries their value of working would be given by \(\frac{H^M_Y W^M_Y + H^M_* W^M_*}{H^M_Y + H^M_*}\). Using the free entry conditions (11) and (26) and also the Nash sharing rules (30), (33), and (38) we get that

\[
\frac{(H^M_h W^M_h + H^M_* W^M_*) - (H^M_h W^M_Y + H^M_* W^M_Y)}{H^M_h + H^M_*} =
\frac{\gamma (V^M (H^M_h, H^M_*)) - (V^M (H^M_h, 0) + V^M (0, H^M_*))}{(1 - \gamma) (H^M_h + H^M_*)}.
\]

As the value function of firms is concave in the number of plants in operation (see Appendix for proof), this is negative for a sufficiently low value of \(F\). Hence, workers value employment in the competitively traded sector more than employment in MNEs. As the average value for working in a MNE is lower than that for working in a competitively traded good sector firm, and as national firms pay the
same wage as competitively traded good sector firms, MNEs pay lower wages than other firms do.

**Proposition 4.** MNEs strategically hire extra workers in the home plant in order to reduce the wage bill in the foreign plant.

Due to the concavity of the revenue labour product function, as $\text{REV}_h^M > \text{REV}_h^M$, this leads to $\frac{\partial \text{REV}_h^M}{\partial H_k^M} < \frac{\partial \text{REV}_h^M}{\partial H_k^M}$. From Eq. (36) it can be seen that $\frac{\partial w_h^M}{\partial H_k^M} < 0$, so the firm has an incentive to hire extra workers in the home plant in order to reduce the wage in the foreign plant. Similarly, when $F < H_k^M - G$ Eq. (41) shows that $\frac{\partial w_h^M}{\partial H_k^M} < 0$, so the firm has an incentive to hire extra workers in the foreign plant to reduce the wage in the home plant. That the firm actually hires extra workers (for a sufficiently low value of $F$) can be shown from the free entry conditions and the wage equations. The free entry conditions (11) and (26) show that in equilibrium the value of a firm is proportionate to the number of workers employed. As MNEs pay lower wages, they also have lower average revenue per worker than competitively traded good sector firms do. If this were not so, MNEs would make excessive profits. Firm entry would reduce these excessive profits until the value of operating as an MNE was proportionate to the number of employees to the same extent as in the competitively traded good sector. MNEs hire extra workers, which suppresses average revenue per worker. This reduces the wage bill. Another interpretation is that the lower wages paid to workers in MNEs help to fund the extra cost of posting vacancies faced by MNEs. MNEs hire workers beyond a level that would be profitable for national firms or competitively traded good sector firms. This serves to increase labour market tightness, $\theta$.

From Proposition 3 - 4 we can see how MNEs affect $\omega^i_k$, $k = Y, N, M$, $i = h, f$. Eq. (27) shows that by paying lower wages the direct effect of MNEs is to reduce the
expected value of employment \( E(W) \); however this is mitigated by the strategic hiring effect which serves to increase \( \theta \) which increases \( \omega_i^k, k = Y, N, M, i = h, f \). It is ambiguous as to which effect dominates. A numerical analysis is required to show which effect is dominant.

### 2.4.5. The effect of transport costs, and \( F \) and \( G \) on the number of multinationals

Where MNEs and national firms coexist it is ambiguous as to whether an increase in \( \tau \) increases the proportion of national firms or MNEs. In the model of Markusen and Venables (1998) an increase in \( \tau \) unambiguously lead to an increase in the number of MNEs. For MNEs the negative effect of an increase in \( \tau \) is stronger if workers have strong bargaining power and where \( \text{REV}_h^M \) and \( \text{REV}_h^M \) are large relative to \( \text{REV}^N \). The importance of bargaining power is intuitive as with stronger unions a firm benefits more from dividing workers between two countries than if unions are weak. More detail is given in Propositions 5 and 6 in the Appendix.

It is possible for MNEs and national firms to coexist in equilibrium. This is due to the different way in which national firms and MNEs interact with the labour market. As national firms can export this has an effect on the product market in both countries, but only affects unemployment in the home market. If a national firm exits, next period a firm may enter to take advantage of the opportunities in the product market, and the firm decides whether to operate as a MNE or national firm. If the firm chooses to operate as a MNE, it must hire workers in the foreign country. This increases wage pressure on MNEs (and foreign country national firms), but does not increase wage pressure for national firms in the home country. Therefore, profits for national firms increase above equilibrium level in the home country. This leads to the entry of new national firms in the home market, and the
exit (through natural wastage) of MNEs, returning the economy to the equilibrium number of MNEs and national firms.

