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ABSTRACT

Multinational Corporations, Wages and Employment: Do Adjustment Costs Matter?*

This Paper investigates the extent to which expansion of international production by US multinationals reduces labour demand at home and at other foreign locations in the presence of labour adjustment costs. The adjustment-cost model of the firm is applied to estimate short-run and long-run price elasticities between home and foreign labour, using dynamic panel data techniques. Evidence is found of significant adjustment costs for employment in Latin American and Canadian affiliates. Also, due to slow adjustments, the relationship between employment in US parents and in Latin American affiliates is reversed from the short to the long-run, changing from substitution into complementarity. Finally, labour substitution prevails both in the short and in the long-run between locations in the Western Hemisphere and in Europe.

JEL Classification: F23, J23
Keywords: multinational corporations, adjustment costs, labour demand, dynamic duality

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NON-TECHNICAL SUMMARY

In the ongoing debate on the effects of globalization on wages and employment, one of the most crucial issues is the role played by multinational corporations (MNCs). It is often claimed that, as long as MNCs establish and/or expand overseas production, they tend to substitute workers at home with workers in foreign affiliates' countries in response to changes in relative wages. Thus, one of the most studied aspects of home country effects of globalization has been whether employment in foreign affiliates is a 'substitute' or a 'complement' to home country employment of the parent firms.

An important point that has to date been neglected is that, in practice, MNCs programs of international production allocation may take time before being accomplished. In general, the sources of costs blamed for causing slow employment adjustments are usually related to: searching activities (i.e. screening and processing new employees); training (including disruptions to production as previously trained workers' time is devoted to on-the-job instruction of new workers); severance pay (mandated and otherwise). With more emphasis on international production, MNCs may incur adjustment costs when allocating activities abroad due to the uneven distribution of skills across international locations, i.e. advanced versus developing countries. For example, the creation of new manufacturing plants in less-developed countries is likely to require an upgrading of the local labour force, entailing costly searching and training activities. In all such instances, short-run responses to relative wage changes can be different from long-run ones in both size and sign.

Stylized facts from industry-level data on US manufacturing MNCs, collected by the Bureau of Economic Analysis (B.E.A.), are somewhat evocative of the presence of employment adjustment costs within foreign affiliates located in particular geographical areas. By grouping foreign affiliates into four areas reflecting, in a very broad sense, proximity and development differences – Canada, Europe, Latin America and Rest of the World – we find, on the one hand, that no clear correlation emerges between relative wage annual changes and employment annual changes at any area. On the other hand, employment annual changes in Latin America and Canada show no negligible auto-correlation coefficients compared to the US, Europe and Rest of the World, which supports slow adjustments for the former class of production factors.

All recent empirical studies on the interplay between MNC activities and the labour market are static in nature, neglecting the possibility of employment adjustment costs. Slaughter (1995), using the BEA data set, estimates a system of input demand equations derived from MNC cost functions to find weak evidence of MNCs substituting parent with foreign labour. Brainard and Riker (1997a) confirm Slaughter's finding for a firm-level panel of US MNCs and their foreign affiliates between 1983 and 1992. They analyse labour demand within firms across plant locations, by fitting a firm-level global cost function specified in terms of relative wages. Little evidence is found of substitutability between parent and affiliates employment. In contrast, in a related paper (Brainard and Riker (1997b)), they report strong substitutability between workers at affiliates in alternative low-wage locations, where the activities most sensitive to labour costs are performed. In a recent paper, using a firm-level panel on Swedish MNCs, Braconier and Ekholm (1999) find different results. The relationship between employment in affiliates in different geographical locations emerges to be mainly one of complementarity, while substitutability is found between parent employment in Sweden and affiliate employment in other high-income locations.

This Paper tackles the substitution-versus-complementarity issue from a broader angle. The adjustment-cost model of the firm (Lucas (1967), Treadway (1971)) is applied for the first time to MNCs, allowing for employment slow adjustments in different international locations. The MNC decides how much employment adjustment for each area will take place in each period to minimize its discounted flow of costs over an infinite horizon. The model is then solved following the dynamic duality approach developed and implemented by Epstein and Denny (1983). Dynamic duality has the distinguishing advantage of simplifying derivation of dynamic input demand functions, plus the complete list of regularity conditions, in models with more than two inputs.

The model is applied to the BEA data set over the period 1982 to 1994. There are three main empirical results. First, employment convincingly emerges as a quasi-fixed input for both Canada and Latin America affiliates, confirming evidence from the stylized facts.

Second, due to slow input adjustments, the complementarity/substitution relationship between employment in US parents and employment in Latin America affiliates is reversed from the short to the long-run. While in the short-run we find evidence of labour substitution, in the long-run a complementarity relationship emerges, suggesting a vertical division of activities to take advantage of different factor proportions.

Third, labour substitution prevails both in the short-run and in the long-run between locations in the Western Hemisphere (North and Latin America) and in Europe, which is supportive of the general idea that proximity to the final market matters in deciding where to locate production.

Multinational Corporations, Wages and Employment: Do Adjustment Costs Matter?

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Abstract

This paper investigates the extent to which expansion of international production by U.S. multinationals reduces labor demand at home and at other foreign locations in the presence of labor adjustment costs. The adjustment-cost model of the firm is applied to estimate short-run and long-run price elasticities between home and foreign labor, using dynamic panel data techniques. Evidence is found of significant adjustment costs for employment in Latin American and Canadian affiliates. Also, due to slow adjustments, the relationship between employment in U.S. parents and in Latin America affiliates is reversed from the short to the long-run, changing from substitution into complementarity. Finally, labor substitution prevails both in the short and in the long-run between locations in the Western Hemisphere and in Europe.

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1. Introduction

In the ongoing debate on the effects of globalization on wages and employment, one of the most crucial issues is the role played by multinational corporations

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(MNCs). It is often claimed that, as long as MNCs establish and/or expand overseas production, they tend to substitute workers at home with workers in foreign affiliates' countries in response to changes in relative wages. Thus, one of the most studied aspect of home country effects of globalization has been whether employment in foreign affiliates is a 'substitute' or a 'complement' to home country employment of the parent firms.

An important point that has to date been neglected is that, in practice, MNCs programs of international production allocation may take time before being accomplished. In general, the sources of costs blamed for causing slow employment adjustments are usually related to: searching activities (i.e. screening and processing new employees); training (including disruptions to production as previously trained workers' time is devoted to on-the-job instruction of new workers); severance pay (mandated and otherwise). With more emphasis on international production, MNCs may incur in adjustment costs when allocating activities abroad due to the uneven distribution of skills across international locations, i.e. advanced versus developing countries. For example, the creation of new manufacturing plants in less developed countries is likely to require an upgrading of the local labor force, entailing costly searching and training activities. In all such instances, short-run responses to relative wage changes can be different from long-run ones in both size and sign.

Stylized facts from industry-level data on U.S. manufacturing MNCs, collected by the Bureau of Economic Analysis (B.E.A.), are somewhat evocative of the presence of employment adjustment costs within foreign affiliates located in particular geographical areas. By grouping foreign affiliates into four areas reflecting, in a very broad sense, proximity and development differences -Canada, Europe, Latin America and Rest of the World- we find, on the one hand, that no clear correlation emerges between relative wage annual changes and employment annual changes at any area. On the other hand, employment annual changes in Latin America and Canada show no negligible autocorrelation coefficients compared to U.S., Europe and Rest of the World, which supports slow adjustments for the former class of production factors.

