Ownership Change, Productivity, R&D and Human Capital: New Evidence from Matched Employer-Employee Data in Swedish Manufacturing

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Abstract

Empirical studies of the impact of changes in ownership of manufacturing plants on productivity (e.g., Lichtenberg and Siegel (1987), McGuckin and Nguyen (1995), and Maksimovic and Phillips (2001)) have provided limited evidence on how such transactions affect investment in R&D and human capital. We attempt to fill this gap, based on an analysis of matched employer-employee data from over 19,000 Swedish manufacturing plants for the years 1985-1998. The sample covers virtually the entire population of manufacturing plants with 20 or more employees and a probability-based sample of smaller plants. Our empirical analysis of the effects of ownership change on productivity will be subject to a series of robustness tests outlined in Van Biesesbroeck (2004). That is, we will use parametric, non-parametric, and semi-parametric methods to estimate productivity. We will also assess whether there are differential effects on productivity, R&D, and human capital for different types of ownership changes, such as partial and full acquisitions and divestitures, and related and unrelated acquisitions.

Our (very) preliminary results suggest that ownership change results in an increase in relative productivity. We also find that plants involved in an ownership change experience the following: increases in average employee age, experience, and the percentage of employees with a college education. Ownership change also leads to an increase in wages and a reduction in the percentage of female workers. All of these patterns emerge most strongly for full acquisitions and divestitures and unrelated acquisitions.

Keywords: Mergers and Acquisitions, Total Factor Productivity (TFP), Human Capital
JEL Codes: G34, D24, C81

I. INTRODUCTION

In the 1990s, there was a substantial increase in the volume of assets transferred through mergers, acquisitions, and divestitures. This trend was especially pronounced outside the U.S. Gugler, Mueller, Yurtoglu, and Zulehner (2003) report that the number of deals consummated in Continental Europe increased from 986 during 1981-1990 to 8609 during 1991-1998. The authors also note that the average value of these transactions rose from $186.1M in 1991 to $414.1M in 1998 (in constant dollars). This new wave of corporate restructuring has stimulated an important debate concerning whether these changes in ownership improve economic efficiency.

Researchers typically address this question by analyzing the impact of ownership change on short-run stock prices ("event studies"), long-run stock prices, or accounting profits (e.g., Ravenscraft and Scherer (1987), Jensen (1988, 1993), and McWilliams and Siegel (1997)). There are several problems with the use of such performance indicators. One problem is that many economists question the validity of the "efficient markets" hypothesis (see Shleifer (2001)), which conjectures that changes in share prices following announcements of ownership changes reflect changes in future real economic performance. Another concern is that accounting profitability and share prices need not be perfectly correlated with real performance. Policy decisions regarding the optimal level of ownership change should be based on an analysis of the effects that such transactions have on economic efficiency. Finally, it is well known that most ownership changes involve privately-held companies and occur below the firm level (e.g., divisions of large, publicly-traded firms), which makes it virtually impossible to assess stock price or accounting profitability effects, except for those transactions involving large, publicly-traded firms. The end result is that analyses of ownership changes based solely on information from public companies could yield misleading estimates of the antecedents and consequences of ownership changes.

To overcome these limitations, several authors (e.g., Lichtenberg and Siegel (1987, 1990a, 1990b), McGuckin and Nguyen (1995), Maksimovic and Phillips (2001), Harris, Siegel, and Wright (2004)) have asserted that a more desirable methodological approach is to assess the total factor productivity (TFP) of plants before and after ownership changes. Empirical evidence from the U.S. has been derived from the Census Bureau's Longitudinal Research Database (LRD).[1] The LRD is a plant-level file constructed by linking information from the quinquennial Census of Manufactures and the Annual Survey of Manufactures. The U.K. empirical findings were derived from the Annual Respondents Database (ARD), consisting of individual establishment records from the U.K. Annual Census of Production.

It is important to note that existing plant-level studies have provided limited evidence on how changes in corporate control affect the demand for different types of workers (e.g., younger vs. older workers, men vs. women, white vs. non-white, highly-educated vs. non-highly-educated) and investment in R&D. The purpose of this study is to fill this gap, based on an analysis of matched employer-employee data for over 19,000 Swedish manufacturing plants for the years 1985-1998. The Swedish sample contains a substantial percentage of the population of manufacturing plants.

Our empirical analysis of the effects of ownership change on productivity will be subject to a series of robustness tests outlined in Van Biesesbroeck (2004). We will also assess whether there are differential effects on productivity, R&D, and human capital for different types of ownership changes, such as partial and full acquisitions and divestitures, unrelated vs. related diversification, and horizontal vs. conglomerate mergers. We also have more recent data on ownership change than existing studies and present the first plant-level findings from Continental Europe.

The remainder of this paper is organized as follows. Section II presents a review and critique of existing plant-level studies of the consequences of ownership change. Section III describes the construction of the micro data set and its salient characteristics. The following section outlines the econometric methodology. Section V presents empirical results. The final section contains preliminary conclusions.

II. REVIEW AND CRITIQUE OF PLANT-LEVEL STUDIES ON THE IMPACT OF OWNERSHIP CHANGE ON PRODUCTIVITY AND LABOR DEMAND

Table 1 presents a summary of plant-level studies of the relationship between ownership change and productivity. Several stylized facts emerge from this table. The first is that there have been no studies based on evidence from Continental Europe. Note also that most authors report that plants involved in an ownership change experience an improvement in relative productivity after the change in ownership.[2] The magnitude of the productivity increase appears to vary for different types of ownership (e.g., leveraged buyouts), which underscores the importance of disaggregating ownership change. Evidence on pre-ownership change relative productivity is much more mixed. Some authors report that plants involved in ownership changes are less productive than comparable plants before the change in ownership, while others report the opposite.

These mixed results could be due to differences in the nature of the samples and the time

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[1] Excellent reviews of LRD-based studies are presented in Caves (1998) and Bartelsman and Doms (2000).

[2] Schoar (2002) assesses whether an acquirer's existing plants ("incumbent" plants) experience a change in

frame of the analysis. Some authors have analyzed mostly large plants (e.g. Lichtenberg and Siegel (1987, 1990b), while others have focused on a single industry (e.g., McGuckin and Nguyen (1995). Several papers use quinquennial Census of Manufactures data, which makes it difficult to analyze timing effects with sufficient precision. This is potentially important since studies based on annual data indicate that major changes occur soon after the change in ownership.

We conjecture that such discrepancies could also be due to the fact that most of these studies use only one method to assess relative productivity. Our advancement of this hypothesis requires that we look more closely at the methodology employed in several papers.

The first plant-level study of the relationship between ownership change and TFP was Lichtenberg and Siegel (1987), based on a balanced panel of 20, 493 U.S. LRD establishments in 450 manufacturing industries. In subsequent empirical work, (Lichtenberg and Siegel 1990a, 1990b) the authors were able to analyze an unbalanced sample of LRD plants. Their econometric analysis was based on the following two-stage approach. In the first stage, the authors computed residuals from within-industry (4-digit SIC) OLS regressions of log-linear Cobb-Douglas production functions of the following form (with error terms suppressed):

$$\text{(1)} \qquad \ln Q_i = \alpha_K \ln K_i + \alpha_L \ln L_i + \alpha_M \ln M_i$$

where Q, K, L, and M refer to output, capital, labor, and materials, respectively, and i denotes a plant. The residuals from equation (1) can be interpreted as an estimate of the relative productivity of each plant (i.e., relative to plants in the same industry). In the second stage of their model, the authors regressed the productivity residuals on a set of dummy variables

productivity in the aftermath of an ownership change.

denoting whether the plant had changed owners:

(2) $\text{RELPROD}_{i,\, t+m} = f\,(\text{OC}_{it+m})$

where RELPROD is the productivity residual of plant i in year t + m (where m can be negative or positive); OC_{it+m} is a dummy variable that equals 1 if plant i was involved in an ownership change in year t + m; 0 otherwise.

McGuckin and Nguyen (1995) conducted a similar analysis of the effects of ownership change on economic efficiency, based on the complete population of plants in the food manufacturing industry (SIC 20) in the U.S. Census of Manufactures. They used the same method as in the previous LRD-based studies to construct estimates of relative TFP, as well as labor productivity. However, they did not employ precisely the same second-stage approach, since they do not observe annual ownership changes, only those occurring between the quinquennial Census of Manufactures.

Maksimovic and Phillips (2001) computed similar measures of relative TFP, based on the following translog (TL) production function (time subscripts suppressed):

(3) $$\ln Q_i = a_i + A + \alpha_A \text{AGE}_i + \alpha_K \ln K_i + \alpha_L \ln L_i + \alpha_M \ln M_i + + \beta_{KK} (\ln K_i)^2 + \beta_{LL} (\ln L_i)^2 + \beta_{MM} (\ln M_i)^2 + \beta_{KL} \ln K_i * \ln L_i + \beta_{LM} \ln L * \ln M_i + \beta_{KM} \ln K_i * \ln M_i$$

where a is a plant-specific fixed effect, A is a technology shift parameter, and AGE denotes the age of the plant.

Table 1 reveals that most authors have used a two-stage method to assess the antecedents and consequences of ownership change. In addition to these two-stage approaches, we propose to employ a variety of estimators of within industry (4-digit SIC), one-stage augmented Cobb-Douglas and Translog production functions, including OLS, Instrumental Variables (e.g., GMM), Stochastic Frontier, and the Olley-Pakes (1996) semi-parametric methods. We conjecture that a one-stage estimation procedure provides more efficient econometric estimates of the conventional arguments of the production function and other determinants of productivity (e.g. a set of ownership change dummies) than those generated using the two-stage approach. The instrumental variables and Olley-Pakes approaches also address another econometric concern: endogeneity of the factor inputs, which might result in inconsistent estimates of the production function parameters. We will discuss these methods in greater detail in Section IV.

Table 2 summarizes plant and firm-level studies of the impact of ownership change on employment, wages, and R&D. Much of the plant-level evidence seems to indicate that ownership change does not result in statistically significant declines in the employment and wages of production workers at production establishments. In fact, the most comprehensive evidence, presented in McGuckin and Nguyen (2001), suggests that wages and employment increase after ownership change. On the other hand, Lichtenberg and Siegel (1990a) find that employment and wage growth are lower in central office or "auxiliary" establishments in the aftermath of an ownership change, suggesting that white-collar workers suffer more than blue-collar employees when such transactions occur.

Table 2 also reveals that these effects vary by type of ownership change. For instance, Baldwin (1998) reports that mergers had a negative impact on the employment and compensation of non-production workers. Similar patterns emerge in the aftermath of leveraged and management buyouts. Bhagat, Shleifer, and Vishny (1990) find that 45% of the firms involved in hostile takeovers laid off workers, affecting about 6% of the workforce.

Another empirical issue is whether ownership change results in a change in the intensity of firm-level investment in R&D. This could be a concern, since there is substantial evidence that R&D generates positive externalities (Griliches (1992)). If ownership change allows firms to internalize some of these externalities, it enhances incentives for firms to conduct R&D. On the other hand, if a merger or acquisition results in the elimination of redundant research projects when rivals combine, ownership change could allow the merged entity to achieve economies of scale or scope, thereby reducing incentives to conduct R&D. Thus, it is important to note that despite the prevalence of R&D spillovers, a decline in the rate of investment in R&D intensity in the aftermath of ownership change does not necessarily signify a reduction in social welfare.

