Trade liberalization and 'delocalization': new evidence from firm-level panel data

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Abstract. We examine how U.S. multinational corporations (MNCs) and their Canadian affiliates responded to the substantial bilateral tariff reductions that occurred over the 1983–92 period. Using confidential firm-level data from the Bureau of Economic Analysis, we focus on the MNCs' allocation of employment and capital across Canada and the United States. We find that Canadian affiliate employment and assets were negatively correlated with Canadian tariff rates, a pattern that contradicts the notion that Canadian tariff reductions would lead to a 'hollowing out' of Canadian manufacturing. We also find evidence of substantial heterogeneity in MNCs' responses to tariff changes, even within narrowly defined industries. JEL classification: F23, F10

Libéralisation du commerce et 'délocalisation': nouveaux résultats à partir de données au niveau de la firme. Les auteurs examinent la réponse des entreprises plurinationales américaines et de leurs filiales canadiennes aux réductions bilatérales substantielles dans les barrières tarifaires entre 1983 et 1992. Utilisant des données confidentielles au niveau de la firme en provenance du Bureau of Economic Analysis, ils examinent l'allocation de l'emploi et du capital de ces plurinationales à travers le Canada et les Etats-Unis. Il appert qu'il y a une corrélation négative entre la taille de l'emploi et des actifs et le niveau des tarifs douaniers. Voilà qui contredit la présomption que la réduction des tarifs douaniers du Canada ne peut que conduire à une éviscération du secteur manufacturier canadien. Les auteurs montrent aussi qu'il y a eu une grande hétérogénéité dans les réactions des plurinationales aux changements dans les tarifs douaniers, et ce même à l'intérieur d'industries définies de manière assez étroites.

The statistical analysis of firm-level data on U.S. multinational corporations reported in this study was conducted at the International Investment Division, Bureau of Economic Analysis, U.S. Department of Commerce, under arrangements that maintained legal confidentiality requirements. Views expressed are those of the authors and do not necessarily reflect those of the Department of Commerce. Suggestions and assistance from William Zeile and Raymond Mataloni are gratefully acknowledged.

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1. Introduction

The potential for import competition has long been the primary reason for public concern about trade liberalization. More recently, however, with the proliferation of foreign direct investment (FDI), the focus has shifted to the activities of multinational companies (MNCs). Concerns about free trade now centre on whether trade liberalization systematically induces MNCs to move certain activities abroad. Indeed, the trade debate in industrialized countries focuses primarily on the extent to which jobs will be 'siphoned out' (Baldwin, 1995) or 'delocalized' (Lawrence, 1994; Messerlin, 1995) as 'runaway plants' move to low-wage countries. For example, with lower domestic tariffs, MNCs can produce abroad to take advantage of lower factor costs and ship finished goods back to the home market. This concern was raised in both the debate over the North American Free Trade Agreement (NAFTA) and in the debate in Canada over the Canada-U.S. Free Trade Agreement (FTA).

This paper examines the impact of U.S.-Canada trade liberalization on U.S. MNCs' employment and capital allocation decisions in Canada from 1983–92. These years encompass tariff reductions from the Tokyo Round of the GATT/(WTO) and the Canada-U.S. Free Trade Agreement that took effect in 1989. The Canadian case differs from the NAFTA in the expected direction of employment and capital flows. In the debate over the NAFTA, the expectation in the United States was that free trade with Mexico would lead U.S.-based companies to open operations in Mexico and ship goods back to the United States. In the Canadian case, the consensus view is that high Canadian tariffs have attracted significant U.S. investments in Canada throughout the century, as U.S. firms sought to gain tariff-free access to Canada's markets. Thus, in Canada, the principal concern with the FTA was that existing Canadian affiliates of U.S. MNCs (so-called tariff factories; Caves 1990) would be closed or 'hollowed out.'

Hollowing out implies that MNCs remain in a market but perform their value-added activities abroad (*Business Week* 1986). Concerns about U.S. MNC affiliates being 'hollowed out' were the basis of the commonly expressed fear that trade liberalization would result in Canada's becoming a 'warehouse economy' (McFetridge 1989). Under this scenario, Canadian affiliates that were not shut down altogether would be confined to a distribution or 'warehousing' function – marketing goods imported from abroad (ibid.). Because of the view that Canadian plants tended to be smaller and less productive than their U.S. counterparts (see Baldwin and Gorecki 1986; Eastman and Stykolt 1967; Harris 1984), there was widespread concern that in many industries U.S. MNCs could more efficiently serve both markets from larger U.S. plants, rather than reorganizing their North American production to take advantage of Canadian and U.S. production capacity. In this paper we examine whether these concerns were borne out.

Our paper makes two contributions to the existing literature on the impact of trade liberalization. First, we use *firm-level* panel data to examine MNCs' employment and capital allocation decisions. Previous research has typically used aggregate and/or single-period data to examine the impact of tariffs on FDI or employment. Most recently, Gaston and Trefler (1997) examine the direct impact of the FTA on Canadian employment and earnings in tweny-two two-digit manufacturing industries using panel data from 1980 to 1993. Grubert and Mutti (1991) examine the impact of taxes and tariffs on MNCs' capital stock in 33 countries, but they use aggregate data for a single year. Caves (1990) uses panel data from 1970 to 1979 to examine the effect of tariff reductions on employment and capital expenditures in Canada, but he uses four-digit industry aggregate data. McFetridge (1989) uses aggregate data from the Bureau of Economic Analysis (BEA) to examine MNCs' changes in employment in Canada for two periods: 1966–77 and 1977–84.

As might be expected, the findings in previous research have been as diverse as the approaches. For example, McFetridge (1989) finds 'not a trace of support' for arguments that Canadian tariff reductions result in the export of jobs. Conversely, Caves (1990) finds that the level of employment in U.S. MNC affiliates in Canada is *positively* related to tariff levels, implying that tariff reductions should decrease affiliate employment in Canada. Similarly, Gaston and Trefler (1997) find a small but positive relationship between Canadian tariffs and employment in twenty-two manufacturing industries. Clearly, although much research has examined the link between trade liberalization and employment, conclusive findings have not emerged. By examining the relationship between capital allocation, employment, and tariffs at the firm level over time, our research provides stronger evidence on the effect of trade liberalization on MNCs' investment and employment decisions.

Our second contribution is to examine the extent to which MNCs' capital and employment decisions vary across firms and industries. Since our study examines the effect of tariff reductions on *U.S. MNCs* in Canada at the *firm* level, we can evaluate the magnitude of both inter- and *intra*-industry variation in responses to tariff changes. (In contrast, Gaston and Trefler 1997 examine only interindustry differences.) From a theoretical perspective, theories of the MNC, in particular the ownership-location-internalization (O-L-I) framework (Caves 1982; Dunning 1979; Rugman 1981), suggest that a combination of country characteristics (i.e., neoclassical-type factor endowments), industry characteristics (i.e., structural market imperfections), and firm characteristics (i.e., specialized knowledge, skills and processes) explains firms' decisions about where and under what type of governance regime to invest abroad. If industry characteristics were the most important influence on MNCs' investment (and employment) decisions, then the removal of trade barriers should have similar effects on all MNCs that are in the same industries. In other words, most of the variance in MNCs' response to tariff changes should be at the industry rather than at the firm level. In this study, we obtain explicit firm- and industry-specific estimates of the tariff coefficients in equations for MNCs' capital and employment allocation decisions. We then examine the relative amount of the variation in MNCs' responses to tariff changes explained by firm- and industry-specific effects.

From a policy perspective, it is important to know whether trade liberalization affects all firms within particular industries in a similar fashion. For example, when governments sponsor trade policies (such as the Semiconductor Trade Agreement or the Multifiber Arrangement) or trade adjustment assistance, typically they focus on particular industries considered to be vulnerable or to have been harmed by trade. If most of the variance in adjustments to trade liberalization is intra- rather than interindustry, however, policies designed to protect vulnerable industries could be misguided.

The data set used in this paper are from the Benchmark and Annual Surveys of U.S. Direct Investment Abroad (USDIA) from the Bureau of Economic Analysis. We use the confidential *disaggregated* data, which include detailed information on the entire population of U.S.-based MNCs and their foreign affiliates from 1983 to 1992. The panel used in this study includes 701 U.S.-based MNC parents and their Canadian affiliates in fifty manufacturing industries.[1] It is the use of the confidential detailed micro data that enables us to evaluate the extent to which MNCs' employment and capital allocation decisions (in response to trade liberalization) are systematically explained by firm or industry characteristics – an issue that other researchers have not been able to examine using only publically available industry-level data. While other researchers, for example, Brainard (1997), have used disaggregated data from the BEA, panel data studies have not been undertaken with this data to examine intra- and interindustry differences in responses to regime changes.

In the next section, we describe the econometric techniques used in this paper. In section 3 we describe the data set used in our estimations. The empirical results for U.S.-based MNCs and their Canadian affiliates' assets and employment are contained in section 4, and we summarize our main findings and conclude in section 5.

2. Econometric framework

The basic regression model used in our analysis is as follows:

$$\ln Y_{it} = \beta_0 + \beta_{i1}\text{CT}_{it} + \beta_{i2}\text{UT}_{it} + \beta_{i3}\,\text{Trend}_t + \beta_4 X_{it} + w_{it}$$
$$i = 1, 2, \ldots, N; t = 1, 2, \ldots T. \qquad (1)$$

Y_{it} is one of the five dependent variables:

1) Assets of Canadian affiliate i in year t
2) Property, Plant, and Equipment (PPE) of Canadian affiliate i in year t
3) Employment of Canadian affiliate i in year t
4) Assets of U.S. Parent i in year t
5) Employment of U.S. Parent i in year t.