All recent empirical studies on the interplay between MNC activities and the labor market are static in nature, neglecting the possibility of employment adjustment costs. Slaughter (1995), using the B.E.A. data-set, estimates a system of input demand equations derived from MNC cost functions to find weak evidence of MNCs substituting parent with foreign labor. Brainard and Riker (1997a) confirm Slaughter's finding for a firm-level panel of U.S. MNCs and their foreign affiliates between 1983 and 1992. They analyze labor demand within firms across plant locations, by fitting a firm-level global cost function specified in terms of relative wages. Little evidence is found of substitutability between parent and affiliates employment. In contrast, in a related paper (Brainard and Riker (1997b)), they report strong substitutability between workers at affiliates in alternative low wage locations, where the activities most sensitive to labor costs are performed. In a recent paper, using a firm-level panel on Swedish MNCs, Braconier and Ekholm (1999) find different results. The relationship between employment in affiliates in different geographical locations emerges to be mainly complementarity, while substitutability is found between parent employment in Sweden and affiliate employment in other high-income locations.[1].

This paper tackles the substitution-versus-complementarity issue from a broader angle. The adjustment-cost model of the firm (Lucas (1967), Treadway (1971)) is applied for the first time to MNCs, allowing for employment slow adjustments in different international locations. The MNC decides how much employment adjustment for each area will take place in each period to minimize its discounted flow of costs over an infinite horizon. The model is then solved following the dynamic duality approach developed and implemented by Epstein and Denny (1983). Dynamic duality has the distinguishing advantage of simplifying derivation of dynamic input demand functions, plus the complete list of regularity conditions, in models with more than two inputs.

The model is applied to the B.E.A. data-set over the period 1982 to 1994. There are three main empirical results. First, employment convincingly emerges as a quasi-fixed input for both Canada and Latin America affiliates, confirming evidence from the stylized facts.

Second, due to slow input adjustments, the complementarity/substitution relationship between employment in U.S. parents and employment in Latin America affiliates is reversed from the short to the long-run. While in the short-run we find evidence of labor substitution, in the long-run a complementarity relationship emerges, suggesting a vertical division of activities to take advantage of different factor proportions.

Third, labor substitution prevails both in the short-run and in the long-run between locations in the Western Hemisphere (North and Latin America) and in Europe, which is supportive of the general idea that proximity to the final market matters in deciding where to locate production (Brainard (1997), Markusen and Venables (1998)).

The structure of the paper is as follows. The next section provides stylized facts on U.S. MNCs. Section 3 sets up the empirical model. Estimation and

[1]Other studies have investigated questions related to the potential substitution effect of production overseas. A first strand in the literature has studied the role of multinationals' activities by testing the effect of producing abroad on parent labor demand per unit of output (see Blomstrom, Fors and Lipsey (1997) and Lipsey (1999)). Another strand has tested whether the transfer of production stages from parents to foreign affiliates has contributed to shifts in home relative labor demand toward the more-skilled (see Slaughter (1999)).

testing methods are presented in Section 4, while empirical results are shown and discussed in Section 5. Section 6 concludes. Details on econometric procedures are relegated into two appendices.

2. Data and Stylized Facts on U.S. MNCs

This study uses industry-level data on U.S. manufacturing MNCs, collected and administered on a mandatory basis by the B.E.A.. The B.E.A. Annual and Benchmark Surveys of U.S. Direct Investment Abroad report foreign affiliates and U.S. parents financial and operating data on an annual basis.[2]

The data set includes all parents and foreign affiliates classified in the manufacturing sector. The activities of MNCs are aggregated into 32 different industries. We construct a panel spanning the period 1982 to 1994 and including parents and affiliates total employment, employee compensation, sales and total assets.[3] Foreign affiliates are grouped into four geographical areas reflecting, in a very broad sense, proximity and development differences: Canada, Europe, Latin America and Rest of the World.

A set of stylized facts on these data is as follows. Over the period 1982-1994, employment is declining both in parents and in foreign affiliates, but in percentage terms this decline was larger for parents (-13.5%) than for affiliates (-7.1%). As a result, relative employment in MNCs shifted slightly towards affiliates (Figure 1). Looking at how the allocation of affiliates' employment has evolved over time across locations, Figure 2 shows that the share of employment at affiliates in Canada and Europe has marginally declined, while the share at affiliates in Latin America and in the Rest of the World has expanded until 1994. Figure 3 shows corresponding changes in relative wages, defined as employee compensation of affiliates in different locations over employee compensation of parents. Figures 2 and 3 taken together suggest that there is no simple correlation between changes in employment shares and changes in relative wages. On the one hand, increasing relative wages seem not to be associated to declining employment shares, as in the case of locations in Europe and in the Rest of the World. On the other hand, low relative wages seem not to be associated to employment expansion, as in Latin America.

Further clues about the substitution-versus-complementarity issue can be drawn by looking at intra-firm trade. The literature on MNCs distinguishes between horizontal and vertical international expansion. Vertical investments take place when the MNC re-deploys only part of its production process. Horizontal investments replicate in a foreign country the complete production structure of the

[2] For more details see Mataloni (1995).

[3] We have retrieved the B.E.A. data set from Feenstra (1997).

home country. The former are principally driven by differences in factor endowments between home and host countries; as such, they are explained by the need to exploit location specific factors of production (cheap labor, natural resources, specific skills) and are complementary to trade. The latter are instead more often market driven, they are generally explained by the need to overcome trade barriers and transport costs, by the availability of firm specific intangible assets and are generally substitute to trade. In order to shed some light on the nature of the relationship between U.S. parents and affiliates in our four geographical locations, we show the shares of U.S. exports and imports of goods shipped to/by affiliates over affiliates' sales, which may be thought of as proxies of intra-firm trade (Table 1). Not surprisingly, we find higher shares of trade with affiliates in Canada and in Latin America, suggesting a vertical decomposition of production activities, and low shares of trade with affiliates in more distant regions of Europe and the Rest of the World.

Finally, as a preliminary check for the presence of adjustment costs, we look at the degree of persistence of employment over time. Evidence from autocorrelation coefficients of employment's annual changes of parents and of foreign affiliates in different geographical areas shows that affiliate employment in Latin America and in Canada present no negligible degrees of persistence (respectively 0.17 and 0.11), suggesting low adjustments. In contrast, autocorrelation coefficients for Europe, the Rest of the World and parents are negligible, suggesting absence of adjustment costs for these areas (Table 2).

The econometric application below will shed light on the significance of the foregoing stylized facts.

3. A Dynamic Model of MNC Behavior

The adjustment-cost model postulates that firms may suffer a short run loss in terms of foregone output when changing stocks of quasi-fixed inputs (Lucas (1967), Treadway (1971)). We apply such a model to MNC behavior, by adapting the dynamic duality approach developed and implemented by Epstein and Denny (1983). The dual approach has the distinguishing advantage of simplifying derivation of both the closed form solutions for input demands and the complete list of regularity conditions in models with more than two inputs.

The MNC can allocate labor among the home parent and its affiliates throughout the world. We focus on four different areas for affiliates: Canada, Europe, Latin America and the Rest of the World. Accordingly, five production inputs are considered: parent employment, l^p, affiliate employment in Europe, l^e, affiliate employment in Canada, l^c, affiliate employment in Latin America, l^{la} and affiliate employment in the Rest of the World, l^{rw}. For each input we have the correspondent input price: p_{l^p}, p_{l^e}, p_{l^c}, $p_{l^{la}}$ and $p_{l^{rw}}$.

We maintain that l^{rw} is the only variable input, while l^p, l^e, l^c and l^{la} are quasi-fixed. Throughout, dots denote derivatives with respect to time, and the superscript τ denotes transposition. To save on notation, let $v \equiv l^{rw}$, $p_v \equiv p_{l^{rw}}$, $l \equiv \left[l^p, l^e, l^c, l^{la}\right]^\tau$ and $p_l \equiv [p_{l^p}, p_{l^e}, p_{l^c}, p_{l^{la}}]^\tau$.