Given that R&D is primarily a corporate-level activity, the firm is the appropriate unit of analysis for an empirical test of the relationship between ownership change and R&D. In a series of comprehensive studies based on Compustat data (publicly traded firms), Bronwyn Hall (1998, 1990) concluded that ownership change does not result in significant reductions in the rate of corporate investment in R&D (Hall 1987, 2001). Lichtenberg and Siegel (1990b) reported insignificant changes in R&D employment at central office or “auxiliary” establishments in the aftermath of ownership change. These authors reported similar findings for leveraged buyouts (Lichtenberg and Siegel (1990a)), although this may be due to the fact that R&D-intensive firms are not regarded as good candidates for buyouts. On the other hand, Long and Ravenscraft (1993) report a 40% decline in R&D intensity (the ratio of R&D to sales) in the aftermath of a leveraged buyout.

As far as we know, there have been no empirical studies of the impact of ownership on R&D investment based on European data. There has also been no evidence on the effects of ownership change on the demand for different types of workers (e.g., younger vs. older workers, men vs. women, white vs. non-white, highly-educated vs. non-highly-educated). In the following section, we describe the data set that allows us to address these issues.

III. DATA

Our empirical analysis is based on a special file that links detailed information on Swedish workers and the establishments that employ them. This file has data on the output and inputs of these plants, which enables us to construct estimates of total factor productivity (TFP). At the same time, we observe a wide variety of worker characteristics, such as the level of education, age, gender, and national origin. Data on corporate investment in R&D were also linked to matched employer-employee data.

The unit of observation in our study is the plant. Following conventional international standards, the plant or establishment is defined as a physically independent unit within a firm. It is assumed that each plant focuses on just one “line of business” (i.e., one activity). If a company is involved in multiple activities at the same physical address, the firm is asked to report separate figures/numbers for each activity. Each figure/number is then tied to a separate plant. In most cases, however, firms focus on a single activity, implying that the local units are seldom split into several plants. Plants that were considered to be “non-active” and “help plants,” such as sales offices (or what would be considered “auxiliary” establishments in the U.S.), were also excluded from the data.

According to Swedish law, each business is required to report information to Statistics Sweden on an annual basis. In 1946, the certainty criterion for inclusion in the annual survey of manufacturing plants was established at a minimum of 5 employees and 10000 SEK (about 1300

USD) in production value. In 1990, this certainty threshold was raised to a minimum of 10 employees, while a stratified sampling procedure is applied to the smaller plants.[3]

Tables 3 through 6 compare our sample of 19010 plants to the population of Swedish manufacturing establishments. The top panel of Table 3 indicates that around half of our establishments fall in the range of 10-49 employees, although both tails of the size distribution are well represented. As shown in the bottom panel of Table 3, the larger size classes represent a larger fraction of total (population) employment. This not only indicates that most workers tend to work for large plants, but also reflects the fact that larger establishments are sampled more thoroughly than smaller plants.

Table 4 compares the size distribution of our sample (top panel) with corresponding values for the population of Swedish manufacturing plants (bottom panel) in 1986, 1990, and 1995. These figures reveal that our sample is not completely representative in terms of size, since it is more heavily weighted towards plants with more than 10 employees. On the other hand, Table 3 indicates that the sample constitutes a large fraction of economic activity in the manufacturing sector, especially for plants with more than 10 employees.

Table 5 presents some statistics on the incidence of ownership change. Over the entire sample period (1985-1998), 5.1 % of plants experienced at least one ownership change. These rates of plant turnover appear to be slightly higher when they are weighted by value-added and employment (columns 2 and 3). An analysis of the annual figures reveals that the incidence of ownership change appears to have risen during the late 1980s, reaching a peak in the early 1990s.

[3] We have a small number of mining plants in our sample. The threshold increase in 1990 only affected manufacturing plants.

In Table 7, we present evidence on the incidence of several types of ownership change involving our sample of plants during the sample period (1986-1998). We can identify whether an acquisition or divestiture involves the buying or selling of an entire firm. Note that the overwhelming majority of such changes are full acquisitions or divestitures, although the relative importance of such transactions diminishes when they are weighted by value-added or employment (columns 2 and 3). We have also identified whether the buyer has existing plants in the same (4-digit) industry, which we refer to as a related acquisition.

A critical issue in the calculation of total factor productivity (TFP) is construction of a capital measure. Some researchers avoid analyzing TFP, and instead, compute labor productivity (LP), which is easier to measure. We will present econometric results based on both TFP and LP. We calculated estimates of the capital stock as follows: First initial values of capital were estimated in 1989, based on the assumption of a constant capital-to-sales ratio across all plants in each 3-digit SIC industry. Using these initial estimates, capital is constructed using the usual perpetual inventory algorithm, $K_{it}^{c} = (1-\delta^{c})K_{it-1}^{c} + \rho_t I_{it}^{c}$,

where i denotes a plant, t denotes a year, c is either machinery or buildings & land, K denotes capital, I denotes investment, δ denotes the depreciation rate, and ρ denotes an investment deflator.[4] The capital estimates for machinery plus buildings and land were summed to create a single combined capital stock measure, K_{it}.

IV. ECONOMETRIC MODELS

In this version of the paper, we estimate two types of model. For analyses of labor and

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[4] The depreciation rate is 0.123 for machinery and 0.036 for buildings and land.

total factor productivity,

(4) $\ln Q_{it} = \text{Ä}_{it} + \omega_{it}$

where Q_{it} denotes plant i's output in year t, Ä_{it} is the logarithm of plant i's production function (either a Cobb-Douglas or Translog specification) in year t, and ω_{it} is an efficiency residual. The efficiency residual is assumed to be influenced by ownership change and other variables, as follows:

(5) $\omega_{it} = \sum_{\iota=-13}^{12} \gamma_{\iota} OC_{it-\iota} + \delta' \mathbf{z}_{it} + \varepsilon_{it}$

where $\sum_{\iota=-13}^{12} \gamma_{\iota} OC_{it-\iota}$ parameterizes the relation to ownership change as discussed below, δ is a vector of coefficients, $\mathbf{Z}_{it}$ is a vector of control variables for plant i in year t, and ε_{it} is the remaining efficiency residual. Rewriting (4) thus yields

(6) $\ln Q_{it} = \text{Ä}_{it} + \sum_{\iota=-13}^{12} \gamma_{\iota} OC_{it-\iota} + \delta' \mathbf{z}_{it} + \varepsilon_{it}$.

Other analyses, which are not based on estimation of a production function, assume the same form:

(7) $y_{it} = \alpha + \sum_{\iota=-13}^{12} \gamma_{\iota} OC_{it-\iota} + \delta' \mathbf{z}_{it} + \varepsilon_{it}$,

where y_{it} is the dependent variable in question (e.g., employment or wages), α is an intercept parameter, and the other terms are as defined above.

The treatment of ownership change in the econometric analysis requires careful consideration. In equation (7), let l denote the year relative to the year of ownership change, so that negative values of l signify years preceding ownership change, l=0 denotes the year during which the plant change owners, and positive values of l pertain to years following ownership change. Also let OC_{it-l} be a dummy variable that equals 1 if plant i's owner changes (with certainty given the data) l years preceding the current year t for $l > 0$, or l years following the current year for l<0; 0 otherwise. Note that our sample allows us to identify each plant's owner for the years 1985 through 1998, so a new owner can be identified in each year for 1986 through 1998. For a plant observed in 1985, we wish to know whether an ownership change will occur for up to 13 years in the future, while for a plant observed in 1998, we wish to know whether an ownership change occurred up to 12 years in the past. This consideration of past and future ownership changes yields a possible range of leads and lags from –13 to +12.

The relation of past and future ownership change to productivity, size, or workforce characteristics can then be assessed, at each value of l, by including in the model the terms $\sum_{l=-13}^{12} \gamma_l OC_{it-l}$, where γ_l parameterizes the relation to ownership change at lead/lag l. To avoid model specification bias, each γ_l is unconstrained and is estimated over the full range of l from –13 to +12. The fitted terms of γ provide estimates of the relationship of ownership change to productivity, size, and workforce characteristics in each year.

If just the ownership change dummies were included as regressors, the estimates would be subject to sample selection and measurement error biases. Sample selection bias results because for large positive or negative values of l, the ownership change variable OC_{it-l} equals one only if the plant survived a large number of years (at least -1 + 1 years for l < 0 or at least 1

+ 2 years for $l \geq 0$). Any characteristics of surviving plants, such as higher productivity, would thus be partially attributed to ownership change.

Measurement error bias could also result, given that ownership changes are unmeasured when they occur outside the sample time frame. For example, for l =-13, OC_{it-l} can equal one only if $t = 1985$ (so t-l = 1998); for other values of t information about ownership changes is unavailable (since $t - l > 1998$, the last year of data), causing, by definition, $OC_{it-l} = 0$. Similarly; for l = -12, OC_{it-l} can equal 1 only if $t \leq 1986$; …; for $l = -1$, OC_{it-l} can equal 1 only if $t \leq 1997$; for l=0, OC_{it-l} can equal 1 only if $t \geq 1986$; …; for l =12, OC_{it-l} can equal 1 only if $t = 1998$. If observations are evenly dispersed across years and the probability of ownership change remains constant at p over time, the expected value of OC_{it-l} would equal 1/14 p for $l = -13$ (as it is artificially 0 in 13 of 14 years of data), 2/14 p for l = -12, …, 13/14 p for l = -1 pr l =0, …, 1/14 p for l =12. Thus, values of OC_{it-l} would constitute error-ridden indicators of ownership change, with the error greatest for the largest (absolute) values of l. If these ownership change measures are uncorrelated with each other and with all other regressors, the resulting coefficient estimates would be biased toward zero, with the greatest bias for estimates at large (absolute) values of l. If the true coefficients all equaled the same constant number c, the expected values of the estimates would follow a U-shape (if $c < 0$) or inverted-U-shape (if $c > 0$). Hence both sample selection and measurement biases could confound our analysis of the relationship between ownership change and plant performance.

We conjecture that the use of appropriate control variables can mitigate these biases. Such biases can be especially severe when researchers use a balanced panel (e.g., Lichtenberg and Siegel (1987), restricted the range of l (McGuckin and Nguyen (1995), and/or analyzed pre- versus post-acquisition periods using a single coefficient for each. For example, the use of a balanced panel imparts a strong selection bias, because the analysis is based only on those plants that survived during the sample period. Restrictions on the range of l effectively constrain γ_l to equal zero outside of the range, yielding possible specification error. Pre- versus post-acquisition periods effectively constrain γ_l to be identical across values of l and hence, constitute an additional source of specification error. Moreover none of these approaches entirely gets rid of the sample selection and measurement biases pointed out above, unless all data points are dropped from analysis if they are within $L+1$ years of the start and L years of the end of the sample and the range of l is constrained to $-L \leq l \geq L$.