1 The 701 unique parent-affiliate pairs are referred to as 'firms' in the remainder of this paper unless specified as 'parents' or 'affiliates.'

CT_{it} and UT_{it} are the relevant Canadian and U.S. tariffs for firm i at time t defined as

$$\text{CT}_{it} \equiv \sum_{j=1}^{J} \text{CT}_{jt} I[i \in j]$$

$$\text{UT}_{it} \equiv \sum_{j=1}^{J} \text{UT}_{jt} I[i \in j]$$

where CT_{jt} and UT_{jt} are Canadian and U.S. tariffs in industry j at time t and $I[i \in j]$ is an indicator for firm i belonging to industry j for $j = 1, \ldots, J$, so that the summations pick out only the industry tariff that is relevant for firm i. The vector X_{it} contains exogenous variables to account for the effects of transportation costs, relative factor costs, demand factors, and other miscellaneous time effects. Specifically, X_{it} includes real U.S. and Canadian manufacturing wages and a measure of transportation costs in the relevant industry j at time t. To capture demand factors, we include real U.S. and Canadian GDP. To capture other miscellaneous time effects, we include real U.S. interest rates, Canadian and U.S. price-earnings ratios, and a time trend. Similar control variables have been used by Gaston and Trefler (1997), Grubert and Mutti (1991), and Brainard (1993). Variable selection and measurement are discussed in greater detail in section 3.

Because of our interest in examining the extent to which firm and industry characteristics explain variations in MNCs' *responses* to trade liberalization, the model allows the slope coefficients on the U.S. and Canadian tariffs to differ across firms and industries. β_{i1} and β_{i2}, the firm-specific coefficients on the Canadian and U.S. tariffs in equation (1), are specified as

$$\beta_{i1} = \beta_1 + \mu_{i1} \qquad \mu_{i1} \sim N(0, \sigma_1^2)$$

$$\beta_{i2} = \beta_2 + \mu_{i2} \qquad \mu_{i2} \sim N(0, \sigma_2^2)$$

where β_1 and β_2 are the mean tariff coefficients in the population of firms and the μ_is capture across-firm heterogeneity in tariff responses.

We estimate β_1, β_2, σ_1^2 and σ_2^2. We can then test the null hypothesis that the variances of the β_is are equal to zero (Hsaio 1986). This is a test for whether there is significant variance across firms in how they respond to tariffs. From our estimated model, we can also construct estimates of *individual* firm and industry betas a posteriori using Bayes's law (see Judge et al. 1985, 541 for a discussion of how this can be done). We can then do an analysis of variance to see what fraction of variance in the β_is is explained by industry factors versus firm-specific factors.

In our estimated model, we also allow for heterogeneity in the time trend. So $\beta_{i3} = \beta_3 + \tau_i$, with $\tau_i \sim N(0, \sigma_\tau^2)$. Because the U.S. and Canadian tariffs have strong trends, it is possible that heterogeneity in the tariff coefficients might simply pick up the effect of unobserved time-varying factors (i.e., changes in technology or demand) that affect individual firms or industries differently. Allowing the trend coefficient to be random removes this potential problem.

Finally, the error term in equation (1) consists of two components: $w_{it} = \phi_i + \epsilon_{it}$ where ϕ_i is a vector of unobserved firm-specific characteristics, while ϵ_{it} is assumed to be i.i.d. over time and across firms. The variance of the firm-specific error component will indicate whether there exists substantial across-firm variation in the MNCs' capital and employment levels due to unobserved characteristics of firms. Incorporating the error components structure and three random slope coefficients into equation (1) yields the random effects (RE) model (2):

$$\ln Y_{it} = \beta_0 + (\beta_1 + \mu_{i1})\text{CT}_{it} + (\beta_2 + \mu_{i2})\text{UT}_{it} + (\beta_3 + \tau_i)\text{Trend}_t + \beta_4 X_{it} + \phi_i + \epsilon_{it}. \quad (2)$$

The key aspect underlying our random effects formulation is the assumption that the firm-specific error components, ϕ_i, μ_{i1}, μ_{i2}, and τ_i are uncorrelated with the independent variables. Since the independent variables in the model are defined at the industry or economy-wide level, this assumption seems plausible. The model in (2) is estimated by maximum likelihood. For comparison purposes, we also report OLS estimates for the five dependent variables, which we obtained by constraining all the coefficients to be homogeneous in the population of firms.

Finally, after estimating equation (2) for each of the five dependent variables, we construct the firm-specific beta estimates a posteriori. We use these betas to decompose the variance of the random coefficients and the random firm effect into within- and across-industry variance. The variance decompositions indicate whether MNCs' choices of capital and employment levels, and the changes in these quantities in response to tariff changes, are explained primarily by the industries in which the MNCs operate or by idiosyncratic firm characteristics. Results of the variance decompositions are reported along with the regression results for each dependent variable.

3. Data

The data set used in this paper is taken from the Benchmark and Annual Surveys of U.S. Direct Investment Abroad administered by the Bureau of Economic Analysis. The Benchmark and Annual Surveys provide the most comprehensive data available on the activities of U.S.-based MNCs and their foreign affiliates. For this study, we used the BEA data disaggregated at the *individual foreign affiliate level* for each MNC from 1983 to 1992. To isolate firm and industry effects, we use only single-industry affiliates (i.e., affiliates that reported sales in only one industry). Since many non-manufacturing industries include non-tradables (such as retail sales and hotel services), which would not be directly affected by tariff reductions, we use only manufacturing affiliates. Our sample includes fifty manufacturing categories. A description of these industries along with mean tariffs and transportation costs is given in appendix table A2.

Several alterations were made to the original sample to construct the panel. First, because the BEA conducts two different surveys – the Benchmark and Annual Surveys – with different reporting requirements in terms of affiliate size, reported data are not available for all the affiliates throughout the ten-year period. In particular, the Benchmark Surveys, conducted in 1977, 1982, and 1989 include the whole population of MNCs and their foreign affiliates, and smaller affiliates are required to report. In the Annual Surveys (for which data are available from 1983 to 1988 and 1990 to 1992), many of the small affiliates that reported data in the 1982 and 1989 Benchmark Surveys are exempt from filing, but the BEA carries them forward by estimating data.[2] Thus, most of the observations for smaller affiliates were estimated data for most of the ten-year period. We did not wish to include in the sample affiliates for which the data were primarily estimated rather than reported. The initial screen used to remove these affiliates was to include in the data set only affiliates with at least two reported (i.e., not estimated) observations or, in the case of affiliates only observed once, only those with reported (i.e., not estimated) data. The next step was to remove estimated data for individual affiliates at the beginning and end of the period over which they appeared in the sample. For example, if an affiliate drops out of the sample (most likely because it drops below the size that it is required to report), the BEA will carry the affiliate forward by estimating data. Because the Annual Survey data contain data on affiliates carried forward from the 1982 and 1989 Benchmark Surveys, for many affiliates in the sample reported data were observed in the middle of the sample period (typically in the 1989 Benchmark Survey), and estimated data were observed at the beginning and end. For these affiliates, estimated data at the beginning and end were eliminated and only the middle observations were kept. After both screens, the total number of firm-year observations was reduced from 5,687 to 3,203, of which only fifty-three were estimated data points.[3]

Data were modified four more times to arrive at the final sample. First, affiliates in the same industry with the same parent were combined. Second, in 1987 SIC codes were revised for many industries, which resulted for the most part in codes being merged.[4] After recoding more than a dozen industries for the entire sample period, affiliates in the same industry with the same parent were merged a second time. These two screens reduced the sample to 2,939 observations. Finally, observations were removed for two industries in which there were no Canadian tariff data, and observations were removed in which affiliates reported zero total sales. These modifications produced the study's ultimate sample of 2,881 firm-year observations on 701 firms in fifty manufacturing industries.[5]

2 Note that the individual affiliates that are carried forward are small and are thus are not likely to have a significant impact on the BEA's published data at the industry or the country level.

3 Recall, that a 'firm-year' observation is a parent-affiliate pair observed in a given year.

4 If two codes existed for two similar industries prior to 1987 and the codes were merged into a single code after 1987, we used the post-1987 code for the entire ten-year period. Similarly, if one code was broken into two after 1987, we used the pre-1987 code for the entire sample period.

5 Our screens have little effect on the size distribution of MNCs. The full BEA data set contains data on 1,596 Canadian manufacturing affiliates of U.S. MNC parents, and the average real parent

Variables were included in the model to control for relative factor prices, demand factors, transportation costs, and miscellaneous time effects. They included a ratio of real Canadian-to-U.S. manufacturing wages (C/U WAGE) and two variables that roughly capture changes in the cost of capital: the real U.S. interest rate, which roughly measures the cost of raising debt capital, and the U.S. and Canadian Price-Earnings ratios, which capture the costs of raising equity capital. We used the real U.S. interest rate because it is almost perfectly collinear with real Canadian interest rates over the sample period. Real U.S. interest rates were obtained by subtracting annual inflation rates from average yields on AAA corporate bonds.[6]

Canadian and U.S. real GDP were included to control for demand factors. To capture relative changes in demand, we used a ratio of Canadian to U.S. GDP (C/U-GDP). To account more accurately for differences in demand cyclicality across different industries, the C/U-GDP variable was interacted with the industry of the affiliate, which we categorized into four industry groupings: Industrial Intermediate Goods (II), Industrial Machinery (IM), Consumer Durables (CD) and Consumer Non-Durables (CN). The industry groupings are shown in appendix table A3. All variables denominated in dollar values were normalized to 1990 CPI dollars, and Canadian dollars were converted to U.S. dollars using annual exchange rates from the *IMF International Financial Statistics Yearbook*.[7]

An annual measure of transportation costs for each three-digit industry was constructed using data reported to the U.S. Census Bureau on freight and insurance charges on Canadian exports to the United States. Since similar data were not available on the cost of shipping goods into Canada from the United States and no systematic differences in transportation costs were assumed to exist, the same measure was used for sales to Canada by U.S. MNC parents. The measure is expressed as a ratio of the value of freight costs and insurance for shipments in industry j at time t to the total value of shipments. Transportation costs average 1.03 per cent across industries over the sample period, and range from 8.44 per cent in agricultural chemicals to close to zero in petroleum products.