3. Equilibrium and calibration

The equilibrium is defined as a set of prices \( P(Y_c), P(X_c), r, w^Y, w^M, w^{M*}, w^N \) and quantities \( Y, m, n, X^N, X^{N*}, X^M, X^{M*}, v, u, H^N, H^M, H^{M*}, L^Y \) that satisfy the free entry conditions for firms, Eqs. (11, 19, and 26), equilibrium in the product market, Eqs. (12 and 1), labour market clearing,

\[
L = u + mH^M_h + m^*H^M_f + L^Y + nH^N
\]

the national income constraint

\[
\Upsilon = P(Y_c)Y + P(X_c)(n(X^N + X^{N*}) + m(X^M + X^{M*})) + m^*H^M_f w^M_f - mH^M_h w^{M*}_h
\]

and

\[
L - u' = \frac{v}{q(\theta)} + (1 - \lambda)(L - u);
\]

where the last equation is the employment law of motion of the aggregate economy.

We solve the model numerically for the steady state. Each period the proportion \( \lambda \) of each type of job is destroyed. To maintain a steady state these jobs must be replaced. We assume that the costs of posting a vacancy are part of the national income of the country where the firm has its home plant, so there is no need to subtract this from these firms’ revenues in order to calculate national income.

The model can be reduced to finding 15 variables. As we only solve for the symmetric case, we reduce the solution to finding eight unknowns. Focusing on symmetric countries is satisfactory as according to UNCTAD (2008) data, 68% of inward FDI is to developed countries and 92% of outward FDI is from developed
countries. The model is solved using the Newton method of convergence, which can only solve for equations, but not inequalities, such as (19) and (26), and the kink in the equation for how hiring in the foreign plant affects wages. It is possible to solve the model for the five different cases whether the inequalities are binding or not, though the calibrated solution results in the case where national firms and multinational coexist, and $H^{M*}_h > F + G$.

As the model is appropriate to a small open economy with a high level of union membership the model was calibrated to data for the Danish economy from 1980-2001 using standard methodology (such as Kydland and Prescott, 1996; and Cooley, 1997). The model abstracts from some important characteristics of open economies (such as asymmetry), so the intention of the calibration is more to provide realistic values for a numerical simulation.

Following standard practice (Pissarides, 2009) the unemployment elasticity of the matching function is set at $\rho = 0.5$ and the bargaining power of workers is set at $\gamma = 0.5$. Ibsen and Westergaard-Nielsen (2005) give data on job creation and job flows in Denmark from 1980 to 2001, which we averaged as in the steady state the rate of job creation equals the rate of job destruction. From this data and data on employment (from Eurostat National Accounts) the average monthly rate of job destruction due to workers and firms separating is calculated to be $\tilde{\lambda} = 0.004453$ and the rate of job destruction due to firm exit to be $\eta = 0.000606$. Data from Layard (2004) shows the Danish vacancy rate to be approximately equal to the Danish average unemployment rate of 6.58 per cent, giving a mean labour tightness of $\theta = 1$. Using $\theta$ and the average number of matches in a period it was possible to calculate the matching function scale parameter to be $s = 0.071783$. Assuming a 4 per cent annual interest rate, and given that each period in the model lasts one
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
<th>Source/Target</th>
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<tbody>
<tr>
<td>$\beta$</td>
<td>0.9967</td>
<td>Monthly discount rate</td>
<td>4% annual discount rate</td>
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<tr>
<td>$\gamma$</td>
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<td>Bargaining power</td>
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<tr>
<td>$\rho$</td>
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<td>Unemployment elasticity of matching function</td>
<td>Standard</td>
</tr>
<tr>
<td>$\lambda$</td>
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<td>Monthly worker/firm separation rate</td>
<td>Ihse and Westergaard-Nielsen (2005) and own calculations</td>
</tr>
<tr>
<td>$\eta$</td>
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<td>Monthly firm exit</td>
<td>Ihse and Westergaard-Nielsen (2005) and own calculations</td>
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<tr>
<td>$s$</td>
<td>0.071783</td>
<td>Matching function scale</td>
<td>Job creation rate</td>
</tr>
<tr>
<td>$\tau$</td>
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<td>Iceberg transport cost</td>
<td>Markusen and Venables (1998)</td>
</tr>
<tr>
<td>$\delta$</td>
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<td>Share of GDP of Contract sector</td>
<td>Markusen and Venables (1998)</td>
</tr>
<tr>
<td>$\alpha$</td>
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<td>Labour elasticity in competitively traded sector</td>
<td>Labour share of income</td>
</tr>
<tr>
<td>$\phi$</td>
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<td>Vacancy posting cost</td>
<td>Mean $\theta$</td>
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<td>Firm fixed costs (measured in labour units)</td>
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<td>Plant fixed costs (measured in labour units)</td>
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<td>Flow value of unemployment</td>
<td>0.71 of marginal productivity</td>
</tr>
<tr>
<td>$L$</td>
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<td>Labour endowment</td>
<td>Foreign firm size</td>
</tr>
<tr>
<td>$R$</td>
<td>370.738</td>
<td>Resource endowment</td>
<td>Ratio of resource endowment to labour endowment</td>
</tr>
</tbody>
</table>

month, $\beta$ was set at $\beta = 0.9967$. Targeting a vacancy rate equal to the unemployment rate the cost of posting a vacancy was found to be $\phi = 0.197013$.

