Globalisation and Labour Demand Elasticities in Britain*

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Abstract

Do multinational firms exhibit different patterns of labor demand from purely domestic firms? Many standard models of trade and multinational companies suggest such differences. We examine this question using a plant-level panel covering U.K. manufacturing from 1973 through 1992, where we can distinguish U.K.-headquartered multinationals, foreign-owned multinationals, and domestic U.K. firms. Across these three ownership groups we look for differences both on the intensive margin, in terms of labor-demand elasticities, and on the extensive margin, in terms of plant shutdowns. For our sample period we estimate that both groups of multinational plants had larger increases than did domestic plants in the elasticity of demand for production labor. These increases were driven largely by greater substitutability between production labor and materials. We also estimate that both types of multinational plants are more likely to shut down than domestic plants are, conditional on a set of operational advantages enjoyed by multinationals that make them less likely to shut down.

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1. Introduction

An important part of globalization in recent decades has been the ongoing rise in foreign direct investment (FDI) by multinational enterprises (MNEs). In fact, cross-border flows of FDI have grown at much faster rates than have flows of goods and services or people. UNCTAD (2001) reports that from 1986 through 2000, worldwide cross-border outflows of FDI rose at an annualized rate of 26.2%, versus a rate of just 15.4% for worldwide exports of goods and services. In the second half of the 1990s this difference widened to 37.0% versus just 1.9%. An important force behind these rising FDI flows have been declining natural and political barriers.[1]

In this paper we investigate whether MNEs exhibit different patterns of labor demand from purely domestic firms. In the literature on globalization and labor markets, the impact of these firms has been much less researched than has the role of trade and immigration.[2] This relative lack of attention is unfortunate because it is the multinationalization of production to which a number of scholars have pointed as the distinguishing feature of the current phase of globalization compared to previous episodes (e.g., Bordo, Eichengreen, and Irwin 1999).

We examine two issues. One is whether MNEs and domestic firms differ on the intensive margin of labor-demand elasticities. The other is whether they also differ on the extensive margin of closing plants. As we will discuss, both these ideas are suggested by standard trade models of MNEs but have almost no empirical evidence. And they both accord with the

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[1] Advances in information and communication technologies (e.g., the Internet) have reduced intra-firm cross-border communication and coordination costs. As for political barriers, UNCTAD (2001, p. 6) reports that since 1991, the annual number of national regulatory changes that have been more favorable towards FDI has averaged over 100 while the less-favorable number has averaged fewer than 10.

[2] For example, in surveying this literature Baldwin (1995, p.55) noted that "there do not seem to be any studies of how the shifts in the pattern of U.S. direct investment and direct foreign investment in the United States have affected relative wages."

conventional wisdom in business and policy discussions that in recent decades MNEs have become much more footloose with greater ability to reorganize production around the world.[3]

Our empirical analysis uses a plant-level panel for all U.K. manufacturing from 1973 through 1992, where we can distinguish U.K.-headquartered multinationals, foreign-owned multinationals, and domestic U.K. firms. The U.K. is of interest for a number of reasons, including being one of the world's largest source and destination countries for FDI (over our sample period the foreign-affiliate share of manufacturing employment rose from 12% to 23%). We estimate elasticities in the framework of a translog production function, allowing these elasticities—both constant-output own-price demand elasticities for production and non-production labor and also the constituent Allen elasticities of substitution—to vary across ownership groups and over time as well. For the plant-death issue, we estimate hazards of plant shutdowns to examine the role of nationality of plant ownership.

We have two main empirical findings. First, for our sample period we estimate that both groups of multinational plants had larger increases than did domestic plants in the elasticity of demand for production labor. These increases were driven largely by greater substitutability between production labor and materials. Second, we estimate that both types of multinational plants are more likely to shut down than domestic plants are, conditional on a set of operational advantages enjoyed by multinationals that make them less likely to shut down. Together, these two findings suggest that MNEs and domestic firms do look different on both the intensive margin of elasticities and also the extensive margin of shutdowns. These findings contribute to literatures on international, labor, and industrial organization.

[3] Rodrik (1997, p. 16) quotes labor representative Thomas R. Donahue as saying, "[T]he world has become a huge bazaar with national peddling their workforces in competition against one another, offering the lowest prices for doing business. The customers, of course, are the multinational corporations."

There are five sections to the rest of the paper. Section 2 briefly discusses the theory of elasticities and plant closures. Section 3 discusses our data, measurement, and estimation issues. Section 4 presents our empirical findings, and Section 5 concludes.

2. Multinationals, Labor-Demand Elasticities, and Plant Closures: Theory and Evidence

2.1 Labor-Demand Elasticities

Why are changing labor-demand elasticities important? Rodrik (1997) discusses three important implications of more-elastic factor demands. First, higher elasticities shift the wage and/or employment incidence of non-wage labor costs (e.g., payroll taxes) towards labor away from employers. Second, higher elasticities trigger more-volatile responses of wages and/or employment to any exogenous shock to labor demand. Third, higher elasticities shift from labor towards capital bargaining power over rent distribution in firms which enjoy extranormal profits.

Hamermesh (1993) summarizes what forces determine a firm's equilibrium own-price elasticity of demand for a type of homogeneous labor with "the fundamental law of factor demand" (p. 24). Modifying his notation slightly, here is the law.

$$(1)\ PED_i = -[1-S_i]\sigma_{LL} - S_i\eta$$

In (1), PED_i is the own-price elasticity of demand for labor of type i; S_i is labor's share of firm total revenue; σ_{LL} is the constant-output elasticity of substitution between labor and all other factors of production; and η is the product-demand elasticity for the firm's output market. The variables S_i, σ_{LL}, and η are all defined to be positive, such that PED_i is defined to be negative. In words, PED_i tells the percentage fall in the quantity of labor demanded by a firm in response to a one-percent increase in the price of labor facing that firm. The larger (in absolute value) is PED_i, the more that firm responds to wage increases by demanding fewer workers—i.e., the more elastic is the labor demand.

As written in (1), PED_i consists of two parts. The first, $-[1-S_i]\sigma_{LL}$, is the "substitution effect." It tells, for a given level of output, how much the firm substitutes away from labor towards other factors when wages rise. This term $-[1-S_i]\sigma_{LL}$ is often called the *constant-output* labor-demand elasticity, distinct from the *total* elasticity PED_i. The second part of (1), $-S_i\eta$, is the "output effect" or "scale effect." It tells how much labor demand changes after a wage change thanks to the change in the firm's output. Higher wages imply higher costs and thus, moving along the product-market demand schedule, lower firm output. When wages rise, both the substitution and scale effects reduce the quantity of labor demanded. The firm substitutes away from labor towards other factors, and with higher costs the firm produces less output such that it demands less of all factors, including labor. Thus, $PED_i < 0$.

