Factor Adjustments after Deregulation: Panel Evidence from Colombian Plants*

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February 2006

Abstract

In this paper, we analyze employment and capital adjustments using a panel of plants from Colombia. We allow for nonlinear adjustment of employment to reflect not only adjustment costs of labor but also adjustment costs of capital, and vice-versa. Using data from the Annual Manufacturing Survey, which include plant-level prices, we generate measures of plant-level productivity, demand shocks, and cost shocks, and use them to measure desired factor levels. We then estimate adjustment functions for capital and labor as a function of the gap between desired and actual factor levels. As in other countries, we find non-linear adjustments in employment and capital in response to market fundamentals. In addition, we find that employment and capital adjustments reinforce each other, in that capital shortages reduce hiring and labor shortages reduce investment. Moreover, we find that the market oriented reforms introduced in Colombia after 1990 increased employment adjustments, especially on the job destruction margin, while reducing capital adjustments. Finally, we find that while completely eliminating frictions from factor adjustments would yield a dramatic increase in aggregate productivity through improved allocative efficiency, the reforms introduced in Colombia generated relatively modest improvements.

Keywords: Joint factor adjustment, irreversibilities, adjustment costs, input reallocation, deregulation.

*We thank Andres Fernández and Pablo Medina for excellent research assistance, Departamento Administrativo Nacional de Estadistica and administrators of the Annual Manufacturing Survey for data access and for answering our queries on methodological issues. We thank seminar participants at IFS/UCL, LACEA Meetings in San Jose, Royal Holloway College, University of Exeter, University of Houston/Rice, Yale University, and especially Orazio Attanasio, Eli Berman, Ken Chay, Penny Goldberg, Rachel Griffith, Dan Hamermesh, Norman Loayza, Steve Pischke and Luis Serven for very useful comments. Research support was provided by the World Bank, the Tinker Foundation, and a GEAR grant from the University of Houston.

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1 Introduction

Well-functioning market economies require that producers be able to change their input mix in response to shocks. Yet, for the main factors of production, namely capital and labor, there is limited scope for continual adjustment. There is evidence that, at the level of production units, changes in investment and employment are associated with substantial restructuring rather than frequent tinkering. Lumpy adjustment of both capital and labor at the plant-level is a stylized fact in studies for the U.S. and other countries (e.g., Caballero, Engel and Haltiwanger (1995, 1997), Cooper, Haltiwanger and Power (1999), Doms and Dunne (1998), Gelos and Isgut (2001), and Nilsen and Schiantarelli (2003)). One explanation behind these findings is that fixed adjustment costs and irreversibilities make changes in factor demands less frequent and more substantial. However, lumpy adjustment has only been studied in the context of individual adjustment margins, either capital or labor. Although a few studies have analyzed joint adjustments of capital and labor, most examine this interaction using sectoral level data and convex adjustment cost models (Nadiri and Rosen (1969), Shapiro (1986), Rossana (1990), and Hall (2004)).[1]

In this paper, we study the joint evolution of employment growth and investment using panel data for Colombian manufacturing plants. In contrast to most previous studies using micro data, our framework analyzes nonlinear adjustment allowing for interactions between the capital and labor margins. Factor demands may be inter-related so that frictions for one factor may generate lumpy adjustment not only for that particular factor but also for other factors of production. Moreover, an interesting question in the context of developing and transition economies is whether the recent wave of market reforms has changed the nature of the adjustment process for manufacturers. Thus, in this paper, we also focus on how inter-related labor and capital adjustments changed after wide spread markets reforms in Colombia in the early 1990s tried, among other goals, to deregulate actor markets..

Colombia is an interesting case to consider these issues. First, Colombia undertook substantial market reforms during the early 1990s, which were in part intended to liberalize labor and financial markets, and to facilitate factor adjustments. For example, in 1990 and 1991, the reforms reduced dismissal costs; liberalized deposit rates; eliminated credit subsidies; modernized capital market and banking legislation; removed restrictions on inflows of foreign direct investment, and greatly reduced bar-

[1] A recent paper by Polder et. al. (2004) investigates the connection between capital and labor adjustment dynamics using micro data for Denmark. This study permits nonlinear adjustment for capital to spillover to the adjustment for labor, where the latter is assumed to be subject to convex adjustment costs. Unlike our analysis which relies on a generalized (S,s) adjustment function approach developed by Caballero and Engel (1999), Polder et al. (2004) use regime switching techniques proposed by Barnett and Sakellaris (1998). Moreover, contrary to our results, Polder et al. (2004) find limited influence of spillovers from nonlinear capital adjustment to labor. The reason is that their estimates of labor adjustment costs are extremely high (in their view, even implausibly high), leaving very little room for interaction.

riers to imports. Second, Colombia has unique longitudinal microeconomic data on businesses. The main distinguishing feature of these data is that they have information on both plant-level quantities and prices, which permits us to separately measure productivity and demand shocks and to examine the impact of these shocks on factor adjustments. This is an innovation with respect to most of the existing literature, which measures productivity as the residual from a production function where physical output is proxied by revenue divided by a common industry-level deflator. The traditional productivity measures thus confound productivity differences across plants with within-industry price differences across plants. If prices reflect idiosyncratic demand shifts or market power variation rather than quality or other differences in product attributes, then productivity shocks as traditionally measured may not be related to technology or efficiency at all. By contrast, our physical output measures deflate revenue by plant-level prices so that we can separate productivity and price effects.

Our paper makes a number of methodological innovations. First, we analyze inter-related factor demands at the micro level in the presence of nonlinear adjustment functions. This allows us not only to characterize the potential nonlinearities in the adjustment of labor relative to capital at the micro level, but also to identify whether there are dynamic complementarities across factors. Second, we use production and demand functions estimated using our rich micro data to identify key parameters as well as productivity and demand shocks, which are used along with input price shocks to estimate desired factor demands. This allows us to examine how the gaps between the actual and desired adjustments of capital and labor depend on productivity, demand and cost shocks. One strength of our analysis is that we measure the desired factor levels by estimating directly the expressions resulting from the frictionless maximization problem. In particular, given data availability and our estimation method, in order to measure factor gaps, we do not have to resort to inference about the relationships between neither employment and hours nor fixed capital and energy utilization.

We find strong evidence of nonlinear micro adjustment, as businesses are much more likely to adjust capital and labor (or adjust by a greater amount) if the gaps between desired and actual levels are large. In addition, we find that capital and labor adjustments tend to reinforce each other in that bigger capital shortages reduce hiring and bigger labor shortages reduce investment, and vice-versa. Moreover, we find strong evidence that the reforms led to more flexible labor adjustment, especially on the job destruction side, while reducing capital adjustments. Even though frictions were reduced in both labor and financial markets, it seems that the impact was much larger on labor adjustment costs, which would have led producers to increase adjustment of labor and decrease adjustment of the more fixed capital input. Finally, we explore how the changes in factor adjustments affected allocative efficiency. We find that the reduction in factor market frictions following the reforms had a positive but modest impact on allocative efficiency. On the other hand, we find that if ad-

justment frictions could be completely eliminated there would be a dramatic increase in productivity.

The paper proceeds as follows. In Section 2, we describe the institutional changes that led to factor market deregulation in Colombia. In Section 3, we set up the building blocks to estimate labor and capital adjustments under nonconvex adjustment costs. In Section 4, we describe the basic data and present our estimates of productivity and demand shocks, which are then used to estimate the distributions of capital and labor shortages. In Section 5, we present evidence on the extent of heterogeneity and nonlinearities in factor adjustments in Colombia, and on the evolution of these adjustments after the Colombian factor market reforms of 1991. In Section 6, we present decompositions of aggregate productivity which allow us to examine the impact of removing frictions in factor markets on productivity enhancing reallocation. We conclude in Section 7.

2 Factor Market Deregulation in Colombia

In the early 1990s, the government of President Cesar Gaviria introduced important reforms to eliminate rigidities and enhance flexibility in factor markets.

Law 50 of December 1990 introduced severance payments savings accounts and reduced dismissal costs by between 60% and 80% (see, e.g., Kugler (1999, 2004)). In 1993, Law 100 changed the social security system by allowing voluntary transfers from a pay-as-you-go system to a fully-funded system with individual accounts, though this law also introduced a mandatory hike in employer and employee contributions up to 13.5% of salaries, of which 75% was paid by employers (see, e.g., Kugler and Kugler (2003)).

Other reforms sought to reduce frictions in financial markets. In 1990, Law 45 eliminated interest rate ceilings as well as requirements to invest in government securities, and lowered reserve requirements. At the same time, supervision of financial markets was reinforced in line with the Basle Accords for capitalization requirements. Law 9 of 1991 established the abolition of exchange controls eliminating the monopoly of the central bank on foreign exchange transactions and lowering substantially the extent of capital controls. Finally, Resolution 49 of 1991 eliminated restrictions to foreign direct investment. This resolution established national treatment of foreign enterprises and eliminated limits on the transfer of profits abroad as well as bureaucratic procedures requiring the approval of individual projects by foreign firms (see, e.g., Kugler (2005)). This measure facilitated capital inflows across all sectors, but also induced entry of foreign banks increasing competition and lowering intermediation costs in the financial sector.

At the same time, international trade was largely liberalized. The gradual decrease in tariffs initiated by the preceding Barco government, between 1986 and 1990, was accelerated by Gaviria. By the end of 1991, 99.9% of items were in the free import regime, nominal protection reached 14.4%, and effective protection 26.6%, down

from 62.5% a year earlier (Edwards (2001)).

If the goal of the reforms of enhancing allocative efficiency was achieved, its success should be reflected in different patterns of factor adjustment dynamics between the 1980s and the 1990s, with increased flexibility of employment and capital adjustments after the reforms. In what follows, we consider the dynamics of factor adjustment before and after the reforms (pre- and post-1990), allowing for interdependence between employment growth and investment.

3 Theoretical Framework

This section explains the methodology we use to estimate adjustment hazards, as a function of the gaps between actual and desired levels of labor and capital, in the presence of either convex or nonconvex adjustment costs. In turn, we propose a framework for deriving the desired factor demands, which are needed to estimate factor gaps.