At time t the MNC combines the variable input $v(t)$, quasi-fixed inputs stocks $l(t)$ and adjustments $\dot{l}\ (t)$, to produce output $y(t)$ according to the production function (from now on t is omitted as an argument of the variables considered):

$$y = F(\dot{l}, l, v) \tag{3.1}$$

Adjustments costs in terms of foregone output are modelled by assuming that $F_{\dot{l}} > 0$ if $\dot{l} < 0$ and $F_{\dot{l}} < 0$ if $\dot{l} > 0$[4]. From F, we define the variable cost function $\widetilde{C}$

$$\widetilde{C}(\dot{l}, l, p_v, y) = \left[\min_v p_v v : y = F(\dot{l}, l, v)\right].$$

The MNC is price taker with respect to p_v and the quasi fixed input prices p_l, which are assumed always strictly positive. Prices p_l are normalized by p_v. Thus let $p_v = 1$ and $\widetilde{C}(\dot{l}, l, 1, y) \equiv C(\dot{l}, l, y)$. Also, let $r > 0$ denote the real rate of discount, assumed constant over time. The MNC chooses adjustments $\dot{l}$ and the variable input level v to minimize its discounted flow of total costs (quasi-fixed cost added to variable cost) in continuous time over an infinite horizon. This defines the value function J associated with the following intertemporal optimization problem

$$J(l, p_l, y) = \min_{\dot{l}, v} \int_0^{+\infty} e^{-rt} \left[p_l^\tau l + v\right] dt, \tag{3.2}$$

subject to $y = F(\dot{l}, l, v)$ and $l(0) = l_0 > 0$.

As typical in the dynamic duality applications, it is assumed that the MNC holds static expectations on p_l and y. Thus, at any time period the MNC makes its decisions on the assumption that all information on future prices and output is embodied in the currently observed variables.

Using the variable cost function, problem (3.2) can be reformulated in a more compact form

$$J(l, p_l, y) = \min_{\dot{l}} \int_0^{+\infty} e^{-rt} \left[p_l^\tau l + C(\dot{l}, l, y)\right] dt \tag{3.3}$$

subject to $l(0) = l_0 > 0$.

[4] Differently from Epstein and Denny (1983), we allow for negative $\dot{l}$.

The variable cost function C offers a representation of the technology that is equivalent to F. Thus, we assume that F is such that C satisfies the following properties: a) $C \geq 0$; b) $C_l < 0$; c) $C_{\dot{l}} > 0$ if $\dot{l} > 0$ and $C_{\dot{l}} < 0$ if $\dot{l} < 0$; d) C is convex in $\dot{l}$; e) problem (3.3) (or (3.2)) has a unique globally stable steady state. Notice that property c) is dual to the adjustment cost property of F.

The function J has a useful property, namely it satisfies the Hamilton-Jacobi equation (Arrow and Kurz (1970)):

$$rJ(l, p_l, y) = \min_{\dot{l}} \left[p_l^{\tau} l + C(\dot{l}, l, y) + J_l(l, p_l, y)\, \dot{l} \right]$$

where J_l is the (1×4) row-vector of shadow prices associated with quasi-fixed stocks. The Envelope Theorem and Shephard Lemma can then be applied to the foregoing equation to derive the policy functions for quasi-fixed input adjustments, $\dot{l}^*$, and the variable input demands, v^*, solutions to (3.2):

$$\begin{aligned} \dot{l}^*(l, p_l, y) &= J_{p_l l}^{-1} \left[r J_{p_l}^{\tau} - l \right] \\ v^*(l, p_l, y) &= r(J - J_{p_l} p_l) - (J_l - p_l^{\tau} J_{p_l l})\, \dot{l}^* \end{aligned} \tag{3.4}$$

Also, the duality between C and J implies that J must satisfy the following list of regularity conditions: a) $J \geq 0$; b) $rJ_l^{\tau} - p_l - J_{ll}\, \dot{l}^* < 0$; c) $J_{\dot{l}}^{\tau} < 0$ if $\dot{l}^* > 0$ and $J_{\dot{l}}^{\tau} > 0$ if $\dot{l}^* < 0$; d) $rJ_y - J_{yl}\, \dot{l}^* > 0$; e) $rJ - J_l\, \dot{l}^*$ is concave in p_l; f) the stock profile l^* associated with $\dot{l}^*(l, p_l, y)$ and l_0 has a unique globally stable steady state $\bar{l}$. Such conditions also offer an exhaustive characterization of J (Epstein and Denny (1983)). The equations in (3.4) constitute the system upon which we base our empirical analysis.

As in many dynamic duality applications, we choose a quadratic specification for J (see Epstein and Denny (1983) among others).

$$J = a_o + a_y y + A_{p_l}^{\tau} p_l + A_{p_l y}^{\tau} p_l y + A_l^{\tau} l + p_l^{\tau} A_{p_l l}^{-1} l + 1/2 \left[y p_l^{\tau} A_{p_l p_l} p_l + l^{\tau} A_{ll} l \right]. \tag{3.5}$$

a_o and a_y are scalar parameters; A_{p_l}, $A_{p_l y}$ and A_l are (4×1) column vectors of parameters; $A_{p_l p_l}$ and A_{ll} are (4×4) symmetric matrices of parameters; $A_{p_l l}^{-1}$ is a (4×4) matrix of parameters.

Considering the whole system (3.4) would require estimation of an extremely large number of parameters, compared to the size of the B.E.A. data set. We, therefore, restrict ourselves to the quasi fixed input subsystem. Applying (3.4) to (3.5), it has

$$\dot{l} = A_{p_l l} \left[r A_{p_l} + r y (A_{p_l y} + A_{p_l p_l} p_l) \right] + (rI - A_{p_l l}) l. \tag{3.6}$$

where I is the (4×4) identity matrix.

For future reference, let

$$A_{p_l y} = \begin{pmatrix} \beta_p \\ \beta_e \\ \beta_c \\ \beta_{la} \end{pmatrix},$$

$$A_{p_l p_l} = \begin{pmatrix} \beta_{p,p} & \beta_{p,e} & \beta_{p,c} & \beta_{p,la} \\ \beta_{p,e} & \beta_{e,e} & \beta_{e,c} & \beta_{e,la} \\ \beta_{p,c} & \beta_{e,c} & \beta_{c,c} & \beta_{c,la} \\ \beta_{p,la} & \beta_{e,la} & \beta_{c,la} & \beta_{la,la} \end{pmatrix}$$

and

$$A_{p_l l} = \begin{pmatrix} \alpha_{p,p} & \alpha_{p,e} & \alpha_{p,c} & \alpha_{p,la} \\ \alpha_{e,p} & \alpha_{e,e} & \alpha_{e,c} & \alpha_{e,la} \\ \alpha_{c,p} & \alpha_{c,e} & \alpha_{c,c} & \alpha_{c,la} \\ \alpha_{la,p} & \alpha_{la,e} & \alpha_{la,c} & \alpha_{la,la} \end{pmatrix}.$$

Finally, notice that according to the regularity conditions spelled out for J, $A_{p_l l}$ does not need to be a symmetric matrix.

4. Estimation and testing strategy

4.1. Estimation

Our panel has an unbalanced structure. Let N be the number of sectors and T_i be the number of time periods for which the i.th sector is observed, $i = 1, ..., N$. For estimation, the vector of purely stochastic components $\epsilon_{it} \equiv \left[\epsilon_{it}^p, \epsilon_{it}^e, \epsilon_{it}^c, \epsilon_{it}^{la}\right]^\tau$ with zero means and variance-covariance matrix Σ is appended to system (3.6). We accommodate sector heterogeneity by allowing A_{p_l} in J to vary across sectors. This yields sector specific coefficients in system (3.6), namely $rA_{p_l l}A_{p_l}^i$, $i = 1, ..., N$. Finally, as standard in the continuous time investment literature, to make (3.6) empirically implementable a discrete time approximation of $\dot{l}$ is employed. Thus

$$l_{it} = rA_{p_l l}A_{p_l}^i + ry_{it}A_{p_l l}(A_{p_l y} + A_{p_l p_l}p_{l_{it}}) + (rI + I - A_{p_l l})l_{i,t-1} + \epsilon_{it}, \qquad (4.1)$$

$t = 1, ..., T_i$, $i = 1, ..., N$.