We hypothesize that, σ_{LL}, the degree of substitutability between labor and other factors, may differ between MNEs and domestic firms. By definition, MNEs hire and coordinate factors of production in more than one country. When wages increase in any one country, then, MNEs operating there are likely to have more margins for substitution than purely domestic firms. With rising global production networks, all firms—both MNEs and domestic—can access foreign factors of production through trade in intermediate inputs. But only MNEs can directly hire foreign factors; moreover, their deeper foreign presence is likely to make them more able to trade intermediate inputs. This link between firm nationality and factor substitutability is discussed in Rodrik (1997); it accords with trade models of vertically integrated production whose stages can move abroad either within firms as multinationals establish foreign affiliates (e.g., Helpman, 1984) or arm's length by importing the output of those stages from other firms (e.g., Feenstra and Hanson, 1996).

This discussion suggests two empirical hypotheses. One is that at each point in time, MNEs have more elastic constant-output labor demands than do domestic firms. The other is that over time, MNEs have larger increases in constant-output labor-demand elasticities than do domestic firms. The extent to which one or both of these predictions holds should depend on the pattern of natural and political barriers to FDI. In an equilibrium world with no such barriers, the prediction of level differences might be expected. As discussed in the introduction, however, recent decades have largely been a period of declining, not zero, FDI barriers. This suggests that the second prediction of different changes may be more relevant.

In labor economics there is a large literature on estimating elasticities of labor demand (see the survey in chapter 3 of Hamermesh, 1993). But we are aware of no study examining the role of nationality of firm ownership. More broadly, we are aware of only two empirical studies linking labor-demand elasticities to any aspect of globalization, both of which have somewhat negative findings. Using industry-level data for U.S. manufacturing, Slaughter (2001) estimates that demand for production labor became more elastic from 1960 to the early 1990s. But he is unable to clearly link these changes in industry elasticities to changes in industry trade and FDI patterns. Using plant-level data for Turkey that span a major trade liberalization, Krishna, et al (2001) find no evidence that labor demands grew more elastic post-liberalization.

2.2 Plant Exit

The idea that MNEs can more easily substitute away from labor in any one country carries another empirical prediction: that MNEs can be more responsive not just on the intensive margin but on the extensive margin as well. That is, MNEs can do more than substitute partially away from labor in one country. They can substitute away entirely by closing that country's plant(s). Indeed, this extensive margin is the focus of much of the business and policy discussions about the threat that MNEs "export jobs" to affiliates via parent-country plant exits.[4] This suggests the empirical hypothesis that within a country, all else equal plants owned by MNEs are more likely to die than are plants owned by domestic firms.

Recent general-equilibrium trade models of MNEs show that cross-country plant relocation can be an important aspect of adjustments across equilibria (for a survey, see Markusen, 2002). In the industrial-organization literature there has been substantial modeling of the determinants of plant closure (e.g., Ericson and Pakes, 1995; Ghemawat and Nalebuff, 1990; Hopenhayn, 1992; Jovanovic, 1982). We are not aware of any link between this literature and that in trade on MNEs. Somewhat related, some work in this literature has investigated the issue of exit in multi-plant firms. Ghemawat and Nalebuff (1985) derive predictions for the setting of multi-plant duopolists, but Whinston (1988) finds no clear generalizations to different market structures.

Empirical research on the determinants of plant shutdowns has spanned a wide variety of situations such as individual industries (e.g., Deily, 1988, 1991 for steel; Olley and Pakes, 1996, for telecommunications) or entire sectors, usually manufacturing (e.g., Disney et al, 2001, for the United Kingdom; Dunne et al, 1989, for the United States). Gibson and Harris (1996) investigate whether (but find no evidence that) trade liberalization induced plant exits in New Zealand. We know of only two very recent studies investigating foreign ownership and closures. Gorg and Strobl (2002) find that foreign-owned plants in Irish manufacturing are more likely to exit. In contemporaneous work on U.S. manufacturing, Bernard and Jensen (2002) report higher death probabilities for plants owned by firms that hold at least 10% of their assets outside the United States.

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[4] About the North American Free Trade Agreement, Choate and Perot (1993, p. 29) write "NAFTA will accelerate the loss of manufacturing jobs in the United States. Some companies will move factories to Mexico to take advantage of low-cost Mexican labor. Others will move to Mexico to escape U.S. regulations. Many American companies will move factories to Mexico, not because they want to, but because their competitors have moved, and they must move to compete."

3. Data, Measurement, and Econometrics

3.1 Overview of the ARD

Details of our data can be found in Barnes and Martin (2002), Griffith (1999), Oulton (1997), Disney et al (2001), and the Data Appendix. Here we briefly set out the main features of the data, and concentrate on issues involved in estimating elasticities and plant closures.

Our main data set is the ARD (Annual Respondents Database), which is the micro-data underlying the U.K. Census of Production. The most disaggregated unit on the ARD is a production facility at a single mailing address, which corresponds to a "production unit" or "plant." Each unit is assigned a unique identification number, which allows units to be linked over time into a panel. Units also have another identification number corresponding to the firm who owns them, where units under common ownership share the same firm identifier.

To maintain the ARD data, the Office for National Statistics (or ONS, previously the Central Statistical Office, or CSO) maintains a register of businesses designed to capture the universe of production-sector activity. The register is drawn from a variety of sources including historical records, tax returns and other surveys.[5] This register is the basis upon which the Census forms are sent out, response to which is mandatory under the 1947 Statistics of Trade Act. These forms request extensive operational information. Computerized ARD forms go back to 1973; paper records for earlier years have been destroyed. In 1993 and 1994, a complete recoding of identification numbers was undertaken that has generated non-trivial problems in matching plants before and after. Thus, we work with data through 1992.