Following Markusen and Venables (1998) $\delta$ was set equal to one half. This means that the competitively traded good sector forms half of GDP. This is appropriate as in Denmark the public sector is sheltered from entry of MNEs and represents approximately half of GDP. That $\alpha = 0.206124$ is found by targeting a labour share of 58.65 per cent, which was calculated from the AMECO database.
$z$ was set equal to $0.594062$ (equivalent to 71 per cent of marginal product in the competitively traded sector and national firms). There is no consensus on an appropriate value for the flow value of unemployment. Using US data Hall and Milgrom (2008) find that 71 per cent of productivity is an appropriate value for $z$, based on estimated values for leisure and an unemployment income replacement ratio of 25 per cent. Using this method, US parameters for values of leisure, and the Danish replacement ratio (55.18 per cent from 1981 to 2001, OECD (2011)) leads to a value of $z$ actually greater than marginal productivity and the average wage. Clearly, this is not plausible so the replacement ratio targeting 71 per cent of productivity was chosen. This value for $z$ is also used by Pissarides (2009), though it is among the higher values of $z$ used in calibrations of Mortensen-Pissarides type matching models.

Along with other parameters, the absolute values of firm and plant non-production workers, $F$ and $G$, determine the entry of firms in the Cournot sector, and their size. The ratio of $F$ and $G$ determines relative employment in national firms and MNEs and relative size. Using data from Malchow-Moller et al. (2007) and Eurostat from 2000 to 2002, in Denmark 13.9752 per cent of the workforce are employed in foreign firms and foreign firms are 14.7853 times larger than the average domestic firm. Unfortunately, data spanning from 1980 to 2001 is not available. Calibrating for firm size must be treated with caution in this model. As firms in the competitively traded sector only employ one person, increasing the labour endowment of the economy would increase the relative size of foreign firms. This is because, with a constant employment share in the Cournot sector, the increased number of competitively traded sector firms would reduce the average size of domestic firms. Data from Malchow-Moller et al. (2007) show that eliminating small
and medium size firms, foreign firms are actually 86 per cent the size of domestic firms (including domestic MNEs). Using this value for relative firm size, and employment in foreign firms, the value for $F$ and $G$ is given as 0.085834 and 14.7218 respectively. This is a rather small value for the number of workers required for headquarter functions; however no data is available for comparison. The labour endowment was set at $L = 370.738$. This was found by targeting average firm size of foreign firms $H^M = 70.67$ (from Malcho-Moller et al., 2007). This is appropriate as Cournot firms sell a homogeneous product, so product market competition represents one sector of the economy. Using these values the model predicts relative firm size between foreign firms and domestic firms (including small firms) to be 14.7277, which is very close to the value of 14.7853 from the data. The ratio of the labour endowment to the resource endowment is arbitrarily set equal to one. The calibration leads to $H^M > F + G$, so in the simulation MNEs can continue production abroad if negotiations break down in the home plant.

Following Markusen and Venables (1998) the transport cost is set at $\tau = 0.15$. For these parameters the model predicts an export share of GDP of 9.975 per cent (which is also the share of imports), a value lower than the data. Using data from Eurostat National Accounts, between 1980 and 2001 exports averaged 37.7 per cent of GDP and imports averaged 34.7 per cent of GDP. As there is no intermediary production in the model, it is useful to adjust these figures for the import content of exports using data from the OECD STAN database. During the mid-1990s (the only period during the sample for which data is available), the import content of exports was 27.1 per cent, leading to an adjusted export and import share of 27.5 per cent and 24.5 per cent respectively. However, the values for the data serve as an upper bound to appropriate trade levels in the model as symmetry is assumed,
preventing trade due to differences between countries, and in the model MNEs do not trade, though in practice MNEs do engage in trade both between subsidiaries, and by using Denmark as an export platform.

