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ABSTRACT

Total Factor Productivity Growth and Job Turnover in Mexican Manufacturing Plants in the 1990s*

This paper analyzes the performance of Mexican manufacturing firms following trade liberalization within a very specific institutional setting: The North American Free-Trade Agreement (NAFTA). We compare plants' productivity growth and patterns of job creation and destruction across their relative degree of integration into foreign product markets, their access to technology, and behavior with respect to research and development. Our findings show that access to imported inputs is the more significant vehicle for productivity enhancing effects of trade openness. Investment in technology is, by far, most strongly correlated with plant productivity. Like productivity, job turnover at firm level is strongly influenced by the degree of integration in international markets, import competition, and R&D behavior.

JEL Classification: C14, D24, F13, G63, O54

Keywords: total factor productivity, NAFTA, R&D, job creation and destruction

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1 Introduction

The analysis of panel data sets of countries that have embarked in sweeping trade reforms over the past four decades has revealed a large degree of within-industry plant heterogeneity in …rm responses[1]. In view of this fact, a consensus has been emerging that aggregate models with representative …rms are ill suited for understanding the e¤ects of trade liberalization on the productivity and employment of manufacturing industries. Recent empirical research has focused on testable hypotheses derived from dynamic models that link trade regimes with theoretical insights from industrial evolution literature and explicitly consider …rm heterogeneity.

The hypothesis that attracted most attention in the analysis of developing countries concerns the positive e¤ect of import competition on the productivity of domestic …rms. Competition from foreign …rms induces a disciplining e¤ect among domestic producers. Hence import tari¤s on …nal products should be negatively correlated with domestic …rms' total factor productivity. Another possible explanation for the relationship between import tari¤s and productivity, which received far less attention, is that tari¤ reductions enhance …rms' productivity by allowing better combinations of domestic and imported intermediate inputs[2].

In addition to the prevalence given to the former channel at the expense of the latter, existing studies implicitly assume that liberalization of trade takes place in institutional contexts in which credibility problems do not exist, or that incentives to invest and become more productive do not depend on the credibility of the trade regime. Lack of credibility of the commitment to irreversible trade reforms is functionally equivalent to a distortion in the structure of intertemporal relative prices (Calvo, 1986). Economic agents base their actions on prices which di¤er from those that will materialize if the reform is carried out to fruition. This distortion creates a second-best environment (Rodrik, 1989). Because this insight has not permeated empirically oriented papers, there is no mention on how their results and estimation procedures would be a¤ected by a lack of a credible commitment for irreversibility of trade liberalization[3].

[1] IDB, 2003 for Mexico and Brazil; Levinsohn and Petrin, 1999, Pavcnik, 2002 and Bergoeing et al., 2003 for Chile; Medina et. al (2002) for Colombia; Haddad, 1993 for Marroco and Pravina and Miltra 1997 for India.

[2] A study by Bernard et. al. (2002) considers a fall in trade costs, which comprise tari¤s paid on importing intermediate goods, as a positive channel for productivity improvements in American …rms. By contrast, Lopez-Cordova and Mesquita Moreira (2002) reject the hypothesis that in Brazil and Mexico expanded use of imported inputs have no impact of total factor productivity of domestic plant and a negative impact on foreign …rms operating in these countries.

[3] The problems associated with it have been well established in theoretical papers. Levinson (1986) proposes a model in which the large degree of within industry heterogeneity increases uncertainty about the distribution of gains from trade reform, rendering the support for reforms weak. Rodrik (1989) develops a model in which this may occurr because of incomplete or asymetric information. The idea that a government that mantains policy discretion might be tempted to use trade instruments follows from the time inconsistency argument. Finally, a similar argument has been advanced to explain why temporary infant industry protection may not lead to expected e¢ciency changes.

The absence of this insight is more conspicuous when liberalization of trade is accompanied by trade agreements with other countries. In these cases a transition from a partially credible to a credible commercial regime can be an important explanatory factor for observed changes in productivity and job turnover in manufacturing firms. The North American Free Trade Agreement (NAFTA) is an archetypical case in which this transition took place. The agreement provided for a phase-out of trade tariffs over a period of 10 to 15 years, a stable and transparent legal environment for foreign investors, a broader protection of trademarks and patents, as well as other measures to facilitate access to foreign technology. In addition, NAFTA provided Mexican manufacturers an unprecedented degree of predictability of trade tariffs and insured rule-bound behavior in Mexican, USA, and Canadian trade policy.

This paper uses plant-level panel data to analyze the performance of manufacturing firms between 1993-2000. The data set combines information from three sources: Annual Industrial Survey (AIS), Industrial Census (IC), and National Survey of Employment, Salaries, Technology and Training (ENESTYC). We seek to shed light on two key issues. Tariff reduction leads to performance improvements through two channels: better access to a larger menu of imported inputs and stronger import competition on domestic markets. The main goal of the empirical analysis is to assess the importance of these two channels in the case of Mexican manufacturing firms.

NAFTA meant a stable and transparent legal environment for foreign investors, a broader protection of trademarks and patents, as well as other measures to facilitate access to foreign technology. For a better understanding of the determinants of plant performance, we analyze the relationship between performance and variables describing access to technology. The two variables considered were expenditures in R&D and technology transfer, and the relative importance of alternative sources of technological transfers.

Throughout, we focus on two aspects of firm performance, total factor productivity (henceforth, productivity) and job turnover. Firm performance is analyzed at several levels. We construct productivity estimates and job turnover rates for the entire manufacturing sector and, separately, for 2-digit SIC industries. Our empirical strategy is to compare performance across plant characteristics intrinsically related to components of the free trade agreement.

We find that most productivity gains at industry level are achieved through reshuffling of resources from less to more productive firms. Our findings underscore the importance of better access to imported inputs as a channel for productivity enhancement effects of tariff reductions. Firms using larger shares of imported inputs show stronger productivity growth. Better access to imported inputs has a stronger positive effect of productivity for firms exporting larger shares of output. We find no significant effect of import competition on productivity. Investments in technology are a strong determinant of firm productivity. Job reallocation patterns differ significantly across years with high/low(or normal) turnover. There are no significant performance differences across integration, import competition, and investments in technology in low turnover year. In high turnover years, integration and expenditures in technology have a positive impact on …rms performance, while import competition a¤ects negatively …rms' prospects.

The remainder of this paper is organized as follows. In section 2 we discuss the free-trade agreement and its implications for the Mexican manufacturing …rms, and review some of the relevant literature. In section 3 we present our empirical strategy. Section 4 contains a detailed description of the data sources used in this paper. In section 5 we describe the technique used for estimating the production functions and discuss the estimation results. The empirical analysis of the e¤ect of trade liberalization on productivity and employment patterns is presented in section 6, followed by concluding remarks and a review of the goals of future research.

2 Background

By January 1994, when manufacturers started to perform within NAFTA's framework, Mexico had already been transformed from an inward-looking economy into a largely open economy. As part of its accession to the GATT in 1986, Mexico had substantially reduced and rationalized its import tari¤s[4]. The economy was largely reliant on private enterprise after privatization, deregulation, and other major economic reforms undertaken after 1985.

Negotiations towards establishing NAFTA began in 1990 and the accord was signed in December 1992. NAFTA was an institutional setting designed to promote foreign investment and enhance e¢ciency in manufacturing sectors. It contained provisions which facilitated the cross-border integration of industries in North America. The most important provisions concerned tari¤ phase-out. A general principle of a ten-year maximum for tari¤ phase-outs was adopted; …fteen-year phase-out schedules were agreed for exceptional cases. Four main staging tari¤ phase-out categories, A-D, and two special cases categories, B+ (most textile tari¤s) and B8- (four tari¤ items in the paper sector) were speci…ed (table 1)[5]. Tari¤ reduction schedules became publicly available one year before the start of NAFTA. For each product, they speci…ed a phase-out category and the 1991 tari¤, chosen as base level.

By the time NAFTA took e¤ect, Mexican import tari¤s of non-agricultural goods have been substantially reduced from their high levels in 1985. As shown in the following table, the treaty involved a relatively low degree of tari¤ liberalization, because trade ‡ows between Canada, Mexico and the United States were already relatively free.

Additional provisions were aimed at establishing a stable and transparent legal environment for foreign investors, a broader protection of trademarks and patents, as well as other measures to facilitate access to foreign technology. The treaty did not cover domestic microeconomic reforms such as privatization or deregulation. Implicitly, however, the treaty signaled to foreign investors that domestic reforms will continue and that Mexico's private sector was in good health (Fernandez and Portes, 1998).

Arguably, the most important characteristic of the free-trade agreement was the unprecedented level of predictability lent to Mexican, U.S.A. and Canadian trade policy. The signing of NAFTA ensured that the openning of Mexican economy to foreign competition was irreversible. All relevant information regarding phasing out of tari¤s was available to private agents one year before the start of NAFTA. Ruling out the discretionary use of trade instruments, unlike previous announcements of tari¤ removal, NAFTA enjoyed full credibility.

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[4] In 1985, over 90% of domestic production was covered by import licences and the average e¤ective tari¤ protection rate was 30.7%; in 1990, only 11.20% of domestic production was covered and the average teari¤ rate was 8.57% (Tybout and Westbrook, 1995).

[5] About 54% of U.S. imports from Mexico were bound to be free on implementation of the Treaty (category A), 8.5% within 5 years (category B), 23% within 10 years (category C) with about 14% of imports already being duty free before NAFTA. For Mexican imports the corresponding estimates were 31% in category A, 17% in category B, 32% in category C, and 8% initially free (Kowalczyk and Davis, 1996).

We expect multiple e¤ects of NAFTA provisions on domestic plants. Manufacturers trying to match their input mix more precisely to a desired technology or product characteristics, were insured low import tari¤s and unfettered access to a large menu of imported intermediate goods. Firms with exporting potential, considering e¢ciency enhancing investments, were reassured that U.S. and Canadian import tari¤s will stay low and contingent protection will not be imposed by these countries. Ruling out the discretionary use of trade instruments was an important element of uncertainty reduction, in view of the major balance of payments crisis that occurred in December 1994 and given memories of previous episodes when balance of payment problems triggered across the board import restrictions[6]. For import competing …rms with a temporarily protected local market, the irreversibility of an open trade regime and the credibility of pre-announced phasing-out of remaining trade tari¤s implied an unambiguous message: this was de…nitively their last "breathing space" to become internationally competitive.

A cursory analysis of the aggregate performance of the manufacturing sector after 1993 indicates that NAFTA might have, indeed, played a signi…cant role. At the end of 1994, manufacturers were exposed to severe macroeconomic shocks. Real exchange rate depreciated in December 1994 by more than 40%. A …nancial crisis and a severe domestic economic recession followed in 1995. The manufacturing sector was driven out of this recession by an unprecedented good performance of exporting …rms. Mexican exporters took advantage of the unprecedented expansion of U.S. market between 1995 and 1998, and of the temporarily undervalued domestic currency. Table 1 shows that during this period Mexican manufactures increased their market share, reaching a new plateau of participation in U.S. markets by 1998.