We hypothesize that there is a way to address this problem without excluding any observations. The intended comparison is between plants that experienced ownership change in year t –l and those that could have but did not experience ownership change in year t –l (not between plants that did experience, versus those that might have or could not have experienced, ownership change). For each l, we divide the observations into three types of establishments: (i) plants that did experience ownership change in year t –l, (ii) plants that could have but did not experience ownership change in year t –l, and (iii) plants that did not exist or those for which it is unknown whether they experienced ownership change in year t –l. To ensure that the coefficients γ_l describe the difference between categories (i) and (ii), it is sufficient to introduce into the model a dummy variable ND_{it-l} that equals 1 for any observations meeting condition (iii) in year t –l and 0 for all other observations. This gives rise to one additional variable for each l, yielding in sum $\sum_{l=-13}^{12} \delta_{1l} ND_{it-l}$, comparable to the ownership change term in the models. $ND_{it-l} = 1$ implies either no data about whether ownership change occurred in year t –l, or nonexistence of the plant in year t –l. Hence these controls potentially remove a substantial source of potential bias in the estimates.

To reduce another possible bias, caused by cross-industry, cross-year, or cross-plant-age differences in both the probability of acquisition and the dependent variable (or productivity), additional controls are used. Fixed effect dummies are included in all analyses for each year, 4-digit industry (according to 1969 Swedish SICs), and plant age.[5] In addition, production function parameters are each allowed to differ by industry, effectively, by including interaction terms that equal industry-specific dummies ($I_{kit} = 1$ if plant i's primary industry is equal to k or $I_{kit} = 0$ otherwise) times each production function parameter. Use of these controls implies that the relations of ownership change are studied largely for plants of comparable industry and age at a comparable date.

As noted earlier, we intend to use several methods to estimate the relationship between ownership change and productivity in the next version of the paper. Each of these approaches will be based on a one-stage analysis of the determinants of relative productivity. For example, in the GMM variant, we estimate the following equation at the detailed industry level:

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[5] Industries must be defined according to 1969 industries because only in the later years of the sample have plants been classified according to more recent industry definitions. Another limitation of the data is that they do not include plant ages, so plants are classified according to their minimum age (1+, 2+, …) if they existed in 1985 or their actual age if they entered after 1985. Fortunately an additional file was available that indicated (for nearly all plants) whether each plant existed in each year, even if it was not present in the sample used here; this file allowed identification of plant age without sample selection in years 1985-1998.

(8) $$\ln Q_{it} = \beta_0 + \beta_K \ln K_{it} + \beta_L \ln L_{it} + \beta_M \ln M_{it} + \sum_{\iota=-13}^{12} \gamma_{\iota} OC_{it+\iota} + \delta' \mathbf{z}_{it} + \varepsilon_{it}$$

where Q is real gross-output, deflated using a plant-specific output price index, K refers to plant and machinery capital stock, L is total employment[6], M is real intermediate inputs, OC is an ownership change dummy, l refers to the number of years before or after an ownership change, **z** is a vector of control variables, and ε_{it} is an error term.

Following Blundell and Bond (1999), we assume that the error term has three components:

(9) $\varepsilon_{it} = \eta_i + \theta_t + e_{it}$

with η_i affecting all observations for cross-section unit i; θ_t affecting all units for time period t; and e_{it} affecting only unit i during period t. e_{it} is assumed to be serially correlated:

(10) $e_{it} = \rho e_{it-1} + u_{it}$,

where u_{it} is uncorrelated with any other part of the model, and $|\rho| < 1$. As shown in Blundell and Bond (1999), if we invoke these assumptions, equation (4) can be transformed into a dynamic form involving first-order lags of the variables and a well behaved error term.

Equation (8), or its dynamic counterpart, can be estimated using the Arellano and Bond (1998) General Method of Moments (GMM) systems method in STATA, since this is sufficiently flexible to allow for the endogeneity of inputs (through the use of appropriate instruments) and a first-order autoregressive error term. We use the GMM systems approach to estimate the model in levels and first-differences. Blundell and Bond (1999) argue that including both lagged levels and lagged first-differenced instruments leads to significant

6 Unfortunately, data on hours worked are not available.

reductions in finite sample bias as a result of exploiting the additional moment conditions inherent from taking their system approach.

Another method we use to assess the relative productivity of plants is stochastic frontier estimation (henceforth, SFE), which was developed independently by Aigner, Lovell, and Schmidt (1977) and Meeusen and Van den Broeck (1977). SFE yields a production frontier with a stochastic error term consisting s of two components: a conventional random error ("white noise") and a term that represents deviations from the frontier, or relative inefficiency.

Assume that the production function (industry and time subscripts suppressed) can be characterized as:

(11) $y_i = \mathbf{X}_i \beta + \epsilon_i$

where the subscript i refers to the i^{th} plant, y represents output, **X** denotes a vector of inputs, β is the unknown parameter vector, and ϵ is an error term that consists of two components, $\epsilon_i = (V_i - U_i)$, where U_i is a non-negative error term representing technical inefficiency, or failure to produce maximal output given the set of inputs used, and V_i is a symmetric error term that accounts for random effects. Thus, we can rewrite equation (11) as:

(12) $y_i = \mathbf{X}_i \beta + V_i - U_i$

Consistent with Aigner, Lovell, and Schmidt (1977), we assume that the U_i and V_i have the following distributions:

$$V_i \sim \text{i.i.d. } N(0, \sigma^2_v)$$
$$U_i \sim \text{i.i.d. } N^+(0, \sigma^2_u), \quad U_i \geq 0$$

That is, the inefficiency term, U_i, is assumed to have a half-normal distribution; i.e, plants are either "on the frontier" or below it.[7] Jondrow, Lovell, Materov, and Schmidt (1982) specify a functional form for the conditional distribution of $[U_i / (V_i - U_i)]$, the mean (or mode) of which provides a point estimate of U_i.

An important parameter in an SFE model is $\gamma = \sigma^2_u / (\sigma^2_v + \sigma^2_u)$, the ratio of the standard error of technical inefficiency to the standard error of statistical noise, which is bounded between 0 and 1. Note that $\gamma = 0$ under the null hypothesis of an absence of inefficiency, which would imply that all of the variance in the observed error term can be attributed to statistical noise.

An important extension of the stochastic frontier literature (see Pitt and Lee (1981)) has been the ability to incorporate determinants of technical inefficiency into these models. This extension is crucial to our analysis, since a chief objective of our study is determine whether ownership change "explains" levels or changes in relative productivity. Consistent with Kumbhakar, Ghosh, and McGuckin (1991) and Reifschneider and Stevenson (1991) we conjecture that the U_i are independently distributed as truncations at zero of the $N(m_i, \sigma^2_u)$ distribution with:

(13) $m_i = \mathbf{Z}_i \theta$

where **Z** is a vector of environmental, institutional, and organizational variables that are hypothesized to influence relative efficiency and θ is a parameter vector.[8]

As shown in Battese and Coelli (1995), simultaneous estimation of the production frontier and inefficiency equations (equations (11) and (13)) by maximum likelihood methods generates estimates of the parameter vectors β and θ, which we can use to compute estimates of relative productivity. The authors also note that this method is preferable to the two-stage

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[7] Other distributional assumptions for the inefficiency disturbance that have been invoked are the truncated normal and exponential (see Sena (1999)).

approach employed in most plant-level studies, which involves computing estimates of relative productivity and then running OLS regressions on a set of determinants of establishment-level relative inefficiency. The problem with the two-stage approach is that it yields inconsistent estimates, since the inefficiency effects in the first stage of the model are assumed to i.i.d., while in the second stage they are hypothesized to be a function of specific factors.

V. EMPIRICAL RESULTS

Table 8 contains descriptive statistics for key variables used in the econometric analysis, presented separately for plants that experience an ownership change and for those that do not. We find that plants involved in these transactions tend to be larger. With respect to the demographics of the workforce, it appears as though they employ slightly smaller percentages of female workers and those with at least a college education, and have slightly more non-Swedish employees than plants that do not experience an ownership change.

As a first cut, in Table 9, we present OLS estimates of four equations: labor productivity, total factor productivity (Cobb-Douglas), output, and employment of the following form:

Labor Productivity

$$(14)\ \ln(Q_{ijt}) = \alpha_{jt} + \beta_{1j}\ln(L_{ijt}) + \sum_{k=-13}^{k=12} \gamma_k OC_{ijt-k} + \sum_{k=-13}^{k=12} \delta_k ND_{ijt+k}$$

$$+\text{Age Dummies} + \text{Industry Dummies} + \text{Time Dummies} + \varepsilon_{ijt}$$

Total Factor Productivity (Cobb-Douglas)

[8] As discussed in Battese and Coelli (1995), this model can also incorporate panel data.

$$(15)\ \ln(Q_{ijt}) = \alpha_{jt} + \beta_{1j}\ln(L_{ijt}) + \beta_{2j}\ln(K_{ijt}) + \beta_{3j}\ln(M_{ijt}) + \sum_{l=-13}^{l=12} \gamma_l OC_{it-l} + \sum_{l=-13}^{l=12} \delta_k ND_{ijt+l}$$

$$+\text{Age Dummies} + \text{Industry Dummies} + \text{Time Dummies} + \varepsilon_{ijt}$$

where K, L, and M are capital, labor and materials, OC and ND are the ownership change and "no-data" dummy variables described earlier. Recall that each regression is estimated at the detailed industry level (4 digit SIC). Thus, the coefficients on the non-ownership change variables (labor, capital and materials) are weighted means of industry-specific coefficients.

The coefficients on capital, labor, and materials appear to be plausible, in the sense that they are reasonably close to their respective factor shares and strongly suggestive of constant returns to scale.[9] Note that we lose a fairly substantial percentage of observations when we estimate the total factor productivity (TFP) equation. That is because the capital measure is only available from 1989 onward and not even for all plants after that point in time. We are confident that we will obtain these measures for a much larger fraction of plants in the near future.

Next, we focus our attention on the coefficients on the ownership change dummies in Table 9. For example, the value -.042 for the coefficient on OC_{-1} in the labor productivity equation, signifies that plants experiencing an ownership change one year hence were 4.2 percent less productive than comparable establishments that did not change owners. Note that while the relative performance of plants changing owners was significantly worse before the transaction, relative efficiency appears to improve after the ownership change, in the sense that such establishments appear to converge to the average level of industry performance.

The output and employment results, which are presented in the last two columns of Table

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[9] A formal test reveals that we cannot reject the hypothesis that there are constant returns to scale.

9, may provide an explanation for the productivity increase. Plants that change owners appear to have higher levels of output and employment than comparable plants both before and after ownership change. It appears that they reduce both output and employment after an ownership change. However, employment declines at a faster rate than output, which results in a productivity increase.

In Table 10, we present averages of the coefficients on the ownership change dummies in the labor productivity (LP), TFP, output, and employment equations for 5 years before and 5 years after the transaction (we exclude year 0, which is the year of the acquisition). In the third row of each panel, we formally test whether the post vs. pre ownership change effects are statistically significant. The results for all ownership change (the first panel) are shown graphically in Figures 1-4. Our findings are also presented separately in Table 10 for various types of ownership change: full acquisitions and partial acquisitions, full divestitures and partial divestitures, related acquisitions, unrelated acquisitions, and changes in ownership involving a single firm.

The "post-pre" results in first panel confirm our earlier assertion that plants involved in an ownership change become more productive after the transaction. We also find that output and employment are reduced after ownership change, with employment declining faster than output. These patterns emerge even more strongly for full acquisitions and divestitures and unrelated acquisitions. The finding that unrelated acquisitions enhance plant productivity is consistent with U.S. evidence presented in Maksimovic and Phillips (2001) and Schoar (2002).