3.1 Inter-related Adjustment Costs

Following Caballero, Engel and Haltiwanger (1995, 1997) (CEH hereafter), our theoretical framework is based on the observation that employment and capital are unlikely to equal their desired levels when they are subject to adjustment costs. In the presence of costs of adjusting employment and capital, thus, plant j will face employment and capital shortages, Z_{jt} and X_{jt} at time t. We measure the employment shortage by

$$Z_{jt} = \frac{L^*_{jt} - L_{jt-1}}{\frac{1}{2}\left(L^*_{jt} + L_{jt-1}\right)}, \tag{1}$$

where L^*_{jt} is the desired level of employment, or the employment level if adjustment costs are momentarily removed, and L_{jt-1} is meant to capture employment after the shocks but before the plant has adjusted employment.[2] Z_{jt} is naturally bounded between -2 and 2. Similarly, we measure the capital shortage by,

$$X_{jt} = \frac{K^*_{jt} - K_{jt-1}}{\frac{1}{2}\left(K^*_{jt} + K_{jt-1}\right)}, \tag{2}$$

[2]The adjustment measures we use are analogous to those developed and used by Davis, Haltiwanger and Schuh (1996) to study plant-level employment dynamics. The difference between two variables a and b divided by the average of a and b is a second-order approximation to the log first difference between a and b. An advantage of the Davis-Haltiwanger-Schuh measures is that they are symmetric and bounded, which reduces the potential for large outliers driving the results. Results are very similar if we use log first differences (not surprisingly, given the second-order approximation).

where K^*_{jt} is the desired level of capital, or the level of capital if adjustment costs are momentarily removed, and K_{jt-1} captures capital after the shocks but before the plant has adjusted the capital stock. We define adjustment functions for employment and capital, $A_{jt}(Z_{jt}, X_{jt})$ and $B_{jt}(Z_{jt}, X_{jt})$, as the fraction of the respective shortage that is actually adjusted, and model them as a function of Z_{jt} and X_{jt}. That is, defining the actual adjustments of employment and capital as:

$$\triangle l_{jt} = \frac{L_{jt} - L_{jt-1}}{\frac{1}{2}(L_{jt} + L_{jt-1})} \tag{3}$$

and

$$\triangle k_{jt} = \frac{K_{jt} - K_{jt-1}}{\frac{1}{2}(K_{jt} + K_{jt-1})}, \tag{4}$$

the adjustment functions $A_{jt}(Z_{jt}, X_{jt})$ and $B_{jt}(Z_{jt}, X_{jt})$, which are also sometimes called "adjustment hazards" in the literature, are given by

$$A_{jt}(Z_{jt}, X_{jt}) = \frac{\triangle l_{jt}}{Z_{jt}}$$

and

$$B_{jt}(Z_{jt}, X_{jt}) = \frac{\triangle k_{jt}}{X_{jt}}.$$

The adjustment functions of employment and capital tell us something about the nature of adjustment costs. In particular, an employment adjustment function independent of the capital shortage, Z, and a capital adjustment function independent of the labor shortage, X, are consistent with quadratic adjustment costs or a partial adjustment model. By contrast, employment and capital adjustment functions that depend on Z and X, respectively, would be consistent with linear or lumpy adjustment costs or non-convexities.[3] For instance, in the presence of fixed costs of adjustment, producers postpone adjustment until they are faced with large enough input shortages or surpluses. Our contribution is to allow the employment adjustment function to depend on the capital gap, X, and the capital adjustment function to depend on the labor gap, Z, which would reveal non-convex dynamic interactions between capital and labor. Adjustment functions can be estimated either non-parametrically or parametrically as in Caballero and Engel (1993, 1999). Here we start with the following parametric specification:

$$\begin{aligned} A_{jt}(Z_{jt}, X_{jt}) &= \lambda_0 + \lambda_1 Z^2_{jt} + \lambda_2 Z_{jt} \times X_{jt} + \lambda_3 X^2_{jt}, \\ B_{jt}(Z_{jt}, X_{jt}) &= \kappa_0 + \kappa_1 X^2_{jt} + \kappa_2 Z_{jt} \times X_{jt} + \kappa_3 X^2_{jt}. \end{aligned}$$

[3] Caballero and Engel (1993,1999) develop the generalized (S,s) approach formally showing that models of nonconvexities imply a richer nonlinear relationship between adjustment and economic fundamentals as captured by the gap between desired and actual stocks.

We modify this specification to permit the impact of Z on employment changes and X on capital changes to depend on the sign of Z and X (i.e., shortages and surpluses). We also permit the adjustment functions to vary across the pre- and post-reform period. Since the adjustment functions $A_{jt}(Z_{jt}, X_{jt})$ and $B_{jt}(Z_{jt}, X_{jt})$ are poorly defined in the neighborhood of $Z_{it} = 0$ and $X_{jt} = 0$, we re-write the adjustment function definitions and estimate the following equations at the micro-level with plant-level effects:

$$\begin{aligned} \triangle l_{jt}(Z_{jt}, X_{jt}) &= Z_{jt}A_{jt}(Z_{jt}, X_{jt}) = Z_{jt}[\lambda_0 + \lambda_1 Z_{jt}^2 + \lambda_2 Z_{jt} \times X_{jt} + \lambda_3 X_{jt}^2], \quad (5) \\ \triangle k_{jt}(Z_{jt}, X_{jt}) &= X_{jt}B_{jt}(Z_{jt}, X_{jt}) = X_{jt}[\kappa_0 + \kappa_1 X_{jt}^2 + \kappa_2 Z_{jt} \times X_{jt} + \kappa_3 X_{jt}^2]. \quad (6) \end{aligned}$$

In order to estimate the cross-section distribution of shortages and the adjustment functions, we first need to determine the desired levels of employment and capital. Given certain conditions, these can be proxied, up to a plant-specific constant, by the frictionless levels of employment and capital, where the frictionless levels are the levels that would be chosen absent any adjustment costs.[4] In particular, the desired and frictionless levels relate to each other as follows:

$$\begin{aligned} L_{jt}^* &= \overline{L}_{jt}\theta_{Lj}, \\ K_{jt}^* &= \overline{K}_{jt}\theta_{Kj}, \end{aligned}$$

where $\overline{L}_{jt}$ and $\overline{K}_{jt}$ are the frictionless demands of employment and capital, and θ_{Lj} and θ_{Kj} are the plant-specific employment and capital constants (which may also capture measurement error). The frictionless levels of employment and capital will be determined below by the first-order conditions of the plants' static optimization problem. Following CEH (1995, 1997), θ_{Lj} and θ_{Kj} can be determined as the ratio between actual and frictionless employment and the ratio between actual and frictionless capital stock for the plants' median employment growth and investment, respectively, where median employment growth and investment are interpreted as reflecting replacement employment changes and investment. In other words, it is assumed that, in the year of a plant's median employment growth (investment), desired and actual adjustment of labor (capital) are equal.[5]

[4] CEH (1995) and Bertola and Caballero (1994) discuss the conditions under which this adjustment is a reasonable approximation.

[5] It is useful to discuss potential limitations about our approach. Cooper and Willis (2003) raise questions about the use of measures of the gap between desired and actual factors to make structural inferences about the presence and magnitude of nonconvexities. Even though, like CEH, we interpret adjustment functions that increase in the magnitude of the shortages as evidence consistent with nonconvexities, we can remain agnostic on the structural interpretation of the adjustment functions. First, our results use a semi-reduced form specification allowing actual factor adjustment to be a nonlinear function of fundamentals (TFP and demand shocks). In this sense, were are not subject

One point to note in our approach is that although we do not specify the underlying structural adjustment costs but rather estimate semi-structural adjustment cost functions we are assuming that the underlying structural adjustment costs are external rather than internal (as defined by Lucas (1967) and Treadway (1969)). That is, the adjustment costs are separable costs in the profit maximization so that the production function depends on the levels of the inputs and not on the changes in the inputs. This approach permits us to both conceptually measure and estimate the desired levels of labor and capital using a standard Cobb-Douglas production function. While, like ours, most papers in the literature assume external adjustment costs, some progress has been made in the recent literature in terms of exploring the role of internal adjustment costs (e.g., Cooper and Haltiwanger (2006) and Cooper, Haltiwanger and Willis (2005)).

3.2 Frictionless Profit Maximization

Both to determine the frictionless levels of employment and capital and to determine the plant-specific constants, we need to specify the plants' optimization problem and obtain the first-order conditions. The plant's production function is:

$$Y_{jt} = K_{jt}^{\alpha} \left(L_{jt} H_{jt}\right)^{\beta} E_{jt}^{\gamma} M_{jt}^{\phi} V_{jt}, \tag{7}$$

where K_{jt} is capital, L_{jt} is employment, H_{jt} are hours per worker, E_{jt} is energy use, M_{jt} are materials, and V_{jt} is a productivity shock.

There is an inverse demand for the product given by:

$$P_{jt} = Y_{jt}^{-\frac{1}{\eta}} D_{jt}, \tag{8}$$

where P_{jt} is the output price and D_{jt} is a demand shock and where $-\frac{1}{\eta}$ is the inverse of the elasticity of demand.

Finally, the firm faces competitive factor markets, where total labor costs, capital costs, energy costs and materials costs are:

$$\begin{aligned} \omega_L\left(L_{jt}, H_{jt}\right) &= w_{0t} L_{jt}\left(1 + w_{1t} H_{jt}^{\delta}\right) \\ \omega_K\left(K_{jt}\right) &= R_t K_{jt}, \\ \omega_E\left(E_{jt}\right) &= P_{Et} E_{jt}, \\ \omega_M\left(M_{jt}\right) &= P_{Mt} M_{jt}, \end{aligned}$$

The wage function depends on the straight-time wage, w_{0t}, as well as on the overtime premium w_{1t}. The firm takes the user cost of capital, R_t, and energy and material prices, P_{Et} and P_{Mt}, as given.

to the criticisms originally raised by Cooper and Willis (2003), since they are concerned in part with the approximations of shortages made by CEH (1997) given data limitations. In addition, our main point here is that the adjustment frictions changed in systematic ways in response to factor market reforms.

The state variables are the capital stock, the level of employment, hours, energy consumption, and materials that the plant would choose in the absence of frictions (the *frictionless* factor demands). These are equivalent to the observed levels for inputs not subject to adjustment costs. We assume here that materials, energy and hours per worker all fall within this category, while we allow adjustment costs for capital and labor.

The firm maximizes frictionless profits by choosing capital, employment, hours, energy consumption, and materials, ignoring adjustment costs. The solution to the system of first-order conditions is given by two equations:[6]

$$\begin{aligned}
\widetilde{\widetilde{L}}_{jt} &= \frac{\left(\frac{\eta}{\eta-1}\right)\left[\ln\left(\frac{\eta}{\eta-1}\right)-\widetilde{D}_{jt}\right]-\widetilde{V}_{jt}-\beta\widetilde{\widetilde{H}}_{jt}-\gamma\widetilde{\widetilde{E}}_{jt}-\phi\widetilde{\widetilde{M}}_{jt}+\left(\frac{\eta}{\eta-1}-\alpha\right)\left[\widetilde{w}_{0t}+\ln(1+w_{1t}H_{jt}^{\delta})-\ln\beta\right]-\alpha\ln\alpha+\alpha\widetilde{R}_{t}}{\left[\alpha+\beta-\left(\frac{\eta}{\eta-1}\right)\right]}, \\
\widetilde{K}_{jt} &= \frac{\left(\frac{\eta}{\eta-1}\right)\left[\ln\left(\frac{\eta}{\eta-1}\right)-\widetilde{D}_{jt}\right]-\widetilde{V}_{jt}-\beta\widetilde{\widetilde{H}}_{jt}-\gamma\widetilde{\widetilde{E}}_{jt}-\phi\widetilde{\widetilde{M}}_{jt}+\left(\frac{\eta}{\eta-1}-\beta\right)\left[\widetilde{R}_{t}-\ln\alpha\right]-\beta\ln\beta+\beta\left[\widetilde{w}_{0t}+\ln(1+w_{1t}\overline{H}_{jt}^{\delta})\right]}{\left[\alpha+\beta-\left(\frac{\eta}{\eta-1}\right)\right]},
\end{aligned} \tag{9}$$

where $\widetilde{y}$ denotes the natural logarithm of variable y.