Canadian and U.S. tariffs were measured as annual ratios of the duties paid to the United States (Canada) on imports of Canadian (U.S.) goods in industry j at time t divided by the total value of imports to the United States (Canada)

assets, sales, and employment are $4.035 billion; $3.279 billion, and 19,906, respectively. For the sample in this study, the comparable figures are $3.964 billion; $3.311 billion, and 20,429, respectively.

6 Bond rates were obtained from *Moody's Industrial Manual* and inflation rates were obtained from the *Survey of Current Business*; U.S. manufacturing wage rates were also obtained from the *Survey of Current Business*. Canadian manufacturing wage rates were obtained from the *Canadian Economic Observer*. United States P-E ratios were taken from *CITIBASE*, and Canadian P-E ratios were obtained from the *Bank of Canada Review*.

7 It would be more appropriate to deflate the asset and PPE variables using deflators for capital equipment and/or structures rather than a CPI deflator. However, the distinction is probably not important for our purposes. Since CPI inflation was at a steady rate of about 4 per cent annually from 1983 to 1992, while PPI for capital equipment grew at a steady rate of about 2.5 per cent per year, switching to the latter deflator would only have the effect of increasing our estimated time trend by about 0.015.

from Canada (United States) in industry j at time t.[8] Similar measures at different levels of aggregation have been widely used in empirical work (see, e.g., Caves 1990; McFetridge 1989). While the tariff measures used here do not reflect non-tariff barriers and are still at a more aggregated level than that at which tariffs are actually imposed, they are more disaggregated than measures typically used in empirical work, and they are longitudinal. During the ten-year period covered in this study, U.S. and Canadian tariffs dropped by approximately 62.5 per cent, the latter dropping from an average tariff level of nearly 8 per cent to only 3 per cent and the former dropping from 4 per cent to less than 1.5 per cent. There is also considerable cross-sectional variation in tariffs, as can be seen in appendix table A2. Mean U.S. tariffs for the ten-year period are 3.1 per cent, ranging from a high of 14.7 per cent for tobacco products to a low of 0.11 per cent in motor vehicles and equipment. Similarly, Canadian tariffs average 6.12 per cent over all industries for the sample period, ranging from a high of 30.27 per cent in the beverages industry to a low of 0.05 per cent in agricultural chemicals. The striking cross-sectional and longitudinal characteristics of the U.S. and Canadian tariff structure indicate how much can be gained by using disaggregated, longitudinal measures.[9]

For U.S. parents and Canadian affiliates, the dependent variable employment is measured by the number of full-time and part-time employees on the payroll for each fiscal year. Parent and affiliate capital are measured by total assets (gross of depreciation). Total assets include not only physical property, plant, and equipment, but also inventories, receivables, and intangible assets. While this is a rough measure of capital stock, in the empirical literature on MNCs there is no single agreed-upon measure of capital stock and capital expenditures. For example, Grubert and Mutti (1991) use the stock of net plant and equipment as a proxy for capital to examine the effects of tariffs on MNC production location decisions. Caves (1990) uses an industry-level measure of real gross fixed capital expenditures, which he subdivides into expenditures on plant construction and expenditures on machinery.

As an alternative measure of capital, we also use gross Property, Plant, and Equipment (PPE) for Canadian affiliates only. The BEA data do not contain annual information on PPE for U.S. parents.[10] As we discuss in the next section, the

8 Tariff and transportation cost SIC codes matched the codes in which the trade flows were reported. Recall that only single-industry affiliates were included in the sample. Because most of the U.S. parents were large, diversified companies, however, it was not possible to limit the sample to single-industry parents as well. It was therefore assumed that parent trade flows were in the same industry as the affiliate. In more than half the cases, the parents' major SIC code was the same as that of the industry of the affiliate.

9 The U.S. tariff data were obtained from the United States Census Bureau and Canadian tariff data were obtained from Statistics Canada. Canadian tariffs were reported in three-digit Canadian SIC codes and were converted to BEA ISI codes by comparing the industry descriptions provided by Statistics Canada and the BEA. The U.S. tariff data were reported in three-digit U.S. SIC codes, then converted to BEA ISI codes using the correspondence tables provided by the BEA (see U.S. Department of Commerce 1989). ISI codes correspond roughly to the two- to three-digit SIC code level. Correspondence tables are available from the authors.

10 PPE for U.S. parents are collected in BEA's benchmark surveys but not in its annual surveys.

regression results for affiliate assets and PPE are generally quite similar in terms of the signs and significance of the coefficients.

Finally, because affiliates in the sample varied significantly in terms of size, the five dependent variables are transformed to logs to mitigate problems of heteroscedasticity. Figure 1a shows the distribution of Canadian affiliate-year observations by number of employees; figure 1b shows the distribution by total assets. As can be seen in figure 1a, 71 per cent of the observations are affiliates with fewer than 400 employees. The distribution is skewed, however, in that 5.8 per cent have more than 1,200 employees. Similar skewness is evident in figure 1b, where 70 per cent of affiliate-year observations are smaller than $30 million but 15 per cent are larger than $65 million. Among the high-employment and high-asset industries are automobiles and auto parts and other transportation equipment (codes 371 and 379). These industries were liberalized under the Autopact in 1965 and thus are among the lowest tariff industries. Hence, we took care to avoid having the regression results dominated by large, low-tariff industries.

Pursuant to this point, and as we discuss further below, we obtained the surprising result that Canadian tariffs are significantly *negatively* related to Canadian affiliate assets and employment. We were concerned that this result may have arisen simply because the large auto industry affiliates also had low tariffs. Hence, we further normalized the five dependent variables, dividing each by a measure of firm size – the sum of the parent and affiliate total sales averaged over the sample period – and taking the logs of the normalized variables. The aim of this additional transformation was to minimize the effect that the very large automobiles and auto parts industries might have on the regression results. (This second set of results is reported in table 3.)

Table 1 gives the means and standard deviations of the five dependent variables. Rows 1 and 2 report the absolute means and standard deviations; rows 3 and 4 give the means and standard deviations of the logs, and rows 5 and 6 give the means and standard deviations of the logs of the normalized variables. Note that since the five dependent variables are divided by the average affiliate *plus* parent sales, the standard deviation of the normalized variables is greater for the three affiliate variables (employment, real assets, and real PPE) but smaller for the two parent variables (employment and real assets).

4. Empirical results

We describe our empirical results in four sections. First, we contrast the OLS and Random Effects (RE) estimates. Then we discuss the economic meaning of the tariff coefficients and the surprising and robust estimates of these coefficients across all of our models. Third, we examine the extent to which our results support the prediction that lower Canadian tariffs would lead to a 'hollowing out' of U.S. MNCs' Canadian affiliates. Finally, we discuss the variance decompositions, which reveal the extent to which firm versus industry factors explain MNCs' responses to tariff changes.

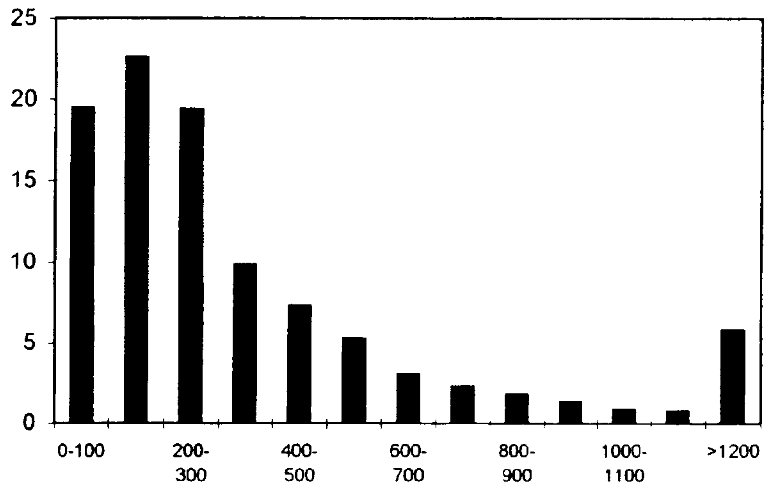

FIGURE 1a Distribution of affiliates by number of employees

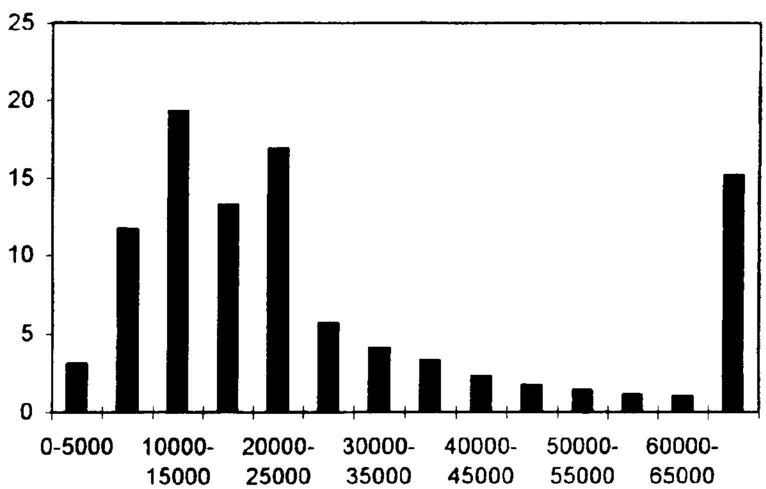

FIGURE 1b Distribution of affiliates by total assets (000s of US$)

4.1. Random effects and OLS results

Table 2 shows the RE and OLS results for the five dependent variables (where $y = \ln(.)$). For the most part, OLS standard errors are much larger than those for RE, indicating that the use of RE is leading to substantial efficiency gains. The constraint of homogeneous coefficients in the OLS estimates is clearly rejected. In the RE panels in table 2, eleven of the fifteen random coefficients have variances

TABLE 1
Means and standard deviations of the dependent variables

	CA employment	CA real assets	CA real PPE	USP employment	USP real assets
Mean	431.07	54404.92	33054.07	20429.53	3964450.78
Standard deviation	874.24	152565.08	98755.22	33419.70	11075109.85
Mean (log(*Y*))	5.46	10.13	9.30	8.91	13.86
St. dev. (log(*Y*))	1.09	1.023	1.38	1.60	1.68
Normalized mean (log(*Y*))	−8.54	−3.86	−4.69	−5.08	−0.13
Normalized st. dev. (log(*Y*))	1.56	1.43	1.69	0.65	0.53

that are significantly greater than zero. The presence of significant heterogeneity means that the OLS standard errors are incorrect.