The main goal of this paper is to provide a detailed analysis of the performance of Mexican manufacturing …rms between 1993 and 2000. We construct estimates of individual plants productivity and investigate the relationship between trade reforms and plant performance. Assessing the relationship between reductions in import tari¤s and changes in e¢ciency is problematic for two reasons. In general, the relationship cannot be cannot be automatically interpreted as causal. Tari¤ rates may be set endogenously in response to changes in ef…ciency. In the case of NAFTA, however, this problem does not exist. Tari¤ levels after 1994 are truly exogenous, as their levels for the entire period are una¤ected by changes in productivity (Lopez-Cordova, 2002). Secondly, even if the relationship can be given a causal interpretation, quantifying it remains problematic. Adjustments of trade tari¤s between 1994 and 2000 were announced in advance and enjoyed credibility. Unless …rms behaved myopically, it is reasonable to assume that their reactions to the change in trade regime do not strictly

[6] This can be contrasted, with the Chilean trade liberalization experience during the eighties and the Colombian one in the nineties. These studies implicitly assumed a context in which a commitment to free trade persisted -and was believed by the private sector to be so. This assumption is does not appear to have held all the time. For example, Pavnik (2002), referred that there was "a transitory period of increased tari¤ protection starting in 1983 in response to the 1982-83 recession".

match these changes time wise. Most likely, …rms responded to expected future tari¤ reductions rather than to realized new levels of tari¤s.

In view of the di¢culties involved in dealing with 'import discipline e¤ect' in this way, we take an alternative route in this paper. We rely instead on a cross section survey that was applied to the majority of …rms for which we calculate yearly changes in total factor productivity. In what turned out to be an extremely timely point in time for the purposes of this analysis - second quarter of 1995 - a survey registered their qualitative perception of the most important e¤ect of foreign trade liberalization policies on their plants.

With the information provided by this survey we classi…ed the set of …rms in four groups, according to their own assessment. Respondents could choose one out of four possible answers, which were: 'an increase in foreign competition in their domestic markets', 'no e¤ect at all', 'more facility to export' and 'access to new and/or better technologies'[7].This route has the disadvantage that we cannot identify productivity changes that were registered in 1993 - the year capturing the e¤ects on …rms of the 'arrival of news of the import liberalization program'. By contrast, it can allow us to assess the robustness of results suggesting that Mexican plants experienced an important 'import discipline e¤ect' during the years 1994-2000.

2.1 Previous studies of the e¤ects of trade liberalization in Mexico that used industry panel data sets

Tybout and Westbrook (1995) use the 1984-1990 sample of the Annual Industrial Survey (AIS), to study the performance of Mexican …rms. They decompose productivity changes into e¤ects of plant-level scale economy exploitation, movements of individual plants toward the production frontier, and shifts of that production frontier due to innovation, externalities, and other forces. They found only mild increasing returns to scale. With few exceptions the largest …rms had already reached a minimum e¢cient scale. The association between openness and …rms productivity were weak[8]. Exporting …rms experience only small ef…ciency gains from the opening up of the economy but bene…ted from lower import prices and better terms of trade. Trade openness - measured by import penetration or changes in o¢cial tari¤ rates - worsened the scale e¢ciency of import competing …rms.

[7] Forty four percent of …rms in our sample responded in the third term of 1994 having to compete more intensively with foreign …rms as the e¤ect of trade liberalization so far undertaken . When they answered this question, NAFTA had already gone into e¤ect along with the most relevant tari¤ adjustments associated to it.

[8] These authors had di¢culties in identifying trade policy measures to analyze the relative openness of the various industries. They found 'surprisingly little association' among the alternative measures of trade exposure, among these, change in e¤ective protection rates, change in licence coverage ratios and change in o¢cial import tari¤ rates; all of them measured as the di¤erence between 1990 and 1984 …gures. They also found that non of them correlated closely with import penetration.

Two recent reports, by the World Bank and the Inter-American Development Bank, respectively, have analyze …rms' performance during NAFTA's years using Mexico's Annual Industrial Survey (AIS). As we do in this study, they followed three steps. The …rst one, estimate production functions for the main manufacturing sectors using plant level data. Then, with the discrepancy between forecasted and actual values of output, obtain plant level total factor productivity. Finally, assess the extent to which estimates of total factor productivity changes are statistically related to a potentially explanatory variables.[9].

IDB (2002) implications about the performance of exporters do not di¤er from those of Tybout and Westbrook. The hypothesis that exporting plants had higher rates of total factor productivity growth than non-exporting ones is rejected. No correlation between export to sales ratio and total factor productivity growth was found at plant level[10].

By contrast, …ndings unambigously supported the import discipline hypothesis. Stronger competition from foreign goods had a positive impact on productivity. The 10 point reduction in tari¤s between 1993-1999 raised productivity by roughly 4 percentage points. The one percent increase in import output ratio raised productivity by an additional quarter of percentage point. They look for evidence that could suggest that an expanded use of imported inputs favored productivity improvements. For the case of domestic …rms they concluded that using imported inputs does not a¤ect total factor productivity growth; for the case of foreign …rms, that imported inputs have an adverse impact on productivity growth.

The World Bank team uses the AIS and ENESTYC survey to estimated plant productivity between 1993-1997. The study assesses the extent to which productivity gains from exporting have been realized through learning by direct exporters or through spillover to indirect exporters and others.

2.2 Studies in Latin America with industry panel data sets and non-parametric techniques

The Chilean experience of the 1970's has become an arhetipical example to study the e¤ects of total factor productivity changes induced by liberalization of trade regime. Two studies, Pavnick (2002) and Levinshon and Petrin (1999), have analyzed this period. In a recent paper, Bergoeing et. al. (2003) ex-

[9] There are at least three reasons for di¤erences in their total factor productivity results and the ones presented in next section. First and most importantly, each study uses a di¤erent method to correct for biases in the estimation of the production function; second, our study corrects for measurement problems in capital stock to conform with economic concepts, these studies rely on accounting values for initial values of capital stock and for their depreciation rates, do not correct for imputed values of rented buildings or sales of assets during a year. Finally, sample sizes may di¤er, the World Bank study stops at 1997 and the IDB report uses investment as an instrumental variable. Because of this, it is forced to leave out of their estimation those …rms with a year without investing.

[10] They found, however that an increase in favor of Mexican goods in the U.S. market is positive associated with an increase in productivity.

tended the period to include the 1990's. In addition to a larger horizon of study they developed the following methodological point. Estimating of total factor productivity requires correcting for the sources of bias in the coe¢cients of a production function. One of them has as a source the determinants of decision to exit the market. According to these authors, estimation of …rms exit decisions require including as their determinant not only stock of capital -as it is usually done when the Olley Pakes method is used. Changes in taxes, if they a¤ect …rm's decisions must also be included[11]. By the same reasoning, other variables re‡ecting distortionary policies, such as barriers to foreign trade, that a¤ect the development of speci…c sectors should also be incorporated among the determinants of …rm's survival.

[11] This methodological point is also in Medina et. al. 2002, for a study of Productivity Dynamics of the Colombian Manufacturing Sector.

3 Empirical strategy

We seek to shed light on two key issues. Tari¤ reduction leads to performance improvements through two channels: better access to a larger menu of imported inputs and stronger import competition on domestic markets. The main goal of the empirical analysis is to assess the importance of these two channels in the case of Mexican manufacturing …rms.

NAFTA meant a stable and transparent legal environment for foreign investors, a broader protection of trademarks and patents, as well as other measures to facilitate access to foreign technology. For a better understanding of the determinants of plant performance, we analyze the relationship between performance and variables describing access to technology. The two variables considered were expenditures in R&D and technology transfer, and the relative importance of alternative sources of technological transfers.

Throughout, we focus on two aspects of …rm performance, total factor productivity (henceforth, productivity) and job turnover. Firm performance is analyzed at several levels. We construct productivity estimates and job turnover rates for the entire manufacturing sector and, separately, for 2-digit SIC industries. Our empirical strategy is to compare performance across plant characteristics intrinsically related to components of the free trade agreement.

We begin by estimating the replacement value of capital stock, combining information from the Industrial Census and Annual Industrial Survey. Production functions are estimated at two-digit SIC level, using a semiparametric, which we present in detail in the next section. Productivity measures are constructed using production function estimates. The second dimension of plant performance - job reallocation rates - are computed at plant level. The joint study of productivity and job reallocation of Mexican …rms has not been yet attempted. Our goal is to document the relationship between these two dimensions of plant performance.

The main part of our empirical analysis contains the analysis of plant performance across three sets of plant characteristics: degree of integration into international markets, relative strength of import competition faced, and investments in technology. The role of import competition has been extensively studied, with mixed results. Our goal in this paper is, however, broader. Not only do we evaluate the e¤ect of import competition and trade integration on plant performance, but we try to shed light on the relative importance of import competition and better access to imported inputs as channels for performance enhancement e¤ects of trade liberalization. The relationship between performance and investments in technology, to our knowledge, has not been analyzed in the case of Mexico. We analyze this relationship using two di¤erent measures of behavior towards R&D. First, we use actual amounts spent on R&D and technology acquisitions. Second, we use …rms perceptions to infer how NAFTA provisions (broader protection of trademarks and patents, etc.) have a¤ected productivity.

4 Data

This paper uses data from three main sources: Annual Industrial Survey (AIS), Industrial Census (IC), and National Survey of Employment, Salaries, Technology and Training (ENESTYC). The National Institute of Statistics and Geography, INEGI, that gathers and processes these data, allowed us to work with them on their premises, in the City of Aguascalientes.

The initial year of our analysis is 1993. This choice has several advantages. The IC, which takes place every …ve years, was conducted in 1993. Using the 1993 Census as universe, a new sample was selected for AIS. The new sample has almost double the size of the 1984-1992 AIS sample. In addition, being based on the IC, is statistically representative for the manufacturing sector in 1993. The 1998 IC did not give place to a new sample of plants for the AIS. No plant was excluded or included to adjust the AIS sample to the universe provided by the new Census. Although this might have updated the statistical representativity of the industrial sector, in terms of the continuity of the panel, it represented an additional advantage. Thanks to the careful follow-up of plants by personnel of the INEGI, …rms included in the sample because of initiation of operations and those excluded because of bankruptcy are well identi…ed in this data set. A set of identi…ers allows us to match AIS plants with both 1993 and 1998 IC.

The capital stock and a detailed estimation of depreciation rates for each of its components were obtained from the Industrial Census conducted in 1993 and 1998. The questions in the IC for capital stock and depreciation rates refer to the cost of reposition or market price of the stock of capital. Firms are asked to consider reevaluations due to exchange rate variations and, most importantly, to deduct for physical deterioration and its obsolescence. Investment expenditures from the AIS were then used to calculate capital stocks at replacement cost values for every year using a perpetual inventory method. Price de‡ators for capital stock, buildings, rents and electricity were obtained from Banco of Mexico's data bases. Firms in AIS are grouped in 205 classes. INEGI generates a price index for each of them. We employed this price index to de‡ate value added.

ENESTYC surveys- Encuesta nacional de Empleo, Salarios, Tecnología y Capacitacion were conducted in 1995 and 1999. They were designed to measure the impact of opening the economy and modernization on employment. From this survey, we use information on two aspects of the plant's activity: the e¤ect of the free-trade agreement and the source of technology.

The structure of the panel data set with is presented in the table 3.