Frictionless levels in equation (9) are estimated numerically by substituting the various parameters of the model, calculated as explained below. Then, taking the exponential of the logarithms of frictionless employment and capital, we obtain desired employment and capital. Finally, we use these to calculate our employment and capital shortages, Z_{jt} and X_{jt}, and in turn to estimate the adjustment functions.

3.3 Estimation

The system of equations above can be estimated numerically by obtaining the parameters, α, β, γ, ϕ, η, and δ as well as the productivity and demand shocks, $\widetilde{V}_{jt}$ and $\widetilde{D}_{jt}$, and input prices, $\widetilde{R}_t, \widetilde{w}_{0t}$, and $\widetilde{w}_{1t}$. The values of, α, β, γ, ϕ, η, $\widetilde{V}_{jt}$ and $\widetilde{D}_{jt}$, are obtained, as described in Section 4, from estimating the output production function and the inverse-demand function. For the user cost of capital, $\widetilde{R}_t$, the results we report use a constant value, 0.15, which is in the lower bound of previous estimates for Colombia. The straight-time wage, $\widetilde{w}_{0t}$, is a sector level wage measure calculated as explained in Section 4 and the overtime premium, $\widetilde{w}_{1t}$, is set to the legally required overtime premium of 25% in Colombia. Materials, energy and hours are measured as explained in Section 4. The only missing parameter is δ. Both Bils (1987) and Cooper and Willis (2003) estimate a δ of 2 for the U.S. We use this parameter as an approximation.[7]

[6] See the Appendix for the full derivation of the first-order conditions.

[7] We tried different values of δ, ranging from $\delta = 1$ to $\delta = 5$. Results are robust to these changes. We have also tried other estimates of $\widetilde{R}_t$, both constant and variable, which yield similar results. This robustness of results to changes in $\widetilde{R}_t$ is reassuring, given that by not properly measuring $\widetilde{R}_t$ we may be missing part of the effects of reforms on allocative efficiency. For instance, the reforms may have affected capital market imperfections, which in turn may be associated with idiosyncratic variation in the user cost of capital. For more on how results are affected by different assumptions

4 Data Description

Our data come from the Colombian Annual Manufacturers Survey (AMS) for the years 1982 to 1998.[8] The AMS is an unbalanced panel of Colombian plants with more than 10 employees, or sales above a certain limit (around US$35,000 in 1998).[9] The AMS includes information for each plant on: value of output and average prices charged for each product manufactured (products are reported at the 8-digit ISIC level); overall cost and average prices paid for each material used in the production process; energy consumption in physical units and average energy prices; production and non-production number of workers and payroll; and book values of equipment and structures. The database also provides information on plant location (state) as well as industry classification codes (at the 5-digit ISIC level).

To implement the methodology explained above, we need measures of productivity and demand shocks as well as factor use at the plant level. We estimate total factor productivity (TFP) for each plant using a capital-labor-materials-energy (KLEM) production function and demand shocks for each plant using a standard inverse-demand function. Therefore, we need to construct physical quantities and prices of output and inputs, capital stock series, and total labor hours. The construction of these variables and productivity and demand shocks is explained below. A more thorough description of the measurement of each variable can be found in Eslava, Haltiwanger, Kugler and Kugler (2004).

4.1 Plant-level Prices and Quantities

With the rich information on prices collected in the AMS, we can construct plant-level price indices for output and materials. This represents an enormous advantage with respect to other sources of data, as the use of more aggregate price deflators is a common source of measurement error due to plant-specific demand shocks. Plant-level price changes of output (and materials) are constructed as weighted averages of the price changes of all products generated (materials used) by the plant. The weights correspond to the average shares of the different products (materials) in the total value of production (materials used) for the period over which the change is calculated. Plant-level price indices are then generated recursively from these price

on $\widetilde{R}_t$, see footnote 22.

[8] The annual data we use are very rich with plant-level measures of outputs, inputs, and output and input prices. One limitation in the current context is that the data are annual and so we are subject to time aggregation issues (see, e.g., Hammermesh (1993) and Hammermesh and Pfann (1996) for an excellent discussion of time aggregation). Since we take a flexible functional form to our adjustment functions and do not attempt to identify the underlying structure of adjustment costs, this mitigates the concerns about time aggregation.

[9] The methodology used to establish longitudinal linkages to follow plants over time is described in detail in the Appendix to Eslava et al. (2004).

changes.[10]

Given prices for materials and output, the quantities of materials and output are constructed by dividing the cost of materials and value of output by the corresponding prices. Quantities of energy consumption are directly reported by the plant. In addition, we need capital stocks to estimate a KLEM production function.

The plant capital stock (which includes equipment and buildings) is constructed recursively using a perpetual inventory method:

$$K_{jt} = (1 - \kappa) K_{jt-1} + \frac{I_{jt}}{P_{It}}$$

for all t such that $K_{jt-1} > 0$, where I_{jt} is gross investment, κ is the depreciation rate and P_{It} is a deflator for gross capital formation. For each plant, we initialize the series at the book value reported in the first year the plant appears in the sample. Our measure of P_{It} is the implicit deflator for capital formation from the input-output matrices for years 1982-1994, and from the output utilization matrices for later years. We use the depreciation rates calculated by Pombo (1999) at the 3-digit sectoral level, which range between 8.7% and 17.7% for machinery and between 2.4% and 9.8% for buildings. Gross investment is generated from the information on fixed assets reported by each plant and can be positive or negative.

Finally, since the AMS does not have data on hours per worker (only employment), we construct a measure of hours per worker at time t for sector $G(j)$, to which plant j belongs, as,

$$H_{jt} = \frac{earnings_{G(j)t}}{w_{G(j)t}},$$

where $w_{G(j)t}$ is a measure of sectoral wages at the 3-digit level from the Monthly Manufacturing Survey, and $earnings_{G(j)t}$ is a measure of earnings per worker constructed using the AMS data, where

$$earnings_{G(j)t} = \frac{\sum_{j \in G} payroll_{jt}}{\sum_{j \in G} L_{j\iota}}.$$

A sector-level nominal wage for year t and sector G is constructed as the weighted average of the wages of non-production and production workers, where the weights are respectively the share of administrative employees and the share of production employees in the total number of employees in year t for the average plant in sector

[10] See Eslava et. al. (2004, 2006) for more details. Given the recursive method used to construct the price indices and the fact that we do not have plant-level information for product and material prices for the years before plants enter the sample, we impute initial product and material prices for each plant with missing values by using the average prices in their sector, location, and year. When the information is not available by location, we impute the national average in the sector for that year.

G. Finally, $w_{G(j)t}$ is equal to the real wage, which is this nominal wage deflated using the CPI.[11]

4.2 Descriptive Statistics of Prices and Quantities

Table 1 presents descriptive statistics of the quantity and price variables just described, for the pre- and post-reform periods. The quantity variables are expressed in logs, while the prices are relative to a yearly producer price index to discount inflation. Output increased between the pre- and post-reform periods. In addition, the table shows that capital, materials and energy use increased, but employment decreased between the pre- and post-reform periods. Relative prices of output and materials prices declined between the pre- and post-reform periods, while energy prices and wages increased.[12] Below, we use these variables to estimate the production function and inverse-demand equation. Also, plant entry decreased after deregulation and exit increased. We don't explore the implications of the latter in the current paper as the focus of the current paper is on adjustment of capital and labor for continuing businesses.[13]

4.3 Productivity Shock Estimation

We estimate total factor productivity for each establishment as the residual from the capital-labor-energy-materials (KLEM) production function, equation (7), which we estimate in logs:

$$TFP_{jt} = \log Y_{jt} - \widehat{\alpha} \log K_{jt} - \widehat{\beta}(\log L_{jt} + \log H_{jt}) - \widehat{\gamma} \log E_{jt} - \widehat{\phi} \log M_{jt}. \qquad (10)$$

where $\widehat{\alpha}$, $\widehat{\beta}$, $\widehat{\gamma}$, and $\widehat{\phi}$ are the estimated factor elasticities for capital, labor hours, energy, and materials. Since productivity shocks are likely to be correlated with inputs, OLS estimates of factor elasticities are likely to be biased. We thus present IV estimates, where we use demand-shift instruments which are correlated with input use but uncorrelated with productivity shocks. As described in Eslava et al. (2004), we construct Shea (1993) and Syverson (2003) type instruments by selecting

[11] By using a sectoral wage index, we are attributing plant-specific differences in wages from the sectoral average to differences in labor quality at the plant.

[12] Caution needs to be used in interpreting mean relative prices in this context since the relative price at the micro level is the log difference between the plant-level price and the log of the aggregate PPI. On an appropriately output weighted basis, the mean of this relative price measure should be close to zero in all periods since the PPI is dominated by manufacturing industries. The larger difference with respect to PPI in the post-reform period reflects that the growth of manufacturing prices fell more rapidly than that of other prices in the economy, possibly due to the fact that external competition introduced by the reforms affected the manufacturing sector more than others.

[13] In another paper we explore the role of reforms for market selection (Eslava et. al. (2006)) but leave for future work a fully integrated approach that explores both market selection and adjustment by continuing businesses.

industries whose output fluctuations are likely to function as approximately exogenous demand shocks for other industries. In addition, we use as instruments one- and two-period lags of the demand shifters just described, energy and materials prices, and government expenditures (excluding investment) in the region where the plant is located.[14]

Columns (1) and (2) of Table 2 present the OLS and IV results from the estimation of the KLEM specification. IV results show larger capital and energy elasticities, but lower employment hours and materials elasticities relative to the OLS elasticities.[15] As a check of instrument relevance, the last column of Table 2 reports partial $R^{2\prime}s$ for the first-stages of the inputs on the various instruments, which show that the instruments can explain a substantial fraction of the variation in input use.[16] We cannot reject the null hypothesis of constant returns to scale, although we do not impose this restriction ex-ante.