In at least two ways, the U.K. government has reduced the reporting burden on firms. First, it has not required all smaller plants to fill out Census forms. Each year, all plants with

[5] Thus, for example, the 1983 Value Added Tax Act allowed the CSO to start using VAT information in compiling the register. In 1994, the CSO moved to a completely new register.

employment over some minimum size (100 in most years) are sampled. Plants with employment below this threshold are sampled with probabilities decreasing in size.[6] Thus, each year's sample consists of a mix of larger plants sampled with certainty and smaller plants sampled with varying probabilities. The sampled plants altogether are referred to as the "selected sample," while all non-sampled plants constitute the "non-selected sample." Each year the selected sample accounts for around 90% of total U.K. manufacturing employment (Oulton, 1997). Non-selected plants have a variety of information on employment and output, some of which comes independently from tax records and some of which is interpolated (some employment is interpolated from tax data on turnover for example).

A second reporting-burden issue is that multi-plant firms have some latitude in the level of aggregation at which they report plant information. If a multi-plant firm considers some of its individual plants to be too small to complete a full Census form, it may report an amalgamation of plants. This reporting level is called an "establishment" or "reporting unit".

The ARD structure raises many issues for our data analysis. Here we highlight two, with these and additional issues addressed more in the next sub-section. First is the level of aggregation for our analysis. In principle, the ARD panel can be configured for plants, establishments, or firms. Firms seem too aggregated: by construction they obscure plant shutdowns, and patterns of elasticities might be obscured for multi-plant firms in multiple regions and/or industries. And since multi-plant firms that aggregate operations into establishments do not report data for each separate plant, at the level of plants we cannot measure many key variables. Accordingly, we choose to work at the level of establishments.

[6] In most years, 50% of plants with employment from 50 to 100 are sampled, and 25% of plants with employment from 20 to 50. Each year in our data sample the very smallest plants are excluded from the Census (Barnes and Martin, 2002).

For brevity and consistency with many earlier studies, we will use the terms establishments and plants interchangeably.

A second issue is what information, if any, can be used from the non-selected data. Since these businesses are not sent a full Census form, we have no information on their inputs (such as material and investment). They do report on nationality of ownership. The ONS imputes their employment levels using turnover data from tax records. The ONS does check employment for plants with imputed employment of over 11. However, due to time lags in the provision of tax data and processing of imputations, such information is typically refers to data from two years earlier (Perry, 1985). In addition, these checked plants are only around 20% of the non-selected sample. For these and other reasons, we exclude from our analysis the non-selected sample.

Finally, before our analysis we cleaned the data via extensive checks for nonsense observations, outliers, coding mistakes, and the like. This task is important in itself, but takes on additional significance for any analysis on time-differenced data, as differencing tends to magnify the role of measurement error. For example, plant identification numbers are supposed to die with the plant, so we deleted any observations where plant identifiers returned after dropping out of the entire data set.[7] We dropped publicly owned plants (mainly in utilities), and plants that seemed to change ownership, industry, or region in unusual fashion.

3.2 Distinguishing Multinational from Domestic Firms

The ARD collects information on nationality of firm ownership, which allows us to distinguish foreign-owned MNEs from all U.K. firms. Nationality of ownership is defined according to whether an overseas investor has an effective voice in the management of the enterprise, where an effective voice is taken as equivalent to a holding of 20% or more in the

[7] A plant might truly do this if it happens not to be sampled for full Census information for some period because of its small size, but we can check on this using the plant records for those who do not fill out the full Census form.

foreign enterprise. In our data, then, foreign-affiliate plants are those plants owned at least 20% by an overseas business interest (beyond this 20% cut-off there is no information on the degree of foreign ownership). One important advantage of the ARD over similar data sets for most other countries is that it reports nationality of ownership in every year.[8]

The ARD does not allow us to separate U.K.-headquartered multinational firms from purely domestic U.K. firms. To do this we used data from the 1998 Annual Survey into Foreign Direct Investment (AFDI). The AFDI identifies those U.K. firms that have FDI (defined as at least a 10% ownership stake) in at least one foreign affiliate. By matching this AFDI information into the 1998 ARD, we were able to identify a set of U.K. firms as MNEs. Using the ARD's firm identifiers, we then backcast this ownership information throughout our 1973-1992 sample. This resulted in three ownership groups in each year of our panel: foreign-owned MNE plants (identified directly in the ARD), U.K. MNE plants (identified by the AFDI backcasting), and U.K. domestic plants (the residual set of U.K. plants).[9]

Backcasting at the firm rather than plant level allows us to capture over time plant births and deaths within firms. If instead we backcast the 1998 U.K. MNE information by plants, by construction we would never observe any deaths of U.K. MNE plants. This would obviously be problematic for our hazards analysis. That said, our backcasting approach has the limitation of assuming that the 1998 split of U.K.-owned firms between MNEs and domestics was the same in all earlier years. In earlier years we miss any transitions of U.K. firms from domestic to multinational or vice versa. We have no direct information on how extensive this mis-classification may be. In light of rising outward U.K. FDI in recent decades, on balance we are

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[8] In contrast, the widely used analogous U.S. data base, the Longitudinal Research Database, does not track nationality of ownership. The only year in which nationality information was merged in (from the U.S. Bureau of Economic Analysis) was 1987 (see examination of this one year in Doms and Jensen, 1998). For the countries providing information and data to the current OECD micro-data project (Finland, Holland, France, U.S., U.K., Germany and Italy), nationality of ownership data is missing for Germany, Holland, Italy, and the U.S.; the French data are incomplete; and only the U.K. and Finland have such data.

probably over-counting U.K. MNE plants in earlier years by incorrectly assuming that U.K. MNEs in 1998 were multinational from 1973 forward. Note that this classification error will work against, not for, us finding any labor-demand differences across ownership groups.

3.3 Econometric Specification for Estimating Elasticities

To examine labor-demand elasticities across ownership groups, we will estimate a set of equations based on a translog production technology. To generate output, each plant must make several input choices. Standard production theory says that given the prices for these various factors, each plant will demand the factor mix that maximizes profits subject to the constraint that the level of output is technologically feasible (or, alternatively, that minimizes costs subject to the constraint of making the target output). Let Y be output and **X** be the vector of inputs used to make that output according to technology indexed by time T.