In Table 11, we present similar results for six labor-related dependent variables: the average age of employees at the plant, average experience, the percentage of female employees, the percentage of Non-Swedish employees, the percentage of college-Educated workers, and wages. Figures 5-10 present graphical representations of the coefficients for all ownership changes. The findings in Table 11 imply that plants involved in ownership change experience the following: increases in average employee age, experience, and the percentage of employees with a college education. The latter result suggests that ownership change reduces the demand for less-educated workers. We also find that ownership change leads to an increase in wages and a decline in the percentage of female workers. Once again, we find that these patterns emerge most strongly for full acquisitions and divestitures and unrelated acquisitions.

VI. PRELIMINARY CONCLUSIONS

More discussion to follow after pre-conference

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Table 1
Plant-Level Studies of the Effects of Ownership Change on Productivity

Authors	Country/ Frequency/ Nature of Sample	Type of Ownership Change	Methodology	Results
Lichtenberg and Siegel (1987)	USA/ Annual Data/ Mostly Large Continuous Plants in the Longitudinal Research Database (LRD)	All Ownership Changes in the Entire Manufacturing Sector	Two-Stage Regressions of Residuals From Cobb-Douglas Production Functions	Plants Involved in Ownership Changes Are Less Productive Than Comparable Plants Before an Ownership Change; They Experience an Increase in Productivity After an Ownership Change
Lichtenberg and Siegel (1990b)	USA/Annual Data/ Mostly Large Plants in the LRD	Leveraged and Management Buyouts (LBOs and MBOs) in the Entire Manufacturing Sector	Two-Stage Regressions of Residuals From Cobb-Douglas Production Functions	Plants Involved in LBOs and MBOs Are More Productive Than Comparable Plants Before the Buyout; LBOs and especially MBO Plants Experience a Substantial Increase in Productivity After a Buyout
McGuckin, and Nguyen (1995, 1998)	USA/ Quinquennial Census of Manufactures /All Plants	All Ownership Changes in the Food Manufacturing Industry (SIC 20)	Two-Stage Regressions of Residuals From Cobb-Douglas Production Functions	Plants Involved in Ownership Changes Are More Productive Than Comparable Plants Before the Change in Ownership; They Experience an Increase in Productivity After the Change in Ownership

Table 1 (cont.)

Plant-Level Studies of the Effects of Ownership Change on Productivity

Authors	Country/ Frequency/ Nature of Sample	Type of Ownership Change	Methodology	Results
Baldwin (1998)	Canada/ Census of Manufactures in 1970 and 1979/ All Plants	Mergers and Divestitures in the Entire Manufacturing Sector	Regressions of Non-Parametric Estimates of Relative Productivity (Computed as Value-Added Per Worker) on Ownership Change Dummies	Plants Involved in Ownership Changes Are More Productive Than Comparable Plants Before the Change in Ownership; Plants Acquired by a Firm in the Same Industry Experience an Increase in Productivity
Maksimovic and Phillips (2001)	USA/ LRD/Full Sample/Plant-Level and Divisional Level	Mergers and Asset Sales	Two-Stage Regressions of Residuals From Translog Production Functions	Acquired Plants and Divisions Tend to be Less Productive; They Experience an Increase in Productivity After the Ownership Change, The Extent of Which Depends on the Whether the Buying or Selling Division is "Main" or "Peripheral"
Schoar (2002)	USA/ LRD Matched to Compustat	Diversification	Two-Stage Regressions of Residuals From Cobb-Douglas Production Functions	Plants That Are Acquired Via Diversification Become More Productive; However "Incumbent" Plants Become Less Productive
Harris, Siegel, and Wright (2004)	U.K./Annual Research Database (ARD)/Full Sample	Management Buyouts	One-Stage GMM Estimation of Augmented Cobb-Douglas Production Functions	Plants Involved in MBOs Are Less Productive Than Comparable Plants Before the Buyout; They Experience a Substantial Increase in Productivity After a Buyout

Table 2
Plant and Firm-Level Studies of the Effects of Ownership Change on Employment, Wages, and R&D

Authors	Country	Unit of Observation	Type of Ownership Change	Results
Lichtenberg and Siegel (1987)	USA	Plant	All Ownership Changes	Labor Input Growth Rates Were Lower For Plants Changing Owners Than Comparable Plants Before the Transaction; Slightly Higher After the Transaction
Brown and Medoff (1988)	USA	Firm	3 Types: Simple Sales, Assets-Only, Sale, Merger	Simple Sales: 9% Increase in Employment, 5% Decline in Wages; Assets-Only Sale: 5% Decline in Employment, 5% Increase in Wages; Mergers: 2% Increase in Employment, 4% Decline in Wages
Hall (1988, 1990)	USA	Firm	Mergers and Acquisitions	No Evidence of a Decline in R&D Intensity After Mergers and Acquisitions
Bhagat, Shleifer, and Vishny (1990)	USA	Firm	Hostile Takeovers	45% of the Firms Involved in Hostile Takeovers Laid Off Workers (Approximately 6% of the Workforce)
Lichtenberg and Siegel (1990a)	USA	Plant and Firm	Leveraged Buyouts (LBOs) and Management Buyouts (MBOs)	Employment and Wages of Non-production Workers (But Not Production Workers) Declines After an LBO; No Evidence of a Post-LBO Decline in R&D
Lichtenberg and Siegel (1990b)	USA	Manufacturing Plants and Auxiliary Establishments	All Ownership Changes	Employment and Wage Growth is Significantly Lower in Auxiliary Establishments Changing Owners Than in Those Not Changing Owners, But Not for R&D Employees; Much Smaller Effects at Production Establishments
Long and Ravenscraft (1993)	USA	Plant	Leveraged Buyouts	Evidence of a Post-LBO Decline in R&D

Table 2 (cont.)

Plant and Firm-Level Studies of the Effects of Ownership Change on Employment, Wages, and R&D

Authors	Country	Unit of Observation	Type of Ownership Change	Results
Baldwin (1998)	Canada	Plant	Related and Unrelated Mergers; Spin-offs	Mergers and Spin-offs Had Very Little Impact on Labor Costs; Related Mergers Had a Positive Impact on Wages; Mergers Had A Negative Impact on Employment and Compensation of Non-Production Workers
McGuckin, and Nguyen (2001)	USA	Plant	All Ownership Changes	For Representative Plants, Wages and Employment Increase After Ownership Change; Effects Worse For Workers in Large Plants
Conyon, Girma, Thompson, Wright (2002)	U.K.	Firm	Related and Unrelated Mergers	19% Decline in Employment for Related Mergers; 8% Decline in Employment for Unrelated Mergers
Harris, Siegel, and Wright (2004)	U.K.	Plant	Management Buyouts (MBOs)	Plants Involved in an MBO Experience a Substantial Reduction in Employment
Gugler and Yurtoglu (2004)	U.S. and Europe	Firm	Mergers	Mergers Do Not Reduce Labor Demand in the U.S.; There is a 10% Decline in Labor Demand in Europe in the Aftermath of Mergers

Table 3

Distribution of Sample of Swedish Manufacturing Plants By Size Category (Percentages)

Year	<5 Employees	5-9 Employees	10-19 Employees	20-49 Employees	50-99 Employees	100-199 Employees	200-499 Employees	500+ Employees
1985	0.9	14.9	28.6	27.2	13.6	7.7	4.9	2.8
1986	0.4	14.4	28.3	28.0	13.2	8.0	5.1	2.7
1987	0.5	13.0	29.0	28.4	13.0	8.1	5.0	2.9
1988	0.6	13.0	28.8	28.4	13.0	8.0	5.3	2.8
1989	1.3	13.5	28.7	28.8	12.9	7.4	4.8	2.7
1990	5.2	6.6	30.0	29.9	13.0	7.7	5.0	2.7
1991	5.3	6.3	30.7	29.7	12.9	7.2	5.1	2.7
1992	5.9	6.6	31.2	28.8	12.6	7.2	5.1	2.7
1993	7.1	6.6	31.2	28.8	12.0	6.9	4.9	2.4
1994	6.7	5.6	30.5	30.5	12.5	6.8	5.0	2.4
1995	5.8	5.9	30.6	30.8	12.7	7.1	4.9	2.3
1996	5.2	6.7	31.7	29.8	12.8	6.8	4.8	2.2
1997	0.5	7.2	37.1	28.8	13.1	7.1	4.3	2.0
1998	0.3	6.7	37.1	29.2	13.5	6.9	4.4	1.9

Percentage of Employment in Sample of Swedish Manufacturing Plants in Each Size Category

Year	<5 Employees	5-9 Employees	10-19 Employees	20-49 Employees	50-99 Employees	100-199 Employees	200-499 Employees	500+ Employees
1985	0.0	1.4	5.1	10.6	11.4	13.6	18.6	39.2
1986	0.0	1.3	4.9	10.7	11.4	13.7	19.4	38.6
1987	0.0	1.2	4.9	10.7	11.1	13.8	18.9	39.3
1988	0.0	1.2	4.9	10.7	11.1	13.4	19.7	39.1
1989	0.0	1.3	5.2	11.6	11.7	13.2	19.0	38.0
1990	0.1	0.6	5.4	11.7	11.6	13.6	19.6	37.3
1991	0.1	0.6	5.5	11.7	11.5	12.9	19.8	37.9
1992	0.2	0.6	5.8	11.6	11.6	13.4	20.4	36.5
1993	0.2	0.7	6.0	12.2	11.5	13.2	20.6	35.7
1994	0.2	0.5	5.9	12.6	11.7	13.0	20.8	35.9
1995	0.2	0.6	5.8	12.5	11.7	13.0	20.2	36.1
1996	0.2	0.7	6.0	12.2	12.0	12.7	19.9	36.3
1997	0.0	0.7	7.5	13.0	13.5	14.7	19.1	31.6
1998	0.0	0.7	7.4	13.2	13.8	14.2	19.4	31.2

Table 4
Comparison of Size Distribution of Sample of Swedish Manufacturing Plants to Population of Swedish Manufacturing Plants (Percentages)

Sample of Swedish Manufacturing Plants

Year	<5 Employees	5-9 Employees	10-19 Employees	20-49 Employees	50-99 Employees	100-199 Employees	200-499 Employees	500+ Employees
1986	0.4	14.4	28.3	28.0	13.2	8.0	5.1	2.7
1990	5.2	6.6	30.0	29.9	13.0	7.7	5.0	2.7
1995	5.8	5.9	30.6	30.8	12.7	7.1	4.9	2.3

Population of Swedish Manufacturing Plants

Year	<5 Employees	5-9 Employees	10-19 Employees	20-49 Employees	50-99 Employees	100-199 Employees	200-499 Employees	500+ Employees
1986	33.1	22.4	16.1	13.8	6.7	4.0	2.3	1.3
1990	36.0	22.6	15.8	12.8	5.9	3.6	2.2	1.0
1995	38.5	23.4	14.8	12.2	5.3	3.0	1.9	0.8

Table 5

Sample Plants (N=19010) Relative to Population of Swedish Manufacturing Plants

Variable	1986	1990	1995
% of Plants With More Than 20 Employees Included in Our Sample	85.6%	91.2%	94.5%
% of Total Employment in Plants With More Than 20 Employees Included in Our Sample	92.0%	95.7%	98.6%
% of Plants With More Than 10 Employees Included in Our Sample	79.8%	84.3%	87.5%
% of Total Employment in Plants With More Than 10 Employees Included in Our Sample	89.7%	92.4%	94.7%
% of Plants With More Than 5 Employees Included in Our Sample	63.6%	62.9%	62.4%
% of Total Employment in Plants With More Than 5 Employees Included in Our Sample	84.9%	87.0%	90.7%