One potential limitation of our approach is that we have imposed the same factor elasticities for all plants in the manufacturing sector. We make this assumption as our IV approach mainly exploits between industry differences in downstream demand factors. As a robustness check, we have also estimated factor elasticities at the 3-digit industry level using the standard cost share approach (where the shares are estimated out of total revenue in the sector) and assuming constant returns to scale so that the capital share can be measured as a residual. When we use these alternative factor elasticities with the plant-level data we obtain an alternative measure of TFP. The correlation of this alternative with our preferred IV measure is very high, 0.88. Moreover, the standard deviation of the two TFP measures are about the same and the correlations of the cost share based TFP with other key variables (e.g., plant-level prices) are very similar to those with our instrumented TFP measure. In other words, our TFP measure has properties that are robust with respect to reasonable alternative methods for estimating TFP, including allowing for sectoral differences in factor elasticities. As a consequence, we have found that the results in this paper are largely robust to using these alternative TFP measure and factor elasticities.

[14]Sargan tests indicate that these are valid instruments, including energy and materials prices which are unlikely to be affected by buyers' market power in the Colombian context. See Eslava et al. (2004) for further details on the instruments.

[15]The correlation between our TFP measure (estimated with constant factor elasticities) and a TFP measure estimated allowing elasticities that vary pre- and post-reform periods is 0.9. Results are thus robust to permitting factor elasticities to vary across the pre and post reform periods. Also, note that it is difficult to allow factor elasticities to vary by sector in our context, since our demand-shift instruments vary mainly by sector. However, as discussed below, we have estimated an alternative TFP measure which allows factor elastiticites to vary by sector and this is highly correlated with our preferred measure.

[16]Given multiple endogenous regressors, the first-stage partial R^2 suggested by Shea (1997) is more appropriate than standard first-stage $R^{2\prime}s$. The partial R^2 measures the correlation between an endogenous regressor and the instruments after taking away the correlation between that particular regressor with all other endogenous regressors.

4.4 Demand Shock Estimation

We estimate establishment-level demand shocks as the residual of the (log) inverse-demand equation (8):

$$d_{jt} = \log \widehat{D_{jt}} = \log P_{jt} + \widehat{\varepsilon} \log Y_{jt}, \tag{11}$$

where ε is the inverse of the elasticity of demand, η.[17]

Table 3 reports the results of the inverse-demand equations using both OLS and IV estimation.[18] The OLS results in Column (1) suggest a large elasticity of -11.05. However, using OLS to estimate the inverse-demand function is likely to generate an upwardly biased estimate of the demand elasticity because demand shocks are positively correlated to both output and prices. To eliminate the upward bias in our estimates, we use TFP as an instrument for Y_{jt} since TFP is positively correlated with output (by construction) but unlikely to be correlated with demand shocks.[19] The 2SLS results indeed show a much lower elasticity of -2.28. We report results keeping the elasticity of demand constant across sectors. However, all of our results are robust to allowing demand elasticities to vary by 3-digit sector.

5 Labor and Capital Adjustments

We now examine the patterns of capital and labor adjustments. Before turning to the estimates of adjustment functions, Table 4 presents the first moments of the distributions of labor and capital shortages, as well as their driving forces, before and after the reforms for the sample of pairwise continuers (i.e., all plants that are present in $t-1$ and t).[20] Table 4 shows that mean labor and capital shortages move closer

[17] While we call the residual from this inverse-demand regression a demand shock, it is possible that this residual captures relative price shocks due to both differences in market power and differences in product quality across plants. For both interpretations, however, higher demand should lead establishments to demand more inputs.

[18] The elasticity of demand may differ across sectors and time. However, the correlation between our demand shock measures estimated allowing for a uniform elasticity and our demand shock measures estimated allowing for different elasticities during the pre- and post-reform period is 0.97. While the demand shock measures differ more when allowing elasticities to vary by sector, all of our results below are robust to the use of demand shocks which take away sectoral differences in elasticities. Results are available upon request.

[19] Using TFP as the instrument in the demand function has been used in Foster et. al. (2005) and in Eslava et. al. (2004).

[20] The focus of the current paper is on capital and labor adjustment for continuing businesses. In Eslava et. al. (2006) we focus on the role of reforms for plant exit. We find evidence that market reforms increased the relative importance of market fundamentals (TFP, demand and costs) in inducing exit. We leave for future work the exploration of the impact of market reforms for plant entry as well as a fully integrated approach that would permit the study of all margins of adjustment. We note that the literature on capital and labor adjustment focuses primarily on continuing businesses.

to zero in the post-reform period. The fact that the absolute value of labor and capital shortages falls substantially after the reforms suggests plants were closer to their desired labor and capital levels in this period, consistent with greater flexibility in factor markets. The reduction of dispersion of both labor and capital shortages in the 1990s relative to the 1980s also suggests greater flexibility. The finding that second moments for both shortages fall is particularly striking given the increased variability in the underlying factors (TFP, demand shocks, input prices) between the two decades. This preliminary evidence, thus, point to increased flexibility in factor markets. We now turn to an investigation of the changing patterns of adjustment.

5.1 Adjustment Functions

Table 5 and Figures 1 and 2 present estimates of the labor and capital parametric adjustment functions using equations (5) and (6). As a benchmark, Table 5 also reports results from estimating a standard partial adjustment model (PAM) , in which changes in labor and capital are independent of the magnitude and sign of shortages, so that establishments always close a constant fraction of the gap. Comparing the results of this specification to those of the non-linear models (5) and (6) highlights the importance of permitting non-linearities.

The employment adjustment function, $A = \frac{\triangle l_{jt}}{Z_{jt}}$, is depicted in Figure 1 as a function of the labor shortage, Z, setting the capital shortage at $X = 0$, X at one standard deviation, and X at minus one standard deviation. Similarly, Figure 2 depicts the capital adjustment function, $B = \frac{\triangle k_{jt}}{X_{jt}}$, as a function of the capital shortage, X, setting the labor shortage at $Z = 0$, Z at one standard deviation, and Z at minus one standard deviation. Figures 1 and 2 also include depictions of the cross sectional distributions of shortages to provide perspective on the relative importance of the regions in the space of shortages.

Consistent with the previous literature, Figures 1 and 2 show highly nonlinear adjustment. Table 5 shows that the nonlinear terms as well as the related terms capturing asymmetries for positive and negative shortages are not only economically but also statistically significant. A standard PAM specification, thus, would miss key aspects of the adjustment process captured by our more flexible nonlinear and asymmetric specification. There are, indeed , striking asymmetries between positive and negative adjustments, as well as important differences in adjustment for different regions of the distributions of shortages. Figure 1 shows that labor adjustment is a nonlinear function of the gap when faced with employment shortages but not with surpluses. We find that an increase in the shortage from 0 to one standard deviation (close to 0.65) implies an increase in the adjustment rate of about 3 to 4 percentage points from an initial level of around 15%, while moving to a shortage of 1.75 basically doubles the adjustment rate. No similar increase is observed for plants faced with employment surpluses. By contrast, for capital, we find nonlinearities on both the creation and destruction sides. Figure 2 shows that plants with larger gaps between

desired and actual capital adjust more. We find that moving from a gap of 0 to a gap of 0.8 in absolute value (a change of about one standard deviation) implies an increase in the adjustment rate of close to 5 percentage points, from initial levels of around 2% for surpluses and around 20% for shortages. In addition, we find clear evidence of irreversibilities for capital on the destruction side as capital shedding is much less likely than investment, even in the presence of large capital surpluses.

Generally, our results are consistent with the findings in CEH (1995, 1997) who also find evidence of nonlinear adjustment for capital and employment separately. Moreover, the finding of irreversibility in capital formation is consistent with the evidence by Caballero and Engel (1999) and Cooper and Haltiwanger (2006) who find that both convex and non-convex costs of adjusting, as well as irreversibilities, are all important components of capital adjustment cost functions.

Our specifications are more general than those in previous studies, as we consider capital and employment adjustment jointly, so it is interesting to study the effects of capital shortages on employment adjustment and of employment shortages on capital adjustment. Figure 1 shows that while higher capital shortages (e.g., increasing X by one standard deviation) reduce the pace of job creation, they do not have a large effect on employment adjustment on the destruction side.[21] On the other hand, Figure 2 shows that greater labor shortages lead to less investment when capital is below its desired level, while greater labor surpluses make firms less likely to shed capital when it is excessive. In this respect, capital and labor frictions appear to be dynamic complements as they reinforce each other (i.e., less adjustment in one factor leads to less adjustment on the other and vice-versa). Put in a different manner, establishments seem to substitute adjustment in one margin for adjustment in another.

Before proceeding to our analysis of the effects of the reforms, it is important to emphasize that taking a flexible nonlinear approach towards estimation of the adjustment dynamics is critical in this context. First, the adjustment of one factor depends not on the gap between actual and desired levels of that factor, but also on the gap of the other factor. Second, the shapes of the adjustment functions are highly nonlinear with important asymmetries for positive and negative shortages and important cross effects. Thus, using our generalized approach is critical for understanding the patterns of adjustment in general, and as we will see for the impact of the reforms in particular.

[21] The fact that capital shortages inhibit job creation is consistent with the finding by Caballero, Engel and Micco (2004) that in Colombia, and other Latin American economies, large firms display more pronounced nonlinearities in their propensity to adjust employment, with resulting substantially lower probability of facing large labor shortages. Large producers in their sample are less likely to face financial constraints to invest and are therefore less likely to exhibit large capital shortages too.

5.2 Adjustments after Deregulation

The reforms had a substantial impact on the patterns of labor and capital adjustments. Figure 3.a shows substantially more employment adjustment on the destruction side after dismissal costs were reduced in 1990. In particular, we find that plants faced with employment surpluses almost doubled the adjustment rate after the reforms. On the creation side, there is less adjustment for small shortages but substantially more for shortages above a threshold, implying more important nonlinearities after the reforms. This is consistent with reforms making fixed costs of increasing the labor force relatively more important, and thus suggests that fixed costs in this margin are more technological than institutional in nature; a more regulated environment seems to be associated to hiring costs, but only of the convex type. The finding of more nonlinear employment growth after reforms is also consistent with greater job creation in response to large labor shortages after credit constraints were relaxed and capital shortages reduced, following financial liberalization.[22] We find that a plant facing a 0.05 employment shortage shows a reduction in the adjustment rate from close to 15% to about 10%, while a plant with an employment shortage of 1.75 exhibits a large increase in the adjustment rate from 15% to close to 30%. Interestingly, after the reforms, the average adjustment rate for destruction is higher than that for creation but the opposite is true pre-reform. Hence, there is evidence of irreversibilities in hiring only before the reforms. The finding of greater labor market flexibility is not surprising given that the labor market reform of 1990 intended to eliminate distortions on dismissals and hiring by reducing dismissal costs. The estimated coefficients in Table 5 show that these effects are statistically significant and show that the PAM model misses most of this story. That is, although the PAM model (column (2)) shows a greater adjustment coefficient post-reform it cannot capture the fact that this result is being driven by a large increase in adjustment on the destruction side and an increase on the creation side only for large shortages.