In table 2, three of the tariff coefficients change signs between the OLS and RE estimates. For Canadian affiliate assets, the U.S. tariff coefficient is significant and negative in the RE specification and significant and positive in the OLS specification. The reverse is true for U.S. parent assets. For U.S. parent employment, the Canadian tariff coefficient changes signs and loses significance. It is significant and negative in the RE specification and insignificant and positive in the OLS model. These sign changes may reflect the importance of the random coefficient on the time trend. Indeed, the variance of the trend coefficient is significant at the 1 per cent level for all five dependent variables, while the mean trend coefficient is not always significant. It may well be that the failure to account for heterogeneity in unobserved time-varying factors is leading to biased estimates of the tariff coefficients in the OLS estimates. Given the clear evidence of parameter heterogeneity, the discussion in the remainder of this paper will focus on the random effects estimates.

Before concluding this section, we note three features of the full set of results. First, as expected, in the RE results in table 2 the levels of affiliate assets, PPE, and employment were positively associated with higher levels of the Canada-U.S. GDP ratios, higher transportation costs, and lower relative Canadian wages. Second, the parameter estimates for the parent variables are considerably smaller than those for the affiliate counterparts. Because the U.S. market is relatively much more important to Canadian affiliates than the Canadian market is to U.S. parent companies, it is not surprising that U.S. parents made smaller adjustments in their levels of assets and employment in response to bilateral trade liberalization than their Canadian affiliates did. Finally, the variance of ϕ_i, the firm-specific error component, is significant at the 1 per cent level for all five dependent variables, indicating that unobserved characteristics of MNCs account for a significant portion of the variation in the levels of U.S. and Canadian capital and employment across firms.

4.2. *Effects of tariff reductions*

In this section, we briefly discuss the economic meaning of the tariff coefficient estimates and compare the different estimates. We first note that the common concern about Canadian affiliates being 'hollowed out' by trade liberalization does not derive from economic theory. Rather, it reflects the implicit assumption that there were no advantages to producing in Canada *other* than the locational advantage conferred by jumping the tariff wall. But from the standpoint of economic theory, there are no strong predictions for the sign and significance of the tariff coefficients for the five dependent variables. For example, theories of the MNC, such as the O-L-I framework, and, more generally, internalization theory (see Dunning 1979; Rugman 1981) suggest that high tariffs *may* induce direct investment in particular countries and industries. When tariffs discourage exporting, however, MNCs may choose an alternative governance mode, such as licensing over FDI. Indeed, FDI should occur only when there exists a combination of firm-specific ownership advantages, transaction-specific internalization advantages, and country-specific location advantages. It is therefore not evident from the O-L-I framework that tariffs should favour direct investment, and it is similarly not clear what the effect of tariff reductions should be. Presumably, if a firm has chosen direct investment when tariffs are high, the same firm-specific or transaction-specific factors may lead the firm to remain in the market when tariffs are reduced. Furthermore, in the O-L-I framework, tariffs are only one component of location advantage, and other components of location advantage, such as proximity to natural resources or final consumers, will persist even when tariffs are removed.

At an aggregate level, factor proportions theory predicts that lower tariffs lead to specialization. Since specialization occurs on an industry-by-industry basis, however, the effect reduced tariffs should have on the allocation of capital and employment across all industries is not evident. Rather, the only clear prediction from factor proportions theory is that, within one country, some industries should expand and others should contract when trade is liberalized, and that most of the variance in firms' responses to trade liberalization should be explained by the industries in which the firms operate.[11]

We now turn to our findings on the impact of U.S. and Canadian tariff reductions on U.S. MNCs' allocation of employment and capital in the United States and Canada. Panels 1–2 in table 2 show the results for Canadian affiliate assets and PPE. In both the OLS and RE specifications, the Canadian tariffs are significant and negative, implying that lower Canadian tariffs are associated with *higher* levels of U.S. MNCs' capital investment in their Canadian affiliates. Although the parameter estimates are larger for PPE than for assets in both the OLS and RE specifications, all the Canadian tariff coefficients are negative and significant at the 1 per cent level.

11 Trade theories based on industrial organization (IO) (see, e.g., Eastman and Stykolt 1967; Wonnacott and Wonnacott 1967) are also indeterminate as to the expected effect of trade liberalization on employment and capital allocation. These theories argue that trade protection encourages sub-optimal production scale. Trade liberalization is generally expected to lead to a rationalization of production facilities in which firms produce fewer product varieties in longer production runs, therefore reducing average production costs. As with factor proportions theory, IO-based trade theories argue that industry characteristics such as economies of scale or the existence of price collusion, will be the primary determinant of adjustments to trade liberalization.

TABLE 2
Random effects and OLS estimates for U.S. and Canadian assets and employment

	CA assets		CA PPE		CA empt.		USP assets		USP empt.	
	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS
Constant β_0	9.8913[c]	10.7871[c]	8.3072[c]	9.2538[c]	5.8589[c]	6.8129[c]	14.3765[c]	16.7306[c]	9.9629[c]	11.5605[c]
	(0.6988)	(1.4377)	(1.0323)	(1.8969)	(0.9305)	(1.5420)	(0.5347)	(2.3719)	(0.4772)	(2.2620)
Can Tariff β_1	−0.0449[c]	−0.0430[c]	−0.1016[c]	−0.0806[c]	−0.0412[c]	−0.0185[b]	0.0366[c]	0.0143	−0.0077[b]	0.0213
	(0.0064)	(0.0088)	(0.0102)	(0.0116)	(0.0072)	(0.0095)	(0.0028)	(0.0145)	(0.0034)	(0.0139)
US-Tariff β_2	−0.0070[b]	0.0124[c]	0.0023	0.0147[c]	0.0072	0.0168[c]	0.0036[c]	−0.0113[a]	−0.0114[c]	−0.0047
	(0.0030)	(0.0039)	(0.0049)	(0.0051)	(0.0051)	(0.0041)	(0.0012)	(0.0064)	(0.0014)	(0.0061)
C/U-WAGE	−0.0577[c]	−0.0670[c]	−0.0653[c]	−0.1104[c]	−0.0300[b]	−0.0378	−0.0458[c]	−0.0724[a]	−0.0178[c]	−0.0306
	(0.0084)	(0.0233)	(0.0132)	(0.0308)	(0.0123)	(0.0250)	(0.0068)	(0.0385)	(0.0062)	(0.0367)
C/U-GDP*CN	0.6420[c]	0.6689[c]	0.8195[c]	1.1439[c]	0.3006[c]	0.3009	0.4569[c]	0.5435	0.2113[c]	0.1268
	(0.0829)	(0.2242)	(0.1373)	(0.2958)	(0.1168)	(0.2404)	(0.0617)	(0.3698)	(0.0575)	(0.3527)
C/U-GDP*CD	0.6534[c]	0.6474[c]	0.7672[c]	1.1075[c]	0.3259[c]	0.3247	0.3909[c]	0.4632	0.1312[b]	0.0993
	(0.0828)	(0.2245)	(0.1382)	(0.2962)	(0.1182)	(0.2407)	(0.0618)	(0.3703)	(0.0578)	(0.3532)
C/U-GDP*II	0.6917[c]	0.6487[c]	0.7712[c]	1.1453[c]	0.2732[b]	0.2815	0.4146[c]	0.4446	0.1001[a]	0.0445
	(0.0818)	(0.2239)	(0.1363)	(0.2955)	(0.1165)	(0.2402)	(0.0615)	(0.3694)	(0.0575)	(0.3523)
C/U-GDP*IM	0.6113[c]	0.6281[c]	0.6963[c]	1.0821[c]	0.2660[b]	0.2867	0.3830[c]	0.4556	0.1281[b]	0.0784
	(0.0830)	(0.2243)	(0.1376)	(0.2960)	(0.1187)	(0.2406)	(0.0619)	(0.3701)	(0.0578)	(0.3529)
Trans. cost	0.0508[c]	0.0824[c]	0.0650[c]	0.1543[c]	0.0225	−0.0275	0.0560[c]	0.0253	0.0456[c]	−0.0137
	(0.0074)	(0.0185)	(0.0105)	(0.0245)	(0.0168)	(0.0199)	(0.0042)	(0.0306)	(0.0057)	(0.0292)
Trend	0.1102[c]	0.1964[c]	0.1272[c]	0.3022[c]	0.0507	0.1446[a]	0.1288[c]	0.3021[c]	0.0135	0.1623
	(0.0251)	(0.0664)	(0.0392)	(0.0876)	(0.0371)	(0.0712)	(0.0206)	(0.1096)	(0.0162)	(0.1045)
US int. rate	0.0522[a]	0.0947	0.0731	0.2127[c]	0.0191	0.0792	0.0179	0.1329	−0.0044	0.0811
	(0.0281)	(0.0599)	(0.0478)	(0.0790)	(0.0362)	(0.0642)	(0.0191)	(0.0988)	(0.0174)	(0.0942)
CAN P-E ratio	−0.0494[b]	−0.1202[b]	−0.0613[b]	−0.1737[c]	−0.0310	−0.1110[b]	−0.0575[c]	−0.1486[a]	−0.0225	−0.1016
	(0.0197)	(0.0489)	(0.0282)	(0.0645)	(0.0278)	(0.0524)	(0.0167)	(0.0807)	(0.0147)	(0.0769)
US P-E ratio	−0.0154	−0.0465[a]	−0.0167	−0.0605[a]	−0.0224	−0.0539[a]	−0.0263[c]	−0.0808[a]	−0.0130[a]	−0.0632
	(0.0112)	(0.0258)	(0.0154)	(0.0341)	(0.0153)	(0.0277)	(0.0094)	(0.0426)	(0.0079)	(0.0406)