It is well known from the dynamic panel data literature that the standard within estimator applied to a first order autoregressive model yields consistent estimates only when the number of time periods T_i is large (Nickell (1981)), which is not the case for most panels, ours included. To solve such a problem, econometricians have suggested various instrumental variable approaches (Arellano and

Bond (1991), Ahn and Schmidt (1995) among others). Here we follow the Generalized Method of Moment (GMM) estimator approach suggested by Arellano and Bond, widely used in most recent dynamic panel data applications, which exploits all available linear orthogonality conditions. The procedure goes as follows.

The individual effects are eliminated by taking the model in first differences:

$$\Delta l_{it} = r\left[A_{p_l l} A_{p_l y} \Delta y_{it} + A_{p_l l} A_{p_l p_l} \Delta(y_{it} p_{l_{it}})\right] + (rI + I - A_{p_l l})\Delta l_{i,t-1} + \Delta\epsilon_{it} \quad (4.2)$$

$t = 1, ..., T_i$, $i = 1, ..., N$, where given any variable x_{it}, $\Delta x_{it} \equiv x_{it} - x_{i,t-1}$.

If Σ is such that the error terms are serially uncorrelated, the errors in first-differences may well exhibit MA(1) autocorrelation. We, therefore, follow an instrumental variable approach to estimate (4.2), with the instruments optimally weighted by the expected variance-covariance matrix of the orthogonality conditions, as required by an optimal GMM estimator (Hansen (1982); Gallant (1987), p. 442).

The model generates valid instrumental variables under the form of lagged values of the endogenous variables. Assume Σ is such that the error terms are serially uncorrelated, that is $E(\epsilon_{it}^{h}\epsilon_{it'}^{h'}) = 0$ for all t and $t' = 1, ..., T_i$, $t \neq t'$, all h and $h' = p, e, c, la$, and all $i = 1, ..., N$, the following orthogonality conditions hold: $E(\Delta\epsilon_{it}^{h}\, l_{i,t-s}^{h'}) = 0$, $s = 2, ..., t-1$, $t = 3, ..., T_i$, $i = 1, ..., N$, h and $h' = p, e, c, la$. As a result, l_{-2}, l_{-3}, and further lags yield valid instruments for all system equations. This will extend to all of the endogenous variables of the model. So in principle, $(T_M - 1)(T_M - 2)/2$ instruments can be obtained from each endogenous variable, where $T_M = max[T_1, ..., T_N]$.

Another source of departure of this analysis from the received empirical literature on MNCs is that output y and relative wages p_l are treated as potentially endogenous. In fact, output is a strategic variable for a MNC, as such it could as well be chosen along with the employment variations. It is also very likely that wage, employment and output are affected by correlated random shocks. In view of these considerations, both y and p_l are instrumented by using the appropriate lags.

Capital stock, measured as total assets of the firm, is added to each equation in level and also included into the instrument set with the appropriate lags. To capture world economy effects, we add time period dummies to each equation and also employ them as instruments. Then, abiding by a standard practice in the dynamic duality applications, we take the real discount rate to be equal to a given plausible value. Results reported are for $r = 0.07$. Other values have been tried, confirming results obtained for $r = 0.07$.

Our model is a dynamic four-equation system, using a potentially high number of instruments. As such, it is computationally troublesome. In order to keep the computational difficulties to a minimum, we have restricted our instrument set to the third and fourth lags for each endogenous variable. Importantly, such choice permits to wipe out measurement errors in the differenced system that present a degree of serial correlation up to the second order.

Finally, the model is estimated by applying a GMM estimator, as coded by the TSP 4.4 procedure *GMM.* Following Bruno (1999), we adapt the single equation two-step procedure by Arellano and Bond (1991) to a system of equations with cross-equation parameter restrictions. This procedure is presented in more detail in Appendix A.

4.2. Hypothesis testing

A convenient feature of our model is that it nests the case of perfectly variable inputs. This hypothesis, therefore, can be tested by computing the joint significance of the set of implied parameter restrictions. The reader can easily verify that the system in (4.1) can be re-arranged according to the following more convenient form

$$\Delta l = M \left[l_{-1} - \bar{l}(p_l, y) \right] \tag{4.3}$$

where $M = rI - A_{p_l l}$ is the adjustment matrix

$$M = \begin{pmatrix} r - \alpha_{p,p} & -\alpha_{p,e} & -\alpha_{p,c} & -\alpha_{p,la} \\ -\alpha_{e,p} & r - \alpha_{e,e} & -\alpha_{e,c} & -\alpha_{e,la} \\ -\alpha_{c,p} & -\alpha_{c,e} & r - \alpha_{c,c} & -\alpha_{c,la} \\ -\alpha_{la,p} & -\alpha_{la,e} & -\alpha_{la,c} & r - \alpha_{la,la} \end{pmatrix}, \tag{4.4}$$

and $\bar{l}(p_l, y) = -(rI - A_{p_l l})^{-1} \left[rA_{p_l l} A^i_{p_l} + ryA_{p_l l}(A_{p_l y} + A_{p_l p_l} p_l) \right]$ is the vector of steady state stock demands. The system (4.3) expresses the short run input adjustment as a proportion of the desired change.

The parameter restrictions implied by the assumption that, say, l^p is perfectly variable are readily obtained:

$$r - \alpha_{p,p} = -1, \;\; \alpha_{e,p} = 0, \;\; \alpha_{c,p} = 0, \;\; \alpha_{la,p} = 0. \tag{4.5}$$

Interpretation of Conditions (4.5) is straightforward. A given input is perfectly variable if a) its short run change is always a 100% adjustment to the desired change, when the other inputs are at their steady state levels and b) the size of its desired change does not interact with the short run adjustments of the other inputs. Conditions (4.5) can be tested by using standard Wald tests on the unrestricted matrix M.

As to the regularity conditions for J, the estimation of system (4.3) (or 4.2) allows us to check only conditions e) and f). Condition e) boils down to $A_{p_l p_l}$ being a symmetric and negative-definite matrix, while condition f) implies that $M + I$ is a stable matrix.

5. Results

We describe our empirical results in two sections. First, we present estimation and testing results from three nested model specifications, checking for the presence of input adjustment costs. Secondly, to asses the issue of input substitutability, we report short-run and long-run elasticity estimates.

5.1. Estimation and Testing Results

The panel based on the B.E.A. data set covers the period 1982-1994 for 32 sectors. Due to confidentiality concerns some observations are missing, which attributes an unbalanced structure to the data set. The panel is unbalanced both because the number of observations is different across industries, and because the observations for the industries do not overlap over time. For 3 sectors there are no years without missing data, as a result these sectors are lost in the data set we use. Besides, after constructing lags and first differencing, the observations of any uninterrupted interval spanning less than three years are lost for each sector. This makes other 4 sectors disappear, eventually leaving us with 25 sectors. However, there are still enough moment restrictions available to estimate the whole set of parameters.

For any specification tried we report and comment the two-step estimates. The findings are however qualitatively the same in the two cases. Results for all models are collected in Table 3.

We start by presenting results from the complete parametric specification (Model 1). We have 186 degrees of freedom corresponding to the number of over-identifying restrictions exploited minus the number of estimated parameters. The Hansen-Sargan test of the over-identifying restrictions does not reject the validity of the instruments used at any conventional significance level.