Figure 4.a shows less capital adjustment to eliminate excess capacity after the reforms, but no discernible change in investment in response to capital shortages.[23] We find a reduction in the adjustment rate of capital of around 0.5 percentage points for plants facing surpluses. There may be a number of factors behind the decline in capital adjustment. For one, the greater flexibility of labor may have induced some substitution away from investment changes, as reforms reduced labor adjustment costs relative to capital adjustment costs. After reforms, a given labor surplus

[22] Indeed, as Figure 1 illustrates, higher capital shortages are associated with less pronounced nonlinearities in response to labor shortages.

[23] These results are, in general, robust to changes in the values of $\widetilde{R}_t$. The only difference emerges when allowing $\widetilde{R}_t$ to vary over time with changes of the ex-post real interest rate. In this case, we obtain that the reduced flexibility of capital is observed also for positive shortages ($X_{jt} > 0$), although the effect is more modest than on the destruction side. However, this result should be considered with caution as it relies on ex-post measures of the real interest rate, which is an imperfect proxy for the expected interest rate.

generates greater job destruction than in the previous period, and the opposite is true for capital, suggesting that capital adjustment has been substituted by employment adjustment. This is consistent with our findings regarding the interaction between the two adjustment margins, as discussed above. Along those lines, one interpretation of the effects of reforms is that the Colombian adjustment patterns have moved closer to those observed in advanced economies after the reforms. That is, comparing Figures 3 and 4 to related figures in CEH (1995, 1997) the post-reform versions of the figures are closer to those in CEH especially with the greater irreversibility for capital relative to labor. It is also worth noting that in examining the estimated coefficients in Table 5 the changes in coefficients are statistically significant and the PAM model interacted with the reform dummy misses most of the story. The PAM model interacted with the reform dummy (column (6)) suggests that capital adjustment speeds have been reduced, which misses the fact that there has been virtually no change in capital adjustment for positive capital shortages and instead a reduction in capital adjustment for establishments with excess capital.

Up to this point, we have discussed changes in the patterns of adjustment between the pre- and the post-reform periods, and have attributed those changes to the reform process. One valid question is whether the reforms are truly behind the observed changes, or maybe other, contemporaneous, forces are at work. To try to get at this question, we allow the adjustment function to vary with an index of overall reform for the Colombian economy.[24] The reform index, which varies yearly, measures the degree of market orientation in the areas of labor regulation, financial sector regulation, trade openness, privatization and taxation. Our index of reform is generated using the data on institutions collected by Lora (2001).[25] Figure 5 presents the index, which has an increasing trend over the period, with an important discrete increase at the beginning of the 1990s.

The results, letting the adjustment functions vary with this measure of reform, are illustrated in Figures 3.b and 4.b, which depict the adjustment function for three different levels of reform. Consistent with our interpretation of the findings in Figures 3.a and 4.a, we find that increased market orientation yields more employment adjustment on the destruction side and more pronounced nonlinearity of employment adjustment on the creation side. Similarly, greater movement towards reforms seems to be associated with less capital shedding, but appears to have very little effect on

[24] In practice, we do this by interacting each term of the adjustment function with the reform index, rather than the reform dummy. Since the series for the index starts only in 1985, when including this index our estimations are restricted to the 1985-1998 period.

[25] Following Lora (2001), we generate indices of market reform in each of the five areas mentioned above, and then average those individual indices to construct the index of overall reform. However, Lora (2001) calculates the individual indices in a 0-1 scale, where 0 (1) corresponds to the most (least) rigid institutions in Latin America over the period for each of the five categories that compose the aggregate index. We use a different 0-1 scale, where the index in each category is calculated relative to the minimum and maximum level of reform in Colombia during the period, rather than the minimum and maximum relative to neighboring countries as calculated in the Lora index.

capital formation. Reform, thus, is found to have effects on the patterns of adjustment in the same direction as the simple pre- and post-reform comparisons.[26] In addition, deregulation of factor markets impacted the nonlinear adjustments of labor and capital in rich ways – that is, the deregulation did not yield simple shifts of the adjustment functions but rather impacted positive and negative shortages differently, linear and nonlinear terms differently and cross terms differently.

6 Factor Reallocation and Aggregate Productivity

In this section, we examine whether there were productivity gains associated with the changes in labor and capital adjustments observed after the reforms. In particular, we measure changes in aggregate productivity due to changes in reallocation from the reduction or removal of labor and capital market frictions. We conduct this exercise by using a cross-sectional decomposition methodology, first introduced by Olley and Pakes (1996). We quantify what part of aggregate productivity every year reflects the productivity of the average plant, and what part captures the concentration of activity in the more productive plants, by conducting the following decomposition of aggregate TFP:

$$TFP_t = \overline{TFP}_t + \sum_{j=1}^{J} \left(f_{jt} - \overline{f}_t\right)\left(TFP_{jt} - \overline{TFP}_t\right),$$

where TFP_t is the aggregate total factor productivity measure for a given 3-digit manufacturing sector in year t. These aggregate measures correspond to weighted averages of our plant-level TFP measures, where the weights are market shares (calculated as described below). The first term of the decomposition, $\overline{TFP}_t$, is the average cross-sectional (unweighted) mean of total factor productivity across all plants in that sector in year t. TFP_{jt} is the total factor productivity measure of plant j at time t estimated as described in Section 5, f_{jt} is the share or fraction of plant $j's$ output out of sectoral output at the 3-digit level in year t, and $\overline{f}_t$ is the cross-sectional un-

[26] Having shown this, it is important to note that not all the time variation in the patterns of adjustment may be attributed to changes in regulations, as captured by the reform index. Adjustment patterns may also change as a reflection of the existence of stochastic adjustment costs, or changes of adjustment costs attributable to cyclical (possibly aggregate) shocks, rather than persistent institutional change. To check for this, we estimate adjustment functions year-to-year. Results of this exercise (available upon request) show that market orientation as captured by the reform index seems to largely account for changes in the shape of the adjustment functions, though it does not capture all the shifts in levels. It is important to note that, despite the clear importance of cyclical factors, the same general patterns described for the pre- and post-reform periods are evident in the year-to-year adjustment functions. In particular, the post-1990 years are characterized by a more pronounced nonlinearity of adjustment on the job creation side, more job destruction, and less capital shedding.

weighted mean of f_{jt} for the sector.[27] The second term in this decomposition allows us to understand whether production is disproportionately located at high-productivity plants, and examining this decomposition over time allows us to learn whether the cross-sectional allocation of activity has changed in response to the market reforms.[28]

We estimate the actual decomposition of TFP and then we construct four counterfactuals, which allow us to answer what would had been the cross-sectional allocation had frictions in factor markets been removed altogether or, alternatively, reduced to the post-reform levels. The decompositions only differ from each other in the shares used in the second term. The first decomposition uses actual output shares. The other decompositions use counterfactual output shares, where output is calculated as:

$$\widehat{Y}_{jt} = \widehat{K}_{jt}^{\widehat{\alpha}} \left(\widehat{L}_{jt} H_{jt} \right)^{\widehat{\beta}} E_{jt}^{\widehat{\gamma}} M_{jt}^{\widehat{\phi}} \widehat{V}_{jt} \tag{12}$$

In each case, the levels of energy, hours, and materials are the observed ones, and the $\widehat{V}_{jt}$ is the exponential of our TFP measure. The levels $\widehat{K}_{jt}$ and $\widehat{L}_{jt}$, however, vary across decompositions. For the second decomposition, $\widehat{K}_{jt}$ and $\widehat{L}_{jt}$ are the frictionless levels of capital and labor.[29] For the third decomposition, $\widehat{K}_{jt}$ and $\widehat{L}_{jt}$ are the capital and employment levels that would had resulted if labor and capital changed according to our estimated adjustment functions in equations (5) and (6), which vary between the pre- and post-reform periods. Finally, for the last two decompositions, we construct counter-factual shares where $\widehat{L}_{jt}$ and $\widehat{K}_{jt}$ are the employment and capital levels that would have prevailed if the labor and capital adjustment functions, respectively, had remained the entire period as during the pre-reform years.

The results for these decompositions are presented in Table 6. The actual decomposition, presented in the first three columns, shows that aggregate productivity grew after the introduction of reforms in 1991. Moreover, Column (3) shows that much of the increase in aggregate productivity over this time is associated with an increase in allocative efficiency.

The next three columns present the frictionless decomposition, which shows how

[27]The fact that we calculate aggregate measures at the sector level means that our focus is on within sector reallocation rather than between sector reallocation, for sectors defined at the 3-digit level. For measurement and conceptual reasons, comparisons of TFP across sectors (in levels) are more problematic to interpret. Focusing on within sector allocation permits us to emphasize the degree to which market reforms have led to an improved allocation of activity across businesses due to less distortions in factor markets and the associated higher competition.

[28]An advantage of this cross-sectional method over methods that decompose changes in productivity over time, is that cross-sectional differences in productivity are more persistent and less dominated by measurement error or transitory shocks.

[29]For all counterfactuals, we estimate the levels of capital and labor, and thus their respective adjustments, holding the demand shocks at their average level for each plant. We do this in order to hold constant any potential independent effect of demand changes on reallocation during the period of reforms. We have also conducted the counterfactuals allowing demand shocks to vary and the results are very similar, suggesting that demand changes, on their own, do not play a crucial role in reallocating activity from low- towards high-productivity plants.

productivity levels would have changed had all frictions in factor adjustment been removed. Comparing Columns (1) and (4) shows that productivity would have been substantially higher in all years had all frictions from factor markets been removed. The difference is quite striking: aggregate productivity is about 25% lower than it would be in the absence of barriers to efficient allocation. Since the average TFP is identical in both decompositions by construction, all gains from the removal of frictions are due to the fact that allowing plants to adjust labor and capital more easily increases the market share of more productive plants and reduces the share of less productive plants. In other words, all of the gains from removing frictions are evident in comparing columns (3) and (6). Note that we also find, in column (6), that allocative efficiency would have improved over the 1990s even in a frictionless environment. This result, which may seem surprising given that all possible barriers to allocation were removed by construction for all periods, is associated with the greater dispersion of TFP across firms following the reforms as reported in Table 4. The scope for gains from improved allocation depends on the volatility of the shocks faced by plants; flexibility is advantageous only to the extent that plants need to adjust to shocks. If shocks are larger and more frequent, the benefits of being able to adjust are also larger.

The next decompositions, reported in Columns (7)-(15), allow answering whether the Colombian labor and capital reforms moved the economy in the direction of a frictionless environment. For these comparisons, we focus on the cross term since that is the only term that is impacted by these counterfactual exercises.[30] Columns (3) and (9) show that the actual and predicted increases in the cross term are about the same and yield an increase in the cross term of almost 17 log points from 1982 to 1998.[31] This compares with an increase in the cross term from the frictionless case of about 25 log points. Thus, allocative efficiency increased significantly following the reforms but not by as much as it would have in a frictionless environment. Note that some adjustment impediments have technological, rather than institutional, origins. Even if deregulation would have removed all distortions to factor markets, some factor adjustment frictions would remain so it is unrealistic to expect that the reforms achieved the gains illustrated in column (6).