5 Production function estimation

Two problems must be addressed in estimating production functions with panel data sets. First, the correlation between input levels and unobserved productivity shocks induces simultaneity bias in the OLS estimation. Second, …rms with low realizations of productivity exit the market. If …rms with larger capital stock are more likely to survive negative realizations of productivity shocks, the OLS estimator of the capital coe¢cient will be biased.

Several ways of dealing with these problems have been used in the literature. Olley and Pakes (1996) proposed a technique that allows corrections for both the selection bias introduced by non-random exits and the simultaneity bias. Firm's investment function is modeled as a function of capital and productivity level - unobserved to the econometrician. Under certain conditions, the investment function can be inverted, thus providing an instrument for the unobserved productivity component. The selection bias is corrected by formally modeling …rm's survival decision and incorporating it into the estimation.

Levinsohn and Petrin (2001) have proposed an approach which requires less strict assumptions than those imposed on the investment function in Olley and Pakes. They argue that investment responds only to the non-forecastable component of the productivity shocks. As a result it does not perform well if the productivity term has both a serially correlated component and an idiosyncratic component. Instead, …rm's intermediate input demand is used to obtain an instrument for the unobserved productivity shock.

A number of recent papers have used this idea and employed a modi…ed version of the initial Olley and Pakes approach in which the investment function was replaced by the intermediate input demand. Electricity provides the best instrument since few …rms produce it and it cannot be stored. In this paper we use this later approach.

Consider the production function of …rm at time t:

$$y_{it} = \alpha + \beta_s l_{it}^s + \beta_u l_{it}^u + \beta_k k_{it} + \omega_{it} + \varepsilon_{it} \qquad (1)$$

where y_{it} is log value added, $_s l_{it}^s$ is log of skilled labor, l_{it}^u is log of unskilled labor, k_{it} is log of plant's capital stock, ω_{it} is the level of plant speci…c productivity, and ε_{it} is white noise. A …rm's private knowledge of ω_{it} plays a role in both exit and input choice decisions. Firm's demand for electricity is:

$$e_{it} = e_{it}(\omega_{it}, k_{it})$$

Under monotonicity conditions, the demand function can be inverted,

$$\omega_{it} = \omega_{it}(e_{it}, k_{it})$$

Replacing ω_{it}, (1) becomes:

$$y_{it} = \beta_s l_{it}^s + \beta_u l_{it}^u + \phi(e_{it}, k_{it}) + \varepsilon_{it} \qquad (2)$$

where $\phi(e_{it}, k_{it}) = \alpha + \beta_k k_{it} + \omega_{it}$

In the first step we use OLS to estimate $\hat{\beta}_s$ and $\hat{\beta}_u$ in (2) where $\phi(e_{it}, k_{it})$ is represented by a polynomial expansion in e_{it} and k_{it}. Using the coefficient estimates at the first step, we calculate an estimate for $\phi(e_{it}, k_{it})$, $\hat{\phi}(e_{it}, k_{it}) = y_{it} - \hat{\beta}_s l^s_{it} - \hat{\beta}_u l^u_{it}$

Let

$$y^*_{it+1} = y_{it+1} - \beta_s l^s_{it+1} - \beta_u l^u_{it+1} = \alpha + \beta_k k_{it+1} + \omega_{it+1} + \varepsilon_{it+1} \quad (3)$$

To address the selection bias problem, firm's exit decision is specifically modelled. Writing the realization of the new productivity shock as a sum of a forecasted component and an idiosyncratic component, $\omega_{it+1} = E[\omega_{it+1}|\omega_{it}] + \eta_{it+1}$,and denoting $g(\omega_{it}) = \alpha + E[\omega_{it+1}|\omega_{it}]$, (3) becomes

$$y^*_{it+1} = \beta_k k_{it+1} + g(\omega_{it}) + \varepsilon_{it+1}$$

A firm is observed only if the realization of productivity is above a certain threshold. The firms exit decision is then represented by:

$$\begin{aligned} X_t &= 1 \text{ if } \omega_t > \underline{\omega_t} \\ X_t &= 0 \text{ otherwise} \end{aligned}$$

Incorporating the exit decision, (3) becomes:

$$\begin{aligned} y^*_{it+1} &= y_{it+1} - \beta_s l^s_{it+1} - \beta_u l^u_{it+1} = \\ &= \alpha + \beta_k k_{it+1} + E\left[\omega_{it+1}|\omega_{it}, \omega_{t+1} > \underline{\omega_{t+1}}\right] + \eta_{it+1} + \varepsilon_{it+1} \end{aligned}$$

The second estimation step is then:

$$\begin{aligned} y^*_{it+1} = y_{it+1} - \hat{\beta}_s l^s_{it+1} - \hat{\beta}_u l^u_{it+1} = \\ = \beta_k k_{it+1} + g\left(\hat{\phi}(e_{it}, k_{it}) - \beta_k k_{it}, \hat{P}_{it}\right) + \eta_{it+1} + \varepsilon_{it+1} \quad (4) \end{aligned}$$

We use a polynomial expansion for g, $g\left(\hat{\phi}(e_{it}, k_{it}) - \beta_k k_{it}, \hat{P}_{it}\right) = \sum_j \sum_l \beta_{jl} \left(\hat{\phi}(e_{it}, k_{it}) - \beta_k k_{it}\right)^j \hat{P}^l_{it}$ and non-linear least square to estimate (4).

Finally, using the coefficient estimates from the two steps, we calculate total factor productivity as

$$\hat{\omega}_{it} = y_{it} - \hat{\beta}_s l^s_{it} - \hat{\beta}_u l^u_{it} - \hat{\beta}_k k_{it} \quad (5)$$

Production functions are estimated separately for eight two-digit SIC manufacturing industries: food processing textiles and apparel, manufacture of wood products, manufacture of paper and paper products, chemical industry, glass, basic metals, and manufacturing of machinery and equipment. We compare coefficient estimates for three alternative specifications: fixed effects estimation of both the balanced panel and the full data set (tables 4 and 5), and the semiparametric estimation of the full data set (table 6). The fixed-effect estimates are similar for the balanced panel and the full-data set. The main reason for this is the small number of firms exiting. Findings are consistent with the predictions about the signs of the biases.

For all sectors, semiparametric estimation yields higher coefficients of capital and skilled labor, and lower coefficients of unskilled labor. This finding is consistent with the predictions regarding simultaneity bias: the use of easily adjustable factors, like unskilled labor, is positively correlated with productivity shocks, inducing upward biased of fixed effect estimates. The reverse is true for factors which are slow to adjust like skilled labor. Higher capital coefficients are consistent with the prediction that large firms have a better chance to survive adverse productivity shocks.

A further indication that the semiparametric estimation provides superior results in given in table 7. We use the estimated coefficients to calculate marginal product of capital and the ratio of the marginal products of unskilled and skilled labor. Fixed effect estimates yield counterintuitive higher marginal product for unskilled workers for six of the eight sectors, while the semiparametric approach delivers reasonable marginal product estimates for the two categories of labor.

Finally, four of the nine sectors display increasing returns to scale when using the semiparametric approach. No sector is characterized by increasing returns to scale if the fixed effect estimates are used.

6 Results

6.1 Manufacturing: productivity and job reallocation

Using coefficient estimates from the semiparametric estimation, we construct a measure of plant productivity. The productivity index (used, among others by Pavcnik, 2002) measures the distance from average industry practice in a base year for each plant. Formally, let pr_{it} be the value of the productivity index of plant i in period t. Then,

$$pr_{it} = y_{it} - \hat{\beta}_s l^s_{it} - \hat{\beta}_u l^u_{it} - \hat{\beta}_k k_{it} - (y_r - \hat{y}_r)$$

where $y_r = \bar{y}_{it}$ and $\hat{y}_r = \hat{\beta}_s \bar{l}^s_{it} - \hat{\beta}_u \bar{l}^u_{it} - \hat{\beta}_k \bar{k}_{it}$

Productivity gains at industry level can be realized either through productivity gains at plant level or through reshuffling of resources from less productive to more productive firms. We compute the measure of aggregate industry productivity W_t as a weighted average of individual productivity levels. Weights s_{it} are given by value added share in total industry value added in a particular year. The aggregate productivity measure is decomposed in two components. The unweighted productivity measure $\overline{pr}_t$ measures productivity gains at plant level while the covariance between plants' value added share and productivity gives a measure of industry productivity gains through resource reshuffling.

$$W_t = \sum_i s_{it} pr_{it} = \overline{pr}_t + \sum_i (s_{it} - \bar{s}_t)(pr_{it} - \overline{pr}_t)$$

Table 8 shows the results of the decomposition. Productivity index measures deviations from mean industry productivity in 1993, the first year of the panel. Values in the table are normalized by subtracting corresponding 1993 levels. Between 1993 and 2000 all industries realize important aggregate productivity gains. Glass, basic metals, and manufacturing of machinery, and equipment are the fastest growing industries. Reshuffling of resources from less productive to more productive firms is the dominant mechanism for industry productivity gains. With the exception of basic metals, the covariance component exceeds the unweighted productivity component for all industries. The crisis of 1995 is clearly marked by sharp drops in unweighted productivity measures and more intense reallocation of resources. The rates of job reallocation, shown in table 12 paint a similar picture. Year 1995 is characterized by large job destruction rates across sectors, while during 1996 most sector rebounded displaying high job creation rates. Just as in the case of productivity, employment reallocation rates were much higher during these years pointing towards an intense process of resource reallocation. Besides the importance of resource reallocation as source of performance improvement, these results underscore the importance of analyzing jointly productivity and job reallocation at plant level.

6.2 Reduction of tariffs: better input mix or import competition

Have reduction in tariffs and the implied international openness of economy affected plants' productivity? We analyze firm performance across two dimensions of market openness. First, we how the degree of integration in international markets affect performance. The degree of integration is measured using plants' export performance and their relative share of imported intermediary inputs. We define three categories of export performance - no exports, export less than 20 percent of sales, and export more than 20 percent of sales - and two categories of usage of imported inputs - import less than 20 percent of inputs and import 20 percent or more. In the regression analysis we use the six categories resulting from the interaction of export performance and use of imported inputs. Table 9 shows the results of a regression of productivity index on a quartic in from size, year dummies, dummy variables for the degree of integration in international markets, and interaction effects of year and degree of integration. Figure 1 compares plant productivity for all years across our measure of degree of integration in international markets. The main feature is the superior performance of firms using a large share of imported inputs. For all years and all categories of export performance, larger shares of imported inputs are associated with higher productivity. The difference becomes stronger over time, as firms using a larger menu of imported inputs display more robust growth patterns. Large exporters using a large share of imported inputs (exp2imp2) have the strongest productivity growth. Firms selling exclusively on the domestic market and using small quantities of imported inputs (exp0imp1) were worst hit by the 1995 crises. At the same time, the downturn in the US economy during late 1990's had a stronger effect on large exporters with low imported inputs use (exp2imp1).

Reduced tariffs stiffen import competition and may have a disciplining, productivity-enhancing effect on domestic plants. We use firms perceptions about the effects of NAFTA to define a measure of import competition at 4-digit SIC level. A sector is categorized as import competing if more than 38 percent (median level) of the firms considered import competition to be the strongest effect of NAFTA. Table 10 shows estimates of a regression of productivity on the level of import competition. As before, we control for plant size and include year dummies and interaction effects. Figure 2 shows the estimated productivity levels. We could find no significant effect of import competition on firm productivity.