TABLE 2 *(concluded)*

	CA assets		CA PPE		CA empt.		USP assets		USP empt.	
	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS
$\sigma^2 \mu_{i1}$	0.1408[c]		0.1731[c]		0.0806[c]		0.0795[c]		0.0882[c]	
	(0.0051)		(0.0043)		(0.0055)		(0.0018)		(0.0025)	
$\sigma^2 \mu_{i2}$	0.0275[c]		0.0004		0.0025		0.0001		0.0001	
	(0.0023)		(0.0033)		(0.0048)		(0.0009)		(0.0012)	
$\sigma^2 \varphi_i$	1.0903[c]		1.4283[c]		1.1354[c]		1.5290[c]		1.8636[c]	
	(0.0128)		(0.0112)		(0.0143)		(0.0035)		(0.0077)	
$\sigma^2 \tau_i$	0.0654[c]		0.0958[c]		0.0707[c]		0.0512[c]		0.0641[c]	
	(0.0023)		(0.0024)		(0.0033)		(0.0010)		(0.0017)	
Model error ($\sigma^2 \epsilon_i$)	0.3139	1.0775	0.4191	1.3204	0.4049	1.0734	0.2133	1.6510	0.1920	1.5745
R-squared		0.0473		0.0888		0.0384		0.0403		0.0386
Log-likelihood	−2175.6		−2963.2		−2617.38		−1706.13		−1693.66	

NOTES:
Sample size is 2,881 for all estimations. Numbers in parentheses are standard errors. *a* Significant at the 10 per cent level. *b* Significant at the 5 per cent level. *c* Significant at the 1 per cent level.

The constraint of equal coefficients across firms is also clearly rejected for both assets and PPE. The variance of the random Canadian tariff coefficients is large and significant for both variables, indicating that given the same set of prices and tariffs, U.S. MNCs choose different levels of capital investment in their Canadian affiliates because of idiosyncratic firm characteristics such as differences in technology or organization.

It is interesting that the estimates for U.S. tariffs are not as robust across the affiliate asset and PPE models as are the estimated Canadian tariff coefficients. In the RE specification, U.S. tariffs are significant and negatively related to affiliate assets, implying that lower U.S. tariffs are associated with higher levels of capital allocated to Canadian affiliates. However, the U.S. tariff coefficient is small and insignificant for affiliate PPE.

In panel 3, we see that the Canadian tariff coefficient is again significant and negative for Canadian affiliate employment in both the RE and the OLS specifications. It appears that bilateral trade liberalization was associated not only with greater capital investment in Canada by U.S. MNCs, but also with higher levels of employment. This result was unexpected given the widely held view that Canadian trade liberalization encouraged the 'migration' of thousands of jobs from Canada to the United States (Uchitelle 1993). As is the case in the results for assets and PPE, there is evidence of significant across-firm heterogeneity in the response of employment levels to tariff changes, as implied by the significant variance of the random Canadian tariff coefficient. United States tariffs were not significantly related to Canadian affiliate employment levels.

Turning to the results for the two U.S. parent variables in panels 4-5, we see that Canadian tariffs were significant and positively related to U.S. parent assets. United States tariffs are also positively associated with U.S. parent assets, although the U.S. tariff coefficient is only one-tenth the size of the Canadian tariff coefficient and is insignificant. Finally, unlike the affiliate results, the tariff coefficients for the two parent variables have opposite signs for assets and employment. Indeed, both the Canadian and U.S. tariffs are significant and negatively related to U.S. parent employment levels, implying that lower bilateral tariffs were associated with higher levels of U.S. MNCs' employment in the United States.

As indicated earlier, after obtaining the surprising and robust estimates in which Canadian affiliate assets, PPE, and employment were significantly *negatively* related to Canadian tariff levels, we were concerned that the log transformations may not have been sufficient to minimize the effect of large, low-tariff industries (particularly automobiles and transportation) on the regression results. We therefore normalized the dependent variables – dividing each by the MNCs' average parent plus affiliate sales – and taking the logs of the normalized variables as a check on the robustness of our results. The RE and OLS results for the normalized variables are presented in table 3.

For the most part, the same patterns reported above – smaller RE standard errors and highly significant random coefficient variances – appear systematically in the normalized results. However, many of the individual parameter estimates change in the normalized results in both the RE and OLS estimates. For example, the GDP coefficients appear to be the least robust, as they change signs and/or significance for three of the five dependent variables. Similarly, parameter estimates of the trend and P-E ratios also change in both the OLS and the RE results.

Of all the estimated coefficients, those on Canadian tariffs are the most robust across the different estimators and in the original and normalized regressions. Since there are no strong theoretical predictions, the consistency and robustness of our finding that lower Canadian tariffs are associated with higher employment and capital allocation in U.S. MNCs' Canadian affiliates are all the more striking. Indeed, of the ten RE tariff coefficient estimates (U.S. and Canadian tariffs for the five dependent variables) only two change. The U.S. tariff coefficient for Canadian affiliate assets is negative and significant in the original RE estimate and positive and significant in the normalized estimate. Similarly, the Canadian tariff coefficient for U.S. parent employment is negative and significant in the original model and positive and significant in the normalized model. But none of the coefficients relating Canadian tariffs to affiliate assets, PPE, and employment changes sign or significance with the normalization. In the next section, we explore the question of whether trade liberalization resulted in a hollowing out of U.S. MNCs' Canadian operations.

4.3. Trade liberalization and 'delocalization'

Table 4 presents the predicted signs for the tariff coefficients under a hollowing-out scenario. Recall the argument is as follows: if Canadian affiliates were established as 'tariff factories,' trade liberalization with the United States will induce U.S. MNCs to reduce their Canadian operations to 'warehousing' or distribution operations. As such, lower Canadian tariffs will lead profit-maximizing MNCs that make labour and capital allocation decisions in Canada and the United States to (1) reduce their Canadian employment; (2) reduce their capital investment in Canada; and (3) shift their Canadian production (e.g., employment and capital investment) to the United States. As noted previously and as shown in table 4, the hollowing-out predictions apply only to *Canadian* tariff reductions. Because Canadian tariffs were so much higher than U.S. tariffs, and because of the view that higher tariffs had sheltered Canada's less efficient affiliate plants (see Eastman and Stykolt 1967; Baldwin and Gorecki 1986), and since the Canadian market is approximately one-tenth the size of the U.S. market, it was commonly believed that U.S. MNCs could easily reorganize to serve Canada and the United States by production and exports from the United States (see McFetridge 1989). Under this scenario, lower Canadian tariffs should increase U.S. employment and capital allocation as production shifts from Canada into the United States.

In table 4, all the Canadian tariff coefficients are significant and in the *opposite* direction from that predicted by the hollowing-out scenario, *except* for the coefficient on U.S. parent employment (the only variable for which the Canadian tariff coefficients have different signs in the original and normalized regression estimates). The parameter estimate is significant and positive in the normalized