Columns (10)-(15) show what would had been the impact of reallocation on productivity had the labor and capital market reforms not taken place in 1991. We first keep the employment adjustment function as during the pre-reform period but allow the capital adjustment function to change, and we then keep the capital adjustment function as during the pre-reform period but allow the labor adjustment function to

[30] It may be that the reforms increased the average productivity in the absence of frictions but our counterfactuals and underlying empirical models are not directly addressing these issues.

[31] The finding that these columns yield roughly the same result is a specification check on our model. That is, Column (3) reflects the actual cross term and Column (9) reflects the cross term from using the outputs implied by measures of factor inputs derived from our model. The model is successful in terms of generating the actual pattern of covariation between output shares and TFP.

change. The cross term is uniformly lower in Column (12) compared to Column (9), reflecting the cost of decreased capital flexibility. However, the differences are very small.

By contrast, the results for the last decomposition in Columns (13)-(15) indicate that productivity and the cross-section term are bigger when only labor adjustment is allowed to change after the reforms compared to when both labor and capital are allowed to change. Our results, thus, suggest that the labor market reform contributed to increase productivity by reallocating activity from low- towards high-productivity plants as labor adjustments moved closer to their desired levels. However, the counterfactual suggests that the impact of the reforms on allocative efficiency via the change in the labor adjustment function is very small.

Overall, our analysis of counterfactuals suggest that frictions in terms of capital and labor adjustment are potentially very important as removal of all such frictions would yield a substantial increase in productivity. While our results in prior sections suggest there are statistically and economically significant changes in the adjustment functions following the reforms, the direct impact of these changes in the adjustment functions on allocative efficiency is quite small. However, all of the counterfactuals (as well as the decomposition using the actual data) show a substantial improvement in allocative efficiency following reforms so it does appear that reforms had an impact on allocative efficiency. Part of the explanation appears to be a greater scope for allocative efficiency to be important given the increased dispersion of productivity shocks after the reforms and interestingly this greater scope has apparently been realized.

7 Conclusion

In this paper, we examine how plant-level adjustment dynamics for capital and labor interact with each other. Given the widespread finding that plant-level adjustments are lumpy, we allow for nonlinear adjustment dynamics. Beyond considering the interaction of capital and labor adjustments, we estimate adjustment dynamics in the context of an emerging economy, namely Colombia, that has undergone a substantial reform process intended to deregulate factor markets. In particular, an important objective of structural reforms in Colombia and other developing economies during the 1990s was to make factor markets more flexible.

Our results can be briefly summarized as follows. First, consistent with the existing literature, we find strong evidence of nonlinear micro adjustment. Businesses are likely to adjust capital and labor by a proportionally greater amount if the gaps between desired and actual levels are large. Second, we find important interactions between capital and labor adjustments. In particular, businesses with capital shortages are less likely to create jobs in response to labor shortages, and businesses with labor shortages are less likely to invest as a result of capital shortages. Similarly, businesses with excess labor are less likely to shed capital when fixed assets are in

surplus. These findings highlight the importance of jointly analyzing capital and labor adjustments. In terms of policy, the evidence highlights a potentially undesirable feature of piecemeal reform, namely that frictions in still regulated factor markets can distort adjustment of a newly deregulated factor, thus hampering the effectiveness of reform.

In terms of the impact of deregulation, the most dramatic effect we find is the increased flexibility of labor especially on the destruction side. Interestingly, this increase in labor flexibility is accompanied by a milder but significant reduction in capital variability, especially on the capital shedding side. Thus, while the reforms may have succeeded in making labor more flexible in Colombia, plants appear to have used that greater flexibility of labor to reduce capital adjustments. One possible explanation for this pattern is that the reduction in frictions from the institutional reform may increase the importance of technology-related frictions. Generally, these latter frictions associated with labor rotation are smaller than those associated with retooling or scrapping in the case of capital. In the absence of distortions, producers would rather respond to shocks through the adjustment of labor, as the more variable factor, as opposed to through the adjustment of fixed capital.

Our findings show that most of these effects of the capital and labor adjustment dynamics would be missed if a standard partial adjustment model was used instead of the more flexible, nonlinear, multivariate model. The partial adjustment model implies only that labor flexibility increases and capital flexibility decreases after the reforms and so misses the finding that it is on the job destruction side that labor flexibility especially increases and it is on the capital destruction side that capital flexibility decreases.

If factor reallocation facilitates the expansion of more efficient incumbents and the contraction of less efficient plants, then we may expect factor market deregulation to be associated with productivity growth. We, thus, explore whether the changes in employment and capital adjustments after the Colombian reforms were productivity enhancing and whether the hypothetical move to a completely frictionless world in factor markets would be productivity enhancing. We find that moving towards frictionless factor adjustment would indeed increase productivity substantially (by more than 20 log points in any given year) by allowing the reallocation of activity from low to high productivity plants. At the same time, we find that, while the reforms themselves seemed to have moved the economy towards an environment with less frictions in factor markets, productivity remains well below the frictionless levels after reforms. These results suggest that Colombian labor and capital adjustment are still subject to many restrictions that inhibit the resource reallocation process and prevent the realization of all potential gains from productivity enhancing reallocation. Although some of the remaining adjustment frictions may be the result of technological impediments (e.g. labor training or capital installation costs), other factor market frictions may be removed by deeper deregulation. In addition, we find that even in the absence of capital and labor market adjustment frictions that allocative efficiency

increased significantly after the reforms. The latter finding suggests that the reforms had an important impact on allocative efficiency above and beyond the impact of reducing capital and labor market adjustment frictions. Overall, then, our results suggest that removal of capital and labor market adjustment frictions has enormous potential for increasing productivity, that the reforms appear to have reduced such frictions modestly, but that the reforms did improve allocative efficiency via effects other than reductions in capital and labor market adjustment frictions.

It is important to note that while our results suggest that the reforms, and mainly the labor market reform, generated efficiency gains, the much greater adjustment in response to labor surpluses after the reforms probably also generated important losses associated with worker displacement that would need to be quantified in order to assess the welfare effects of the reforms.

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Appendix

The first-order conditions for capital, employment, hours, energy and materials yield the following system of equations:

$$\widetilde{\overline{K}}_{jt} = \frac{\zeta + \left(\frac{\eta}{\eta-1}\right)\left[\widetilde{R}_t - \ln\alpha\right] - \widetilde{V}_{jt} - \beta\left(\widetilde{\overline{L}}_{jt} + \widetilde{\overline{H}}_{jt}\right) - \gamma\widetilde{\overline{E}}_{jt} - \phi\widetilde{\overline{M}}_{jt}}{\left[\alpha - \left(\frac{\eta}{\eta-1}\right)\right]}, \tag{13}$$

$$\widetilde{\overline{L}}_{jt} = \frac{\zeta + \xi + \left(\frac{\eta}{\eta-1}\right)\ln(1 + w_{1t}\overline{H}_{jt}^{\delta}) - \widetilde{V}_{jt} - \alpha\widetilde{\overline{K}}_{jt} - \beta\widetilde{\overline{H}}_{jt} - \gamma\widetilde{\overline{E}}_{jt} - \phi\widetilde{\overline{M}}_{jt}}{\left[\beta - \left(\frac{\eta}{\eta-1}\right)\right]} \tag{14}$$

$$\widetilde{\overline{H}}_{jt} = \frac{\zeta + \xi + \left(\frac{\eta}{\eta-1}\right)\left[\widetilde{w}_{1t} - \widetilde{\overline{L}}_{jt}\right] + \ln\delta - \widetilde{V}_{jt} - \alpha\widetilde{\overline{K}}_{jt} - \beta\widetilde{\overline{L}}_{jt} - \gamma\widetilde{\overline{E}}_{jt} - \phi\widetilde{\overline{M}}_{jt}}{\left[\beta - \left(\frac{\delta\eta}{\eta-1}\right)\right]} \tag{15}$$

$$\widetilde{\overline{E}}_{jt} = \frac{\zeta + \left(\frac{\eta}{\eta-1}\right)\left[\widetilde{P}_{Et} - \ln\gamma\right] - \widetilde{V}_{jt} - \alpha\widetilde{\overline{K}}_{jt} - \beta\left(\widetilde{\overline{L}}_{jt} + \widetilde{\overline{H}}_{jt}\right) - \phi\widetilde{\overline{M}}_{jt}}{\left[\gamma - \left(\frac{\eta}{\eta-1}\right)\right]}, \tag{16}$$

$$\widetilde{\overline{M}}_{jt} = \frac{\zeta + \left(\frac{\eta}{\eta-1}\right)\left[\widetilde{P}_{Mt} - \ln\phi\right] - \widetilde{V}_{jt} - \alpha\widetilde{\overline{K}}_{jt} - \beta\left(\widetilde{\overline{L}}_{jt} + \widetilde{\overline{H}}_{jt}\right) - \gamma\widetilde{\overline{E}}_{jt}}{\left[\phi - \left(\frac{\eta}{\eta-1}\right)\right]}, \tag{17}$$

where $\widetilde{\overline{L}}_{jt}$, $\widetilde{\overline{K}}_{jt}$, $\widetilde{\overline{H}}_{jt}$, $\widetilde{\overline{E}}_{jt}$, and $\widetilde{\overline{M}}_{jt}$ are the logs of $\overline{L}_{jt}$, $\overline{K}_{jt}$, $\overline{H}_{jt}$, $\overline{E}_{jt}$, and $\overline{M}_{jt}$, respectively. Also, $\zeta - \left(\frac{\eta}{\eta-1}\right)\left[\ln\left(\frac{\eta}{\eta-1}\right) - \widetilde{D}_{jt}\right]$ and $\xi - \left(\frac{\eta}{\eta-1}\right)[\widetilde{w}_{0t} - \ln\beta]$. Given our assumption of no adjustment costs for the use of hours, energy, and materials, $\widetilde{\overline{H}}_{jt}$, $\widetilde{\overline{E}}_{jt}$, and $\widetilde{\overline{M}}_{jt}$ are equal to their observed values. Therefore, the system is reduced to two equations and two unknowns: $\widetilde{\overline{L}}_{jt}$ and $\widetilde{\overline{K}}_{jt}$. These equations, captured by (9), are expressed in terms of the parameters of the model, wages, interest rates, energy and materials prices, unobservable productivity and demand shocks, and the use of other factors: $\widetilde{\overline{H}}_{jt}$, $\widetilde{\overline{E}}_{jt}$, and $\widetilde{\overline{M}}_{jt}$.