4. Results

<table>
<thead>
<tr>
<th>Table 2: Results: full model</th>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td>Unemployment rate</td>
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<tr>
<td>Average wage</td>
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<tr>
<td>Competitively traded good</td>
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<tr>
<td>sector wage</td>
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</table>

We made a numerical simulation, based on the parameters presented in the
previous section (Table 1). We present the results in Table 2. There are three possible equilibria (Beugnot and Tidball, 2010, highlight the prevalence of multiple equilibria in models of matching frictions with intra-firm bargaining). The first column presents the baseline case of an economy fully open to trade and to MNEs, calibrated to Danish data. The second column is for the case where countries are open to trade, but MNEs do not exist. This contrasts with the paper of Eckel and Egger (2009) who chose autarky as the baseline. By comparing the calibrated equilibrium with the equilibrium where MNEs do not exist, we avoid confusion as to which effects are due to trade and which are due to MNEs. In the third column MNEs are permitted to exist, but the international strategic hiring effect is set to zero \( \frac{\partial w^M}{\partial H} = \frac{\partial w^M}{\partial H^*} = 0 \). Comparing the first and second columns shows that permitting MNEs leads to lower wages and lower unemployment.

Overall, the effects of MNEs are small. This is as the negative effect of MNEs on wages due to their better bargaining position, and the positive effect due to increased hiring, almost completely cancels out. Contrasting the first and third columns of Table 2 highlights the importance of the strategic hiring effect. As can be seen, suppressing the international strategic hiring effect leads to significantly lower wages and higher unemployment. (It should be noted that the third column is not a genuine equilibrium and national firms are suppressed. For this case, national firms could out compete MNEs and the actual equilibrium would be as in the second column). The first column shows that for the baseline case MNEs pay lower wages than average. This is as the low value of \( F \) calibrated ensures that \( \text{REV}^M_h < \text{REV}^M_{h^*} + \text{REV}^M_h \). Such concavity gives the MNE a bargaining advantage by splitting its workforce into two separate bargaining units. However, the difference is small. MNE wages are on average just 0.02 per cent lower than wages in national
firms. This is consistent with the literature that shows that once firm and worker characteristics are controlled for, foreign and domestic firms pay the same wage. Using Danish data, Braun (2009) found that the foreign ownership wage premium was somewhere from two to four per cent, but was zero in highly unionised companies (and the trade union premium was eliminated). As all Cournot sector firms are unionised the results are qualitatively consistent with those of Braun (2009).

The results also show that MNEs have slightly lower productivity than national firms do. This contrasts with what is usually found in the data. As MNEs can pay lower wages, they can survive in the market place with slightly lower productivity.

As the home plant must have $F$ more non-production workers than the foreign plant, output per worker in the home plant is slightly below that in the foreign plant, yet home plant workers receive a higher wage. Looking at equations (35) and (40) we see that home (foreign) wages are affected by the output per worker gained when negotiations break down in the foreign (home) plant. Therefore, the MNE's threat to continue production in the other plant during negotiations is more effective against workers in the foreign plant than in the home plant, as the home plant already has workers assigned to headquarter functions. In addition, due to non-simultaneous bargaining, firms and unions renegotiate wage if there is a breakdown in negotiations in the other plant. This gives home plant workers extra advantage (as their cooperation is necessary to continue production if negotiations break down in the foreign plant, and therefore suppress wages in the foreign plant), and in equilibrium this allows home plant workers to negotiate higher wages at the expense of workers in the foreign plant. Though foreign workers also benefit from the fact their production can reduce wages in the home plant, as $\widehat{REV}_h^M > \widehat{REV}_M^h$, it is home plant workers who gain more, though wages would be higher for
both home and foreign plant workers if they cooperated during bargaining. This asymmetry depends crucially on the value of $F$, with a higher value of $F$ increasing the asymmetry.

Table 3: Results of simplified model. All values are in real terms.

<table>
<thead>
<tr>
<th></th>
<th>MNEs permitted</th>
<th>MNEs suppressed</th>
<th>Strategic hiring effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate</td>
<td>6.081%</td>
<td>6.274%</td>
<td>6.564%</td>
</tr>
<tr>
<td>Average wage</td>
<td>0.8330</td>
<td>0.83651</td>
<td>0.7978</td>
</tr>
<tr>
<td>Competitively traded good sector wage</td>
<td>0.8330</td>
<td>0.8365</td>
<td>0.7975</td>
</tr>
<tr>
<td>National firm wage</td>
<td>n/a</td>
<td>0.83651</td>
<td>n/a</td>
</tr>
<tr>
<td>MNE wage (home plant)</td>
<td>0.8332</td>
<td>n/a</td>
<td>0.7963</td>
</tr>
<tr>
<td>MNE wage (foreign plant)</td>
<td>0.8528</td>
<td>n/a</td>
<td>0.7084</td>
</tr>
<tr>
<td>National income</td>
<td>506.951</td>
<td>495.934</td>
<td>483.148</td>
</tr>
<tr>
<td>Workers per national firm</td>
<td>n/a</td>
<td>92.3689</td>
<td>n/a</td>
</tr>
<tr>
<td>Workers per MNE (home plant)</td>
<td>69.9522</td>
<td>-</td>
<td>18,0001</td>
</tr>
<tr>
<td>Workers per MNE (foreign plant)</td>
<td>48.7704</td>
<td>-</td>
<td>55,007</td>
</tr>
<tr>
<td>Revenue per national firm worker</td>
<td>-</td>
<td>0.8607</td>
<td>-</td>
</tr>
<tr>
<td>Revenue per MNE worker (home plant)</td>
<td>0.7008</td>
<td>-</td>
<td>0.2200</td>
</tr>
<tr>
<td>Revenue per MNE worker (foreign plant)</td>
<td>1.0031</td>
<td>-</td>
<td>1.0515</td>
</tr>
<tr>
<td>Revenue of MNE</td>
<td>104.243</td>
<td>-</td>
<td>62,270.5</td>
</tr>
<tr>
<td>$\widetilde{REV}_h^M$</td>
<td>61.2558</td>
<td>-</td>
<td>6.8725</td>
</tr>
<tr>
<td>$\widetilde{REV}_h^M$</td>
<td>39.5733</td>
<td>-</td>
<td>45.9727</td>
</tr>
<tr>
<td>Revenue per Cournot sector worker</td>
<td>0.8780</td>
<td>0.8607</td>
<td>0.8000</td>
</tr>
<tr>
<td>Proportion working in MNEs</td>
<td>82.0095%</td>
<td>0</td>
<td>82.004%</td>
</tr>
</tbody>
</table>