TABLE 3
Random effects and OLS estimates for *normalized* assets and employment

	CA assets		CA PPE		CA empt.		USP assets		USP empt.	
	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS
Constant β_0	−5.4514[c]	−5.6785[c]	−6.4865[c]	−7.2118[c]	−9.3578[c]	−9.6527[c]	−0.0323	0.2650	−5.0419[c]	−4.9051[c]
	(0.7232)	(2.0074)	(1.0003)	(2.3472)	(0.9574)	(2.2076)	(0.4743)	(0.7443)	(0.4797)	(0.8958)
Can Tariff β_1	−0.0556[c]	−0.0438[c]	−0.0190[b]	−0.0814[c]	−0.0295[c]	−0.0194	0.0205[c]	0.0135[c]	0.0290[c]	0.0204[c]
	(0.0049)	(0.0123)	(0.0091)	(0.0144)	(0.0093)	(0.0135)	(0.0045)	(0.0046)	(0.0023)	(0.0055)
US-Tariff β_2	0.0070[c]	0.0228[c]	0.0080	0.0251[c]	0.0091[b]	0.0271[c]	0.0025	−0.0009	−0.0383[c]	0.0057[b]
	(0.0025)	(0.0054)	(0.0059)	(0.0063)	(0.0045)	(0.0059)	(0.0016)	(0.0020)	(0.0008)	(0.0024)
C/U-WAGE	−0.0087	−0.0092	−0.0333[c]	−0.0527	0.0106	0.0199	−0.0149[b]	−0.0147	0.0244[c]	0.0271[a]
	(0.0089)	(0.0326)	(0.0119)	(0.0381)	(0.0130)	(0.0358)	(0.0063)	(0.0121)	(0.0057)	(0.0145)
C/U-GDP*CN	0.2208[b]	0.2481	0.4248[c]	0.7231[b]	−0.0496	−0.1199	0.1321[b]	0.1227	−0.1976[c]	−0.2940[b]
	(0.0885)	(0.3130)	(0.1248)	(0.3660)	(0.1217)	(0.3442)	(0.0576)	(0.1160)	(0.0562)	(0.1397)
C/U-GDP*CD	0.2240[b]	0.2857	0.4285[c]	0.7458[b]	−0.0484	−0.0370	0.1264[b]	0.1015	−0.2564[c]	−0.2624[a]
	(0.0877)	(0.3134)	(0.1244)	(0.3665)	(0.1219)	(0.3447)	(0.0571)	(0.1162)	(0.0566)	(0.1399)
C/U-GDP*II	0.2032[b]	0.3105	0.4885[c]	0.8070[b]	−0.0984	−0.0567	0.1345[b]	0.1064	−0.2712[c]	−0.2938[b]
	(0.0876)	(0.3127)	(0.1240)	(0.3656)	(0.1205)	(0.3438)	(0.0574)	(0.1159)	(0.0563)	(0.1395)
C/U-GDP*IM	0.2164[b]	0.2836	0.4080[c]	0.7376[b]	−0.0444	−0.0578	0.1346[b]	0.1110	−0.2399[c]	−0.2661[b]
	(0.0870)	(0.3132)	(0.1245)	(0.3662)	(0.1211)	(0.3444)	(0.0573)	(0.1161)	(0.0566)	(0.1398)
Trans cost	0.0277[c]	0.0449[a]	0.0700[c]	0.1169[c]	0.0109	−0.0650[b]	0.0246[c]	−0.0122	0.0052	−0.0512[c]
	(0.0082)	(0.0259)	(0.0097)	(0.0303)	(0.0157)	(0.0285)	(0.0074)	(0.0096)	(0.0055)	(0.0116)
Trend	0.0033	−0.0276	0.0626[a]	0.0782	−0.0440	−0.0794	0.0600[c]	0.0780[b]	−0.0929[c]	−0.0617
	(0.0269)	(0.0927)	(0.0346)	(0.1084)	(0.0373)	(0.1020)	(0.0182)	(0.0344)	(0.0153)	(0.0414)
US Int. rate	−0.0042	−0.0358	0.0399	0.0822	−0.0247	−0.0513	−0.0136	0.0024	−0.0549[c]	−0.0494
	(0.0293)	(0.0836)	(0.0446)	(0.0978)	(0.0359)	(0.0919)	(0.0163)	(0.0310)	(0.0183)	(0.0373)
CAN P-E ratio	0.0271	0.0087	−0.0114	−0.0448	0.0450	0.0179	−0.0039	−0.0198	0.0397[c]	0.0273
	(0.0205)	(0.0683)	(0.0266)	(0.0798)	(0.0300)	(0.0751)	(0.0153)	(0.0253)	(0.0137)	(0.0305)
US P-E ratio	0.0151	0.0214	0.0020	0.0075	0.0110	0.0141	−0.0037	−0.0128	0.0118	0.0047
	(0.0116)	(0.0360)	(0.0145)	(0.0421)	(0.0163)	(0.0396)	(0.0085)	(0.0134)	(0.0074)	(0.0161)

TABLE 3 *(concluded)*

	CA assets		CA PPE		CA empt.		USP assets		USP empt.	
	RE	OLS	RE	OLS	RE	OLS	RE	OLS	RE	OLS
$\sigma^2\mu_{i1}$	0.1360[c]		0.2640[c]		0.1336[c]		0.0741[c]		0.0839[c]	
	(0.0035)		(0.0067)		(0.0061)		(0.0023)		(0.0018)	
$\sigma^2\mu_{i2}$	0.0001		0.0056[a]		0.0082[b]		0.0001		0.1190	
	(0.0017)		(0.0033)		(0.0035)		(0.0017)		(0.0009)	
$\sigma^2\phi_i$	1.3514[c]		1.8812[c]		1.7173[c]		0.4190[c]		0.8124[c]	
	(0.0098)		(0.0154)		(0.0120)		(0.0066)		(0.0064)	
$\sigma^2\tau_i$	0.0800[c]		0.0972[c]		0.0862[c]		0.0541[c]		0.0655[c]	
	(0.0021)		(0.0022)		(0.0030)		(0.0013)		(0.0012)	
Model error ($\sigma^2\epsilon_i$)	0.3181	1.3973	0.4146	1.6338	0.3969	1.5366	0.1928	0.5181	0.1833	0.6235
R-squared		0.0402		0.0727		0.0313		0.0520		0.0777
Log-likelihood	−2357.21		−3089.87		−2855.62		−733.234		−1021.175	

NOTES:
Sample size is 2,881 for all estimations. Numbers in parentheses are standard errors. *a* Significant at the 10 per cent level. *b* Significant at the 5 per cent level. *c* Significant at the 1 per cent level.

TABLE 4
Expected sign patterns under the 'Hollowing-Out' scenario versus actual estimates

	CA assets	CA PPE	CA empt.	USP assets	USP empt.
Canadian tariff[b]	+	+	+	−	−
U.S. tariff[c]	?	?	?	?	?
Log(Y)					
Canadian tariff	−0.0449	−0.1016	−0.0412	+0.0366	−0.0077
U.S. tariff	−0.0070	+0.0023[a]	+0.0072[a]	+0.0036	−0.0114
Normalized log(Y)					
Canadian tariff	−0.0556	−0.0190	−0.0295	+0.0205	+0.0290
U.S. tariff	+0.0070	+0.0080[a]	+0.0091	+0.0025[a]	−0.0383

a Estimate not significant. *b* The sample mean of the Canadian tariff is 5.85, and the sample standard deviation is 5.54. *b* The sample mean of the U.S. tariff is 2.967, and the sampe standard deviation is 2.46.

model, implying that lower Canadian tariffs *reduced* U.S. parent employment – a finding that is certainly not consistent with hollowing-out predictions.

From table 4 we can calculate the effect of a one percentage point drop in the Canadian tariff on employment and capital allocation decisions in the United States and Canada.[12] For Canadian affiliates, a one percentage point decrease in the Canadian tariff increases Canadian affiliate assets by approximately 4.5 per cent in the original regression and 5.6 per cent in the normalized regression. Canadian affiliate PPE increases by 10.1 per cent in the original regression, but only by 1.9 per cent in the normalized regression. It appears that the effect of Canadian tariff reductions on PPE may have been biased up in the original regression. Perhaps the most surprising finding is the effect of Canadian tariff reductions on Canadian affiliate employment. Rather than showing that Canadian tariff reductions led to a reduction in Canadian affiliate employment, our results indicate that a one percentage point drop in Canadian tariffs increased Canadian affiliate employment by 2.95 per cent (in the normalized regression).[13] As mentioned above, the results for U.S. parent assets and employment were also significant and in the opposite direction from that predicted under hollowing out in the normalized regression. Indeed, a one percentage point drop in Canadian tariffs led to a 2 per cent *decrease* in U.S. parent assets and a 2.9 per cent *decrease* in parent employment. From the results obtained here, we can find no evidence to support concerns that freer bilateral trade would turn Canada into a 'warehouse economy.' In the next section, we examine the extent to which the variance in MNCs' U.S. and Canadian asset and employment levels is explained primarily by characteristics of the industries in which the MNCs operate or by idiosyncratic characteristics of the MNCs.

12 To calculate the effect of a one percentage point drop in tariffs with log dependent variables, we use the formula: $\ln Y = \beta T$. So $1/Y{*}dY/dT = \beta$ and $dY/Y = \beta{*}dT$.

13 This very large effect of Canadian tariff reductions on employment may reflect the fact that our sample includes only U.S. MNC affiliates in Canada.

4.4. Variance decompositions

In section 2, we indicated that the estimated random effects models can be used to construct individual firm and industry betas *a posteriori* via Bayes's law. We can then examine the relative magnitude of firm and industry effects in MNCs' responses to tariff changes by decomposing the variance of the random coefficients into within- and across-industry variance. Schmalensee (1985) used a similar approach to evaluate the relative contribution of firm and industry effects to the total variance in firm profitability. But we depart here from the standard variance components models in that we decompose the variance not only in the regression error ($w_{it} = \phi_i + \epsilon_{it}$), but also in the random coefficients. This allows us to evaluate the importance of firm and industry effects in MNCs' *responses* to changing tariff levels. In table 5, we report the percent of variance in the three random coefficients and the firm effect explained by within-industry and across-industry variance.[14]

As can be seen in panels 1–5 of table 5, within-industry variance accounts for more of the total variance in the random tariff coefficients, time trend, and firm effect than across industry variance does. With regard to the tariff coefficients, these results imply that given the same set of prices and tariffs, individual MNCs within the same industry choose very different levels of U.S. and Canadian assets and employment. In other words, idiosyncratic firm characteristics explain most of behaviour.