Our findings underscore the importance of better access to imported inputs as a channel for productivity enhancement effects of tariff reductions.

Tables 9 and 10 show results for regressions of gross job reallocation rate and rate of net employment change, respectively, on the same right hand side variables - measure of plant size, and variables describing the degree of integration into international markets and the level of import competition. Figures 3 to 6 plot the estimated turnover rates. Year 1995 to 1997 are characterized by high turnover rates. In 1995 they were driven by large job destruction an in the subsequent years by high job creation rates. During the rest of the period turnover rates were at normal levels, 10-15%. Plant behavior with respect to these two dimensions of performance is di¤erent across periods with high and normal turnover. Degree of integration has no signi…cant e¤ect during normal turnover years. Exporting …rms and those using larger shares of imported inputs perform better during high turnover years. Plants in import competing sectors appear to be more "under the weather" as far as job turnover rates are concerned. They display higher rates of gross job reallocation in more turbulent years. rates of net employment change are more extreme for import competing plants. They tend to destroy more jobs in years with negative overall job change and to create more jobs in years with employment growth.

6.3 Investment in technology

Recent empirical studies suggest that adoption of technology may be far from automatic. Gri¢ th et. al. (2000), for example, highlight that investments in research an development help …rms achieve an "absorptive capacity" which facilitates technology adoption. This argument suggest that productivity growth is related to expenditures in research and development in technology, as well as to other variables directly re‡ecting a degree of access to foreign technology.

We use estimated productivity index to study the relationship between investments in R&D and productivity. Plants are classi…ed in three categories according to the annual amount allocated to R&D and transfer of technology: zero expenditures (noinv), positive amount but below 5% of yearly sales (invsm), and those with expenditures above 5% (invlrg). Table 11 shows the results of the regression of productivity index on a quartic in plant size, year dummies, dummy variables for categories of investment in R&D, and interactions between year and investment categories. Figure 2 compares estimated productivity levels for every year across levels of investment in R&D. Regression results show a clear positive e¤ect of investments in technology. Firms that invest in R&D are, at all times, more productive than …rms that do not invest and display faster growth. Figure 2 shows an even sharper picture. Not only investments in R&D are raising productivity, but the amount invested signi…cantly determines the rate of growth. If in 1993 …rms with small and large investments were not signi…cantly di¤erent, by 1997, the higher rate of growth made large investors signi…cantly more productive - di¤erence which persisted until 2000. It is interesting to note that …rms which invest more in R&D performed better during the 1995 crisis and showed no productivity decline in 2000.

Job turnover rates are also signi…cantly di¤erent across levels of investment in technology. During years with high turnover rates, 1994 to 1998, …rms which make no investments experience higher rates of gross job reallocation and lower rates on net employment change. Plants investing in R&D were less a¤ected by the 1995 crisis. Their job turnover rates remained relatively unchanged and positive net change rates resumed after one year of employment loss.

7 Conclusions and future research directions

We analyze performance of Mexican manufacturing firms between 1993 and 2000, following implementation of North-American Free-trade agreement. The plant-level panel data set was constructed combining information from three sources: Annual Industrial Survey, Industrial Census, and National Survey of Employment, Salaries, Technology and Training. The main goal of the empirical analysis is to evaluate the effect integration into international markets, import competition, and investment in technology on two dimensions of firm performance, productivity and job turnover. Production functions for two-digit SIC industries are estimated using a semiparametric approach which controls for selection and simultaneity biases. Estimates are used in subsequent analysis.

Our findings suggest that the degree of integration in international markets is a strong determinant of firm performance. Firms using larger shares of imported inputs show stronger productivity growth. Better access to imported inputs has a stronger positive effect of productivity for firms exporting larger shares of output. Results are mixed with respect to import competition. The most significant results indicate that firms in facing stronger import competition do not become more productive. Particularly sharp are the results concerning the effect of using more imported inputs. Combined, these results suggest that better access to imported inputs is the more significant vehicle for productivity enhancing effects of trade openness. Investment in technology is, by far, most strongly correlated with plant productivity.

The study of job turnover in relation to trade-related plant characteristics yielded very interesting results. Like, productivity, job turnover at firm level is strongly influenced by the degree of integration in international markets, import competition, and R&D behavior. Firm performance differs significantly across years with high/low(or normal) turnover. With a high variation in job turnover over a relatively short period of time, Mexican economy during 1993-2000, provides the perfect case study. There are no significant performance differences across integration, import competition, and investments in technology in low turnover year. In high turnover years, integration and expenditures in technology have a positive impact on firms performance, while import competition affects negatively firms' prospects.

Our results differ from findings of IDB (2002) in several respects. We found that efficiency gap between exporters and non exporters and between large and small exporters grew significantly during the period. Exporters with high share intermediate input users were those that gain most in terms of efficiency[12]. We also find no evidence of enhanced productivity in import competing firms.

We are still in the process of checking alternative and complementary specifications and variables, regarding the effect of enhanced foreign competition in

[12] The data base is the same as the one used in the IDB study: It excludes in-bond plants, called as well maquiladoras.

local markets of …nal products. Firstly, we are considering if the e¤ect of import tari¤s reductions during the period 1993-2000 have adequately been captured with the qualitative variables based on manufacturer's own perceptions. An initial procedure to check the robustness of our results is to regress our rates of growth on plant's total factor productivity with variations in import tari¤s as independent variable - thereby re‡ecting some degree of myopic behavior.

A more elaborate procedure involves constructing a variable that indicates the phasing out category for the elimination of tari¤s to which the product belonged. Knowledge of their category allowed each producers to anticipate tari¤ levels for the rest of the decade. This step, as suggested in the text would require reestimation of production function, to the extent that exit decisions - a source of bias in estimations - are also a¤ected by this variable. (A similar line of argument suggests the inclusion of proxies of …rms' …nancial liquidity to explain their exit decisions).

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Table 1. Tari¤ phase-out schedules

Tari¤ category	Phase-out schedule
A	elimination upon the implementation of NAFTA, Jan 1994
B	…ve equal annual stages, between 1994 and 1998.
C	ten equal annual stages, between 1994 and 2003.
D	already free trade
B+ (most textile tari¤s)	seven stages: 20% in 1994, 0% in 1995, 10% per year between 1996 and 2000, 30% in 2001.
B8-	two stages: 50% in 1998 and 50% in 2001.

Table 2. U.S. imports from Mexico 1993-1998.

Sector	value (millions USD)			share of total US imports (%)			
	1993	1996	1998	1993	1996	1997	1998
Textiles	204	775	1,343	1.88	6.89	8.46	8.92
Apparel	2,367	4,319	6,889	7.65	11.30	12.91	14.24
Furniture	956	1,514	2,248	14.42	15.98	16.76	16.85
Primary metal	3,139	5,517	6,064	12.53	16.82	17.39	16.31
Fabricated metal	1,124	1,957	3,193	7.23	9.43	11.80	13.04
Machinery	2,471	3,853	5,251	3.21	4.88	5.42	6.14
Electrical	8,888	10,293	10,020	11.62	17.94	17.95	18.07
Transportation	6,015	15,034	17,741	6.22	12.40	12.20	12.08
Scienti…c instr.	1,459	2,481	3,549	6.61	9.47	10.16	12.35
Total non-oil	35,685	66,602	89,700				

Table 3. The number of …rms in the unblalanced panel and average employment by sector

Sector	1993	1994	1995	1996	1997	1998	1999	2000
Observations								
Food	743	735	731	720	707	702	702	702
Textiles	747	733	704	674	634	630	627	627
Wood	150	148	142	133	129	129	127	127
Paper	328	325	321	318	317	316	317	317
Chemical	870	863	846	830	819	820	818	818
Glass	287	275	264	254	245	243	242	242
Metals	111	108	104	105	101	101	101	101
Machinery	1013	1005	981	948	924	920	915	915
Mean employment								
Food	365.9	368.9	368.8	378.2	391.1	404.5	418.3	421.2
Textiles	190.8	187.9	179.4	200.5	232.4	235.3	239.9	241.7
Wood	119.3	122.6	116.0	132.3	147.2	155.9	160.9	160.8
Paper	215.7	213.2	204.0	209.5	218.3	222.0	226.4	228.2
Chemical	205.9	206.0	199.8	210.9	226.4	239.2	243.7	249.3
Glass	233.2	234.0	224.6	232.1	249.4	262.7	266.4	271.5
Metals	443.8	442.2	429.2	442.6	476.0	470.3	457.8	454.2
Machinery	285.3	279.9	254.7	282.3	326.7	362.3	375.3	390.1

Table 4. Estimates of production functions. Balanced Panel, Fixed e¤ects

sector	capital		labor unskilled		labor skilled	
	coe¤.	S.E.	coe¤.	S.E	coe¤.	S.E
Food processing	0.247**	0.021	0.430**	0.027	0.225**	0.022
Textiles	0.101**	0.021	0.577**	0.029	0.196**	0.025
Wood	0.238**	0.051	0.554**	0.061	0.060	0.060
Paper	0.119**	0.027	0.484**	0.040	0.277**	0.038
Chemical	0.204**	0.018	0.499**	0.023	0.229**	0.021
Glass	0.117**	0.030	0.603**	0.052	0.041	0.047
Basic metals	0.079	0.059	0.596**	0.060	-0.038	0.060
Machinery	0.220**	0.014	0.658**	0.018	0.141**	0.017

**Signi…cant at 95 percent level. *Signi…cant at 90 percent level

Table 5. Estimates of production functions. Unbalanced Panel, Fixed e¤ect

sector	capital		labor unskilled		labor skilled	
	coe¤.	S.E.	coe¤.	S.E	coe¤.	S.E
Food processing	0.231**	0.020	0.426**	0.027	0.241**	0.022
Textiles	0.123**	0.020	0.603**	0.028	0.184**	0.025
Wood	0.241**	0.050	0.617**	0.060	0.058	0.060
Paper	0.127**	0.026	0.485**	0.040	0.277**	0.038
Chemical	0.206**	0.017	0.507**	0.023	0.229**	0.021
Glass	0.145**	0.031	0.671**	0.051	0.016	0.046
Basic metals	0.116**	0.058	0.586**	0.058	-0.011	0.059
Machinery	0.253**	0.015	0.685**	0.018	0.154**	0.017

**Signi…cant at 95 percent level. *Signi…cant at 90 percent level

Table 6. Estimates of production functions. Unbalanced Panel, Semiparametric estimation

sector	capital		labor unskilled		labor skilled		RTS	
	coe¤.	S.E.	coe¤.	S.E	coe¤.	S.E	Coe¤.	S.E
Food processing	0.340**	0.048	0.294**	0.033	0.303**	0.031	0.94	0.05
Textiles	0.352**	0.043	0.487**	0.030	0.307**	0.029	1.15**	0.04
Wood	0.380**	0.106	0.345**	0.086	0.345**	0.063	1.07	0.13
Paper	0.196**	0.085	0.375**	0.047	0.391**	0.030	0.96	0.10
Chemical	0.522**	0.036	0.137**	0.036	0.500**	0.031	1.16**	0.05
Glass	0.351**	0.109	0.148**	0.053	0.388**	0.049	0.89	0.11
Basic metals	0.485**	0.149	0.516**	0.100	0.221**	0.075	1.22	0.16
Machinery	0.475**	0.026	0.289**	0.025	0.402**	0.022	1.17**	0.03

**Signi…cant at 95 percent level. *Signi…cant at 90 percent level
Note: bootstrap standard errors are presented

Table 7. Comparison of estimation results

sector	capital	labor	MP_{BC}/MP_{WC}	
	%VAD	%VAD	OLS	Semiparametric estimation
Food processing	0.700	0.380	0.86	0.479
Textiles	0.568	0.690	0.792	0.383
Wood	0.563	0.642	2.206	0.207
Paper	0.516	0.618	1.06	0.607
Chemical	0.694	0.308	1.322	0.163
Glass	0.659	0.533	14.40	0.128
Basic metals	0.527	0.725	-22.66	0.955
Machinery	0.628	0.511	1.53	0.252

Table 8. Change in productivity by sector.