We also carried out a modification of the Verbeek and Nijman's (1996) variable addition test to check for ignorability of the selection rule determining the unbalanced structure of our panel. First, we found a set of variables likely to comprise the pattern of missing data. Then, we added such variables to each system equation, and finally we calculated the Wald test of joint significance. Results was supportive of ignorability, and so we did not correct our estimates for sample selectivity. Details and results for the variable addition test are collected into Appendix B.

In Model 1 none of the testable regularity conditions can be rejected. As to condition f), $rI + I - A_{p_l l}$ is a stable matrix, as all its eigenvalues turn out to be within the unit circle, which implies that the employment profiles converge to a unique steady state. The other regularity condition is e), which imposes that $A_{p_l p_l}$ is a symmetric and negative definite matrix. We maintain symmetry and check for negative definiteness. Results are less clear-cut in this case as some principal minors have the wrong sign. None of these, however, turns out to be significantly wrong.

It is worth analyzing both the size and the statistical significance of the adjustment speeds in all areas. To begin with, we focus on the own adjustment speeds, which are given by the coefficients on the main diagonal of the adjustment matrix M in (4.4). They measure the actual input variation within one year as a proportion of the desired change in the input stock. Results are quite consistent with the stylized facts shown in Section 2. First, adjustment costs are important in the case of affiliate employment in Latin America and Canada. If the other inputs are at their steady state levels, then only 69% of the adjustment to any desired change in the stock of Latin America affiliate employment occurs within one year. A similar result obtains for affiliate employment in Canada, where only 78% of the adjustment occur within one year. Second, adjustments are much faster for both parent employment and Europe affiliate employment: very close to 100% within one year.

However, to properly assess whether an input is perfectly variable we need to test the joint parameter restrictions in (4.5), involving not only the own adjustment speed, but also the interaction terms in the other input demands. In this respect, tests of perfect variability are quite clear-cut. We reject the assumption of all inputs being perfectly variable at 5% significance level. Also, perfect variability is refuted for Latin America and Canada affiliate employment, both jointly and individually. In contrast, we fail to reject the same hypothesis when restricted to parent employment and Europe affiliate employment.

In Model 1 a large number of parameters are not individually significant. A Wald test on 40 such parameters does not reject the hypothesis of coefficients all equal to zero. Therefore, to obtain a more parsimonious specification, we have set such parameters to zero and estimated the system (4.2) with the restrictions imposed (Model 2).

As before, the Hansen-Sargan test for this restricted specification does not reject the validity of the instruments used at any conventional significance level, and none of the testable regularity conditions is significantly refuted. As to adjustment speeds, we do not register dramatic changes with respect to evidence from Model 1. Affiliate employment in Latin America still presents the lowest adjustment speed -76% of the desired change within one year- even if quite close to that of affiliate employment in Canada (77%). Adjustment speeds for both parent employment and affiliate employment in Europe are not significantly different from -1, which is evidence of a 100% adjustment. Tests of perfect variability confirm results from Model 1 at any conventional significance level.

Our third specification (Model 3), along with the restrictions of Model 2, maintains that both parent employment and affiliate employment in Europe are perfectly variable inputs. Restrictions (4.5) are therefore imposed for both such inputs. The whole set of parameter restrictions maintained by Model 3 is not rejected by a Wald test carried out on Model 1. The Hansen-Sargan test is supportive of instrument validity and the regularity conditions cannot be rejected. Adjustment speeds are comparable with the previous findings: 71% and 79%, respectively for Latin America and Canada. Finally, perfect variability tests on these two inputs, both individually and jointly, reject the hypothesis at any conventional significance level.

Some comments on these results are at order. The MNC may slowly adjust its labor employment stocks due to the uneven distribution of skills across international locations. The creation of new manufacturing plants in less developed countries is likely to require an upgrading of the local labor force, entailing costly searching and training activities. In particular, this seems to have been the case of Mexico, which accounts for a large share of U.S. affiliates' manufacturing employment in Latin America (51% in 1994), and so may be crucial in characterizing employment in this area as a quasi fixed input. The presence of U.S. MNCs in Mexico is largely the result of the FDI boom following the relaxation of the restrictions on foreign investments in the early 1980s. As illustrated by Feenstra and Hanson (1997), this inflow of capital is positively correlated with the relative demand of skilled labor.

For Canada, which is the smallest and perhaps most homogeneous area in our geographical partition, more traditional explanations for employment adjustment costs could be invoked. In this respect, we notice that during the 80s Canadian labor laws have increased job protection for workers, causing higher layoff costs (Hornstein and Yuan (1999)). It might also be noticed that relatively slow employment adjustments for this area seem to be consistent with Feinberg, Keane and Bognanno's (1998) findings of Canadian affiliates of U.S. MNCs rationalizing and reorganizing production in response to trade liberalization boosted by the Canada-U.S. Free Trade Agreement.

Our finding of fast employment adjustments in Europe may be regarded at odds with the popular wisdom of rigid European labor markets. Nonetheless, we observe the following. First, in an advanced area such as Europe a problem of skill upgrading seems in general not too severe. Secondly, in the last two decades the entry of U.S. MNCs has principally taken the form of mergers and acquisitions (United Nations, various years). With the acquisition of a local firm, MNCs take advantage of already established assets, e.g. in the form of management staff, distribution networks, manufacturing skills, lowering the potential for employment adjusting costs. Finally, although existing regulations of most western European countries are often believed to inhibit the labor market to work correctly, there are countries quite flexible, as the United Kingdom, which accounts for the largest share of employment in European manufacturing affiliates (28% in 1994).

5.2. Elasticity Estimates

In the received literature, the MNC responsiveness to relative price variations is investigated by estimating price (own-price and cross-price) elasticities. In this respect, our intertemporal analysis can produce novel insights as we can distinguish between short-run and long-run behavior. Nonetheless, a problem seems to emerge here. That is, the estimation of the long run stock price elasticities requires estimating the steady state levels $\bar{l}(p_l, y) = -(r - A_{p_l l})^{-1}\left[rA_{p_l l}A^i_{p_l} + ryA_{p_l l}(A_{p_l y} + A_{p_l p_l}p_l)\right]$. Unfortunately, the latter depend on the sector specific effect $rA_{p_l l}A^i_{p_l}$, which is not consistently estimated when T_i is small. We work around this problem by focusing on long-run *flow* elasticities, which measure the response of the annual change in the steady state employment to relative wage changes. On the one hand, flow elasticities are identified under our parametrization as the sector specific effect is differenced out. On the other hand, flow elasticities convey the same information about long-run substitution as stock elasticities, since derivatives with respect to relative wages are the same.

For computational ease, we concentrate only on price elasticities estimated from Models 2 and 3. Elasticities and corresponding standard errors are calculated at each sample observation. Notably, corresponding elasticities in both model have the same sign and their values are not very different. Elasticities that are more frequently significant are: parents and Latin American affiliates own price elasticities; cross price elasticities of employment in parents/Latin America in response of a wage change in Latin America/parents; the cross price elasticity of employment in Europe in response of a wage change in Latin America. Tables 4 and 5 present the values of the medians of short-run stock and flow, and long-run flow price elasticities for Model 2 and 3, respectively.

We find that, in the long-run, there is complementarity between affiliates located in Latin America and parents in the U.S.. This suggests a vertical division of activities among countries with different workforce skill levels. In the light of growing costs of performing labor intensive activities in developed countries, MNCs can decide to increase the delocation of these stages of production towards developing regions and maintain the skilled intensive activities in the parent. In the long-run, due to the vertical link between different stages of production, the expansion of activities performed by Latin American affiliates may tend to bring with it an expansion of activities performed by parents.

Importantly, short-run cross price elasticities show that the relationship between employment of affiliates in Latin America and of U.S. parents is one of substitution. How to interpret such reversion from the short-run to the long-run?