Table 6

Incidence of Ownership Change for 19,010 Swedish Manufacturing Plants During 1986-1998

Year	% of Plants Involved in an Ownership Change	% of Value-Added Involved in an Ownership Change	% of Employment Involved in an Ownership Change
1986	3.2%	3.2%	3.3%
1987	4.3%	5.2%	5.7%
1988	5.5%	8.1%	7.5%
1989	5.0%	5.1%	5.6%
1990	4.8%	7.8%	8.2%
1991	4.8%	7.8%	7.4%
1992	5.6%	5.0%	5.7%
1993	6.0%	4.6%	5.2%
1994	4.6%	7.7%	6.7%
1995	3.9%	4.8%	5.3%
1996	3.9%	2.7%	3.1%
1997	3.7%	4.7%	3.8%
1998	3.2%	2.7%	3.0%
Entire Period	5.1%	5.4%	5.6%

Table 7
Incidence of Ownership Change for 19,010 Swedish Manufacturing Plants During 1986-1998
By Type of Ownership Change

Type of Ownership Change	% of Plants Involved in a Particular Type of Ownership Change	% of Value-Added Involved in a Particular Type of Ownership Change	% of Employment Involved in a Particular Type of Ownership Change
All Ownership Changes	5.1%	5.4%	5.6%
Partial Acquisition	0.9%	2.5%	2.4%
Full Acquisition	4.2%	2.9%	3.2%
Partial Divestiture	0.7%	1.9%	1.8%
Full Divestiture	4.4%	3.5%	3.8%
Related Acquisition	0.8%	1.3%	1.3%
Unrelated Acquisition	0.6%	0.7%	0.6%
Change in Ownership Involving a Single Plant	3.7%	3.4%	3.7%

Table 8
Means and Standard Deviations (in parentheses) of
Production Function Variables and Worker Characteristics

Variable	All Plants	Plants That Experience an Ownership Change	Plants That Do Not Experience an Ownership Change
Log Gross Output	10.07 (1.48)	10.37 (1.45)	9.92 (1.47)
Log Real Value of Plant & Machinery Capital Stock	10.55 (1.22)	10.70 (1.25)	10.45 (1.18)
Log Plant Employment	3.36 (1.21)	3.67 (1.22)	3.18 (1.17)
Log Materials	8.80 (1.82)	9.18 (1.75)	8.59 (1.82)
Average Age of Employees	39.53 (5.36)	39.57 (4.95)	39.45 (5.56)
Percentage of Female Employees	25.77 (21.64)	25.18 (20.61)	26.08 (22.17)
Percentage of Non-Swedish Employees	9.24 (11.49)	9.62 (11.17)	9.04 (11.66)
Percentage of Employees With At least A College Education	2.81 (7.11)	2.45 (5.85)	3.00 (7.68)
Log Wage	11.86 (0.37)	11.85 (0.36)	11.86 (0.38)

Table 9

Parameter Estimates from Labor Productivity, Total Factor Productivity, Output, and Employment Regressions for All Ownership Changes (Standard Errors in Parentheses)

Coefficient on:	Labor Productivity	TFP (Cobb-Douglas)	Output	Employment
Labor ‡	1.039 *** (0.004)	.316 *** (0.10)	-------	-------
Capital ‡	-------	.233 *** (.011)	-------	-------
Materials ‡	-------	.454*** (.081)	-------	-------
OC_{-13}	-.053 (.035)	-------	.092 (.093)	.162 † (.085)
OC_{-12}	-.042 † (.025)	-------	.020 (.060)	.058 (.052)
OC_{-11}	-.010 (.020)	-------	.049 (.045)	.055 (.041)
OC_{-10}	-.027 † (.017)	-------	.060 (.039)	.083 ** (.035)
OC_{-9}	-.036 ** (.015)	.011 (0.28)	.114 *** (.035)	.142 *** (.032)
OC_{-8}	-.035 *** (.013)	.027 (.020)	.137 *** (.029)	.163 *** (.026)
OC_{-7}	-.035 *** (.013)	.004 (.012)	.162 *** (.026)	.191 *** (.023)
OC_{-6}	-.039 *** (.011)	.014 (.013)	.186 *** (.023)	.216 *** (.020)
OC_{-5}	-.041 *** (.010)	-.012 (.012)	.205 *** (.022)	.232 *** (.019)
OC_{-4}	-.041 *** (.009)	-.013 (.010)	.179 *** (.020)	.208 *** (.017)
OC_{-3}	-.042 *** (.009)	-.022 ** (.009)	.178 *** (.019)	.208 *** (.016)
OC_{-2}	-.035 *** (.008)	-.025 *** (.009)	.179 *** (.018)	.202 *** (.015)
OC_{-1}	-.050 *** (.009)	-.031 *** (.009)	.153 *** (.018)	.194 *** (.015)
OC_{0}	-.022 *** (.008)	-.022 ** (.009)	-.001 (.017)	.021 *** (.015)
OC_{+1}	-.009 (.008)	-.020 ** (.008)	.082 *** (.018)	.085 *** (.015)
OC_{+2}	-.004 (.009)	-.010 (.007)	.092 *** (.019)	.087 *** (.016)
	.002	-.005	.101 ***	.092 ***

OC_{+3}	(.010)	(.008)	(.021)	(.018)
OC_{+4}	.002 (.010)	-.013 † (.008)	.095 *** (.023)	.088 *** (.019)
OC_{+5}	.005 (.011)	-.014 † (.008)	.097 *** (.025)	.090 *** (.021)
OC_{+6}	.019 † (.013)	-.011 (.009)	.142 *** (.028)	.120 *** (.024)
OC_{+7}	.043 *** (.014)	.010 (.010)	.187 *** (.033)	.140 *** (.027)
OC_{+8}	.030 † (.013)	.018 (.011)	.159 *** (.037)	.119 *** (.030)
OC_{+9}	.037 ** (.018)	.016 (.014)	.139 *** (.041)	.096 *** (.034)
OC_{+10}	.040 † (.022)	--------	.175 *** (.050)	.124 *** (.041)
OC_{+11}	.061 ** (.030)	--------	.201 *** (.069)	.120 ** (.057)
OC_{+12}	.024 (.054)	--------	.171 *** (.108)	.103 (.091)
"No-Data" Dummies	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Age Dummies	Yes	Yes	Yes	Yes
Intercept	6.365 *** (0.032)	2.084 *** (.143)	10.610 *** (.059)	4.057 *** (.049)
R^2	0.859	0.970	0.358	0.301
Number of Plants	18,495	2295	18,513	18,962
Number of Observations	124,381	19724	124,441	125,416

Notes: † p<.10, * p<.05, ** p<.01, *** p<.001. These are two-tailed significance levels using robust standard errors, allowing for correlated ("clustered") errors within plants. ‡ Weighted means of industry-specific coefficients from separate regressions at the detailed (4-digit SIC) industry level.

Table 10
Estimated Effects of Ownership Change on Labor Productivity (LP), Total Factor Productivity (TFP), Output, and Employment for Various Types of Ownership Changes

All Ownership Changes

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	-0.042 ***	-0.021 **	0.179 ***	0.209 ***
Post-Ownership Change (Average-5 years After)	-0.001	-0.012 *	0.093 ***	0.089 ***
Post-Pre	0.041 ***	0.008	-0.086 ***	-0.120 ***

Full Acquisitions

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	-0.055 ***	-0.016 *	0.061 **	0.111 ***
Post-Ownership Change (Average-5 years After)	-0.007	-0.014 †	-0.055 **	-0.046 **
Post-Pre	0.047 ***	0.002	-0.116 ***	-0.156 ***

Partial Acquisitions

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	0.011	-0.042 *	0.633 ***	0.584 ***
Post-Ownership Change (Average-5 years After)	0.019	-0.009	0.556 ***	0.510 ***
Post-Pre	0.008	0.033 †	-0.077 *	-0.073 *

Full Divestitures

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	-0.052 ***	-0.016 *	0.092 ***	0.137 ***
Post-Ownership Change (Average-5 years After)	-0.005	-0.014 *	-0.012	-0.007
Post-Pre	0.047 ***	0.002	-0.104 ***	-0.144 ***

Partial Divestitures

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	0.019	-0.051 *	0.684 ***	0.628 ***
Post-Ownership Change (Average-5 years After)	0.018	-0.006	0.594 ***	0.551 ***
Post-Pre	-0.001	0.045 †	-0.090 *	-0.077 *

Notes: † p<.10, * p<.05, ** p<.01, *** p<.001. These are two-tailed significance levels using robust standard errors, allowing for correlated ("clustered") errors within plants.

Table 10 (cont.)

Estimated Effects of Ownership Change on Labor Productivity (LP), Total Factor Productivity (TFP), Output, and Employment for Various Types of Ownership Changes

Related Acquisitions

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	0.018	-0.028 †	0.451 ***	0.409 ***
Post-Ownership Change (Average-5 years After)	0.002	-0.010	0.350 ***	0.329 ***
Post-Pre	-0.016	0.018	-0.101 *	-0.080 *

Unrelated Acquisitions

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	-0.025	-0.035 *	0.341 ***	0.353 ***
Post-Ownership Change (Average-5 years After)	0.043 †	-0.017	0.291 ***	0.237 ***
Post-Pre	0.068 **	0.019	-0.050	-0.116 **

Change in Ownership Involving a Single Firm

Period	LP	TFP	Output	Employment
Pre-Ownership Change (Average-5 years Before)	-0.016	-0.007	0.198 **	0.194 **
Post-Ownership Change (Average-5 years After)	-0.048	-0.005	0.073	0.112
Post-Pre	-0.032	0.002	-0.125 †	-0.081

Notes: † p<.10, * p<.05, ** p<.01, *** p<.001. These are two-tailed significance levels using robust standard errors, allowing for correlated ("clustered") errors within plants.

Table 11

Estimated Effects of Ownership Change on Age, Experience, % Female, % Non-Swedish, % College-Educated, and Wages for Various Types of Ownership Changes

All Ownership Changes

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wages
Pre-Ownership Change (Average-5 years Before)	0.052	0.045	0.766 ***	0.360 *	-0.051	-0.009 ***
Post-Ownership Change (Average-5 years After)	0.213 ***	0.213 ***	0.117	0.245	0.126	0.004 †
Post-Pre	0.160 *	0.167 **	-0.649 **	-0.115	0.177 *	0.013 ***

Full Acquisitions

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wages
Pre-Ownership Change (Average-5 years Before)	-0.028	0.009	0.540 *	0.253	-0.111 m	-0.014 ***
Post-Ownership Change (Average-5 years After)	0.127 †	0.176 **	-0.289	0.111	0.028	0.001
Post-Pre	0.155 *	0.167 **	-0.829 ***	-0.143	0.140 m	0.015 ***

Partial Acquisitions

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wages
Pre-Ownership Change (Average-5 years Before)	0.396 **	0.204 **	1.680 ***	0.787 *	0.225	0.012 *
Post-Ownership Change	0.482 ***	0.339 ***	1.423 **	0.674 *	0.438 **	0.015 **

(Average-5 years After)						
Post-Pre	0.085	0.135	-0.256	-0.113	0.213	0.003

Notes: † p<.10, * p<.05, ** p<.01, *** p<.001. These are two-tailed significance levels using robust standard errors, allowing for correlated ("clustered") errors within plants.