Sector	1994	1995	1996	1997	1998	1999	2000
Aggregate productivity							
Food	0.045	-0.003	-0.032	0.015	0.113	0.178	0.260
Textile	0.071	0.125	0.224	0.200	0.200	0.181	0.190
Wood	-0.030	-0.137	0.019	0.049	0.067	0.137	0.144
Paper	0.006	0.029	0.034	0.113	0.151	0.213	0.198
Chemical	0.046	0.034	0.065	0.153	0.184	0.168	0.187
Glass	0.121	0.020	0.279	0.359	0.419	0.450	0.503
Metals	0.174	0.262	0.413	0.523	0.460	0.473	0.475
Machinery	0.110	0.070	0.316	0.376	0.361	0.382	0.502
Unweighted productivity							
Food	0.020	0.056	0.035	0.018	0.079	0.100	0.056
Textile	0.045	-0.043	0.039	0.059	0.008	-0.026	-0.053
Wood	-0.038	-0.193	0.002	-0.008	0.025	0.023	-0.055
Paper	0.053	-0.038	-0.016	0.142	0.167	0.172	0.173
Chemical	0.023	-0.021	0.050	0.038	0.069	0.040	-0.008
Glass	0.075	-0.223	-0.134	0.019	0.082	0.220	0.160
Metals	0.070	0.098	0.188	0.288	0.390	0.380	0.281
Machinery	0.052	-0.125	0.021	0.095	0.105	0.055	0.073
Covariance							
Food	0.025	-0.059	-0.067	-0.003	0.034	0.078	0.203
Textile	0.025	0.169	0.185	0.142	0.192	0.207	0.244
Wood	0.007	0.056	0.016	0.057	0.042	0.114	0.199
Paper	-0.047	0.067	0.049	-0.030	-0.016	0.040	0.025
Chemical	0.023	0.055	0.015	0.115	0.115	0.128	0.195
Glass	0.046	0.243	0.413	0.339	0.337	0.230	0.343
Metals	0.104	0.163	0.225	0.235	0.070	0.093	0.193
Machinery	0.058	0.195	0.295	0.281	0.256	0.326	0.430

Table 9. The effect of the degree of integration in international markets on firm performance

Variable	Productivity		Empl. change (abs.)		Net Empl. change	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Const	4.493**	2.121	3.589**	0.277	-3.659**	0.291
Year dummies						
1994	0.038**	0.018	-	-	-	-
1995	-0.146**	0.024	0.068**	0.013	-0.109**	0.015
1996	-0.084**	0.026	0.047**	0.013	-0.031**	0.015
1997	-0.004	0.025	0.038**	0.014	0.016	0.016
1998	0.037	0.025	-0.036**	0.012	0.080**	0.014
1999	0.059**	0.026	-0.039**	0.011	0.071**	0.013
2000	0.029	0.027	-0.079**	0.009	0.060**	0.011
size	-3.381**	1.650	-5.059**	0.470	5.264**	0.490
size^2	0.889*	0.465	2.785**	0.293	-2.827**	0.303
size^3	-0.099*	0.056	-0.675**	0.079	0.667**	0.081
size^4	0.004*	0.002	0.060**	0.008	-0.058**	0.008
Interactions export status x import status						
exp0imp2	0.111**	0.054	-0.019	0.017	0.052**	0.021
exp1imp1	0.059**	0.029	-0.014	0.010	0.027**	0.012
exp1imp2	0.072**	0.035	-0.038**	0.010	0.023*	0.012
exp2imp1	-0.167**	0.024	-0.002	0.015	0.041**	0.019
exp2imp2	-0.027	0.146	-0.028**	0.011	0.030**	0.013

Table 9 (continued). The e¤ect of the degree of integration in international markets on …rm performance.

Variable	Productivity		Empl.change (abs.)		Net Empl. change	
	Coe¤.	S.E.	Coe¤.	S.E.	Coe¤.	S.E.
Interactions export status x import status x year						
exp0imp2						
1994	0.007	0.043	-	-	-	-
1995	0.144**	0.054	-0.060**	0.022	0.006	0.027
1996	0.108*	0.058	-0.015	0.029	0.014	0.035
1997	-0.020	0.061	-0.055**	0.024	0.014	0.029
1998	0.016	0.057	0.036	0.029	-0.063*	0.034
1999	0.004	0.059	-0.010	0.020	-0.060**	0.024
2000	0.026	0.064	0.028	0.021	-0.056**	0.025
exp1imp1						
1994	-0.024	0.025	-	-	-	-
1995	0.046	0.032	-0.032**	0.015	0.020	0.019
1996	0.080**	0.035	-0.021	0.017	0.076	0.020*
1997	0.032	0.035	-0.009	0.018	0.049	0.021**
1998	-0.016	0.035	0.024*	0.015	-0.040	0.017**
1999	-0.032	0.036	0.009	0.013	-0.063	0.016**
2000	-0.049	0.038	0.030**	0.011	-0.051	0.014**
exp1imp2						
1994	0.019	0.026	-	-	-	-
1995	0.183**	0.035	-0.045	0.015	0.055	0.018
1996	0.210**	0.036	-0.015	0.017	0.111	0.020
1997	0.167**	0.037	-0.019	0.016	0.071	0.019
1998	0.155**	0.037	0.045	0.014	0.000	0.017
1999	0.087**	0.041	0.038	0.013	-0.037	0.016
2000	0.093**	0.041	0.070	0.011	-0.034	0.014

Table 9 (continued). The effect of the degree of integration in international markets on firm performance.

Variable	Productivity		Empl. change (abs.)		Net empl. change	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E
Interactions export status x import status x year						
exp2imp1						
1994	-0.005	0.048	-	-	-	-
1995	0.240**	0.057	-0.046**	0.021	0.114**	0.029
1996	0.226**	0.062	-0.019	0.022	0.133**	0.027
1997	0.148**	0.063	-0.012	0.025	0.045	0.031
1998	0.085	0.063	0.014	0.019	-0.062**	0.025
1999	-0.050	0.070	0.024	0.020	-0.086**	0.026
2000	-0.002	0.068	0.039**	0.019	-0.114**	0.025
exp2imp2						
1994	0.051	0.042	-	-	-	-
1995	0.283**	0.044	-0.054**	0.016	0.076**	0.020
1996	0.280**	0.045	-0.009	0.019	0.112**	0.023
1997	0.193**	0.043	-0.011	0.018	0.088**	0.021
1998	0.162**	0.042	0.049**	0.016	-0.014	0.019
1999	0.102**	0.043	0.039**	0.015	-0.074**	0.018
2000	0.119**	0.044	0.076**	0.013	-0.049**	0.017

Table 10. The effect of import competition on firm performance. Import competition is a dummy variable

	Productivity		Emp. change (abs.)		Net emp.change	
Variable	Coeff.	S.E	Coeff	S.E	Coeff	S.E
Const	4.485**	2.144	3.583**	0.278	-3.644**	0.296
Year dummies						
1994	0.023*	0.014	-	-	-	-
1995	-0.052**	0.018	0.027**	0.007	-0.066**	0.009
1996	0.005	0.019	0.021**	0.007	0.016*	0.009
1997	0.050**	0.019	0.018**	0.008	0.036**	0.009
1998	0.090**	0.019	-0.016**	0.007	0.038**	0.008
1999	0.096**	0.019	-0.022**	0.006	0.018**	0.008
2000	0.055**	0.021	-0.049**	0.006	0.011*	0.007
size	-3.419**	1.666	-5.034**	0.472	5.201**	0.498
size2	0.907**	0.469	2.754**	0.293	-2.762**	0.308
size3	-0.101*	0.057	-0.664**	0.079	0.648**	0.083
size4	0.004*	0.003	0.059**	0.008	-0.056**	0.008
impcomp	0.003	0.025	-0.007	0.007	-0.011	0.008
Interactions import competition x year						
1994	0.031*	0.019	-	-	-	-
1995	-0.003	0.025	0.023**	0.010	-0.021*	0.013
1996	0.036	0.026	0.029**	0.012	0.043**	0.014
1997	0.022	0.027	0.018	0.011	0.049**	0.014
1998	-0.018	0.027	0.009	0.010	0.047**	0.012
1999	-0.051*	0.028	-0.003	0.009	0.021*	0.011
2000	-0.023	0.029	0.011	0.008	0.021**	0.010

Table 11. The e¤ect of investments in R&D on …rm performance

Variable	Productivity		Empl. change (abs.)		Net empl. change	
	coe¤.	S.E	coe¤.	S.E	coe¤.	S.E.
Constant	4.518**	2.148	3.602**	0.276	-3.681**	0.294
Year dummies						
1994	0.025*	0.016	-	-	-	-
1995	-0.114**	0.021	0.055**	0.011	-0.095**	0.013
1996	-0.038*	0.023	0.061**	0.013	0.014**	0.015
1997	0.009	0.023	0.035**	0.013	0.042**	0.014
1998	0.042*	0.023	-0.035**	0.010	0.071**	0.012
1999	0.020	0.024	-0.048**	0.009	0.052**	0.011
2000	-0.005	0.024	-0.078**	0.008	0.045**	0.010
size	-3.435**	1.671	-5.076**	0.468	5.269**	0.495
size^2	0.912*	0.471	2.795**	0.291	-2.814**	0.306
size^3	-0.103*	0.057	-0.677**	0.079	0.660**	0.082
size^4	0.004*	0.003	0.060**	0.008	-0.057**	0.008
Investment status (no R&D investments excluded)						
Small R&D inv.	0.078**	0.026	-0.040**	0.008	0.032**	0.010
Large R&D inv.	0.113**	0.051	-0.047**	0.011	0.041**	0.014