For empirical work, a functional form for technology must be selected. One common choice is the translog function, obtained by expanding the underlying production function in a second-order Taylor series. For this translog case, output as a function of inputs is given as follows,

$$(2) \qquad \ln Y = \alpha_0 + \sum_i \alpha_i \ln X_i + \frac{1}{2}\sum_i \sum_j \gamma_{ij} \ln X_i \ln X_j + \beta_t T + \frac{1}{2}\beta_{tt} T^2 + \sum_i \beta_{it} T \ln X_i \ ,$$

where in (2) the coefficients represent derivatives from the Taylor expansion and symmetry has been imposed on all cross derivatives. For this functional form, optimal activity choices, as a share of total costs, are given by

$$(3) \qquad S_{it} = \frac{\partial \ln Y}{\partial \ln X} = \alpha_i + \beta_i T + \sum_j \gamma_{ij} \ln X_{it} \ ,$$

where S_{it} is the share of factor I in plant costs at time T; α_i represents the level of technology bias toward factor I; and β_i represents the change in technology bias towards factor I. Across the

[9] For assistance in merging in the AFDI information, we thank Ralf Martin.

exhaustive set of I activity choices, at each point in time the activity shares S_{it} must sum to one. If the time-difference operator Δ is applied to (3), this results in the following set of equations:

$$(4) \qquad \Delta S_{it} = \beta_i \Delta T + \sum_j \gamma_{ij} \Delta \ln X_{it} \; .$$

With data on S_{it} and the inputs X_{it}, equation (4) can be estimated. Coefficient estimates for the γ_{ij} parameters can then be combined with sample data on the S^i shares to calculate various elasticities of interest. For factor I, its constant-output own-price demand elasticity, PED_i, is

$$(5) \qquad PED_i = \frac{\gamma_{ii} + S_i - 1}{S_i}$$

while the various Allen elasticities of substitution[10], EOS_{ij}, are given by

$$(6) \qquad EOS_{ij} = \frac{\gamma_{ij} + S_i S_j}{S_i S_j}$$

and the two are related as follows:

$$(7) \qquad PED_i = -\sum_{j \neq i} \left(EOS_{ij}\right)\left(S_j\right).$$

When calculating elasticities using (5) and (6) for observed cost shares, standard errors for these elasticities can be obtained from the estimated standard errors on the γ_{ij} by applying the delta method (e.g., Greene, 1993, chapter 10).

An important advantage of the translog framework is that it does not impose any restrictions on the pairwise elasticities of substitution between activities, and thus generalizes from more-restrictive technologies such as Cobb Douglas (all elasticities equal one) or CES (all elasticities equal some constant). This flexibility is particularly appealing for our analysis because *ex ante* we expect inputs to vary in terms of substitutability and complementarity.

We estimate equation (4) separately for production labor and non-production labor, with each equation estimated at each point in time for each of our three ownership groups by pooling all plants within that group. This allows us to obtain estimates of the key parameters γ_{ij} that vary by both ownership group and time. By combining these estimates with sample data on cost shares that vary similarly, we calculate a set of elasticities that vary by both ownership group and time. We use these elasticities to investigate the hypotheses laid out in Section 2.2.

To estimate (4), output is measured as gross output. Our inputs are production labor, non-production labor, materials, and capital. The first three are reported directly in the ARD full-form surveys. Both labor types counting both part-time and full-time workers, and materials includes both energy and non-energy purchases. Output and materials are deflated using industry-level price indexes as detailed as possible. The ARD does not ask plants to report capital stocks, so we used plant investment data to calculate capital stocks. We chose industry-level starting capital-stock values and depreciation rates for buildings, plant and machinery, and vehicles taken from O'Mahony and Oulton (1990). We deflated each component of investment by ONS industry-year investment deflators. We experimented with different capital-stock computations (the two main variables affecting the capital-stock path are starting values and depreciation rates), but these did not overly affect the results. Changes in technology T are measured using log changes in total factor productivity (TFP). Note that in addition to removing any fixed plant-specific unobservable variation α_i, time differencing in (4) also removes any fixed regional and industrial effects.

One important estimation choice is the length of time differences in (4). One well-known cost of differencing is that it can aggravate any measurement error in the regressors, and thereby

[10] These elasticities are defined as the percentage change in relative demand between two factors in response to a one-percent

introduce biases (the direction of which cannot be signed in a multivariate setting). Longer time differences tend to attenuate this problem (Griliches and Hausman, 1986), but at the cost of fewer usable years in our sample. We report results using five-year time differences. Qualitatively similar results were obtained for three-year differences, and so are not reported.

3.4 Econometric Specification for Estimating Plant Deaths

To investigate if plant shutdowns depend on nationality of ownership, for our entire plant-year panel we estimated a Cox proportional hazard model on all cohorts of establishments born between 1973 and 1991. Let λ_{it} be the hazard rate of plant i at time t, i.e., this is the probability that plant i exits in interval t to t+1, conditional upon having survived from birth until period t. This hazard rate can then be explained with the following equation,

$$(8) \qquad \lambda_{it} = \lambda_0(t)\exp(Z(t)\beta),$$

where $\lambda_0(t)$ is the baseline hazard, t is measured as time since entry, and Z is a vector of variables hypothesized to influence exit. For our baseline hazard we choose the Cox (1972) specification, which is non-parametric and therefore is quite flexible.

As for our regressors in Z, of primary interest are indicators of nationality of ownership. We start by including in Z just two categorical variables for each plant-year observation: one equal to one if the plant-year is part of a U.K. MNE, and the other equal to one if the plant-year is part of a foreign MNE. As discussed in Section 2.2, we are interested in the hypothesis that MNE plants are more likely to die than are purely domestic plants, all else equal.

One potential concern with this parsimonious specification is that all else is not equal. A number of studies (e.g., Doms and Jensen, 1998 for the United States; Criscuolo and Martin, 2002 for the United Kingdom), have documented that multinational plants tend to be larger,

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change in the relative price of these factors, holding fixed all other factor prices.

more capital intensive, more skill intensive, and higher-paying than are purely domestic plants. If these performance differences themselves influence the probability of plant closure, then to identify the multinational effect of interest they must be directly controlled for in Z. Accordingly, we estimate versions of (8) with a much larger set of Z regressors that includes employment and previous-year employment growth in levels and squared; output growth; capital per unit of output; the non-production share of total employment (to measure skill intensity); wages paid to production and non-production workers; output per production and non-production worker. Beyond these plant-year regressors, we also include a full set of indicators for region, industry, and cohort. Many of these variables were used in related studies cited in Section 2.2.

4. Empirical Results

4.1 Elasticities of Demand for Labor

Table 1 reports plant-year summary statistics for our three sub-samples of ownership groups. Both U.K. and foreign MNEs plants employ an average of more than twice as many workers as U.K. domestic plants. These MNE plants also exhibit much higher labor productivity, which is at least partly due to their greater capital intensity and greater skill intensity as well. These performance differentials between MNE and domestic plants are qualitatively the same as the cross-sectional evidence in Criscuolo and Martin (2002) and Doms and Jensen (1998). We regard this to be a good check on our method for distinguishing U.K. MNEs from U.K. domestics (see Section 3.2).