We see this asymmetry more clearly in Table 3 where $\tau = G = 0$. $F$ is set at a value that equals $F + G$ in the original calibration. These changes mean that national firms and MNEs face identical requirements in terms of hiring non-production workers. As all the MNE’s non-production workers are now employed in the home plant, the asymmetry between the home and foreign plant is greater than in the full model. In this simplified model openness to MNEs leads to higher
wages and lower unemployment. This is in contrast to the full model where MNEs must hire more workers that are not available for production, reducing the average revenue of the firm. Therefore, trade frictions and the costs of opening a new plant help explain why the strategic hiring effect does not lead to higher average wages in the full model. Finally, the third column highlights the importance of the strategic hiring effect, as suppressing this effect leads to lower wages and higher unemployment.

4.1. Sensitivity analysis

To examine the robustness of the simulation results we conducted a sensitivity analysis on the parameters. Returns to scale were examined by keeping the ratio of national firm to MNE non-productive workers \( \frac{F+G}{F+2G} \) constant but altering the minimum number of workers required for a firm to function \( (F+G) \), and also by keeping \( F+G \) constant, but altering \( \frac{F+G}{F+2G} \). Qualitatively the model was robust to changes in the parameters. Equilibria where there are more MNEs always have lower unemployment. Where parameter values only allow an equilibrium in which MNEs exist alone, wages can be higher than when we suppress MNEs. However, this is as in such circumstances MNEs can operate more efficiently, so the higher wages are due to greater efficiency of MNEs rather than the strategic hiring effect. However (with the exception of \( \rho \)) the "mixed" solution, whereby MNEs and national firms coexist, survives as an equilibrium for only very small changes in the parameters. That the mixed solution is a knife-edge solution is not surprising. The model abstracts from the usual trade-offs in trade theory, such as differences in factor endowments or country size. With the exception of where MNEs and national firms coexist, an increase in \( \frac{F+G}{F+2G} \) and \( \tau \) are favourable to MNEs, which is consistent with the model of Markusen and Venables (1998). An
increase in $F + G$ (whilst holding $\frac{F+G}{F+G}$ constant), is also favourable to MNEs. This is as MNEs can better cope with an increase in the number of non-production workers required as they face lower labour costs.

Overall the changes to average wages by permitting or prohibiting MNEs are small. This is as the labour market is relatively close to the outcome of a perfectly competitive labour market (whereby MNEs have close to zero advantage in bargaining over other firms). By decreasing $s$ (which reduces the efficiency of the matching function, Eq. (4)) the sensitivity of average wages to the presence of MNEs increases. (This sensitivity increases from 0.019 per cent to 0.045 per cent when $s$ is decreased from 0.08 to 0.06). Therefore, the effect of MNEs is likely to be smaller in countries such as Denmark, where active labour market policies can be interpreted as improving the efficiency of the labour market, though the effect is minor. Also, the sensitivity of the model is greater when the competitively traded sector output elasticity of labour, $\alpha$, is lower. For the plausible range of values of the labour share, a lower $\alpha$ increases the importance of the specific resource, and the effect of drawing labour from the competitively traded sector. (The sensitivity of average wages to the presence of MNEs increases from 0.02 per cent to 0.082 per cent when $\alpha$ is decreased from 0.2 to 0.1) This implies the model is more sensitive when calibrated to a lower labour share of GDP.