To fix ideas, assume a reduction in the relative wage of affiliates in Latin America. This will increase the desired stock of labor in this area and, through the long-run complementarity relationship, also in U.S. parents. However, in the short-run, the complementarity effect on U.S. parent labor demand is more than offset by the impact of slow employment adjustment in Latin America, which results in a short-run decrease in U.S. parent employment. Our findings show that the result of low price substitutability in Brainard and Riker (1997a) may actually conceal contrasting short-run and long-run effects.

Labor substitution prevails both in the short-run and in the long-run between locations in the Western Hemisphere (North and Latin America) and in Europe. This suggests that European affiliates are predominantly horizontal, consistently with MNC concerns of proximity to the final markets, trade barriers and transport costs (Brainard (1997), Markusen and Venables (1998)).

6. Conclusions

In this study we have developed a dynamic model of the MNC that explicitly allows for the presence of input adjustment costs. Using such a model, we have carried out an empirical application to industry level data on U.S. MNCs.

Treating labor in different geographical locations as separate factors of production, we have tested for the presence of adjustment costs and also estimated short-run and long-run price elasticities. Our findings are the following. First, employment convincingly emerges as a quasi-fixed input for both Canada and Latin America affiliates. Second, due to slow input adjustments, the complementarity/substitution relationship between employment in U.S. parents and employment in Latin America affiliates is reversed from the short to the long-run. While in the short-run we find evidence of labor substitution, in the long-run a complementarity relationship emerges, suggesting a vertical division of activities. Third, labor substitution prevails both in the short-run and in the long-run between locations in the Western Hemisphere (North and Latin America) and in Europe, which is supportive of the general idea that proximity to the final market matters in deciding where to locate production.

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Appendix A

Estimation Procedure

We describe here a simple procedure (Bruno (1999)) that generalizes the Arellano and Bond (1991) GMM estimator to the case of a system of equations with cross-equation parameter restrictions.

Assume that we have a panel of N individuals and that each individual i is observed for $T_i \geq 3$ periods of time. Consider a system of M equations with random disturbances $\epsilon = \left[\epsilon^{1\tau}, ..., \epsilon^{M\tau}\right]^{\tau}$ which have the properties defined in Section 4.1. We wish to estimate a vector of parameters β, assuming that the dimension of β guarantees the identification. Let Z be the $\sum_{i=1}^{N}(T_i - 2) \times k$ matrix of instruments as derived in Section 4.1 For each equation, define the corresponding $K \times 1$ vector of orthogonality conditions $m^i(\beta) = Z^{\tau}\ (\Delta\epsilon^i)$, $i = 1, ..., M$, and then stack them in a single vector $m(\beta) = \left[m^{1\tau}(\beta), ..., m^{M\tau}(\beta)\right]^{\tau}$. Let A_N be the $(M \times K) \times (M \times K)$ optimal weighting matrix. The optimal GMM estimator is then given by

$$\widehat{\beta} = \arg\min_{\beta}\left[m^{\tau}(\beta)\ \ A_N\ \ m(\beta)\right].$$

Hansen (1982) showed that the optimal choice for A_N is $\left(\frac{1}{N}\ \widehat{m}\ \widehat{m}^{\tau}\right)^{-1}$, where $\widehat{m}$ is an estimate of $m(\beta)$ from a consistent one-step estimator $\widehat{\beta}_1$. As a result, a feasible GMM estimator can be obtained in two steps. The one-step estimator is obtained by slightly generalizing the Arellano and Bond procedure. Let H_i be a $(T_i - 2)$ square matrix that has twos in the main diagonal, minus one in the first subdiagonals and zeroes otherwise. Then, form a $\sum_{i=1}^{N}(T_i - 2)$ block diagonal matrix H, with $H_i =$ block i of H. Let $\overline{A}_N = \left(\frac{1}{N}\ Z^{\tau}\ H\ Z\right)^{-1}$ and, finally, get the first step estimator

$$\widehat{\beta}_1 = \arg\min_{\beta}\left[m^{\tau}(\beta)\ \ \overline{A}_N\ \ m(\beta)\right].$$

Now, use $\widehat{\beta}_1$ to construct $\widehat{m}$, which yields the second step estimator

$$\widehat{\beta}_2 = \arg\min_{\beta}\left[m^{\tau}(\beta)\ \ \left(\frac{1}{N}\ \widehat{m}\ \widehat{m}^{\tau}\right)^{-1}\ \ m(\beta)\right].$$

$\widehat{\beta}_1$ and $\widehat{\beta}_2$ are asymptotically equivalent if the ϵ_{it}^{s}, $s = 1, ..., M$, $i = 1, ..., N$, $t = 3, ..., T_i$ are independent and homoskedastic across individuals, equations and over time.

Appendix B

Variable Addition Test of Selection Bias

It is crucial for estimation to assess whether the selection rule determining the unbalanced structure of the panel depends or not on the variables to explain. If it does, then ignoring the selection rule would lead to biased estimates. We tackle this point by adopting a simple variable addition test as suggested by Verbeek and Nijman (1996). Verbeek and Nijman's test is based on the idea that if the selection rule is not ignorable, the pattern of missing observations should significantly affect the relationship between endogenous and exogenous variables. Thus, they suggest to include three variables supposedly comprising the effect of the missing data: T_i, the number of years sector i does not present missing data, c_i a dummy variable that is equal to one if sector i never presents missing data and, finally, $s_{i,t-1}$ the selection indicator lagged one time, indicating whether sector i is observed in the previous year. If the coefficients on these variables are significantly different from zero, there would be evidence of non-ignorable selection rules, and so a correction procedure for sample selection bias should be adopted.

A problem with applying the foregoing test as it is to our framework is that the first two variables proposed are in fact time-invariant, and so the corresponding coefficients would not be identified in a fixed effects framework. Moreover, as the dynamic panel approach imposes to discard any uninterrupted interval spanning less than three years, all the 25 sectors are in fact observed in the previous two periods, which makes both $s_{i,t-1}$ and $s_{i,t-2}$ time-invariant. Therefore, we modify the Verbeek and Nijman test, checking for the joint significance of $s_{i,t-3}$ and the interaction between $s_{i,t-3}$ and T_i. By applying the modified test to Model 1 we find that, in both one-step and two step estimation, the Wald test of joint significance of the coefficients on $s_{i,t-3}$ and $s_{i,t-3}\times T_i$ in the four equations does not reject the hypothesis of ignorability at any conventional level of significance. The one-step procedure yields $\chi^2(8) = 6.829$, $(P - value = 0.555)$, and the two-step procedure yields $\chi^2(8) = 11.687$ $(P - value = 0.166)$.