Such a finding is consistent with theories of FDI such as the OLI paradigm, in which characteristics of countries (i.e., 'location advantages,' such as neoclassical factor endowments or barriers to trade), industries (i.e., 'internalization advantages,' such as structural or transactional market failures), and firms (i.e., 'ownership advantages,' such as the privileged possession of or access to income generating assets; see Dunning 1979) are considered to be important determinants of foreign investment decisions. Since there are many components of location advantage, of which getting around tariff walls is only one potential source, a tariff reduction may lead different firms to react differently. For instance, if getting around the tariff wall was important to a firm, it could pull out of Canada when its tariff wall comes down. On the other hand, suppose a firm's technology is such that it is most efficient to ship intermediate goods to Canada and to do other processing there (because of, e.g., the location advantage of being close to resources or to final consumers). Then a tariff reduction could *expand* Canadian operations. Our finding that firm characteristics explain most of the variance in MNCs' responses to changes in tariff levels implies that unobserved characteristics of firms, such as their technology, are important to whether and how they reconfigure their international production when tariffs are reduced.

Our results are surprising in the context of international trade theories, discussed in section 4.2. Rather than implying that some industries in a country expand while others contract when trade is liberalized, our results indicate that most of

14 Only the percentage of total variance explained is reported here. More details are available from the authors.

TABLE 5
Percent of variance in random effects explained by within- and across-industry variance

	CA assets		CA PPE		CA empl.		USP assets		USP empl.	
	Within	Across	Within	Across	Within	Across	Within	Across	Within	Across
Canadian tariff $\sigma^2\mu_{i1}$	69%	31%	69.33%	30.67%	69%	31%	70.6%	29.4%	73.02%	26.98%
US tariff $\sigma^2\mu_{i2}$	72.2%	27.8%	69.23%	30.77%	75.83%	24.17%	72.41%	27.59%	70.33%	29.67%
Time trend $\sigma^2\tau_i$	72.13%	27.87%	70.55%	29.45%	71.45%	28.55%	73.22%	26.78%	74%	26%
Firm effect $\sigma^2\phi_i$	63.33%	36.67%	65.81%	34.19%	64.32%	35.68%	72.23%	27.22%	69.26%	30.74%

the variance in firms' responses to trade liberalization is *not* accounted for by the industries in which the firms operate. This result should not be interpreted as supporting theories of intra-industry trade (see, e.g., Eastman and Stykolt 1967). For although these theories predict that adjustments to trade liberalization will take the form of intra-industry rationalization, they also predict that industry characteristics will explain firms' adjustment behaviour. If our results supported these theories, we would expect that industry effects would account for most of the variance in firms' responses to trade liberalization.

To illustrate the magnitude of inter- and intra-industry variance, appendix table A1 gives the industry-specific Canadian tariff betas for affiliate assets and employment.[15] In addition to the industry-specific betas, table A1 also gives the range of firm-specific Canadian tariff coefficients in each industry. Notice that *not a single industry* has a positive Canadian tariff coefficient for Canadian affiliate employment. Thus, employment levels in every industry increase with Canadian tariff reductions. In the employment range column, however, we note that the maximum values of more than half of the firm-specific Canadian tariff betas (within each industry) are positive (although in total, only 13.5 per cent of firms have a positive Canadian tariff beta for Canadian affiliate employment).

Figures 2 and 3 illustrate the within-industry variance in Canadian tariff coefficients for Canadian affiliate employment in two industries: furniture and fixtures (which Gaston and Trefler 1997 suggested was particularly 'hard hit' by trade liberalization) and industrial chemicals. It is interesting that none of the firm-specific tariff betas in the furniture and fixtures industry is positive, indicating that lower Canadian tariffs are associated with *increased* Canadian affiliate employment for *every* MNC in the industry. Conversely, several affiliates in the industrial chemicals industry, in which Canada is considered to be particularly 'competitive' (see D'Cruz and Rugman 1994 for a discussion of the Canadian chemicals industry) experienced *reduced* employment with trade liberalization. (For more detail, see appendix table A1 betas for industries 281 – industrial chemicals and synthetics – and 250 – furniture and fixtures. Note that the maximum betas in the industrial chemicals industry are positive.)

5. Discussion and conclusions

The results presented in the previous sections clearly demonstrate the importance of tariff reductions to MNCs' asset and employment allocation decisions. Canadian tariff levels were negatively related to U.S. MNCs' assets and employment in Canada, indicating that reductions in Canadian tariffs actually *increased* capital and employment in Canada by U.S. MNCs. Overall, trade liberalization appears to have stimulated growth for the U.S. MNCs. Since tariffs are taxes on cross-border

15 As discussed in section 2, the firm-specific parameters are calculated using Bayes's law. Given the prior that the ϕ_i, μ_{i1}, μ_{i2}, and τ_i are normally distributed in the population, combined with the likelihood for the model, we calculate the posterior density for the ϕ_i, μ_{i1}, μ_{i2}, and τ_i and determine the vector that gives the posterior mean for each firm. Industry-level parameters are obtained by averaging the firm-level parameters calculated for the firms in each industry.

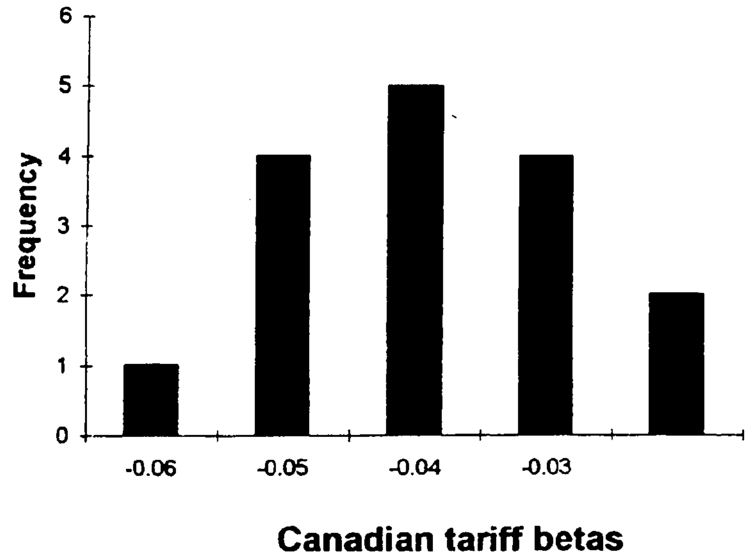

FIGURE 2 Firm-specific Canadian tariff coefficients for Canadian affiliate employment: Furniture and Fixtures industry

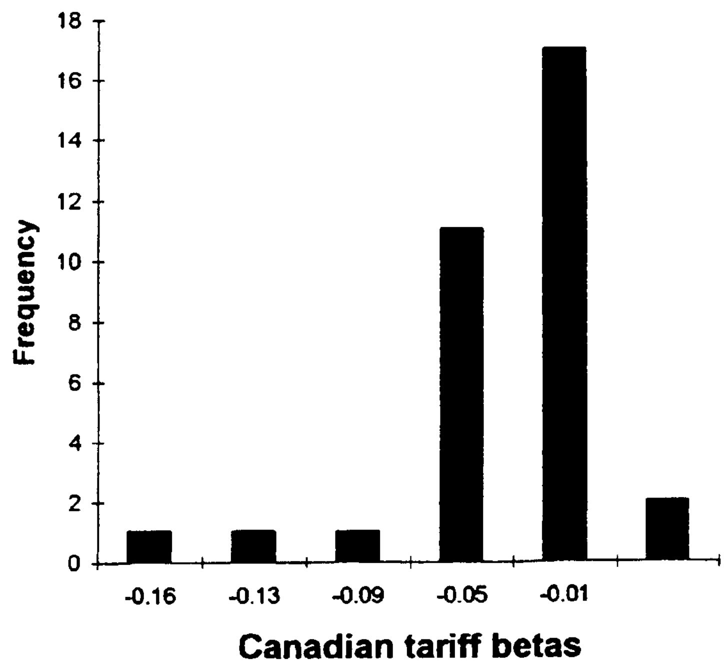

FIGURE 3 Firm-specific Canadian tariff coefficients for Canadian affiliate employment: Industrial Chemicals industry

transfers within MNCs, lower tariffs created opportunities for MNCs to organize production more efficiently in North America.

The kinds of reorganization undertaken by U.S. MNCs and their Canadian affiliates in response to Canada-U.S. trade liberalization were discussed by several corporate executives at MNC affiliates in Canada who were interviewed as part of this study.[16] One talked about the superior productivity his company was able to achieve at its Canadian facilities by installing high-performance work systems in which worker participation, speed, and flexibility more than compensated for smaller Canadian plant sizes. Rather than shut down smaller Canadian plants when trade was liberalized, his company developed new production technologies that enabled it to achieve high productivity in small plants – even in an industry with important scale economies. Another manager discussed how, when several important Canadian customers of his company moved to the United States when trade was liberalized, his company decided not to close its Canadian plants but rather to use them to fulfil small-batch orders for the MNC's global operations. Both managers stressed that when trade was liberalized, lower tariffs alone were not sufficient to close Canadian plants. Other factors, such as the age of the plants and the products they produced were at least as important. Lower tariffs, however, did enable both companies to organize their North American production more efficiently. These reorganizations illustrate that in many cases, U.S.-Canada trade liberalization enabled MNCs to achieve a finer segmentation of production – one in which *intra*-industry reallocations of resources enhanced the efficiency of North American operations. Such patterns are inconsistent with the concern that Canadian production would be hollowed out by trade liberalization.

Our other main finding was that firm-specific characteristics of MNCs explained more of the variance in adjustments to trade liberalization than industry characteristics did. This finding has important theoretical and policy implications. From a theoretical standpoint, it implies that MNC-specific characteristics are more important in determining incremental foreign investment and employment decisions than industry characteristics such as factor endowments or structural market imperfections. This finding is surprising given the considerable U.S. investment in Canada that is concentrated in resource-based sectors such as food, chemicals and timber.

From a policy perspective, it is important to know whether trade liberalization creates more interindustry or intra-industry adjustments. Because trade protection, subsidies, and trade adjustment assistance are typically targeted at entire industries assumed to be 'losers' from free trade, our finding of substantial *within*-industry differences in firms' employment and capital allocation decisions implies that such policies may be misguided.