Figure 1 plots constant-output own-price elasticities of demand for both production and non-production labor that were obtained by estimating equation (4) *without* separating the data into our three ownership groups. These pooled estimates provide evidence on elasticity trends for overall U.K. manufacturing. With five year-time differences in (4), 1978 is the first year for which we can calculate elasticities. To smooth out yearly fluctuations in these elasticities, three-year moving averages are plotted in this (and subsequent) figures. The central message of Figure 1 is that demand for production labor in overall U.K. manufacturing appears to have grown more elastic, from about –0.25 to about –0.35. There is no obvious trend in the elasticity of demand for non-production labor. Note that these magnitudes accord with the range of [-0.15, -0.75] that Hamermesh (1993) proposes as plausible based on this literature survey.

Figure 2 plots constant-output own-price elasticities of demand for both production labor across our three ownership groups. The overall elasticity increase in Figure 1 appears in Figure 2 to be driven mostly by larger elasticity increases for the multinational plants. Both U.K. and foreign MNE plants had elasticities in the (-0.20, -0.25) range in early years, which then fell to around –0.40 by 1992. In contrast, U.K. domestic plants started with more-elastic demands but experienced a smaller change. This visual impression is confirmed by pairwise t-tests. In some of the earlier years, the multinational elasticities are significantly smaller (in absolute value) than the domestic ones. And each group of multinational plants has elasticities at the end of its sample period that are significantly larger (in absolute value) than elasticities earlier in its sample period. The same is not true for the group of domestic U.K. plants: no two pairs of calculated elasticities are different from each other at the standard 5% significance level.[11] Overall, then, Figure 2 shows that both groups of multinational plants had larger increases than did domestic plants in the elasticity of demand for production labor.

[11] For example, in 1984 a t-test of equality between the U.K. MNE elasticity of –0.189 (standard error of 0.048) and the U.K. domestic elasticity of –0.300 (standard error of 0.023) is rejected with a t-statistic of 2.104. For U.K. MNEs, a t-test of equality between that 1984 elasticity and the 1992 elasticity of –0.404 (standard error of 0.056) is rejected with a t-statistic of 2.918. Similarly, for foreign MNEs a t-test of equality between the 1983 elasticity of –0.235 (standard error of 0.037) and the 1991 elasticity of –0.502 (standard error of 0.111) is rejected with a t-statistic of 2.275. For domestic MNEs, the pair that comes closest to being statistically different are the 1983 elasticity of –0.290 (standard error of 0.034) and the 1992 elasticity of –0.376 (standard error of 0.042), for which a t-test of equality is rejected with a t-statistic of only 1.608.

The source of these elasticity changes is investigated in Table 2. For each of the three ownership groups, this table reports estimates of elasticities of demand and substitution for production labor. For each group, reported in the first row are the estimated elasticities plus observed factor-cost shares averaged over the three years 1978 through 1980. Reported in the second row are the similar averages over the three years 1990 through 1992. PED_P is the constant-output own-price elasticity of demand for production labor (in absolute value) calculated by equation (5). EOS_{ij} is the estimated Allen elasticity of substitution between factors I and J calculated by equation (6). S_i is the share of factor I in total costs, averaged across all plants of that ownership group. The factors are production labor (P), non-production labor (N), materials (M), and capital (K). In each year, PED_P is related to the constituent EOS_{ij} as given by equation (7). Because of the averaging across years, for each of the first two rows this equality holds approximately.

For each group, reported in the third row of Table 2 is the level change across the two periods in PED_P. This, in turn, is decomposed into the contribution of level changes in Allen elasticities and level changes in cost shares according to the formula $\Delta PED_i = \sum_{j \neq i} (\Delta EOS_{ij})(\overline{Share_j}) + \sum_{j \neq i} (\overline{EOS_{ij}})(\Delta Share_j)$, where the Δ operator indicates level changes and the bar indicates average values. As before, because of the averaging across years in the first two rows, in this third row this equality holds approximately.

Looking down the PED_P column of Table 2 across ownership groups confirms the visual impression of Figure 2. The level change in elasticities for U.K. domestics (0.048) was less than half that of foreign MNEs (0.097) and barely one third that of U.K. MNEs (0.141).

Looking across the third row of Table 2 for each ownership group shows an important new fact: that for both groups of multinational plants, these increases in labor-demand elasticities were driven largely by greater substitutability between production labor and materials. For U.K. MNEs, all three elasticities of substitution involving production labor rose, but the contribution of the rise in substitutability with materials (0.055) was larger than that of substitutability with capital (0.049) or with non-production labor (0.032). For foreign MNEs, the contribution of the rise in substitutability with materials (0.100) was even more important, explaining virtually all of the overall labor-demand elasticity change. In contrast, for U.K. domestics the smaller rise in labor-demand elasticities was accounted for mainly by greater substitutability with capital (0.044). Note that in all three cases, changing cost shares account for very little of the changes in labor-demand elasticities. Instead, what matters are changes in the elasticities of substitution.

The key message of Table 2, then, is that for both groups of multinational plants, increases in labor-demand elasticities were driven largely by greater substitutability between production labor and materials. This finding broadly accords with the theory discussion from Section 2.1. If access to foreign factors of production has been rising over time for MNEs, then in any one country like the United Kingdom these firms are likely to show rising substitutability between domestic production labor and materials sourced from abroad. Ideally, we could examine this more closely by separating materials purchases between foreign and domestic sources. But this information is not recorded in the ARD. Nevertheless, we note that Campa and Goldberg's (1997) finding of rising U.K. reliance on imported intermediate inputs accords with this idea.[12]

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[12] For the United Kingdom, Canada, Japan, and the United States, Campa and Goldberg (1997) combine national trade data and input-output tables to calculate what share of intermediate inputs are imported. For all U.K. manufacturing together, this share rose from 13.4% in 1974 to 21.6% in 1993. This was the largest percentage-point increase among the four countries. Large increases were also calculated for specific U.K. industries including chemicals (13.1% to 22.5%), industrial machinery (16.1% to 31.3%), electronics (14.9% to 34.6%), and transportation equipment (14.3% to 32.2%).