Table 1: Descriptive Statistics, Before and After Reforms

Variable	Pre-Reforms	Post-Reforms
Output	10.49	10.90
	(1.67)	(1.88)
Capital	8.21	8.75
	(2.05)	(2.18)
Labor Hours	10.97	10.95
	(1.1)	(1.25)
Energy	11.30	11.55
	(1.88)	(1.99)
Materials	9.61	10.25
	(1.85)	(1.88)
Output Prices	-0.08	-0.15
	(0.44)	(0.74)
Energy Prices	0.25	0.55
	(0.50)	(0.43)
Material	0.02	-0.10
Prices	(0.35)	(0.57)
Wages	193	229.56
	(54.05)	(76.05)
N	55,298	44,816

Notes: This table reports means and standard deviations of the log of quantities and of prices deviated from yearly producer price indices. It also reports means and deviations of yearly wages in thousands of pesos of 1982. The pre-reform period includes the years 1982-90 and the post-reform period includes the years 1991-98.

Table 2: Production Function Equations

	Production Function OLS	Production Function 2SLS	First Stage Partial R- squared
	(1)	(2)	(3)
Capital	0.0764	0.3027	0.128
	(0.0025)	(0.0225)	
Labor Hours	0.2393	0.2126	0.139
	(0.0037)	(0.0313)	
Energy	0.124	0.1758	0.231
	(0.0028)	(0.0143)	
Materials	0.5891	0.2752	0.324
	(0.0026)	(0.0095)	
Root Mean Squared Error	0.6545	0.7670	
N	48,114	48,114	

Notes: Standard errors are reported in parentheses. The regression uses physical output as the dependent variable, and capital, employment hours, energy, and materials as regressors, where all variables are in logs. The following variables are used to instrument the inputs: Shea's (1993) downstream demand instruments constructed as the demand for the intermediate output (calculated using the input-output matrix); one- and two-period lags of downstream demand; regional government expenditures, excluding government investment; and energy and material plant-level prices, deviated from the yearly PPI. The first stage R^2 reports the square of the sample correlation coefficient between I_{jt} and $\hat{I}_{jt}$, where I=K,L,E,M and $\hat{I}_{jt}$ are the predicted values of the inputs from a regression of I_{jt} on the instruments. The RMSE reports the square root of the mean squared error.

Table 3: Inverse Demand Equations

	Inverse-Demand OLS	Inverse-Demand 2SLS	First Stage R-squared
Regressor	(1)	(2)	(3)
Physical Output	-0.0905	-0.4381	0.2177
	(0.0011)	(0.0034)	
RMSE	0.5543	0.8267	-
N	86,251	86,251	86,251

Notes: Standard Errors are in parentheses. The dependent variable is the plant-level price minus the yearly PPI (all in logs). The two-stage least squares regression instruments physical output with the 2SLS TFP measure estimated using Column (2) in Table 2. The RMSE reports the square root of the mean squared error.

Table 4: Moments of Determinants of Adjustment, Before and After Reforms

Variable	Pre-Reforms	Post-Reforms
Labor Shortage	0.04	-0.01
	(0.65)	(0.63)
Capital Shortage	0.17	-0.04
	(0.81)	(0.80)
TFP	1.07	1.10
	(0.68)	(0.90)
Demand Shocks	4.60	4.70
	(0.79)	(0.89)
Material Prices	0.02	-0.10
	(0.36)	(0.55)
Energy Prices	0.28	0.54
	(0.52)	(0.42)
N	36,999	33,300

Notes: The table reports the first two moments of labor and capital shortages estimated using equations (1) and (2), as well as driving forces behind shortages: tfp, demand and input prices. The pre-reform period includes the years 1982-1990, while the post-reform period includes the years 1991-1998. The figures for imput prices differ slightly from those reported in Table 1 because here the sample is being restricted to plants that have no missing values for labor and capital shortages.

Table 5: Labor and Capital Adjustment Functions

	Labor Adjustment				Capital Adjustment			
	(1) PAM	(2) PAM/ POSREF	(3) NLAM	(4) NLAM/ POSREF	(5) PAM	(6) PAM/ POSREF	(7) NLAM	(8) NLAM/ POSREF
Constant	0.1902	0.1661	0.218	0.184	0.1568	0.1771	0.024	0.063
	(0.002)	(0.003)	(0.006)	(0.008)	(0.002)	(0.003)	(0.007)	(0.010)
Pos. Shortage			-0.071	-0.012			0.190	0.158
			(0.010)	(0.012)			(0.012)	(0.014)
L Shortage^2			-0.009	-0.009			-0.002	-0.009
			(0.003)	(0.004)			(0.004)	(0.007)
L Shortage^2			0.056	0.029			-0.008	-0.008
× Pos. Shortage			(0.005)	(0.006)			(0.005)	(0.008)
K Shortage^2			-0.010	-0.009			0.042	0.040
			(0.003)	(0.004)			(0.003)	(0.005)
K Shortage^2			0.015	0.006			-0.001	-0.001
× Pos. Shortage			(0.004)	(0.006)			(0.004)	(0.006)
L Shortage			0.005	-0.001			-0.054	-0.060
× K Shortage			(0.003)	(0.003)			(0.004)	(0.006)
L Shortage			-0.053	-0.031			-0.029	-0.015
× K Sh. × Pos. Sh			(0.004)	(0.007)			(0.005)	(0.007)
Post-reform		0.051		0.065		-0.0429		-0.072
		(0.004)		(0.009)		(0.004)		(0.011)
Pos. Shortage				-0.113				0.056
× Post-reform				(0.013)				(0.015)
L Shortage^2				0.006				0.010
× Post-reform				(0.005)				(0.008)
L Shortage^2				0.041				0.013
× Pos. Sh. × Post				(0.007)				(0.011)
K Shortage^2				-0.000				0.010
× Post-reform				(0.005)				(0.006)
K Shortage^2				0.009				-0.002
× Pos. Sh. × Post				(0.008)				(0.007)
L Shortage				-0.002				0.008
× K Sh. × Post				(0.005)				(0.007)
L Sh. × K Sh.				-0.016				-0.036
× Pos. Sh. × Post				(0.008)				(0.009)
R squared	0.1071	0.1100	0.1121	0.1162	0.1029	0.1045	0.1405	0.1421
N	70,299	70,299	70,299	70,299	70,299	70,299	70,299	70,299

Notes: The table reports partial and non linear adjustment functions estimated using equations (5) and (6). The labor shortage is estimated using equation (1) and the capital shortage using in equation (2). The sample is a panel of pairwise continuining plants. The positive shortage dummy takes the value of 1 when there is a labor or capital shortage and the value of 0 when there is a labor or capital surplus. The post-reform dummy takes the value of 1 for plants observed during the years 1991-98 and the the value of 0 for plants observed during the years 1983-90. Column (1) and Column (5) show results for the Partial Adjustment Model. Column (2) and Column (6) show results for the Partial Adjustment Model with coefficients that vary pre- and post-reform. Column (3) and Column (7) exhibit the non linear adjustment model. Finally, Column (4) and Column (8) exhibit the non linear model with coefficients that vary pre- and post-reform.

Table 6: Cross-Section Decomposition of Three-Digit Level TFP, 1982-1998

	Shares calculated with actual output			Shares calculated with frictionless output			Shares from counterfactual output: both capital and labor adjustments vary post-reform			Shares calculated with counterfactual output: only capital adjustment varies post-reform.			Shares calculated with counterfactual output: only labor adjustment varies post-reform.		
Year	Aggregate (Weighted) (1)	Simple Average (2)	Cross-term (3)	Aggregate (Weighted) (4)	Simple Average (5)	Cross-term (6)	Aggregate (Weighted) (7)	Simple Average (8)	Cross-term (9)	Aggregate (Weighted) (10)	Simple Average (11)	Cross-term (12)	Aggregate (Weighted) (13)	Simple Average (14)	Cross-term (15)
1983	1.3560	0.9695	0.3865	1.6148	0.9695	0.6453	1,3766	0,9695	0,4070	1,3766	0,9695	0,4070	1,3766	0,9695	0,4070
1984	1.3175	0.9878	0.3297	1.5201	0.9878	0.5322	1,3392	0,9878	0,3513	1,3392	0,9878	0,3513	1,3392	0,9878	0,3513
1985	1.3896	1.0446	0.3450	1.5976	1.0446	0.5529	1,4019	1,0446	0,3572	1,4019	1,0446	0,3572	1,4019	1,0446	0,3572
1986	1.4066	1.1015	0.3051	1.5959	1.1015	0.4943	1,4152	1,1015	0,3137	1,4152	1,1015	0,3137	1,4152	1,1015	0,3137
1987	1.4262	1.1126	0.3136	1.5915	1.1126	0.4789	1,4286	1,1126	0,3160	1,4286	1,1126	0,3160	1,4286	1,1126	0,3160
1988	1.4702	1.1689	0.3013	1.6455	1.1689	0.4765	1,4792	1,1689	0,3103	1,4792	1,1689	0,3103	1,4792	1,1689	0,3103
1989	1.4478	1.1636	0.2842	1.6132	1.1636	0.4496	1,4540	1,1636	0,2904	1,4540	1,1636	0,2904	1,4540	1,1636	0,2904
1990	1.4994	1.1415	0.3580	1.6919	1.1415	0.5505	1,5051	1,1415	0,3637	1,5051	1,1415	0,3637	1,5051	1,1415	0,3637
1991	1.5266	1.1601	0.3665	1.7089	1.1601	0.5487	1,5329	1,1601	0,3728	1,5323	1,1601	0,3722	1,5336	1,1601	0,3735
1992	1.5105	1.0738	0.4368	1.7579	1.0738	0.6841	1,5201	1,0738	0,4464	1,5185	1,0738	0,4448	1,5210	1,0738	0,4473
1993	1.4779	1.1042	0.3737	1.6658	1.1042	0.5616	1,4856	1,1042	0,3814	1,4851	1,1042	0,3808	1,4865	1,1042	0,3823
1994	1.5135	1.0812	0.4323	1.7192	1.0812	0.6381	1,5194	1,0812	0,4382	1,5187	1,0812	0,4375	1,5201	1,0812	0,4389
1995	1.5168	1.0346	0.4822	1.7149	1.0346	0.6803	1,5294	1,0346	0,4948	1,5287	1,0346	0,4941	1,5302	1,0346	0,4956
1996	1.5768	1.0065	0.5703	1.8209	1.0065	0.8145	1,5952	1,0065	0,5888	1,5942	1,0065	0,5878	1,5964	1,0065	0,5899
1997	1.5941	1.0594	0.5348	1.8327	1.0594	0.7733	1,6148	1,0594	0,5554	1,6142	1,0594	0,5549	1,6163	1,0594	0,5569
1998	1.6209	1.0873	0.5336	1.8596	1.0873	0.7722	1,6349	1,0873	0,5476	1,6339	1,0873	0,5466	1,6367	1,0873	0,5494

Notes: All figures are simple means of 3-digit sector level statistics. The sample has been restricted to plants for which counterfactual output in Columns (7) through (15) can be calculated. The first column of each group shows the weighted mean of TFP, where market shares are the weights. Market share is the contribution of each plant to output (or counterfactual output calculated as in equation (12)) of its 3-digit sector. The second column of each group shows the contribution to those weighted means of the simple means of TFP. The third columns show the contribution of the cross-sectional correlation between market share and TFP. Shares in Columns (7)-(9) are obtained by allowing both capital and labor adjustments functions to change after reforms. Shares in Columns (10)-(12) are obtained by allowing only the capital adjustment function to change after reforms. Shares in Columns (13)-(15) are obtained by allowing only the labor adjustment function to change after reforms.

