Do Labor Market Rigidities have Microeconomic Effects? Evidence from Within the Firm

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1 Introduction

Labor market regulations that constrain the ability of firms to adjust employment levels are an important and controversial public policy issue in many countries around the world. Popular support for such regulation is quite high, and proposed changes often give rise to strong emotional reactions by both opponents and proponents. For example, a recent proposed relaxation of firing rules for younger workers in France had to be withdrawn in the face of mass demonstrations.

There is considerable variation in the extent of labor regulation across countries, however (see Table 1). Given this variation, the impact of these policies on growth and employment at the national level is an important question for research. While a number of papers have examined this at a macro level (e.g., Botero, Djankov, La Porta, Lopez-de-Silanes and Shleifer, 2004; Lazear, 1990), there have been very few microeconomic cross-country empirical studies of the impact of labor market rigidities on firm level outcomes.

An important channel through which labor market rigidities could affect aggregate growth would be by impeding reallocation of resources across firms, which should be reflected in labor choices made at the firm level. In this paper, we exploit a unique cross-country dataset to examine whether and how labor regulations affect flexibility and input decisions at a microeconomic level. Our dataset, obtained from an international fast-food chain, provides information on labor choices at a *weekly* frequency across more than 2,500 outlets in 43 countries over multiple years. Confidentiality restrictions prevent us from disclosing the name of the company and also specific information on some of the variables in the dataset. Hereafter, we refer to the firm as the "Company" and its main product as "the product."[1]

To our knowledge, ours is the first cross-country study to use establishment level data to examine the consequences of rigidity in labor market regulations on firm behavior. The paper

[1] The product is a common fast-food item and for the purposes of thinking about our results, the reader may consider her favorite fast-food item as the product here.

closest in spirit to ours is Cabellero, Cowan, Engel and Micco (2004), who use cross-country 3-digit ISIC UN data to test for the effects of labor regulation (also measured per the Botero et al., 2004 index) on adjustment costs. They find that adjustment costs are greater in countries with more rigid labor regulation, and that these effects are stronger for countries that have better law enforcement. In recent work, Haltiwanger, Scarpetta and Schweiger (2006) also find that gross industry-level job turnover is affected by labor regulations.[2]

Our data present some unique advantages that we rely on in this study. First, the data cover outlets of the same firm operating under a single, common brand worldwide. In other words, we are comparing decisions at outlets that produce basically the same output using the same technology around the world. These comparisons thus are unaffected by firm specific policy and technology differences that could confound other firm-level cross-country studies. Second, the availability of high frequency data at the outlet level allows us to include outlet, outlet year and outlet-year-season fixed effects in our analyses, thereby controlling for a variety of factors that could confound analyses of more aggregate data. Finally, most firm-level studies of labor rigidity and adjustment costs use annual data, which as pointed out by Hamermesh and Pfann (1996) can hide a lot of turnover that occurs within the year.[3] Our data allow us to examine weekly employment decisions and thus capture these changes.

We model the effect of an increase in the rigidity of labor regulation as an increase in the cost of adjusting labor levels. We generate testable implications first by examining a simple model of optimal labor choice based on a Cobb-Douglas production function, combined with quadratic adjustment costs and quadratic costs of being off-equilibrium. This model yields two important implications that we bring to the data, namely: (1) increases in rigidity increase the persistence of labor decisions, as reflected in an increased elasticity of labor costs with respect to lagged labor costs, and (2) increases in rigidity reduce the responsiveness of labor costs to changes in output (revenue).[4] Both of these implications are intuitive, and the former has been

[2]Other important papers that have examined the impact of labor regulation include Blanchard and Wolfers (2000), who examined the effects of labor regulation on European unemployment, and Besley and Burgess (2004), who examined the impact of variations in labor protections legislation across states in India. Piketty (1997) compares the distribution of employment across industries in France and the U.S., and finds a large relative deficit in employment in the retail and hospitality sectors in France which he attributes to the high cost of unskilled labor in France (which in turn he associates to the regulatory regime). A large literature also has examined the effect of labor regulation on overall employment levels, labor turnover and unemployment duration, using household survey data (see Heckman and Pagés, 2004, or Addison and Teixera, 2001, for reviews of this literature). Petrin and Sivadasan (2006) and Aguirregabiria and Alonso-Borrego (2004) consider the effect of increasing labor regulation on firm behavior within a country. A separate literature has looked specifically at the nature of labor adjustment costs, including whether they are symmetric, convex (smooth) or non-convex (s, S) (see Bond and Van Reenen, forthcoming, for a review).