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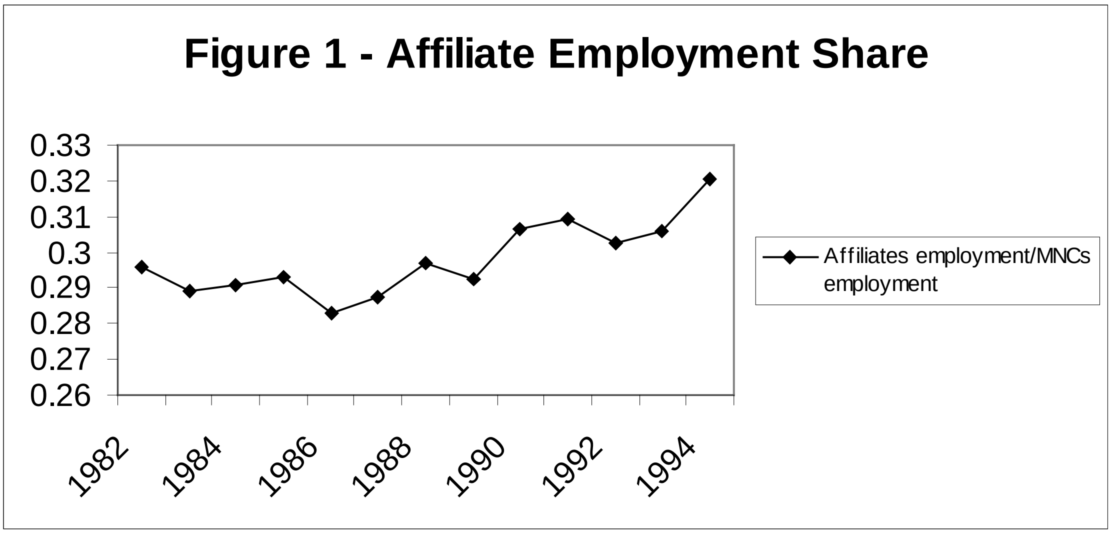
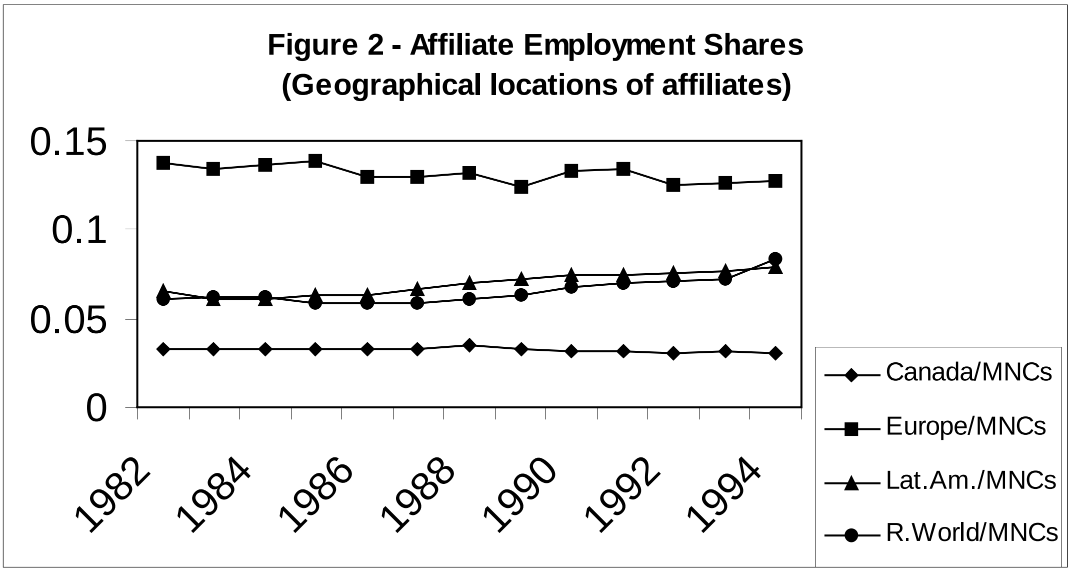


Source: our calculations on B.E.A. data retrieved from Feenstra (1997)



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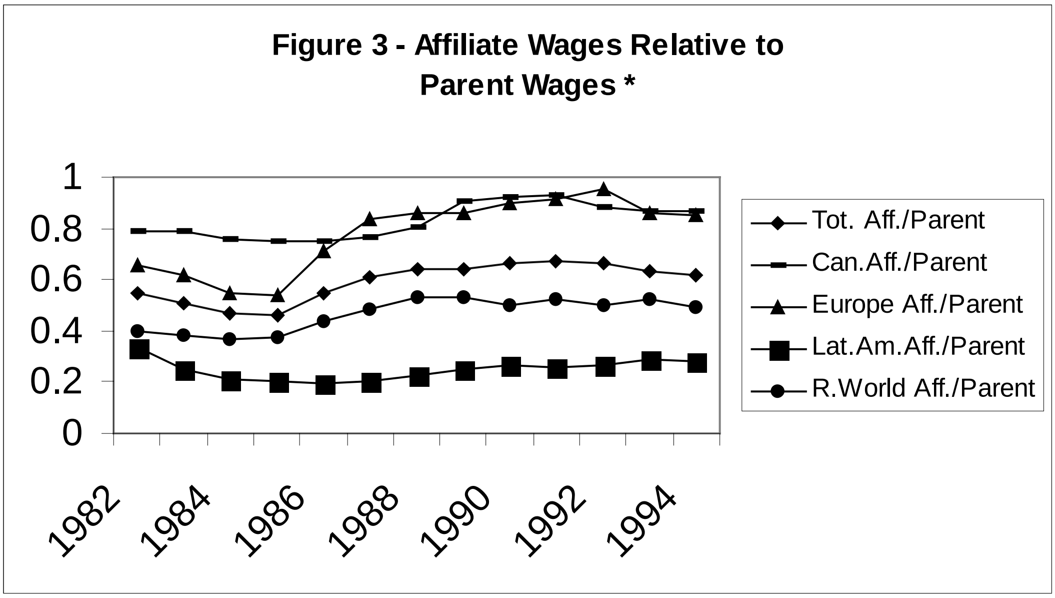

Source: our calculations on B.E.A. data retrieved from Feenstra (1997)
(*) Employee compensation of affiliates in different locations over employee compensation of parents.

Table 1 - Trade flows of MNCs

Share of U.S. Exports of goods shipped to Affiliates over Affiliates' sales

	Canada	*Europe*	*Latin America*	*Rest of theWorld*
1982	0.290	0.055	0.095	0.082
1983	0.316	0.060	0.111	0.063
1984	0.340	0.063	0.119	0.072
1985	0.357	0.058	0.131	0.070
1986	0.366	0.046	0.149	0.064
1987	0.366	0.044	0.147	0.062
1988	0.350	0.048	0.137	0.059
1989	0.318	0.050	0.148	0.068
1990	0.322	0.044	0.145	0.062
1991	0.351	0.046	0.177	0.065
1992	0.359	0.048	0.191	0.069
1993	n.a.	0.053	0.187	n.a.
1994	0.404	0.054	0.185	0.075

Share of U.S. Imports of goods shipped by Affiliates over Affiliates' sales

	Canada	*Europe*	*Latin America*	*Rest of theWorld*
1982	0.289	0.018	0.056	0.118
1983	0.308	0.021	0.087	0.103
1984	0.325	0.026	0.116	0.110
1985	0.333	0.030	0.123	0.127
1986	0.341	0.029	0.143	0.126
1987	0.320	0.031	0.143	0.130
1988	0.322	0.033	0.138	0.124
1989	0.341	0.031	0.145	0.145
1990	0.346	0.030	0.144	0.140
1991	0.356	0.027	0.153	0.130
1992	0.382	0.029	0.170	0.136
1993	0.404	0.033	0.167	0.119
1994	0.417	0.036	0.184	0.129

Source: our calculations on B.E.A. data retrieved from Feenstra (1997)

Table 2 - Autocorrelation coefficients of MNCs employment annual changes

	Autocorrelation coefficients
Parents	0.05
Europe	-0.04
Canada	0.11
Latin America	0.17
Rest of the World	0.05

Source: our calculations on B.E.A. data retrieved from Feenstra (1997)