Figure 3 and Table 3 replicate our analysis for non-production labor. Like the all-groups pattern in Figure 1, Figure 3 shows no clear, consistent trends in elasticities for any of the three ownership groups. For both groups of multinationals, these elasticities rise and fall over the sample and end up at about their starting levels. The U.K. domestic group has the strongest downward trend of the three, starting at about –0.35 and ending somewhere approaching –0.45. In Table 3, this group's rising elasticities is shown to be accounted for primarily by greater substitutability between non-production labor and materials.

4.2 Determinants of Plant Shutdowns

Table 4 reports estimation results from equation (8), our hazard for plant deaths. Column 1 reports coefficient estimates (and, in parentheses, robust standard errors clustered on plants) for the simple specification where the only two regressors are dummy variables indicating ownership by either a U.K. MNE or a foreign MNE. Both coefficients are negative and very statistically significant, indicating that multinational plants are much *less* likely to close than purely domestic plants are. This finding accords with the overall distribution across ownership groups of plant-year observations versus death events. In our regression sample for column (1), multinationals account for 32.1% of the plant-year observations (with 20.1% for U.K. MNEs and 12.0% for foreign MNEs) but for just 24.6% of the death events (of which there were 16,594, with 15.8% by U.K. MNEs and 8.8% by foreign MNEs).[13]

As discussed previously, multinational plants are likely to enjoy a nexus of performance characteristics, such as superior production technology, that make them much less likely to close than purely domestic plants. Accordingly, these other characteristics must be controlled for directly to allow any chance of seeing the multinational linkage of interest.

Column 2 of Table 4 adds in a large set of additional regressors (listed in Section 3.4). With this richer set of controls, the coefficients on multinational ownership now reverse sign and become significantly positive. Now the key message is that both types of multinational plants are *more* likely to shut down than domestic plants are, conditional on a set of operational advantages enjoyed by multinationals that make them less likely to shut down. These two positive coefficient estimates are robust to many different combinations of other control regressors, which for brevity are not reported.

Column 3 adds to the specification in Column 2 a categorical variable for whether the plant is part of a firm that operates additional plants in the United Kingdom. Our intuition for why multinational plants may be more likely to close is that MNE firms are more flexible thanks to their operation of other plants in other countries. This same intuition may apply within U.K. borders as well as across them. Regardless of nationality of ownership, firms that operate more than one plant inside the U.K. should have more flexibility than their single-plant counterparts.

The positive, very significant coefficient estimate on this multi-plant indicator confirms this idea. Note that the coefficient estimate on foreign ownership remains significantly positive, but that on U.K. multinationals has gone to zero. This is because of the very high collinearity between U.K. MNE ownership and multi-plant status. In every year of our hazards sample, between 94.6% and 98.5% of the plants that are part of U.K. MNEs are also part of multi-plant operations (whereas only about 50%-60% of the foreign-owned plants are also part of multi-plant operations).

5. Conclusions

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[13] This sample size is smaller than the number of observations in Table 1 used for estimating elasticities. The reason is that a key variable used in column 3 of the hazards analysis, the indicator for whether a plant is part of a firm that operates additional plants in the United Kingdom, is missing for many of the observations from Table 1.

This paper has examined two issues. One is whether MNEs and domestic firms differ on the intensive margin of labor-demand elasticities. The other is whether they also differ on the extensive margin of closing plants. For a panel covering all U.K. manufacturing plants from 1973 through 1992, we found differences on both dimensions.

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Figure 1: Elasticities of Demand for Both Labor Types, All Plants Pooled