[3]Examples of the use of higher frequency data include Anderson (1993) and Hamermesh (1989) who used weekly and monthly data respectively. See Hamermesh (1993) for a review.

[4]Because of our data, we modify the standard model slightly to yield a regression specification of log labor *costs* on lagged log labor costs and log revenue.

tested extensively in a number of previous studies (see Heckman and Pagés, 2004 for a review). Our tests on simulated data in a more general dynamic optimization framework show that these predictions hold also for asymmetric linear and for lump sum, hence non-convex, adjustment costs, and for both IID and persistent shocks.

Results from our baseline specifications suggest a strong effect of labor regulations on labor choice at the outlet level. For the labor regulation index developed by Botero et al. (2004), our estimates imply that the effect of a one standard deviation change in lagged labor on current labor demand is higher by 9.3 percentage points (increased from 17.3 per cent to 26.6 per cent) in a country that has the regulation index one standard deviation above the mean. For the revenue elasticity, we find that the effect of a one standard deviation change in revenue on labor demand is lower by 4.6 percentage points (change from 26.9 percent to 22.3 percent) in a country whose regulation index is one standard deviation above the mean. The statistical significance and the magnitude of the effects are very similar when we use an alternative measure of hiring/firing inflexibility obtained from the 2002 Global Competitiveness Survey.

We use a number of strategies, including: (i) examining the effect of labor regulation on materials costs, (ii) incorporating interactions of per capita GDP and other country level variables, (iii) examining within-country changes, and (iv) VAR estimation, to address various potential identification issues. We find that our results concerning increased hysteresis in labor costs are robust across all our specifications. The finding of negative correlation of revenue elasticity with labor regulation holds in most but not all of our specifications.[5]

The rest of the paper is organized as follows. Section 2 describes the theoretical motivation for our empirical analysis. Section 3 discusses the data and key variables. Section 4 reports results from the baseline specification and the robustness to using an alternative measure of the rigidity of labor regulations. Section 5 discusses potential identification issues and reports the results from robustness checks to address these issues. Section 6 reports estimates of the extent of dampening of labor adjustment induced by labor market regulations. Section 7 concludes.

2 Theory and econometric specification

A standard test for the presence of labor adjustment costs is to examine whether hysteresis in labor demand (i.e. elasticity of current period labor with respect to lagged labor) increases with adjustment costs (Abraham and Houseman, 1994; several studies in Heckman and Pagés, 2004). The intuition behind this effect is that with increased adjustment costs, firms facing demand or productivity shocks would not adjust fully from previously chosen labor levels.[6] Similar

[5] We also undertook a series of additional robustness checks, discussed in Section 5.5.

[6] Another interpretation is that when faced with adjustment costs, firms would not adjust at all unless the shocks are sufficiently large. The former (partial adjustment) occurs in models with symmetric strictly convex

reasoning suggests that the observed elasticity of labor demand with respect to output would be lower in the presence of adjustment costs.

In what follows, we present a very simple model with quadratic adjustment costs that formalizes these predictions and provides a framework for our empirical analyses below.[7] The model draws on Heckman and Pagés (2004) (who drew on the work of Holt, Modigliani, Muth and Simon, 1960).

2.1 A simple model of labor demand with quadratic adjustment costs

Let the optimal labor choice at date t be determined by a static theory. Assuming a Cobb-Douglas production function, outlet-level output is given by:

$$Q_t = \Theta_t L_t^{\alpha} M_t^{\beta},$$

where Q_t is the quantity of output produced by the outlet in period t, L_t is the level of labor used, and M_t represents materials. This specification assumes that the capital stock is fixed, so that the productivity term Θ_t can be interpreted as a Hicks-neutral total factor productivity term augmented by firm-specific capital stock.[8]

Assume the outlet faces an iso-elastic demand curve: $P_t = \Lambda_t Q_t^{\frac{1}{\mu}}$, where P_t is the price per unit of output in period t, Λ_t represents demand shifters, and μ is the own-price elasticity of demand.[9] The outlet's profit function is: $\Pi_t = P_t Q_t - W_t L_t - S_t M_t$, where W_t is the wage rate per unit of labor in period t, and S_t is the price per unit of material. Assuming inputs are supplied competitively, first-order conditions yield optimal labor and materials input demand functions conditional on output (sales revenue) and input prices. Since input prices and quantities are not separately observable in our data (see Section 3 below), we derive input demand equations in terms of labor cost ($b_t = \log(W_t L_t)$) and materials cost ($f_t = \log(S_t M_t)$), which are observable.