Changes in $\gamma$ are perhaps most interesting (Table 4). A large increase in $\gamma$ results in an equilibrium where only MNEs operate (decreases much below $\gamma = 0.5$ only allow an equilibrium in which MNEs do not exist). This is unsurprising as their advantage over national firms in wage bargaining is greater where workers have greater bargaining power. When $\gamma = 0.7$ national firms do not exist in equilibrium, so the higher wages paid by MNEs are most likely due to their greater
efficiency for the given parameters. However, for the mixed solution, small changes in $\gamma$ (and indeed all the other parameters) has the opposite effect on multinationals compared to non-mixed solutions.

Table 4: Sensitivity Analysis: $\gamma$

<table>
<thead>
<tr>
<th>$\gamma = 0.5$</th>
<th>$\gamma = 0.7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>MNE only solution</td>
<td>National firm only solution</td>
</tr>
<tr>
<td>average wage</td>
<td>unemployment</td>
</tr>
<tr>
<td>0.813528</td>
<td>6.5679%</td>
</tr>
<tr>
<td>0.813753</td>
<td>6.5862%</td>
</tr>
</tbody>
</table>

The changes in parameters affect whether the economy is more favourable to MNEs or national firms, in a discontinuous fashion. This is due to counteracting effects of a change in parameters on the profitability of MNEs and national firms. When there is an equilibrium where national firms and MNEs coexist, there are also two other equilibria, one where only national firms exist, and one where only MNEs exist. For example, increasing $\gamma$ from 0.3 to 0.7, there is first only one equilibrium, with only national firms. Then where $\gamma$ is close to 0.5 there are three equilibria, and as $\gamma$ moves towards 0.7 there is again only one equilibrium, with only MNEs. So increases in $\gamma$ are favourable towards an equilibrium with MNEs, as one would expect. However, for the range of values of $\gamma$ where there is a mixed equilibrium there increases in $\gamma$ lead to a decrease in the number of MNEs. This unusual effect is because national firms tend to dominate when there is a lower national income. An increase in $\gamma$ decreases national income (as firms invest less in creating vacancies). This has a negative effect on national income, and counteracts the positive effect of a higher $\gamma$ on MNEs. This only applies for a narrow range of values. Nevertheless, the key findings of the model that MNEs tend to lead to
lower wages but higher employment are robust.

5. Conclusion

In this paper, we put forward a new mechanism for how globalisation may affect labour markets. When firms open a plant abroad to improve their outside option in the wage bargain and lower their wage bill, the demand for labour increases. This can cause an increase in wages. We showed that, for symmetric countries, in a simplified model where there are no international trade frictions or extra costs in establishing a foreign plant (so national firms and MNEs face identical cost structures) increased firm mobility can lead to higher wages. This is as MNEs strategically hire extra workers to improve their outside option in the wage bargain. Increased firm mobility leads to an increase in the demand for labour. However using the full model we found that the number of non-production workers needed for plant operations plays a crucial role with higher plant level fixed costs reducing the benefit of MNEs hiring extra workers. Increased openness leads to lower unemployment. Only where MNEs have so great an advantage that national firms do not enter in equilibrium does openness lead to both lower unemployment and higher wages. This contrasts with Eckel and Egger (2009) where MNEs always have higher productivity that increases the real wage. The decrease in wages due to the improvement in firms outside option during wage bargaining is mitigated by the international strategic hiring effect. We show the importance of accounting for the international strategic hiring motive of MNEs by suppressing this motive, which leads to significantly lower wages and higher unemployment. The results are robust to changes in key parameters. Overall, the effects on wages and unemployment of allowing MNEs are small.
Acknowledgements

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Appendix A. Calculation of MNE wages

If bargaining breaks down in the foreign (home) plant the firm only produces in the home (foreign) plant. The value function of a MNE that is temporarily only producing in one country is very similar to the value function of a national firm, with the exception that the firm posts vacancies for plants in both countries. Next period the firm will return to operating as a normal MNE. A hat (tilde) over a variable signifies its value if negotiations break down with workers in the foreign (home) plant. As the firm operates under Cournot competition it assumes its actions have no effect on national income or labour market tightness. The firm continues to assume this even if negotiations with workers break down. The firm assumes it has an effect on the product market, though it ignores the possible reaction of other firms. Focusing first on negotiations with workers in the foreign plant; using these assumptions

\[
\hat{X}_c^* - \hat{X}_h^{M*} = X_c^* - X_h^{M*},
\]