Table 11 (cont.)
Estimated Effects of Ownership Change on Age, Experience, % Female, % Non-Swedish, % College-Educated, and Wages for Various Types of Ownership Changes

Full Divestitures

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wages
Pre-Ownership Change (Average-5 years Before)	0.019	0.032	0.589 **	0.311 *	-0.088	-0.010 ***
Post-Ownership Change (Average-5 years After)	0.177 *	0.209 ***	-0.241	0.185	0.020	0.003
Post-Pre	0.158 *	0.178 **	-0.830 ***	-0.127	0.109	0.013 ***

Partial Divestitures

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wage
Pre-Ownership Change (Average-5 years Before)	0.270	0.135	1.834 **	0.661	0.213	-0.003
Post-Ownership Change (Average-5 years After)	0.382 **	0.230 *	1.896 **	0.551	0.647 **	0.011
Post-Pre	0.112	0.095	0.063	-0.109	0.434	0.014 †

Notes: † p<.10, * p<.05, ** p<.01, *** p<.001. These are two-tailed significance levels using robust standard errors, allowing for correlated ("clustered") errors within plants.

Table 11 (cont.)

Estimated Effects of Ownership Change on Age, Experience, % Female, % Non-Swedish, % College-Educated, and Wages for Various Types of Ownership Changes

Related Acquisitions

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wage
Pre-Ownership Change (Average-5 years Before)	0.511 **	0.005	0.636	0.222	0.020	0.022 ***
Post-Ownership Change (Average-5 years After)	0.490 **	0.178	0.192	0.103	0.209	0.021 ***
Post-Pre	-0.021	0.173	-0.444	-0.119	0.189	-0.002

Unrelated Acquisitions

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wage
Pre-Ownership Change (Average-5 years Before)	0.171	0.205 *	1.137 *	0.218	0.109	-0.006
Post-Ownership Change (Average-5 years After)	0.672 ***	0.460 **	0.782	-0.032	0.137	0.023 **
Post-Pre	0.501 **	0.255 †	-0.355	-0.251	0.028	0.029 ***

Change in Ownership Involving a Single Firm

Period	Age	Experience	% Female	% Non-Swedish	% College-Educated	Wage
Pre-Ownership Change (Average-5 years Before)	0.264	-0.175	0.224	0.423	-0.185	0.012
Post-Ownership Change	-0.092	-0.101	-0.587	0.454	0.18	-0.003

(Average-5 years After)						
Post-Pre	-0.356	0.073	-0.811	0.032	0.365	-0.015

Notes: † p<.10, * p<.05, ** p<.01, *** p<.001. These are two-tailed significance levels using robust standard errors, allowing for correlated ("clustered") errors within plants.