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16 More details are available from the authors.

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Appendix

TABLE A1
Industry-specific Canadian tariff coefficients for CA assets and CA employment

Industry	CA assets	Asset range[a]		CA empt.	Employment range[a]	
		Low	High		Low	High
201	−0.02018	−0.02980	−0.00082	−0.04308	−0.05559	−0.01806
202	−0.06578	−0.06578	−0.06578	−0.05330	−0.05330	−0.05330
203	−0.04114	−0.04595	−0.02980	−0.03860	−0.06433	−0.01806
204	−0.05254	−0.08933	0.05728	−0.04131	−0.06629	−0.03258
205	0.00028	−0.03990	0.04798	−0.04591	−0.06433	−0.04104
208	0.06366	−0.05630	0.23716	−0.01606	−0.06629	0.12035
209	−0.09003	−0.28278	0.04169	−0.03348	−0.06433	0.04630
210	0.00192	−0.06997	0.07301	−0.00103	−0.06433	0.02333
220	0.00706	−0.18451	0.10520	−0.02152	−0.06629	0.04456
230	−0.05294	−0.21363	0.07385	−0.01090	−0.05559	0.05894
240	−0.01990	−0.04595	0.04073	−0.04275	−0.06629	0.01767
250	−0.04629	−0.10877	0.00799	−0.04142	−0.06629	−0.01597
262	−0.02963	−0.07320	0.04798	−0.03317	−0.06433	0.02632
265	−0.04412	−0.12304	0.02545	−0.02541	−0.06433	0.07244
270	0.00140	−0.08866	0.04560	−0.02532	−0.06629	0.02680
281	−0.05493	−0.46236	0.21431	−0.05479	−0.16492	0.02632
283	−0.08896	−0.35300	0.05127	−0.02657	−0.12752	0.07244
284	−0.06274	−0.26352	0.09969	−0.04094	−0.06629	0.01198
287	0.05321	−0.06997	0.11266	−0.05291	−0.08093	−0.01093
289	−0.05228	−0.26085	0.06709	−0.04844	−0.11988	0.03595
299	−0.19700	−0.19700	−0.19700	−0.05318	−0.05318	−0.05318
305	−0.02721	−0.26085	0.15353	−0.01478	−0.06433	0.02632
308	−0.08125	−0.23157	0.00799	−0.03820	−0.08093	0.01198
310	−0.07208	−0.10877	−0.06997	−0.03266	−0.06629	−0.01806
321	−0.12962	−0.35534	−0.00447	−0.01925	−0.05559	0.02052
329	−0.01623	−0.12304	0.05728	−0.02753	−0.06433	0.02395
331	−0.01051	−0.08524	0.07389	−0.00917	−0.05559	0.03595
335	−0.07411	−0.08239	0.06888	−0.08317	−0.21905	−0.01806
341	−0.00751	−0.08866	−0.02990	−0.04161	−0.06433	−0.01806
342	−0.03991	−0.08866	0.04798	−0.03480	−0.05743	0.01198
343	−0.01812	−0.21363	0.11755	−0.02651	−0.06629	0.06541
349	−0.02363	−0.26515	0.10520	−0.04488	−0.11388	0.04160
351	−0.07954	−0.08866	−0.05354	−0.05392	−0.05559	−0.04617
352	−0.02453	−0.04973	0.00067	−0.01808	−0.04399	0.00783
353	0.01894	−0.08866	0.12996	−0.03539	−0.11247	0.04475
354	−0.05000	−0.19555	0.05792	−0.02573	−0.12752	0.02632
355	−0.00847	−0.13166	0.10485	−0.01580	−0.06433	0.02632
356	−0.06568	−0.10877	0.00342	−0.02459	−0.06629	0.01198
357	−0.04909	−0.08866	0.04798	−0.04025	−0.05559	−0.01355
358	−0.03270	−0.21363	0.04073	−0.03152	−0.07781	0.00783
359	−0.02428	−0.04274	0.04798	−0.03957	−0.05559	−0.01806
363	−0.01024	−0.08239	0.00799	−0.03735	−0.06433	−0.01415
366	−0.03182	−0.08524	0.09969	−0.04273	−0.06629	−0.01597
367	−0.02903	−0.08866	0.07385	−0.04213	−0.06433	−0.01093
369	−0.02224	−0.22007	0.07301	−0.03245	−0.06629	0.05463
371	−0.03830	−0.13166	0.12996	−0.03000	−0.09207	0.04630
379	−0.06857	−0.11777	0.04798	−0.02339	−0.06433	0.02395
381	0.00035	−0.07320	0.15353	−0.04495	−0.12835	−0.00092
384	−0.01244	−0.08866	0.07385	−0.01639	−0.06433	0.04630
390	−0.03529	−0.35300	0.11390	−0.04512	−0.06629	−0.02434

a Range refers to the range of firm-specific Canadian tariff coefficients in each industry.

TABLE A2
Industry average U.S. and Canadian tariffs and transportation costs

IND	Industry description	U.S. tariff	Can. tariff	Trans. cost
201	Meat Products and Packaging	0.82%	1.80%	0.41%
202	Dairy Products and Processing	6.61%	8.30%	3.89%
203	Preserved Fruits and Vegetables	7.29%	5.91%	1.25%
204	Grain Mill Products	2.33%	4.72%	1.34%
205	Bakery Products	0.56%	5.32%	0.44%
208	Beverages	3.08%	30.27%	1.01%
209	Other Food and Kindred Products	3.30%	3.98%	1.01%
210	Tobacco Products	14.74%	24.83%	0.87%
220	Textile Mill Products	8.11%	13.27%	0.64%
230	Apparel and other Textile Products	10.56%	20.82%	0.71%
240	Lumber and Wood Products	0.43%	2.56%	4.01%
250	Furniture and Fixtures	1.72%	9.35%	0.66%
262	Pulp, Paper and Board Mills	0.16%	3.31%	2.59%
265	Other Paper and Allied Products	2.29%	6.49%	0.84%
270	Newspapers, Printing and Publishing	3.15%	1.41%	1.32%
281	Industrial Chemicals and Synthetics	3.50%	3.41%	2.22%
283	Drugs	3.14%	5.05%	0.37%
284	Soap, Cleaners and Toilet Goods	4.64%	10.73%	0.62%
287	Agricultural Chemicals	0.23%	0.05%	8.44%
289	Chemical Products, n.e.c.	2.79%	5.48%	0.71%
299	Petroleum and Coal Products	4.52%	0.91%	0.00%
305	Rubber Products	3.32%	5.95%	0.69%
308	Miscellaneous Plastics Products	4.34%	8.87%	0.70%
310	Leather and Leather Products	5.77%	10.83%	0.72%
321	Glass Products	2.03%	4.56%	0.59%
329	Stone, Clay and Concrete	2.11%	3.79%	2.39%
331	Primary Metal Industries, Ferrous	3.34%	4.38%	1.12%
335	Primary Metal Industries, Nonferrous	2.27%	1.19%	0.42%
341	Metal Cans, Forgings and Stampings	0.65%	6.12%	1.27%
342	Cutlery, Hardward and Screw Products	2.23%	7.23%	0.58%
343	Heating Equipment and Plumbing Fixtures	3.91%	9.65%	0.79%
349	Metal Services Products, Ordinance, n.e.c.	2.38%	5.79%	0.60%
351	Engines and Turbines	1.46%	9.32%	0.15%
352	Farm and Garden Machinery	0.19%	0.11%	0.79%
353	Construction, Mining and Machinery	1.96%	3.38%	0.32%
354	Metalworking Machinery	3.36%	5.87%	0.34%
355	Special Industry Machinery	2.78%	3.16%	0.31%
356	General Industrial Machinery	2.25%	3.20%	0.43%
357	Computer and Office Equipment	0.51%	1.08%	0.77%
358	Refrigeration and Service Industry Machinery	2.45%	4.28%	0.40%
359	Industrial and Commercial Machinery, n.e.c.	2.16%	2.67%	0.61%
363	Household Appliances	2.63%	8.82%	0.76%
366	Household Audio and Video and Communications	3.71%	4.55%	0.48%
367	Electronic Components and Accessories	1.92%	6.79%	0.78%
369	Electrical Machinery, n.e.c.	2.38%	4.11%	0.44%
371	Motor Vehicles and Equipment	0.11%	0.37%	0.39%
379	Other Transportation and Equipment	0.51%	1.71%	0.22%
381	Measuring, Scientific and Optical Instruments	2.19%	2.16%	0.35%
384	Medical Instruments and Supplies	4.46%	1.89%	0.49%
390	Miscellaneous Manufacturing Industries	3.66%	6.40%	0.50%
	AVERAGES	3.10%	6.12%	1.03%

TABLE A3
Industry categories and observations

IND	Total obs.	Ind. category	IND	Total obs.	Ind. category
201	3	CN	329	57	II
202	5	CN	331	74	II
203	11	CN	335	54	II
204	22	CN	341	19	II
205	10	CN	342	46	II
208	46	CN	343	83	IM
209	75	CN	349	118	IM
210	22	CN	351	10	IM
220	57	II	352	3	IM
230	70	CD	353	65	IM
240	61	II	354	41	IM
250	58	CD	355	47	IM
262	66	II	356	44	IM
265	70	II	357	16	IM
270	80	II	358	59	IM
281	169	II	359	13	IM
283	131	CN	363	28	CD
284	102	CN	366	34	CD
287	13	II	367	63	CD
289	121	II	369	154	CD
299	3	II	371	196	CD
305	59	II	379	53	CD
308	94	II	381	63	IM
310	14	CN	384	43	IM
321	38	II	390	98	CD