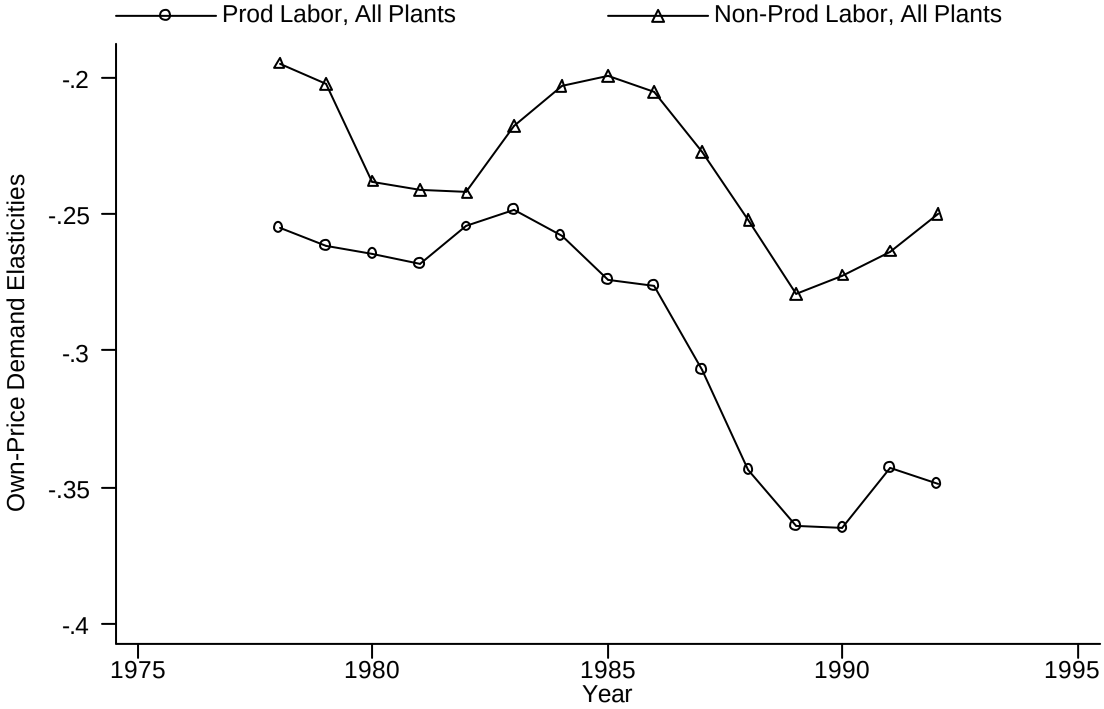

Figure 2: Elasticities of Demand for Production Labor, By Ownership Group

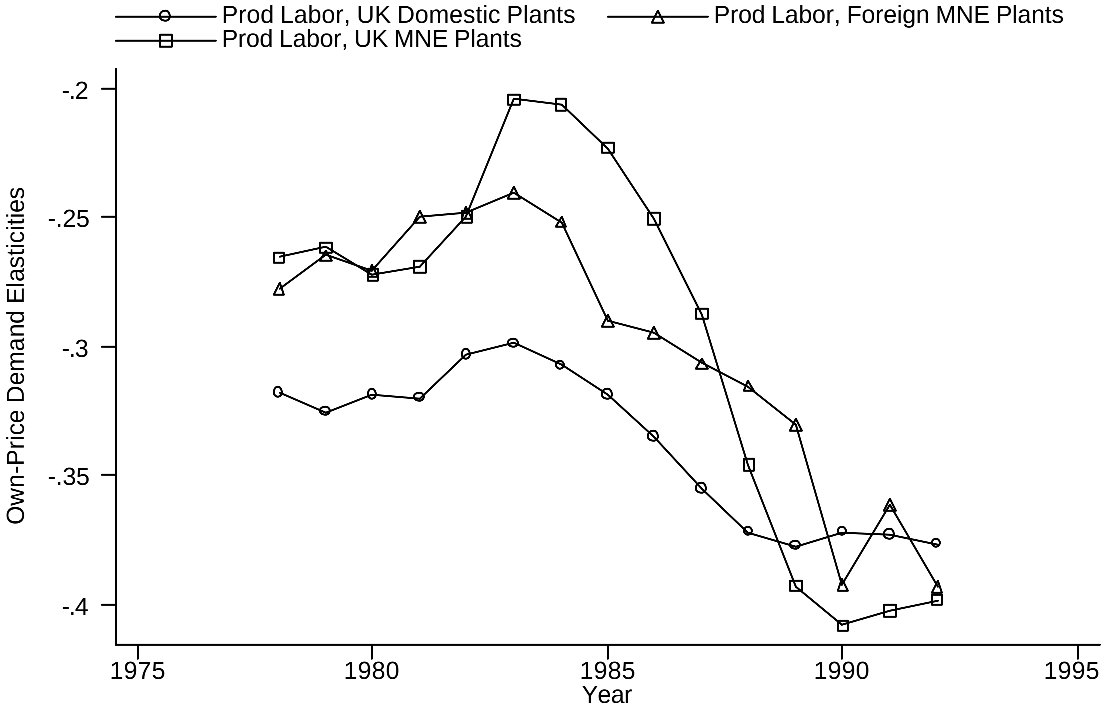

Figure 3: Elasticities of Demand for Non-Production Labor, By Ownership Group

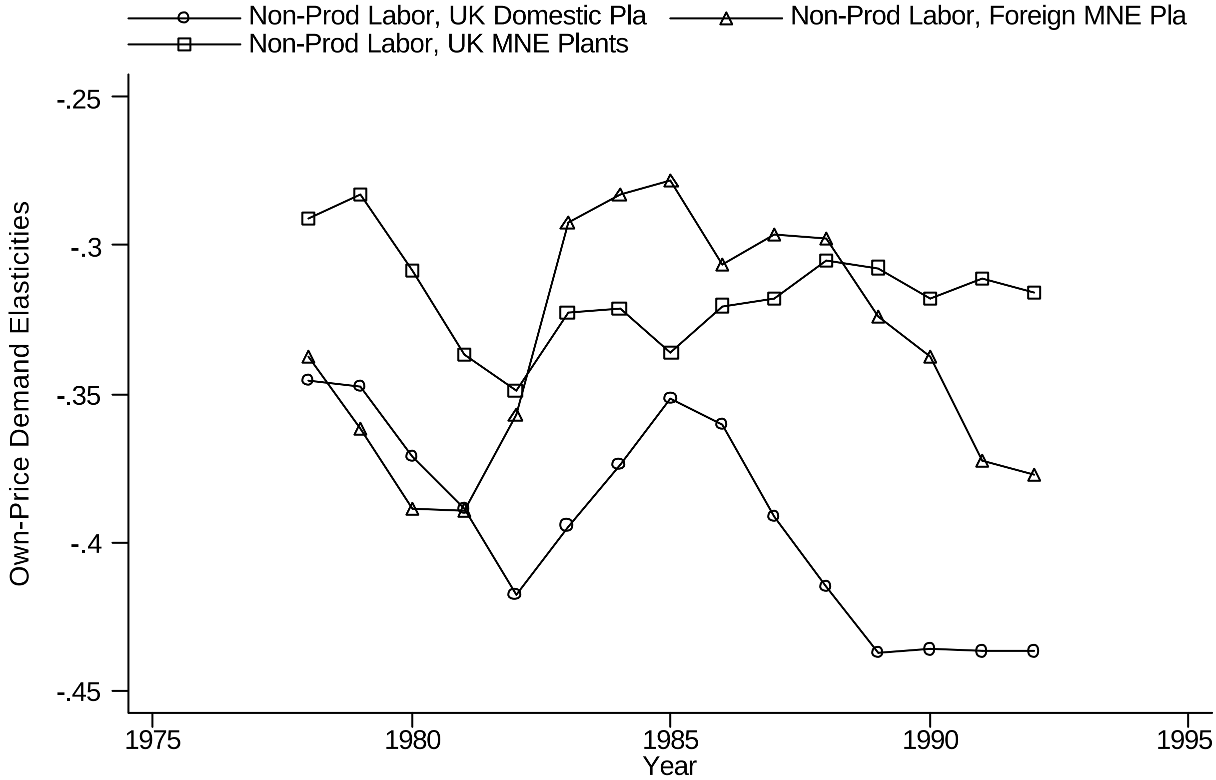

Table 1: Summary Statistics, By Ownership Group

Variable	U.K. MNEs	For. MNEs	U.K. Domestics
Employment	608.31	579.42	249.37
	(1435.03)	(1818.16)	(1142.47)
Sales per Worker	42,733.21	52,337.03	27,520.49
	(55,023.70)	(68,753.34)	(36,587.78)
Capital per Worker	28,155.85	28,490.31	15,873.96
	(60,520.71)	(47,375.26)	(30,958.03)
Skill Intensity	0.31	0.37	0.25
	(0.16)	(0.18)	(0.15)
No. Observations	33,488	23,190	179,894

Notes: Each cell reports the variable mean and, in parentheses, its standard deviation. These statistics are for the full panel used in the estimation of elasticities and shutdowns, where each observation is a plant-year. See text for details, in particular for the method of identifying ownership groups. Employment is number of workers; sales and capital per worker are in pounds, and skill intensity is the share of non-production workers in total employment.
Source: Authors' calculations using Annual Business Inquiry Respondents Database and the Annual Survey into FDI.