(A.1)

where \(\hat{X}_c^*\) represents the quantity of the Cournot good consumed in the foreign country in the case of negotiations breaking down in the foreign plant, and \(\hat{X}_h^{M*}\) is the amount of the Cournot good that would be supplied by the firm to the foreign country if negotiations break down. The outside option of the firm is

\[
V^M (H_h^M, 0) = \max_{\hat{v}_h^M, \hat{v}_h^{M*}, \hat{X}_h^M, \hat{X}_h^{M*}} \left\{ \frac{H_h^M}{1 - \tilde{\lambda}} \hat{v}_h^M - \frac{H_h^{M*}}{\theta} \hat{v}_h^{M*} \left( \hat{v}_h^M + \hat{v}_h^{M*} \right) + (1 - \eta) \beta V^M (H_h^{M'}, H_h^{M'*}) \right\},
\]

(A.2)

subject to

\[
H_h^{M'} = \left( 1 - \tilde{\lambda} \right) H_h^M + q (\theta) \hat{v}_h^M,
\]

\[
H_h^{M*'} = q (\theta^*) \hat{v}_h^{M*},
\]

47
and
\[ H_h^M = F + G + \dot{X}_h^M + (1 + \tau) \ddot{X}_h^M. \]

For convenience we can write \( \overline{REV}_h^M = P \left( \dot{X}_h \right) \dot{X}_h^M + P \left( \ddot{X}_h \right) \ddot{X}_h^M. \) The firm tries to maximise its profits using the number of workers it still has available. The first order conditions of \( V^M \left( H_h^M, 0 \right) \) for \( \dot{X}_h^M \) and \( \ddot{X}_h^M \) lead to
\[
\frac{(1+\tau)\bar{Y}(\dot{X}_h^* - \ddot{X}_h^*)}{(\dot{X}_h^*)^2} = \frac{\bar{Y}(\dot{X}_h^* - \ddot{X}_h^*)}{(\dot{X}_h^*)^2},
\]
which using equation (A.1) leads to
\[
\ddot{X}_h^* = \frac{X_c + (1 + \tau) \left( X_c^* - X_h^M \right)}{\left[ \frac{\bar{Y}(1+\tau)(X_c - X_h^M)}{\bar{Y}(X_c^* - X_h^M* )} \right]^{1/2} + (1 + \tau)}.
\]

Similarly to the case of the national firm we can get \( \overline{REV}_{h^M} \) and combining with Eq. (A.3) we get
\[
\overline{REV}_h^M = \delta \left[ \frac{(1+\tau)\bar{Y}(X_c^* - X_h^M* )^{1/2} - (\bar{Y}(X_c - X_h^M))^{1/2}}{(1+\tau)(X_c^* - X_h^M) + (X_c - X_h^M)} \right] ^2 + \delta \frac{(H_h^M - F - G)\left( (1+\tau)\bar{Y}(X_c^* - X_h^M* )^{1/2} + (\bar{Y}(X_c - X_h^M))^{1/2} \right)}{(1+\tau)(X_c^* - X_h^M) + (X_c - X_h^M) + (1 + \tau)(X_c^* - X_h^M* )},
\]

It is also useful at this point to show
\[
\partial \overline{REV}_h^M \over \partial H_h^M = \delta \left( \frac{(1+\tau)\bar{Y}(X_c - X_h^M))^{1/2} + (1 + \tau) \bar{Y}(X_c^* - X_h^M* )^{1/2}}{H_h^M - F - G + (X_c - X_h^M) + (1 + \tau)(X_c^* - X_h^M* )} \right)^2,
\]
which is positive if the firm is not operating as a monopoly, and
\[
\partial \overline{REV}_h^M \over \partial H_h^M = 0.
\]

Subtracting Eq. (A.2) from Eq. (20) we get the marginal value of the foreign plant as
\[
V^M \left( H_h^M, H_h^M* \right) - V^M \left( H_h^M, 0 \right) = \overline{REV}_h^M - \overline{REV}_{h^M} - H_h^M \left( w_h^M - w_h^M* \right) - w_h^M* H_h^M* + \phi \left( 1 - \lambda \right) H_h^M*,
\]
\( (A.4) \)
where \( \text{REV}_h^M = P(X_c)X_h^M + P(X^*_c)X_h^{M*} \). This is simply the marginal value of the foreign plant plus the value of not needing to replace the workers in the foreign plant, minus the difference between the equilibrium wage and renegotiated wage in the home plant, and the wage bill of the foreign plant. Similar to the case for national firms, the renegotiated wage in the home plant is given as

\[
\tilde{w}_h^M = \gamma \left( \frac{\text{REV}_h^M}{H_h^M} + \phi \frac{(1 - \lambda)}{q(\theta)} \right) + (1 - \gamma) \omega_h^M.
\]

The first order condition of Eq. (32) leads to

\[
H_h^{M*} (1 - \gamma) [W_{h*}^{M*} - U^*] = \gamma (V^M (H_h^M, H_h^{M*}) - V^M (H_h^M, 0)). \tag{A.5}
\]