Table 11 (continued). The e¤ect of investments in R&D on …rm performance

Variable	Productivity		Empl. change (abs.)		Net empl. change	
	coe¤.	S.E	coe¤.	S.E	coe¤.	S.E.
Interactions investment status x year						
Small R&D investments						
1994	0.020	0.020	-	-	-	-
1995	0.101**	0.026	-0.028**	0.012	0.033**	0.015
1996	0.092**	0.028	-0.044**	0.014	0.035**	0.016
1997	0.072**	0.029	-0.015	0.014	0.030*	0.016
1998	0.049*	0.029	0.032**	0.011	-0.022*	0.014
1999	0.067**	0.030	0.037**	0.011	-0.036**	0.013
2000	0.059*	0.031	0.052**	0.009	-0.037**	0.012
Large R&D investments						
1994	0.045	0.032	-	-	-	-
1995	0.136**	0.045	-0.024	0.017	0.013	0.020
1996	0.150**	0.051	-0.026	0.020	0.025	0.024
1997	0.159**	0.049	0.003	0.021	-0.003	0.025
1998	0.150**	0.053	0.068**	0.019	0.001	0.023
1999	0.171**	0.052	0.050**	0.015	-0.046**	0.019
2000	0.193**	0.055	0.068**	0.014	-0.034*	0.018

Table 12. Rates of job creation and distruction

Sector	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Rate of job creation							
Food	0.058	0.062	0.065	0.067	0.065	0.068	0.044
Textiles	0.054	0.039	0.125	0.130	0.063	0.065	0.057
Wood	0.095	0.051	0.131	0.135	0.099	0.066	0.069
Paper	0.048	0.032	0.059	0.065	0.055	0.068	0.041
Chemical	0.056	0.037	0.073	0.086	0.089	0.062	0.056
Glass	0.051	0.031	0.054	0.070	0.068	0.052	0.053
Metals	0.044	0.054	0.077	0.070	0.060	0.021	0.030
Machinery	0.052	0.035	0.131	0.150	0.125	0.081	0.086
Rate of job distruction							
Food	0.060	0.069	0.055	0.052	0.039	0.034	0.037
Textiles	0.091	0.126	0.055	0.047	0.057	0.050	0.049
Wood	0.083	0.140	0.069	0.059	0.041	0.050	0.069
Paper	0.070	0.089	0.042	0.027	0.041	0.045	0.032
Chemical	0.064	0.087	0.039	0.029	0.037	0.046	0.033
Glass	0.089	0.108	0.063	0.036	0.024	0.043	0.034
Metals	0.072	0.120	0.036	0.036	0.072	0.048	0.038
Machinery	0.079	0.152	0.062	0.029	0.027	0.051	0.047

Table 12 (continued). Rates of job creation and distruction

Sector	93-94	94-95	95-96	96-97	97-98	98-99	99-00
Rate of net change							
Food	-0.002	-0.007	0.010	0.016	0.027	0.034	0.007
Textiles	-0.037	-0.087	0.069	0.083	0.006	0.015	0.007
Wood	0.013	-0.089	0.062	0.076	0.058	0.016	0.000
Paper	-0.022	-0.057	0.018	0.038	0.014	0.023	0.008
Chemical	-0.008	-0.050	0.035	0.057	0.051	0.016	0.023
Glass	-0.038	-0.076	-0.010	0.035	0.044	0.010	0.019
Metals	-0.027	-0.066	0.040	0.034	-0.012	-0.027	-0.008
Machinery	-0.027	-0.117	0.069	0.121	0.099	0.030	0.039
Rate of reallocation							
Food	0.118	0.131	0.120	0.119	0.104	0.102	0.081
Textiles	0.145	0.165	0.180	0.176	0.119	0.116	0.106
Wood	0.178	0.191	0.200	0.193	0.141	0.116	0.138
Paper	0.119	0.121	0.101	0.092	0.096	0.114	0.073
Chemical	0.121	0.124	0.112	0.115	0.126	0.108	0.089
Glass	0.140	0.139	0.117	0.106	0.092	0.095	0.087
Metals	0.116	0.175	0.113	0.106	0.132	0.069	0.069
Machinery	0.131	0.188	0.193	0.179	0.152	0.131	0.133
Rate of excess reallocation							
Food	0.116	0.124	0.110	0.104	0.077	0.068	0.074
Textiles	0.108	0.079	0.111	0.093	0.113	0.101	0.099
Wood	0.165	0.102	0.138	0.117	0.083	0.100	0.138
Paper	0.097	0.064	0.083	0.055	0.083	0.091	0.065
Chemical	0.113	0.073	0.077	0.058	0.075	0.092	0.067
Glass	0.101	0.062	0.107	0.071	0.048	0.085	0.067
Metals	0.089	0.109	0.073	0.072	0.120	0.042	0.061
Machinery	0.104	0.071	0.124	0.058	0.054	0.102	0.094