In the presence of adjustment costs, at any time t the outlet may not choose labor levels corresponding to the static equilibrium. Let the cost of being off the static optimum be quadratic in log labor costs: $c_t^o = \gamma_o (b_t^* - b_t)^2$, where $\gamma_o > 0$. Additionally, assume a cost of adjustment that is again quadratic in log labor costs: $c_t^a = \gamma_a (b_t - b_{t-1})^2$. The optimal policy then minimizes

adjustment costs, while the latter (lumpy adjustment) is the case in models with fixed costs. In either case, taking an average over a number of firms facing uncorrelated shocks, the correlation of current period labor with prior period labor would be higher when adjustment costs are higher (see Section 2.2).

[7]The simplifying assumption of quadratic adjustment costs makes this model very tractable. In the next section, we verify that the predictions derived here are robust to using a more general dynamic optimization model with other assumptions about adjustment costs.

[8]That is, the actual production function may be a three input production function: $Q_t = \Theta_t' L_t^{\alpha} M_t^{\beta} K_t^{\gamma}$. Then in our two input production function, $\Theta_t = \Theta_t' K_t^{\gamma}$.

[9]If μ is finite, then the outlet faces a downward sloping demand curve and enjoys some market power. The case of a perfectly competitive output market in this context corresponds to $\mu = -\infty$.

the sum of the cost of being out of static equilibrium (c_t^o) and the adjustment cost (c_t^a). This yields the following equation for optimal labor cost:

$$b_t = \omega^j b_{t-1} + (1-\omega^j) r_t + (1-\omega^j)\log\alpha' \tag{1}$$

where $\alpha' = \alpha(1+\frac{1}{\mu})$, $\omega^j = \frac{\gamma_a^j}{\gamma_a^j+\gamma_o}$, small cap variables indicate logs, and $r_t = \log(P_t Q_t)$ stands for the log of sales revenue. In this setting, labor regulations that affect labor market flexibility would be expected to increase adjustment costs. Hence, in the above equation, we expect the adjustment cost parameter in country j, γ_a^j, and thus ω^j, to be an increasing function of the labor regulation index (i.e., $\omega_a^j = f(\tau^j)$, $\frac{\partial f}{\partial \tau} > 0$, where τ^j = index of labor regulation in country j). Using the first-order approximation for ω^j, $\omega^j \simeq a_o + a_1\tau^j$, yields the following econometric specification:

$$\begin{aligned} b_{it} &= (a_0 + a_1\tau^j) b_{i,t-1} + (1 - a_0 - a_1\tau^j) r_{it} + (1 - a_0 - a_1\tau^j)\log\alpha' \\ &= \gamma b_{i,t-1} + \beta r_{it} + \delta_b \tau^j b_{i,t-1} + \delta_r \tau^j r_{it} + \eta_{is} + \varepsilon_{it}, \end{aligned} \tag{2}$$

where b_{it} represents log labor cost, and r_{it} is log revenue, for outlet i in period t, while τ^j represents the index of labor regulation for country j, where outlet i is located. The η_{is} are outlet, outlet-year or outlet-year-season fixed effects, while ε_{it} represents the residual error term.

The parameters of interest are the coefficients on the interaction terms, δ_b and δ_r. The model implies that $\delta_b = a_1 > 0$, and $\delta_r = -a_1 < 0$.[10] In other words, the model predicts that if labor regulations increase the labor adjustments costs faced by outlets, then in countries with a larger index of labor regulation: (1) the elasticity of labor cost with respect to last period's labor cost will be higher; and (2) the elasticity of total labor cost with respect to output will be lower.

2.2 An infinite horizon asymmetric cost dynamic model

One potential concern with the predictions above is that the specification and implied effects on labor demand may be driven by the simplifying assumption of symmetric, quadratic adjustment costs, and/or by the simplification of the complex dynamic labor choice problem to the simpler static problem (Heckman and Pagés, 2004). In this section, we briefly examine a dynamic stochastic programming model with four alternative specifications for the adjustment costs, and two alternative specifications for the shock process (for a total of eight different simulations). This model does not yield closed form solutions, but for each of the specifications we can estimate optimal policy functions numerically. We then use the resulting policy functions to simulate

[10] Note that $\delta_b = -\delta_r = a_1$. However this prediction holds only if our model specification is exactly correct. In particular, if the adjustment cost or the cost of being off equilibrium is not quadratic, or if our first-order approximation for ω above is inexact, then this relation would not hold. This is illustrated in the simulation results in Section 2.2 below.

the actions of firms operating under different adjustment costs regimes, and test whether the predictions derived above hold in this more realistic environment using the simulated data.