Figure 1

Graphs of the Coefficients on the Ownership Change Dummies in the LP Equation

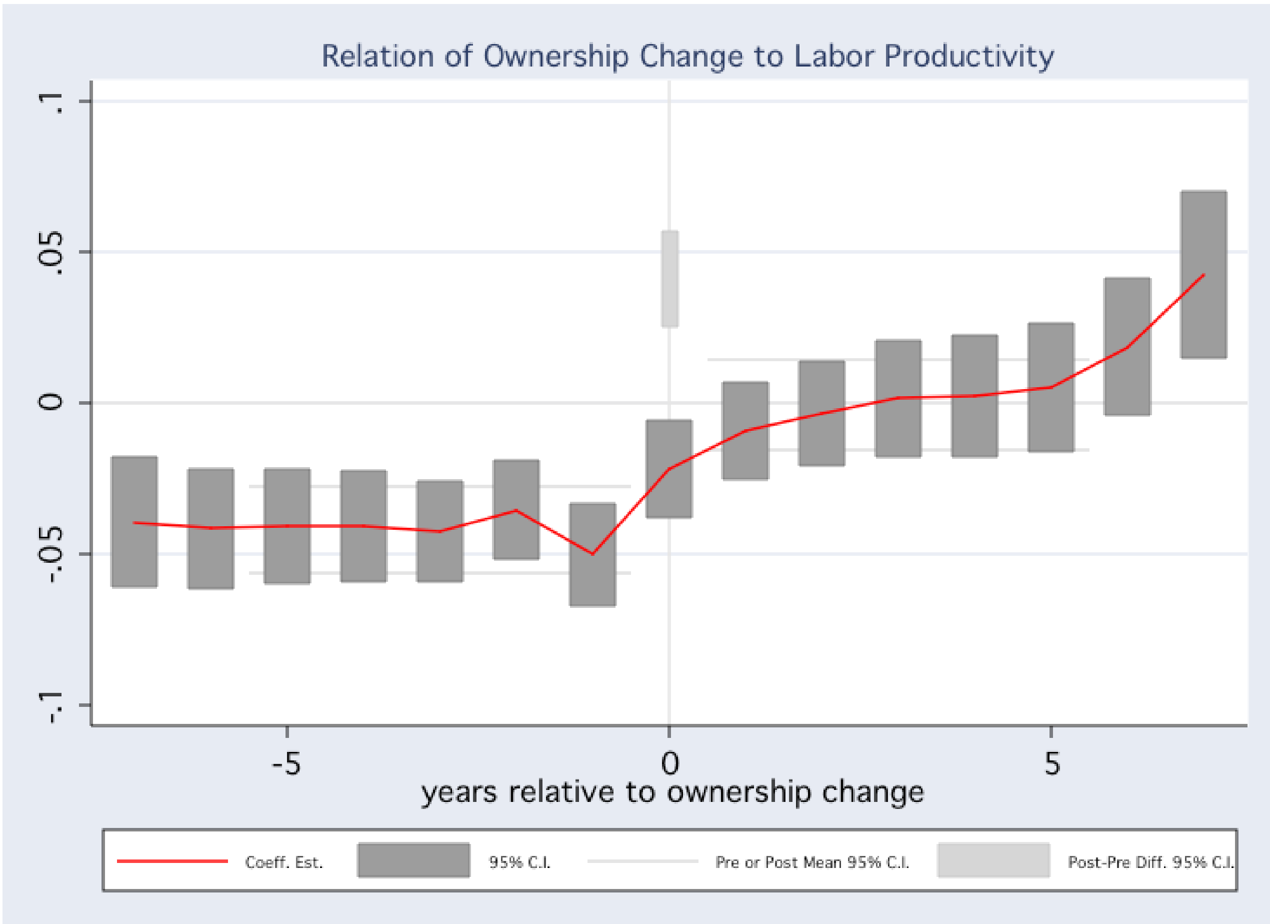

Figure 2

Graphs of the Coefficients on the Ownership Change Dummies in the TFP Equation

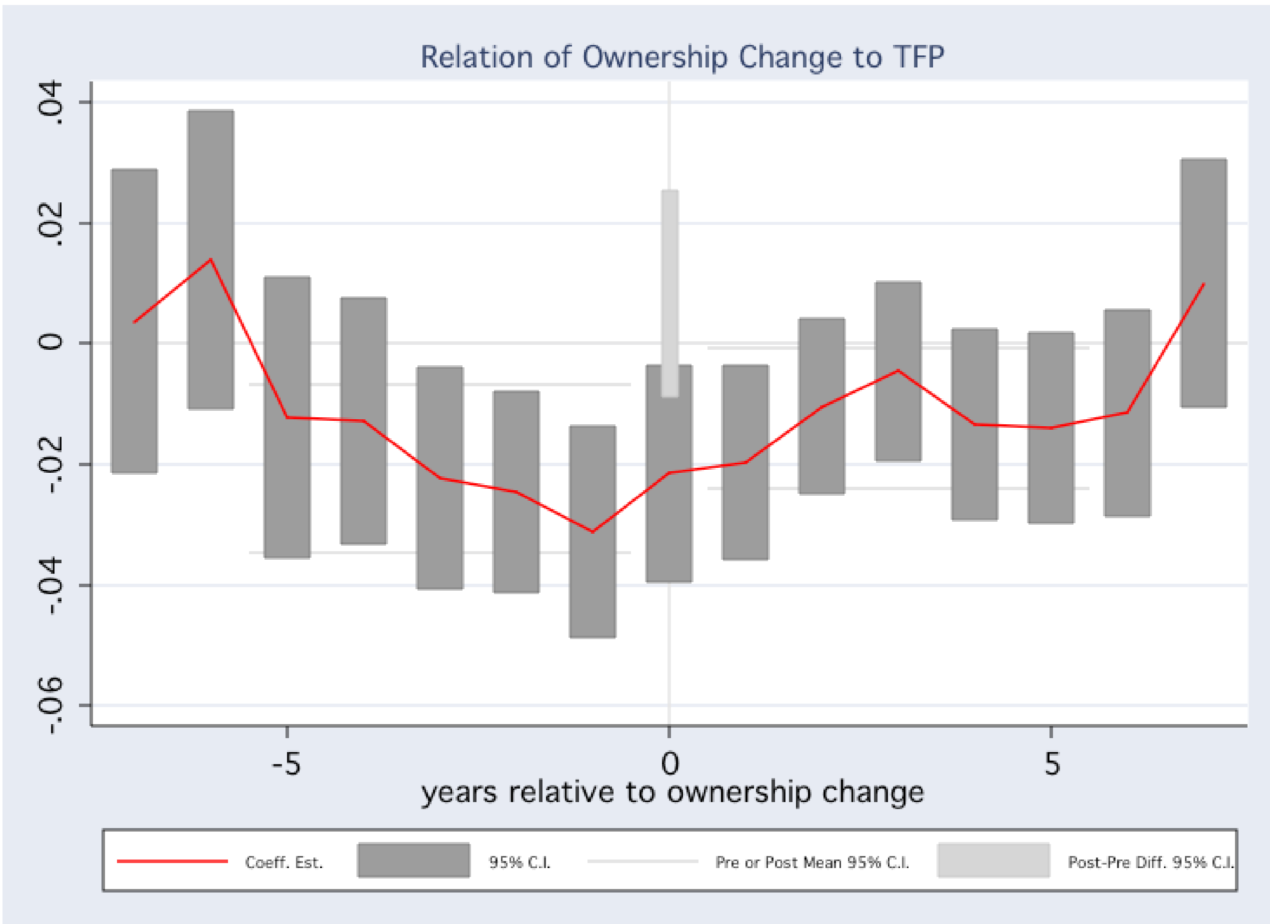

Figure 3

Graph of the Coefficients on the Ownership Change Dummies in the Output Equation

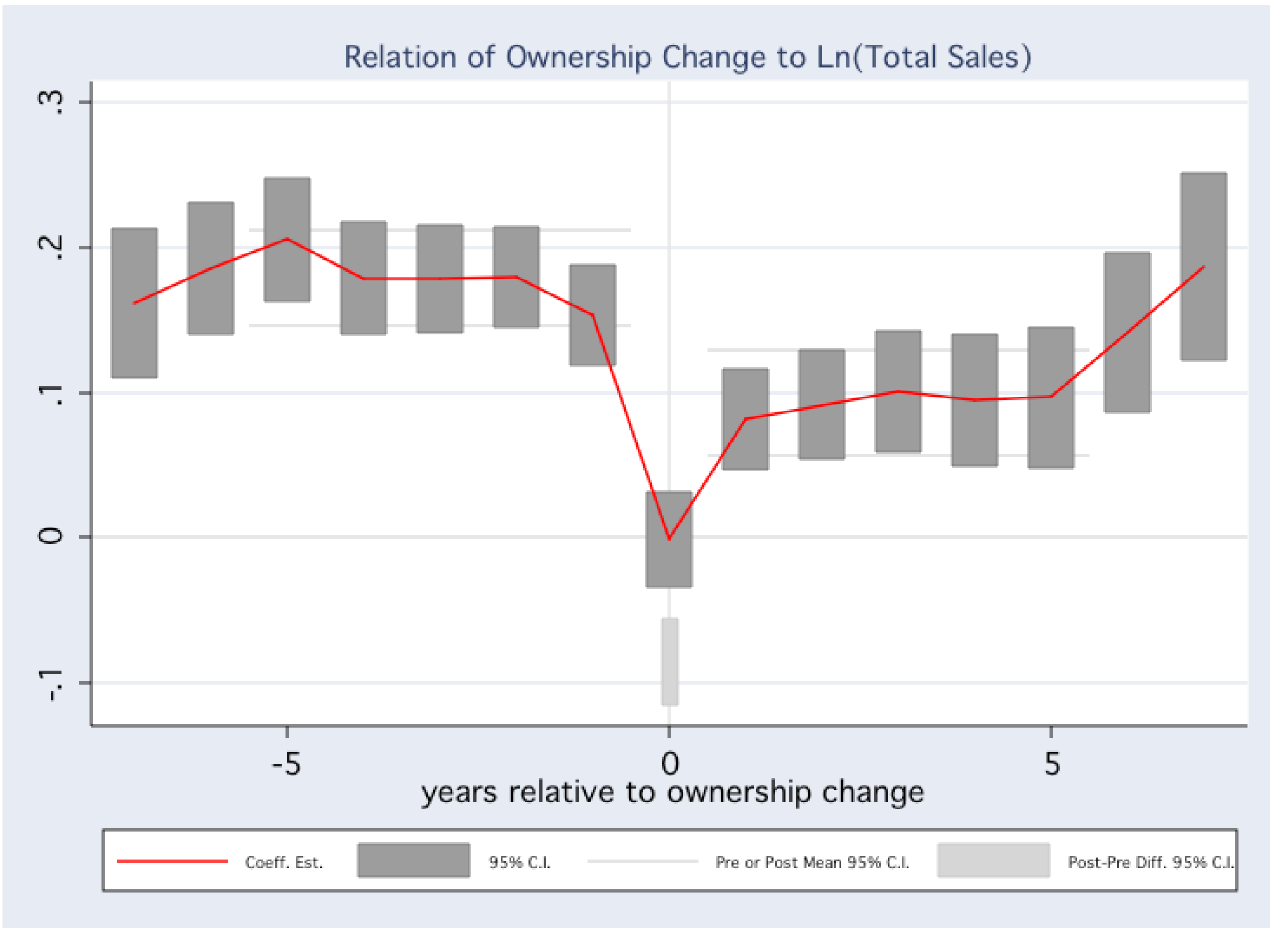

Figure 4

Graph of the Coefficients on the Ownership Change Dummies in the Employment Equation

Figure 5
Graph of the Coefficients on the Ownership Change Dummies in the Mean Employee Age Equation

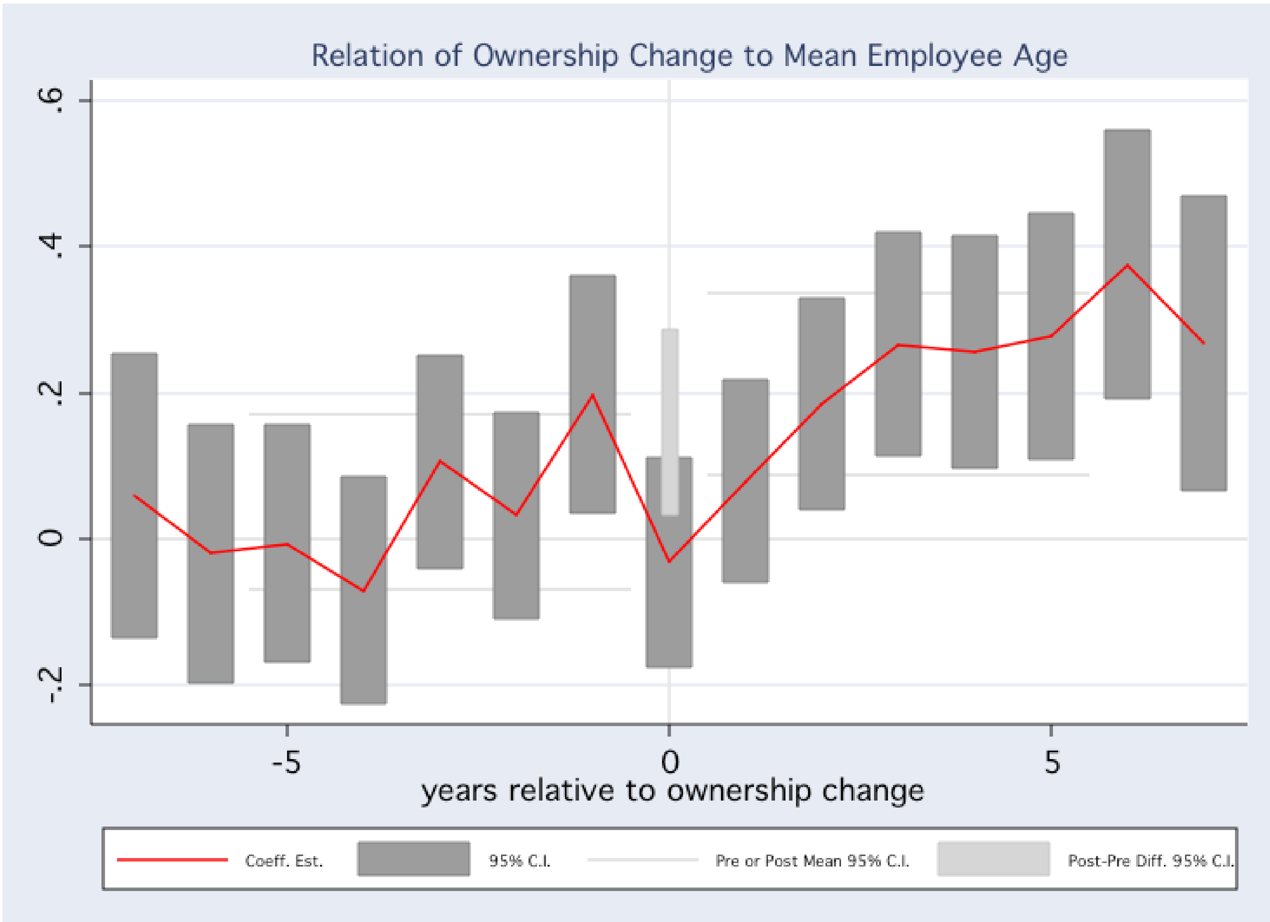

Figure 6
Graph of the Coefficients on the Ownership Change Dummies in the Mean Employee Experience Equation

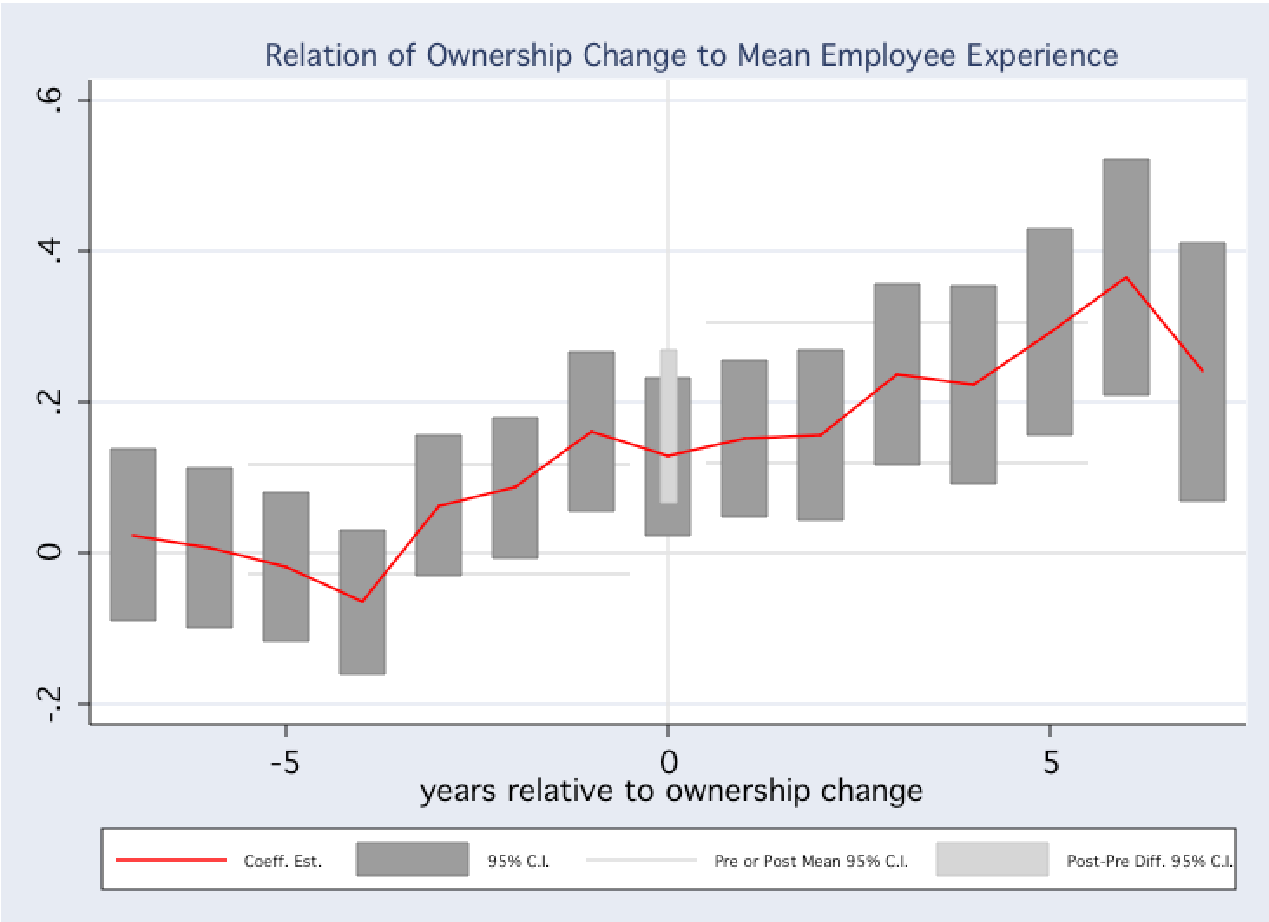

Figure 7
Graph of the Coefficients on the Ownership Change Dummies in the Percentage Female Workers Equation