Figure 1. The e¤ect of trade integration on productivity

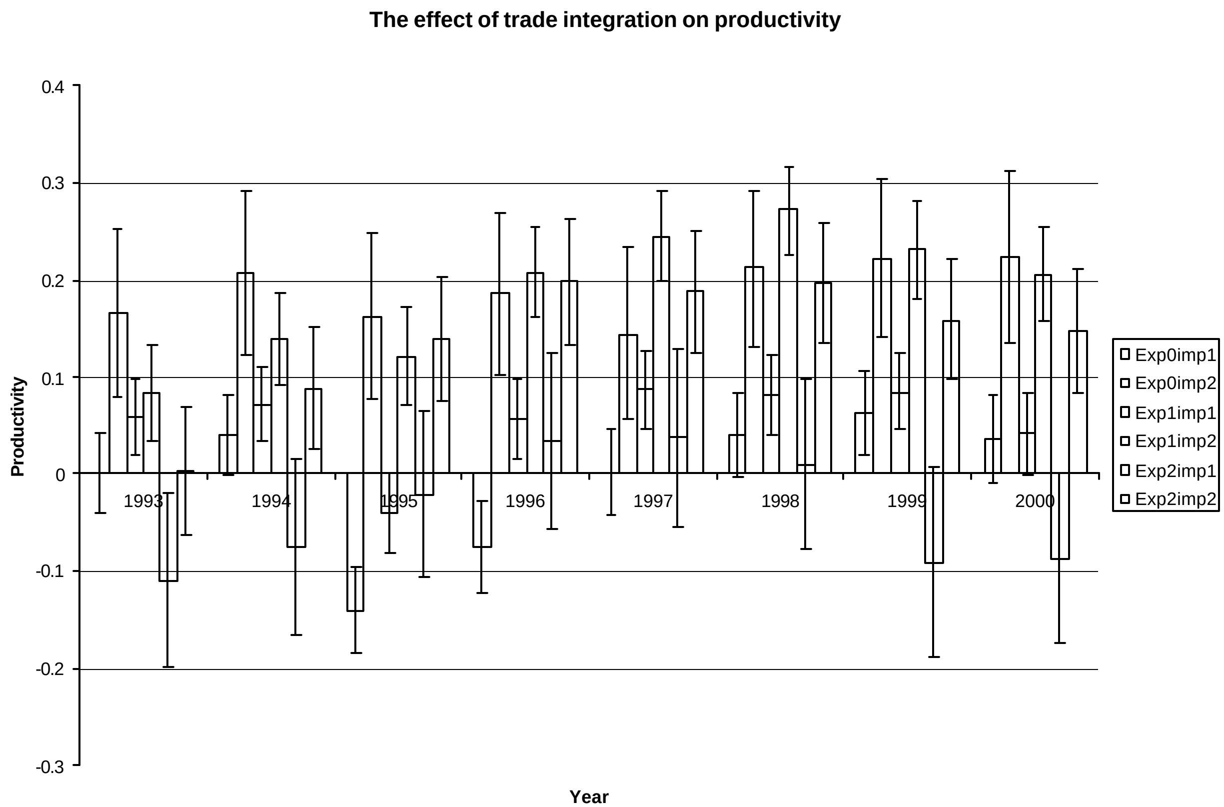


Figure 2. The e¤ect of import competition on productivity

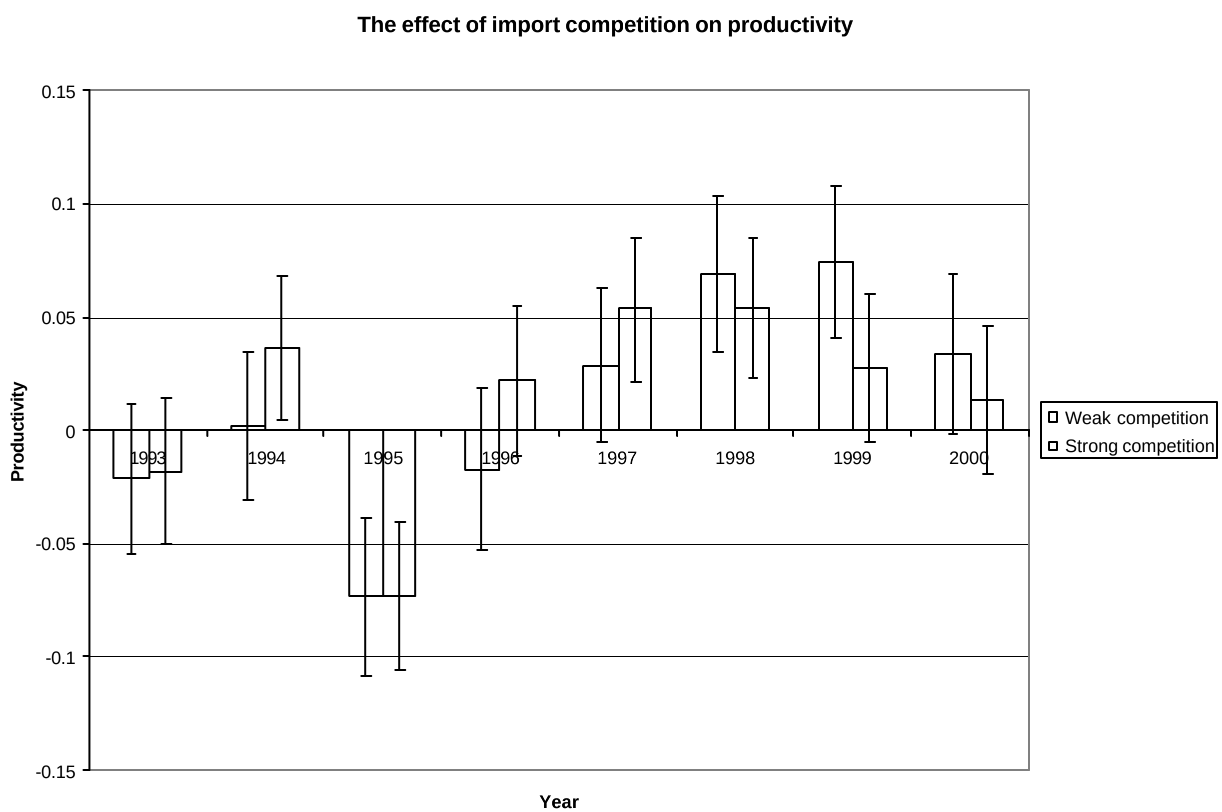


Figure 3. The e¤ect of trade integration on the rate of net job change

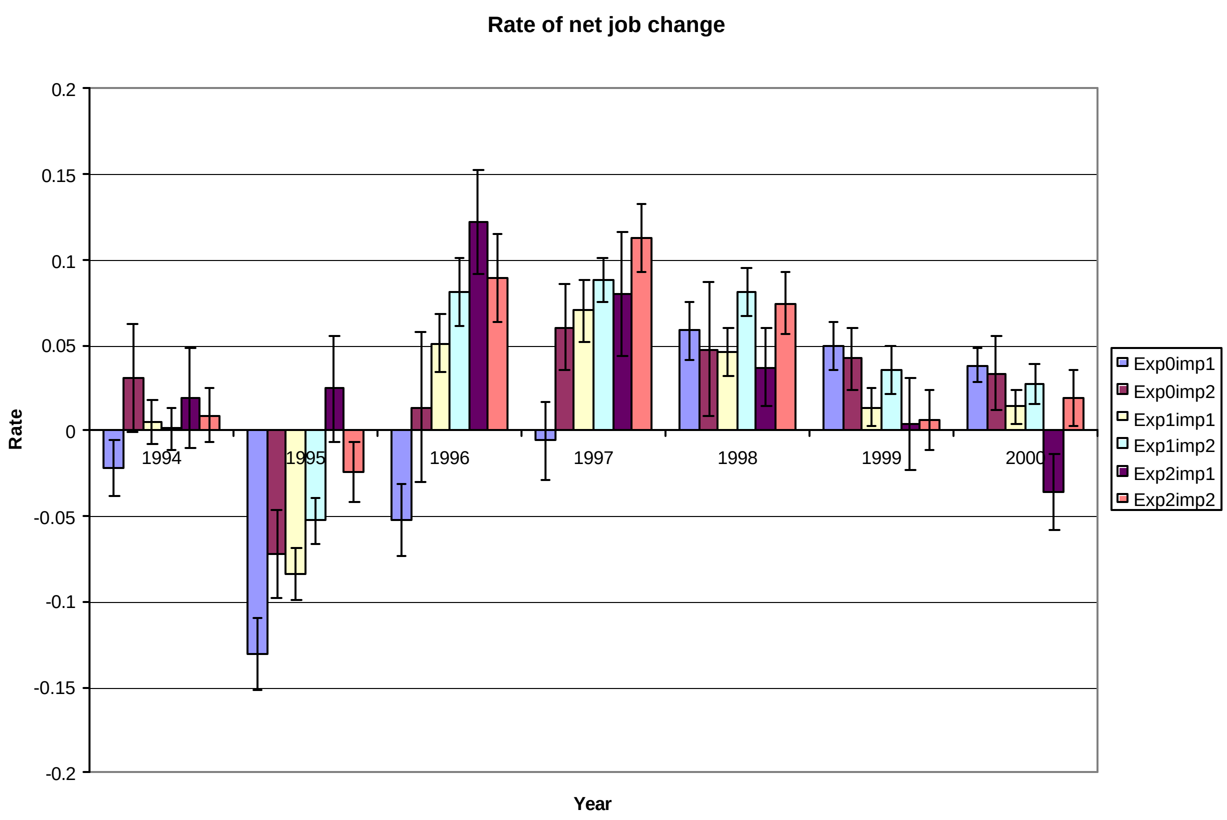


Figure 4. The e¤ect of trade integration on the rate of job reallocation

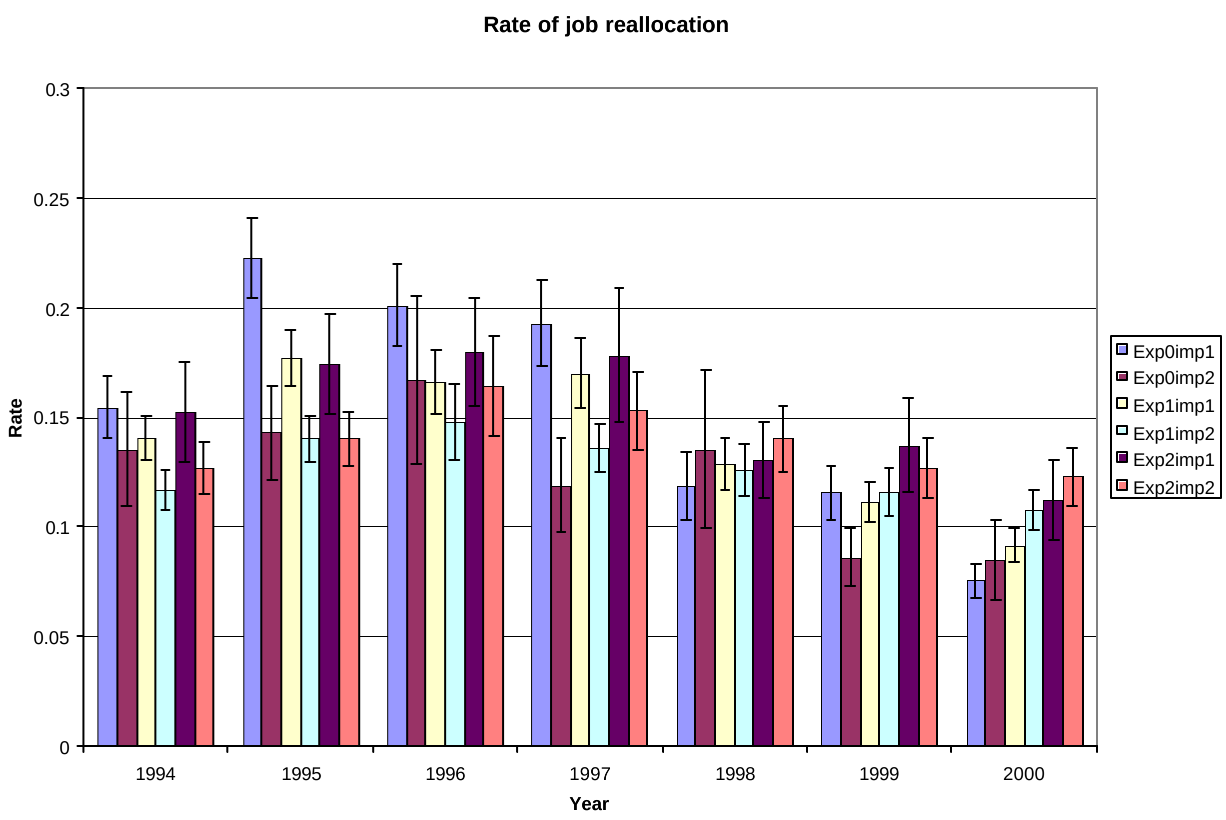


Figure 5. The e¤ect of import competition on the rate of net job change

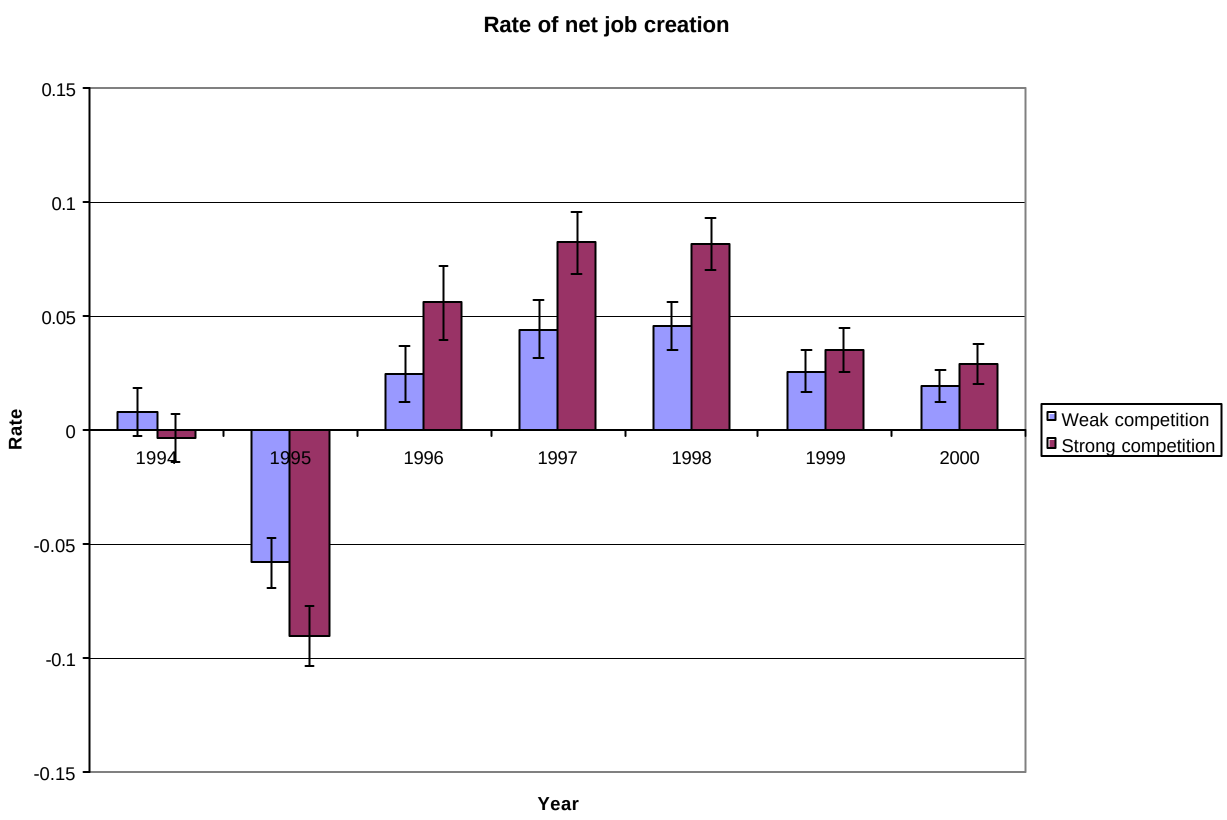