The stochastic dynamic model and the simulation procedure are discussed in detail in Appendix 1. To verify that our predictions are robust to the type of asymmetries and non-convexities documented in the literature (see e.g. the review by Bond and Van Reenen, forthcoming), we simulate data for four different types of adjustment cost scenarios: (1) a benchmark case with no adjustment costs; (2) symmetric, quadratic adjustment costs, as in our model above; (3) asymmetric, linear adjustment costs; and (4) non-convex (lump-sum) adjustment costs. For each of these scenarios, we choose 45 adjustment cost regimes and simulate data for 75 firms over 104 periods (corresponding to two years at weekly frequency) in each regime. This roughly matches our data where we have information for about 45 countries, and a total sample size of about 350,000.[11]

In addition, as discussed in Heckman and Pagés, (2004), the persistence of demand and productivity shocks faced by firms could affect labor demand. In particular, if firms expect shocks to be persistent in their market, they may be more willing to adjust labor towards a new static optimum than if they expect no persistence. For this reason, for all the scenarios above, we simulate two types of shock processes: (i) iid across firms and over time, and (ii) highly persistent within firms over time (iid across firms).

For each of the four adjustment cost scenarios and the two types of shock processes, we run a regression per equation (2) using the simulated data (see Appendix 1, Section D for details). Consistent with our simple model above (in Section 2.1), the results, summarized in Table 2, show that in the absence of adjustment costs the coefficient on lagged labor cost is zero while the coefficient on revenue is almost one, and the coefficient on the interaction terms are zero.[12] The results in columns 3 to 8 indicate that, across alternative functional forms for the adjustment costs and types of shock processes, the predictions of the simple model in Section 2.1 hold also in our simulated data.[13] Across all specifications, the coefficient on lagged labor cost is higher and the coefficient on revenue is lower when adjustment costs are higher. Interestingly, the reduction in the revenue elasticity with increases in adjustment costs is greatest when adjustment costs are non-convex (fixed adjustment cost case). The increase in hysteresis (elasticity with respect to prior period's labor cost) in contrast is highest for the scenario where adjustment costs are asymmetric, but remains a feature of the data in the alternative scenarios nonetheless. The qualitative conclusions remain the same whether or not the shocks are persistent, though

[11] All 45 regimes have zero adjustment costs in the benchmark zero adjustment cost case.

[12] The small discrepancy from a coefficient equal to one arises because the optimal labor choices are rounded to increments of 0.2 when we solve for the optimal policy function.

[13] We show only results obtained with the more detailed outlet-year-season fixed effects for space reasons, but our results held also with just outlet or just outlet-year fixed effects.

persistence increases the impact of adjustment costs on the responsiveness of labor costs to revenue changes while lowering the impact of adjustment costs on hysteresis.

The main conclusion we draw from our simulations is that the predictions in Section 2.1 are not artifacts of our simple modelling framework, but are robust to modelling optimal responses in a more complex infinite horizon framework with different forms of adjustment costs and shock processes. In the remainder of the paper, we focus on these predictions and proceed to test and quantify the effect of labor regulations that are expected to affect adjustment costs.[14]

3 Data description and definition of variables

The main data source for this study is an internal dataset from a US-based international fast-food chain, which operates in over 43 countries around the world. This dataset contains weekly outlet-level financial data on inputs and outputs. Specifically, we observe sales revenue, labor costs and material costs each week for every outlet in every foreign country over a number of years.[15] Since we rely on labor regulation indices defined and assessed in the early 2000s, we focus on the 4-year period 2000-2003.[16]

In our analyses, we want to ensure that we compare outcomes obtained under similar circumstances. For that reason, we eliminate all observations that pertain to potentially unusual situations, such as outlets operating with a different type of facility (e.g., limited menu facilities), or observations relating to unusual time periods (i.e., at start-up or within a short time from the closing of an outlet). Thus, we exclude observations pertaining to the first and last years of operation for all outlets.