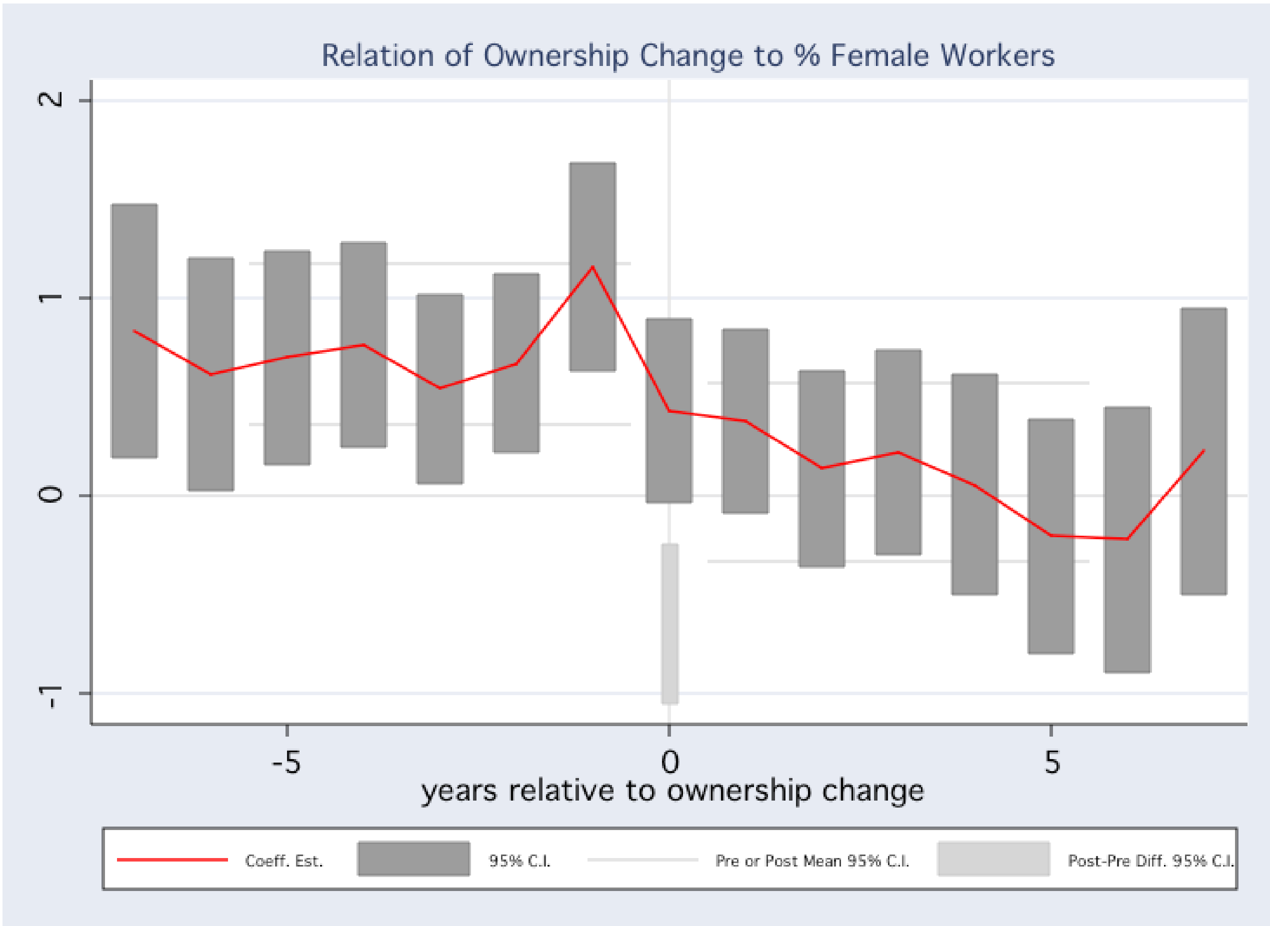

Figure 8
Graph of the Coefficients on the Ownership Change Dummies in the Percentage of Non-Swedish Workers Equation

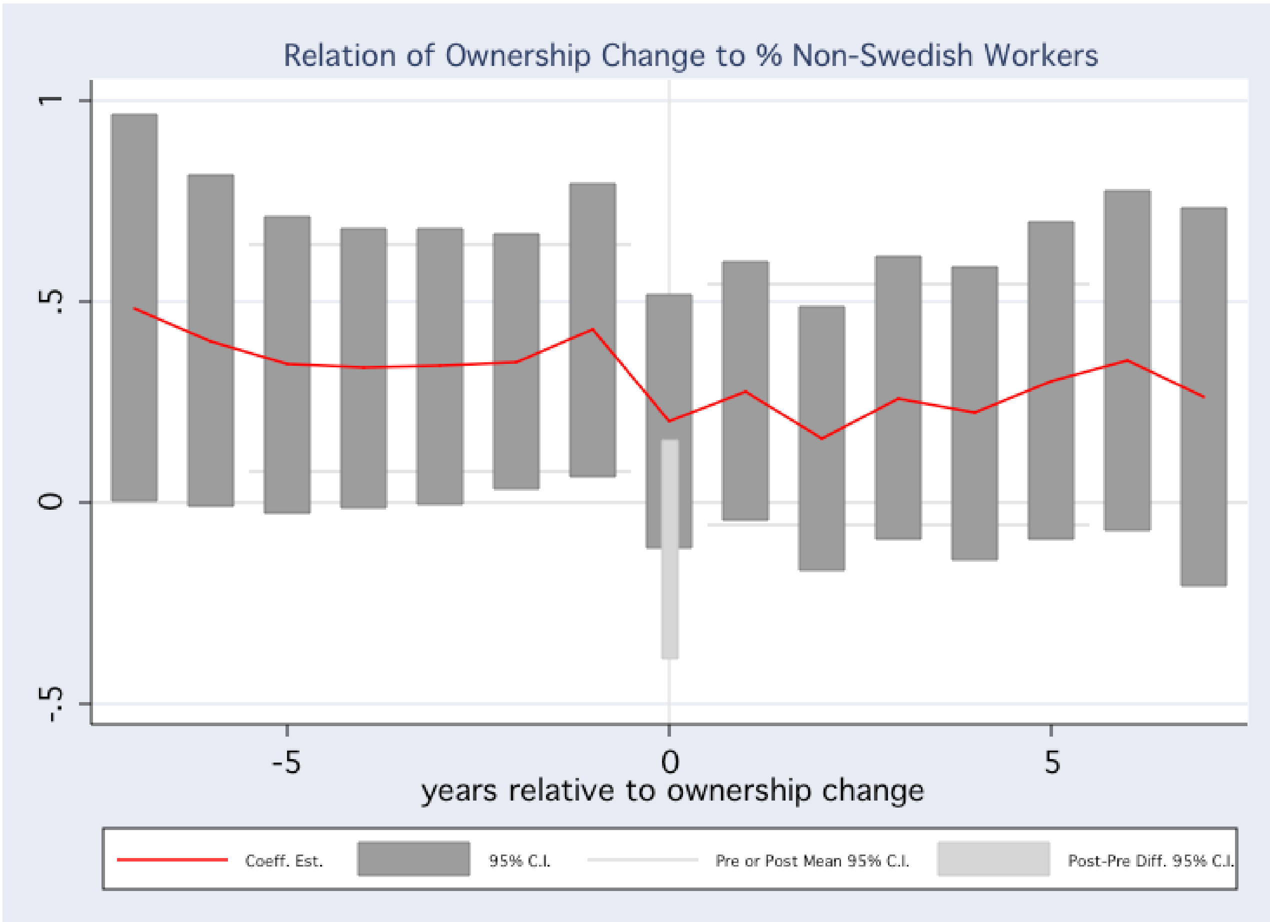

Figure 9
Graph of the Coefficients on the Ownership Change Dummies in the Percentage of College-Educated Workers Equation

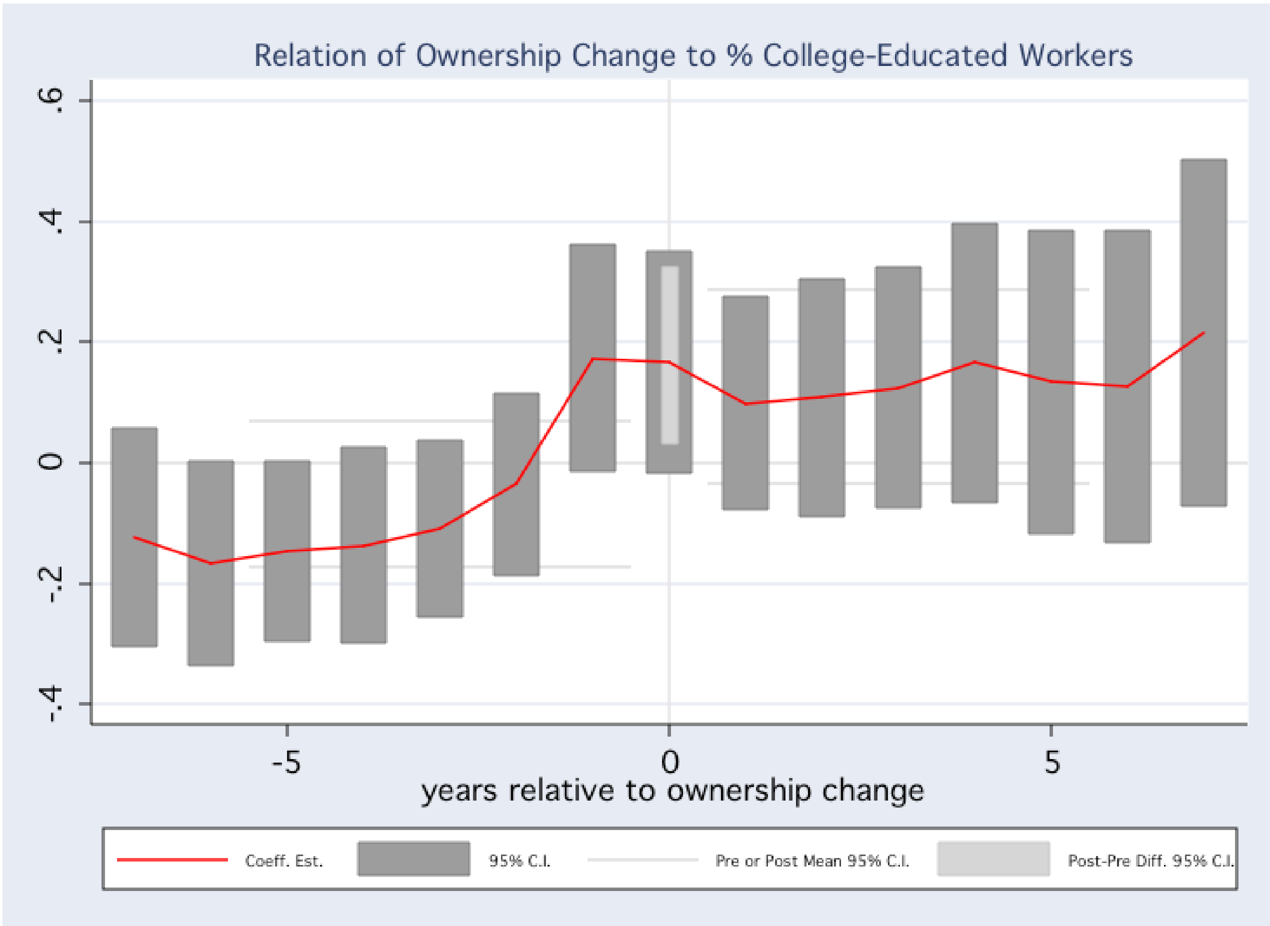

Figure 10

Graph of the Coefficients on the Ownership Change Dummies in the Mean Wage Equation