Figure 1: Estimated Employment Adjustment Function and Distribution of Employment Shortages

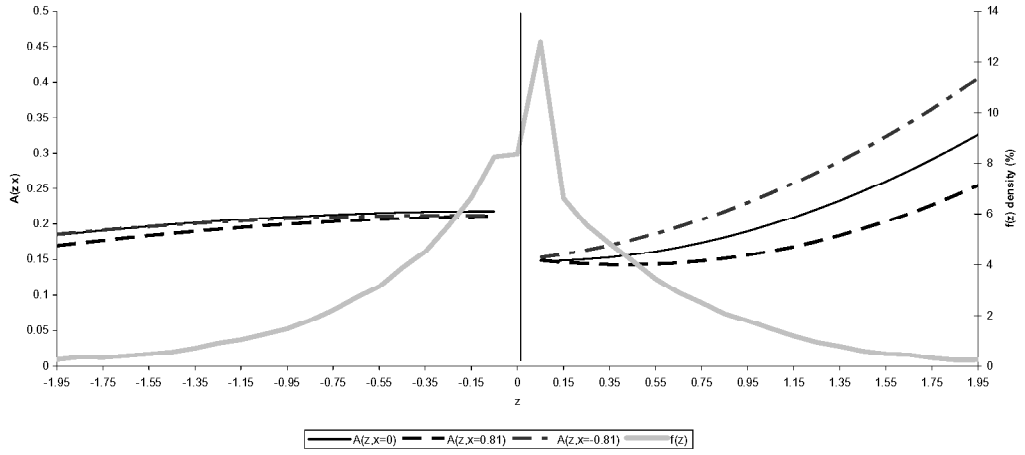


Figure 2.: Estimated Capital Adjustment Function and Distribution of Capital Shortages

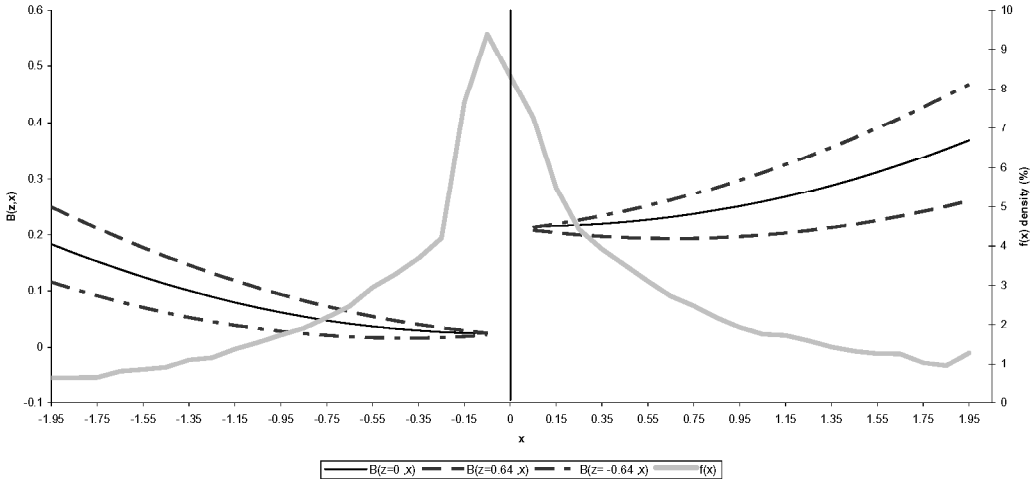


Figure 3.a.: Estimated Employment Adjustment Function and Distribution of Employment Shortages, Pre- and Post-Reform (x=0)

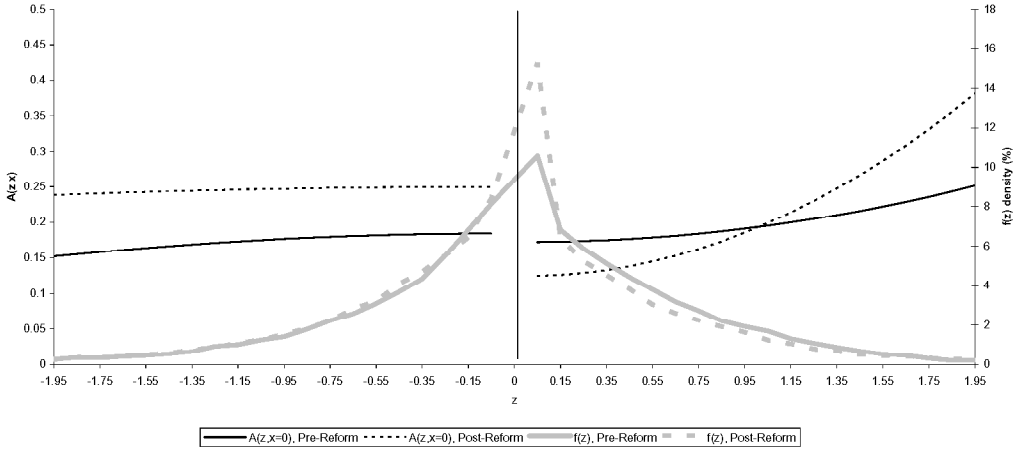


Figure 3.b.: Estimated Employment Adjustment Function at Different Levels of Reform Index (x=0)

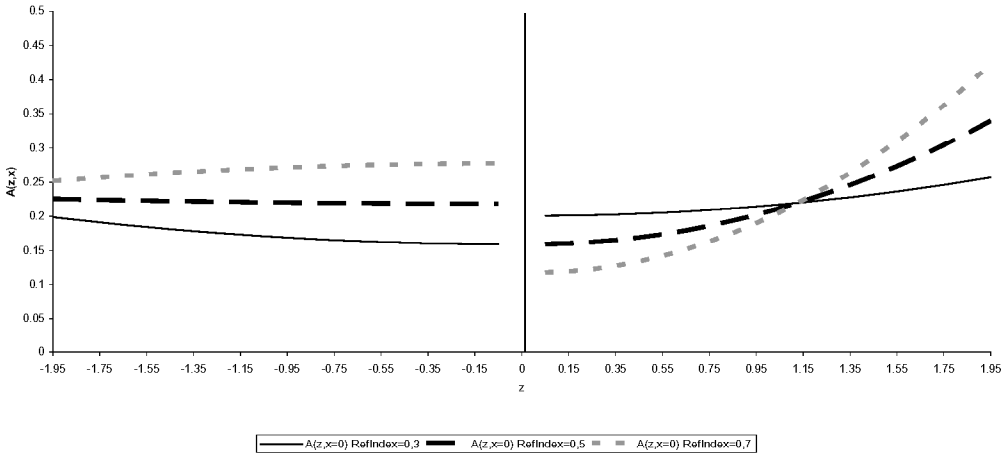


Figure 4.a.: Estimated Capital Adjustment Function and Distribution of Capital Shortages, Pre- and Post-Reform (z=0)

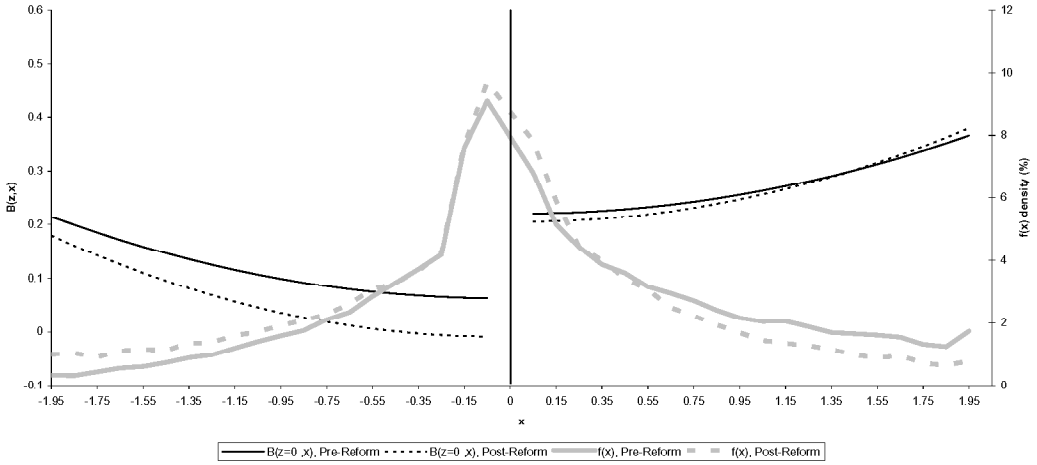


Figure 4.b.: Estimated Capital Adjustment Function at Different Levels of Reform Index (z=0)

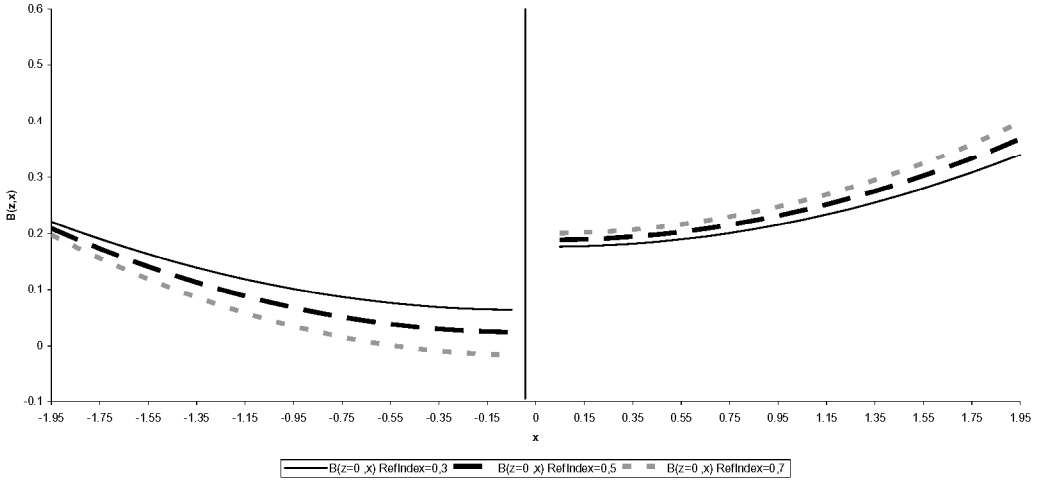


Figure 5.: Re-scaled Reform Index for Colombia, 1985-1998