Table 3 – Estimation and test results

Parameter estimates, t-statistics in parenteses			
	Model 1	***Model 2***	***Model 3***
$\beta_{p,la}$	.0000568 (.062274)		
$\beta_{e,la}$	.0004545 (.489282)	.0005947 (.786587)	.0008919 (1.21839)
$\beta_{c,la}$	.0011017 (1.49569)		
$\beta_{la,la}$	-.0079823 (-2.87436)	-.0054578 (-2.87400)	-.0063784 (-3.40657)
β_{la}	-.0043556 (-1.32232)	-.0037769 (-1.50844)	-.0048493 (-1.86685)
$\beta_{p,c}$	-.0006593 (-1.54727)	-.0003695 (-1.27622)	-.0003212 (-1.14111)
$\beta_{e,c}$	.0000020 (.004592)		
$\beta_{c,c}$	.0000844 (.221203)	.0001269 (.438061)	.0001538 (.537792)
β_{c}	.0003563 (.218294)	.0016530 (1.44905)	.0012097 (1.15515)
$\beta_{p,e}$	.0005256 (.690804)	.0006850 (1.19966)	.0038337 (.904954)
$\beta_{e,e}$	.0001626 (.198290)	-.0004131 (-.697749)	-.0003379 (-.718924)
β_{e}	-.0028490 (-.975183)	-.0026949 (-1.34792)	-.0028345 (-1.68023)
$\beta_{p,p}$	-.012847 (-3.18604)	-.013168 (-4.08789)	-.014150 (-4.19955)
β_{p}	.106808 (6.16808)	.099519 (7.25967)	.105089 (7.67935)
$\alpha_{p,p}$	1.16195 (17.8447)	1.13588 (18.8764)	1 + *r* (imposed)
$\alpha_{p,e}$	.482769 (.536236)		
$\alpha_{p,c}$	4.45659 (2.76860)	4.09179 (2.53222)	4.11989 (2.54328)
$\alpha_{p,la}$	-.750719 (-.817346)	-1.42301 (-1.97380)	-1.26049 (-1.80444)
$\alpha_{e,e}$	.995513 (7.95628)	.921465 (9.30242)	1 + *r* (imposed)
$\alpha_{e,p}$	-.0090718 (-1.00506)		
$\alpha_{e,c}$	.085477 (.345663)		
$\alpha_{e,la}$	-.275293 (-2.07188)	-.257099 (-2.32636)	-.302182 (-3.07826)
$\alpha_{c,c}$	.850586 (6.63589)	.846345 (7.86765)	.860225 (8.13202)
$\alpha_{c,p}$	-.0048766 (-1.03245)	-.0055304 (-1.38920)	
$\alpha_{c,e}$	-.048261 (-.734117)		
$\alpha_{c,la}$	-.026677 (-.388649)		
$\alpha_{la,la}$	.766117 (6.10158)	.835258 (8.26826)	.781014 (7.85235)
$\alpha_{la,p}$	-.0080947 (-.998388)	-.0093934 (-1.30924)	
$\alpha_{la,e}$	-.024391 (-.217021)		
$\alpha_{la,c}$	-.332180 (-1.42846)	-.450059 (-2.33846)	-.443708 (-2.22934)
Tests, p-value in parentheses			
$Test_p$	$\chi^2(4)$ = 4.101 (.392)	$\chi^2(3)$ = 4.320 (.229)	
$Test_e$	$\chi^2(4)$ = 1.089 (.895)	$\chi^2(1)$ = 2.248 (.134)	
$Test_c$	$\chi^2(4)$ = 11.251 (.023)	$\chi^2(3)$ = 14.304 (.002)	$\chi^2(3)$ = 13.577 (.003)
$Test_{la}$	$\chi^2(4)$ = 11.471 (.021)	$\chi^2(3)$ = 15.878 (.001)	$\chi^2(3)$ = 23.216 (.000)
$Test_{p,e}$	$\chi^2(8)$ = 12.498 (.130)	$\chi^2(4)$ = 6.534 (.163)	
$Test_{c,la}$	$\chi^2(8)$ = 23.819 (.002)	$\chi^2(6)$ = 30.215 (.000)	$\chi^2(6)$ = 37.604 (.000)
$Test_{p,e,c,la}$	$\chi^2(16)$ = 31.726 (.010)	$\chi^2(10)$ = 39.728 (.000)	
Model-2	$\chi^2(40)$ = 25.973 (.958)		
Model-3	$\chi^2(44)$ = 31.250 (.926)		
H-S	$\chi^2(186)$ = 169.728 (.798)	$\chi^2(226)$ = 164.105 (.999)	$\chi^2(230)$ = 173.185 (.998)
R squared			
R_p^2	.987	.986	.986
R_e^2	.997	.997	.998
R_c^2	.988	.989	.989
R_{la}^2	.986	.986	.985

Notes to Table 3

1) The instrument set includes the values of the following lagged variables: $\boldsymbol{y_{-3}}$, $\boldsymbol{y_{-4}}$, $\boldsymbol{l_{-3}}$, $\boldsymbol{l_{-4}}$, $\boldsymbol{p_{l-3}}$, $\boldsymbol{p_{l-4}}$. Time dummies and capital stock (total assets) are added to each equation and are also included into the instrument set (capital stock is included with the appropriate lags).
2) **H-S** is the Hansen-Sargan Test of the over-identifying restrictions, asymptotically distributed as $\chi^2(k)$ under the null.
3) $\boldsymbol{Test_i}$ is the Wald test for the parameter restrictions implied by perfect variability of input ***i***, ***i*** = ***p***,***e***,***c***,***la***. $\boldsymbol{Test_{i,j}}$ is the Wald test for the parameter restrictions implied by perfect variability of inputs ***i*** and ***j*** jointly, ***i*** and ***j*** = ***p***,***e***,***c***,***la***, with $\boldsymbol{i \neq j}$. $\boldsymbol{Test_{p,e,c,la}}$ is the Wald test for the parameter restrictions implied by perfect variability of all inputs jointly.
4) ***Model-2*** and ***Model-3*** are the Wald test for the parameter restrictions implied by Model 2 and Model 3 respectively.
5) ***r*** denotes the real discount rate and it is assumed to be equal to 0.07.
6) Notation is as follows: ***p*** denotes U.S. parents, ***e*** denotes affiliates in Europe, ***c*** denotes affiliates in Canada, ***la*** denotes affiliates in Latin America.

Table 4 - Stock and flow price elasticities (Model 2) – Medians

Price	Parent	Europe	Canada	Latin America
Short-run Stock				
W - Parent	-0,45209*	0.0949	-0.12909	0,065543*
W - Europe	-0.001306	-0.05339	-0.00152	0.077411
W - Canada	0.002304	0,0000	0.046897	-0.00961
W - Latin America	0,047012*	0,06687*	0.0000	-0,23128*
Short-run Flow				
W - Parent	-5,46690*	3,35760*	-3,03428	1,12283*
W - Europe	-0,014377	-1,95163	-0,032722	1,36463
W - Canada	0,022758	0,0000	1,11093	-0,16745
W - Latin America	0,51559*	2,31217*	0,0000	-4,33215*
Long-run Flow				
W - Parent	-4,54911*	3,56680*	-5,64566*	-0,084430*
W - Europe	0,18838	-1,38424	0,0083489	1,35341
W - Canada	-0,11270	0,0065113	1,67101	0,012698
W - Latin America	-0,053042*	0,48155	-0,015544	-3,47157*

Note: * indicates significance at the 5 percent level.

Table 5- Stock and flow price elasticities (Model 3) - Medians

Price	Parent	Europe	Canada	Latin America
Short-run Stock				
W - Parent	-0,45538*	0.061071	-0.1502	0.032089
W - Europe	-0.013587	-0.06291	0.0000	0.11059
W - Canada	0.006727	0.0000	0.055307	-0.0121
W - Latin America	0,049546*	0,098683*	0.0000	-0,25532*
Short-run Flow				
W - Parent	-5,40272*	2,16991	-3,75306*	0,56312
W - Europe	-0,15247	-2,35175	0,0000	2,01460
W - Canada	0,072329	0,0000	1,38332	-0,22039
W - Latin America	0,56647*	3,15450*	0,0000	-4,55033*
Long-run Flow				
W - Parent	-4,72664*	2,04044	-4,29439*	-0,042163
W - Europe	0,11571	-1,32898	0,0000	1,68733
W - Canada	-0,096054	0,010291	1,75029	0,016168
W - Latin America	-0,058824*	0,87913	0,0000	-3,40103*

Note: * indicates significance at the 5 percent level.