Table 2: Elasticities of Demand and Substitution for Production Labor, By Ownership Group

Ownership Group	Time Period	PED_P	EOS_{PN}	S_N	EOS_{PM}	S_M	EOS_{PK}	S_K
U.K. MNEs	Avg., ’78-’80	0.262	0.430	0.067	0.315	0.387	0.272	0.413
	Avg., ’90-’92	0.402	0.813	0.083	0.458	0.386	0.393	0.402
	Change	0.141	0.032	0.007	0.055	-0.000	0.049	-0.003
For. MNEs	Avg., ’78-’80	0.265	0.724	0.084	0.070	0.419	0.456	0.385
	Avg., ’90-’92	0.361	0.587	0.085	0.302	0.430	0.477	0.386
	Change	0.097	-0.012	0.001	0.100	0.001	0.008	0.000
U.K. Domestics	Avg., ’78-’80	0.325	0.789	0.070	0.455	0.381	0.255	0.375
	Avg., ’90-’92	0.373	0.723	0.087	0.460	0.369	0.372	0.375
	Change	0.048	-0.006	0.014	0.002	-0.005	0.044	-0.000

Notes: For each of the three ownership groups, this table reports estimates of elasticities of demand and substitution for production labor. For each group, reported in the first row are the estimated elasticities plus observed factor-cost shares averaged over the three years 1978 through 1980. Reported in the second row are the similar averages over the three years 1990 through 1992. PED_P is the estimated constant-output own-price elasticity of demand for production labor (in absolute value). EOS_{IJ} is the estimated Allen elasticity of substitution between factors I and J. S_I is the share of factor I in total costs averaged across all plants of that ownership group. The factors are production labor (P), non-production labor (N), materials (M), and capital (K). In each year, $PED_i = -\sum_{j \neq i} \left(EOS_{ij}\right)\left(S_j\right)$. Because of the averaging across years, for each of the first two rows this equality holds approximately. For each group, reported in the third row is the level change across the two periods in PED_P. This, in turn, is decomposed into the contribution of level changes in Allen elasticities and level changes in cost shares according to the formula $\Delta PED_i = \sum_{j \neq i} \left(\Delta EOS_{ij}\right)\left(\overline{S_j}\right) + \sum_{j \neq i} \left(\overline{EOS_{ij}}\right)\left(\Delta S_j\right)$, where the Δ operator indicates level changes and the bar indicates average values. As before, because of the averaging across years in the first two rows, in this third row this equality holds approximately.
Source: Authors’ estimates using Annual Business Inquiry Respondents Database and the Annual Survey into FDI.

Table 3: Elasticities of Demand and Substitution for Non-Production Labor, By Ownership Group

Ownership Group	Time Period	PED_N	EOS_{NP}	S_P	EOS_{NM}	S_M	EOS_{NK}	S_K
U.K. MNEs	Avg., ’78-’80	0.282	0.131	0.133	0.446	0.387	0.307	0.413
	Avg., ’90-’92	0.311	0.608	0.129	0.062	0.386	0.519	0.402
	Change	0.028	0.095	0.001	-0.148	-0.001	0.085	-0.003
For. MNEs	Avg., ’78-’80	0.362	0.187	0.113	0.358	0.419	0.495	0.385
	Avg., ’90-’92	0.373	0.003	0.096	0.411	0.430	0.508	0.386
	Change	0.011	-0.018	-0.003	0.023	0.004	0.005	0.000
U.K. Domestics	Avg., ’78-’80	0.347	0.845	0.173	0.138	0.381	0.395	0.375
	Avg., ’90-’92	0.437	0.438	0.168	0.487	0.369	0.491	0.375
	Change	0.090	-0.068	-0.004	0.129	-0.002	0.036	-0.000

Notes: For each of the three ownership groups, this table reports estimates of elasticities of demand and substitution for non-production labor. For each group, reported in the first row are the estimated elasticities plus observed factor-cost shares averaged over the three years 1978 through 1980. Reported in the second row are the similar averages over the three years 1990 through 1992. PED_N is the estimated constant-output own-price elasticity of demand for non-production labor (in absolute value). EOS_{ij} is the estimated Allen elasticity of substitution between factors I and J. S_I is the share of factor I in total costs averaged across all plants of that ownership group. The factors are production labor (P), non-production labor (N), materials (M), and capital (K). In each year, $PED_i = -\sum_{j \neq i} \left(EOS_{ij}\right)\left(S_j\right)$. Because of the averaging across years, for each of the first two rows this equality holds approximately. For each group, reported in the third row is the level change across the two periods in PED_N. This, in turn, is decomposed into the contribution of level changes in Allen elasticities and level changes in cost shares according to the formula $\Delta PED_i = \sum_{j \neq i} \left(\Delta EOS_{ij}\right)\left(\overline{S_j}\right) + \sum_{j \neq i} \left(\overline{EOS_{ij}}\right)\left(\Delta S_j\right)$, where the Δ operator indicates level changes and the bar indicates average values. As before, because of the averaging across years in the first two rows, in this third row this equality holds approximately.

Source: Authors’ estimates using Annual Business Inquiry Respondents Database and the Annual Survey into FDI.

Table 4: Estimated Hazards for Plant Deaths

Regressor	(1)	(2)	(3)
U.K. MNE Indicator	-0.254	0.098	-0.027
	(0.021)	(0.022)	(0.023)
For. MNE Indicator	-0.328	0.084	0.057
	(0.028)	(0.028)	(0.028)
Multi-Plant Indicator			0.289
			(0.017)
Other Regressors	No	Yes	Yes
No. Observations	158,306	144,639	144,639

Notes: Each cell reports the coefficient estimate and, in parentheses, its standard error from estimating the hazard of plant closure on our entire plant-year panel. Standard errors are robust and clustered by plant. In specification (1) the only regressors are two categorical variables indicating whether a plant is owned by a U.K. multinational or a foreign multinational. Specifications (2) and (3) include a large set of other regressors including employment and previous-year employment growth in levels and squared; output growth; capital and skill intensity (as defined in Table 1); wages paid to production and non-production workers; output per production and non-production worker; and a full set of indicators for region, industry, and cohort. Specification (3) also includes a categorical variable for whether the plant is part of a firm that operates additional plants in the United Kingdom.

Source: Authors' estimates using Annual Business Inquiry Respondents Database and the Annual Survey into FDI.