Figure 6. The e¤ect of import competition on the rate of job reallocation

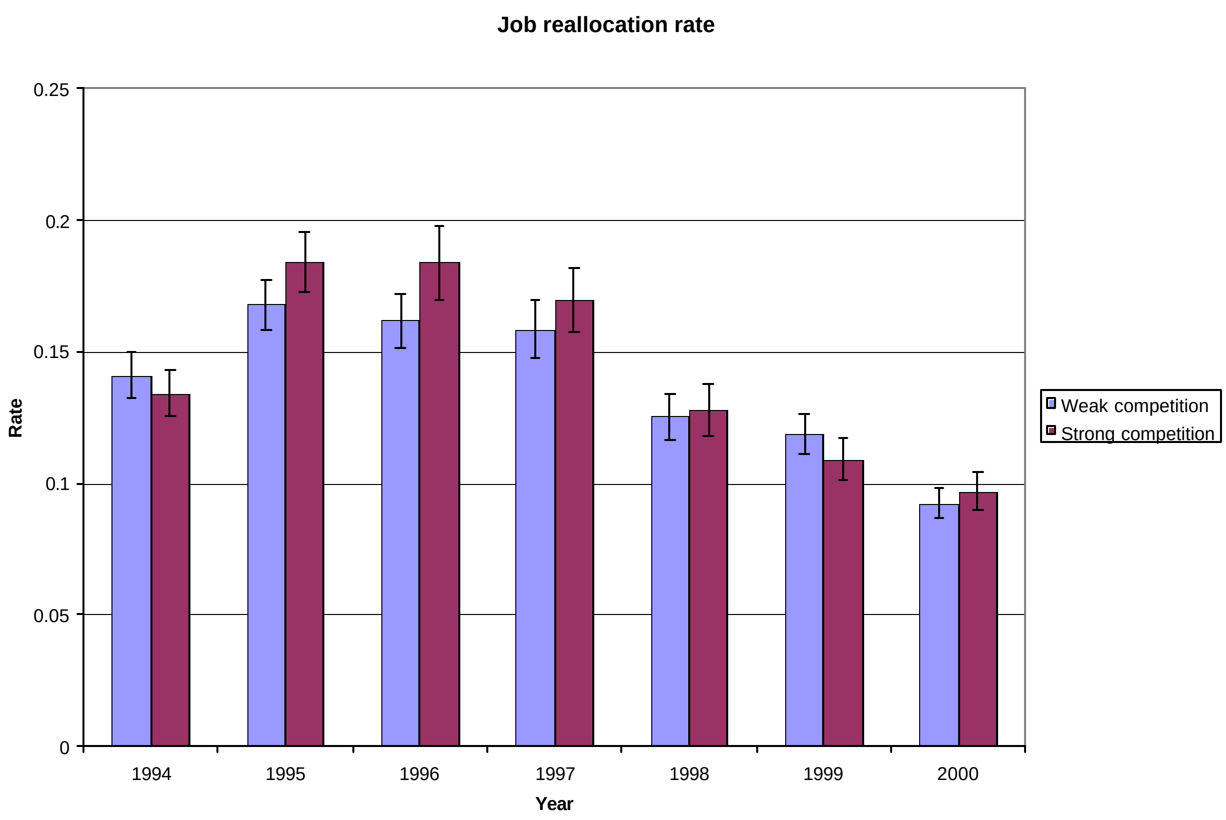


Figure 7. The e¤ect of expenditure in technology on productivity

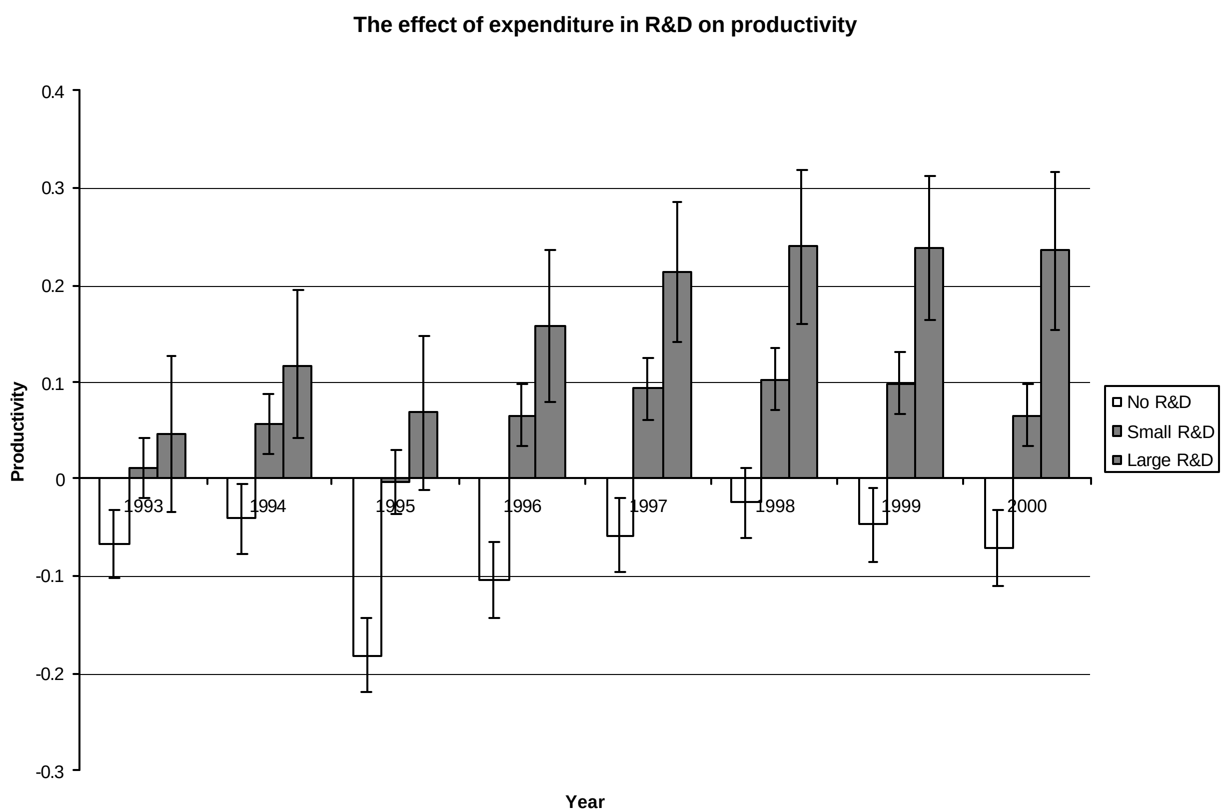


Figure 8. The e¤ect of expenditure in technology on the rate of net job change

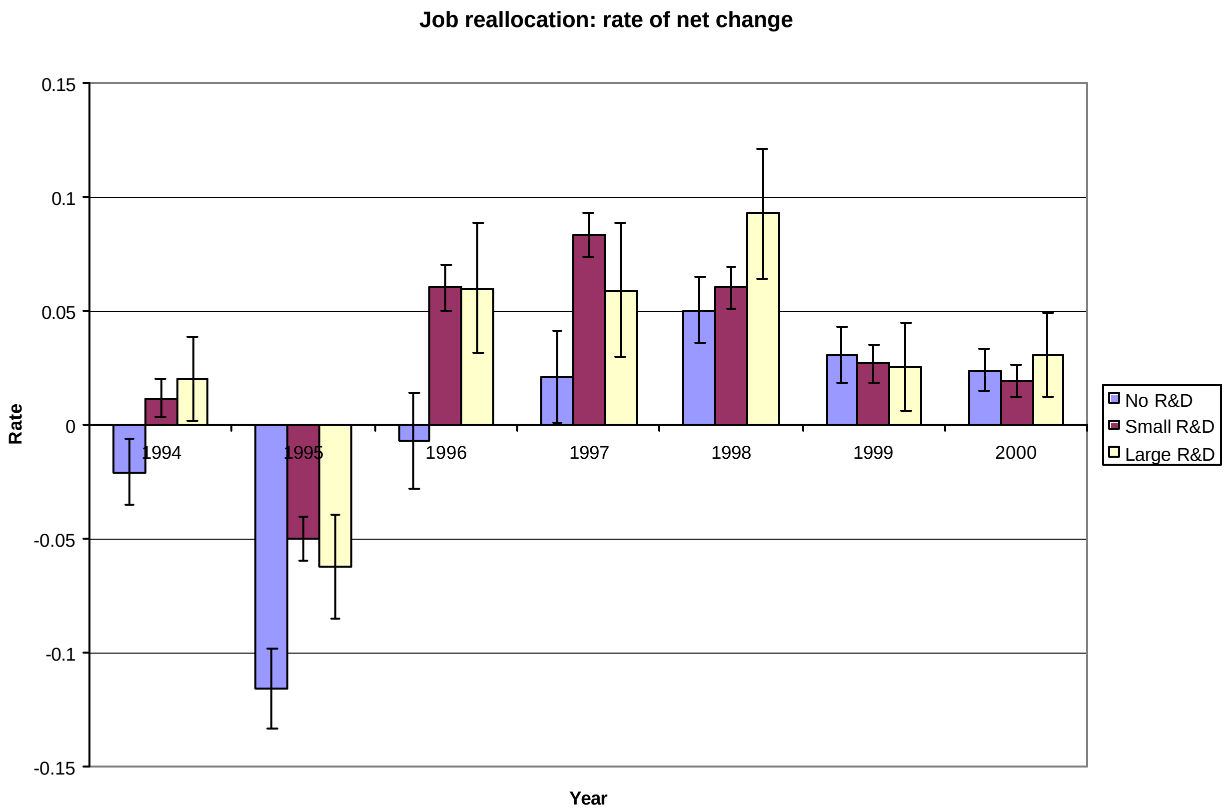
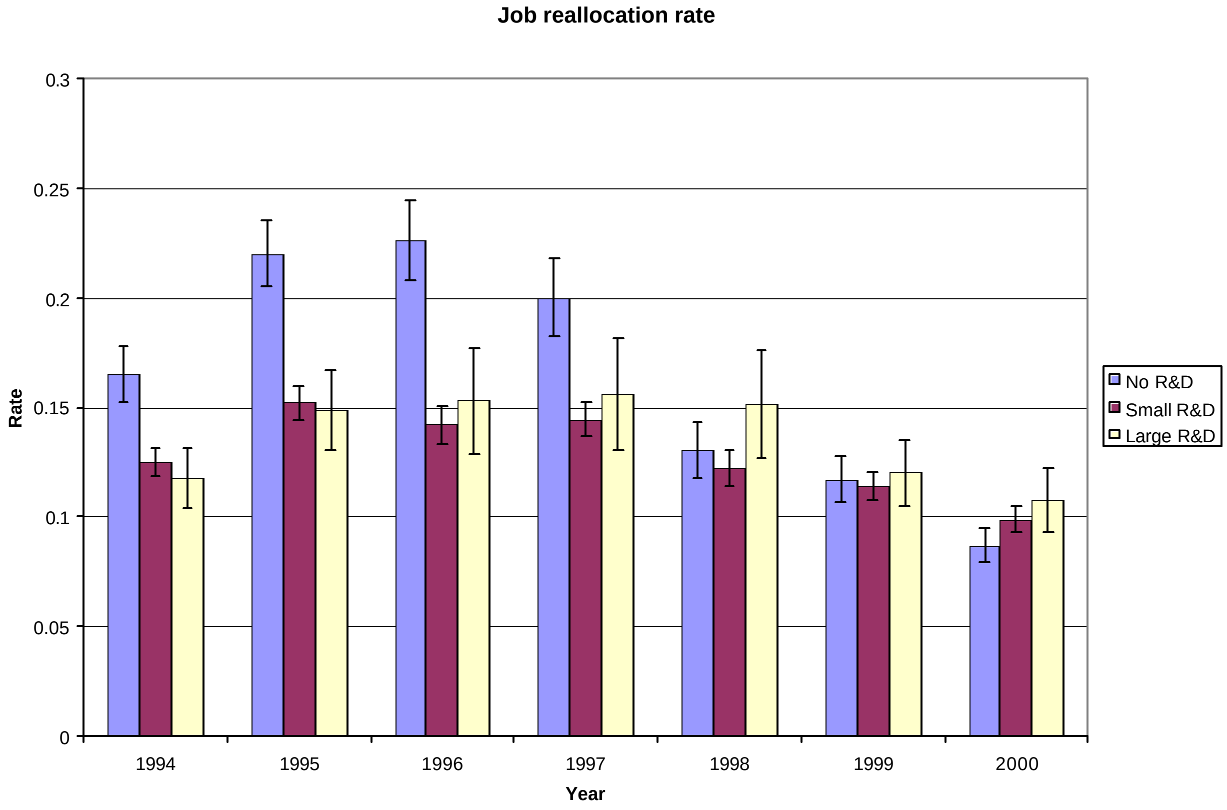


Figure 9. The e¤ect of expenditure in technology on the rate of job reallocation



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