Combining Eqs. (29), (A.5), and (A.4), and rearranging we get

\[
w_{h*}^M = \gamma \left( \frac{\text{REV}_h^M - \text{REV}_h^{M*} + \gamma \text{REV}_h^M}{(1 + \gamma) H_h^{M*}} + \phi \frac{(1 - \lambda)}{q(\theta)} \right) + (1 - \gamma) \omega_h^{M*}.
\]

Negotiations in the home plant are similar to the above. We get the renegotiated wage in the foreign plant as

\[
\tilde{w}_h^{M*} = \gamma \left( \frac{\text{REV}_h^{M*}}{H_h^{M*}} + \phi \frac{(1 - \lambda)}{q(\theta^*)} \right) + (1 - \gamma) \omega_h^{M*}.
\]

Using the first order condition (37) and substituting in Eqs. (20), (29), and MNE value function, the wage is

\[
w_h^M = \gamma \left( \frac{\text{REV}_h^M - \text{REV}_h^{M*} + \gamma \text{REV}_h^M}{(1 + \gamma) H_h^M} + \phi \frac{(1 - \lambda)}{q(\theta)} \right) + (1 - \gamma) \omega_h^M.
\]

**Appendix B. Proof**

For a sufficiently low value of \( F \), the value function of MNEs is concave in the number of plants in operation. For multinationals, revenue from the home plant is
higher when wage negotiations break down in the foreign plant ($\hat{REV}_h^N > P(X_c)X_h^N$).

This is as if all workers in the foreign plant separate from the firm, it is still possible for the plant in the home country to generate a revenue of $P(X_c)X_h^N$. However, as supply in the foreign country has been reduced (due to the closure of the foreign plant) and concavity due the assumption of Cournot competition; marginal revenue in the foreign country increases. Hence the plant in the home country can maximise profits by exporting to the foreign country, leading to $\hat{REV}_h^N > P(X_c)X_h^N$.

Similarly, for a sufficiently low value of $F$, revenue from the foreign plant is higher when wage negotiations break down in the home plant ($\hat{REV}_h^N \geq P(X_c^*)X_h^N$). As headquarter functions must be carried out in the foreign plant during the period there are $F$ fewer workers available for production. A necessary condition for $\hat{REV}_h^N \geq P(X_c^*)X_h^N$ is that $H_h^{M^*} > F + G$. This implies that for a sufficiently low value of $F$,

$$REV_h^N < \hat{REV}_h^N + REV_h^N.$$

As $\hat{REV}_h^N > P(X_c)X_h^N$ the condition necessary for $F$ is weaker than for $\hat{REV}_h^N \geq P(X_c^*)X_h^N$. It must be remembered that the reason that $REV_h^N < \hat{REV}_h^N + REV_h^N$.

This is unsustainable in equilibrium. Next period a new firm can enter to replace the supply of the good that was lost when negotiations broke down.

Using the wage Eqs. (34), (35), (39), and (40), we can show that

$$V^N(H_h^M, H_h^{M^*}) - (V^N(H_h^M, 0) + V^N(0, H_h^{M^*})) = \left(\frac{1 - \gamma}{1 + \gamma}\right)\left(REV_h^N - \hat{REV}_h^N + \hat{REV}_h^N\right).$$

It follows that $V^N(H_h^M, H_h^{M^*}) \leq V^N(H_h^M, 0) + V^N(0, H_h^{M^*})$, so MNEs are concave in the number of plants in operation.
Appendix C. Propositions

Proposition 5. Increasing firm level fixed costs \( F \) relative to plant level fixed costs \( G \) increases the likelihood that MNEs exist in equilibrium.

Keeping \( F + G \) constant, an increase in the ratio \( \frac{F}{G} \) has no effect on the revenue generated in the home plant or on \( \widehat{REV}_h^M \) or \( \tilde{REV}_h^M \) as the number of workers available for production in these cases depends on the total \( F + G \). As \( F + G \) is kept constant, an increase in \( \frac{F}{G} \) reduces \( G \) and increases the number of workers available for production in the foreign plant, and increases revenue in the foreign plant. Proposition 2 shows that changes in the ratio \( \frac{F}{G} \) has no direct effect on \( n \) (the indirect effect only being through changes in \( m \)). As productivity for MNEs increases relative to all other firms, this leads to an increase in the proportion of MNEs in the economy. This result is consistent with the model of Markusen and Venables (1998).

Proposition 6. If only MNEs operate in the Cournot sector \( (n = 0) \) an increase in transport costs \( \tau \) reduces the number of MNEs \( (m) \)

This is as an increase in \( \tau \) reduces \( \widehat{REV}_h^M \) and \( \tilde{REV}_h^M \). This reduces the outside option of MNEs leading to higher wage costs for MNEs and lower profitability. This causes a reduction in \( m \). This is in contrast to the model of Markusen and Venables (1998), as in that model \( \tau \) had no direct effect on the profitability of MNEs.