Our main measure of cross-country labor regulation inflexibility is an index of labor regulation constructed by Botero et al. (2004). The index, which we normalize to be mean zero for our sample of countries, is shown in Table 1. Given the heavy reliance on part-time labor and flexible schedules in the fast-food industry, we focus on regulations affecting the ability of firms to adjust labor flexibly, namely those governing alternative employment contracts, regulatory costs of increasing work hours, regulatory cost of firing workers and mandated dismissal procedures. Detailed information on the different components that make up the index are given in Appendix 2a. Since a common basis is used to evaluate the laws across all countries, this index

[14]Issues relating to the exact nature of the induced adjustment costs are beyond the scope of this paper. However, see Heckman and Pagés (2004) and Hamermesh and Pfann (1996) on these.

[15]The Company operated in several other foreign countries during the period of the study. However, data availability constraints on the labor regulation variables limit our sample to 43 countries for most of our analyses. Note that the dataset that the company provided did not include information for outlets located in the United States, where the Company is headquartered.

[16]To analyze reforms in South Korea, we rely on data from earlier years (see Section 5.3.2). However, 2003 is the last year in the data.

has the advantage of being comparable across countries.

Summary statistics for our key variables are shown in Table 3. The statistics are reported for the sample of outlets and countries that appear in our baseline analyses in Table 4 (i.e., observations for which we have data on labor costs, lagged labor costs, revenue and the Botero et al. (2004) index of labor regulation). As mentioned above, the index of labor regulation is demeaned so that the mean value is zero in our baseline sample.

In Panel A, we show that the Company operated a different number of outlets in different numbers of countries each year, but a total of 2,526 outlets in 43 countries are included overall in our data. Panels B and C show the mean, standard deviation and some percentiles of labor cost, revenue, and materials cost, all of which are shown in a re-scaled version of U.S. dollars, to preserve confidentiality. The labor cost excludes costs related to social security and other non-wage benefits. The number of observations and countries where relevant data are available is higher when we rely on the GCS index of inflexibility, as reflected in Table 5. Data for the GCS index are available for 48 of the countries where the firm operates, and the number of observations (outlets) thus goes up to 338,659 (2841).

In Panels B and C, we show our main variables of interest, first in log and then in levels. The latter allow us to gage the importance of labor and material costs, which represent 21.2% and 31.9% of weekly revenues on average for outlets in our data. Note that the coefficient of variation is greatest for labor costs, a fact that might be interpreted to mean that labor costs are not adjusted as well as material costs are.

A number of other outlet characteristics are available from the parent Company for various subsets of our data. In our analyses in Section 4, however, these characteristics are controlled for by outlet, outlet-year and outlet-season-year fixed effects as most are fixed over time, or only vary once every few months. For example, the form of corporate governance varies across outlets, but remains fixed over time during the period of our data. Hence these are absorbed by outlet-level fixed effects in our analyses below. However, we rely on a few of these variables to generate useful sub-samples for some of our robustness tests.

4 Empirical results

4.1 Baseline specification

Table 4 summarizes results from our baseline specification (equation (2)), using the Botero et al. (2004) index of labor regulation. Because the variation in the regulatory index is at the country level, we cluster all standard errors at that level.

In the first three columns of the table, we show estimates of the labor cost specification without interaction terms. We find that the hysteresis (elasticity of labor cost in period t with respect to labor cost in period $t-1$) varies from 0.54 to 0.2, decreasing as we move from outlet to outlet-year-season fixed effects.[17] The elasticity of labor cost with respect to revenue is between 32.6 and 38.8 percent (depending on what fixed effects we control for).

The results in columns 4, 5 and 6, where we include interaction terms, imply greater labor costs hysteresis in countries with more regulated labor markets, as predicted by theory. Also consistent with the theory, we find that the elasticity of labor costs with respect to revenue is significantly lower in countries with more rigid labor regulation. These effects are all statistically significant at the 5 percent level or better.

The economic importance of the effects can be gauged using the coefficients combined with summary statistics, as shown in the bottom panel of Table 4. From column 4, where we control for outlet fixed effects, we see that a one standard deviation increase in lagged log labor cost (0.85) is associated with a 42.5 percent (0.85*[0.50]) increase in current labor cost. By comparison, in a country with labor regulation one standard deviation above the mean (0.16), a one standard deviation increase in lagged log labor cost is associated with a 56.3 percent (0.85*[0.501 + 1.01*0.16]) increase in labor cost. Thus, the estimates imply that the effect of a one standard deviation change in lagged labor costs on labor cost is 13.8 percentage points higher in a country that has the regulation index one standard deviation above the mean. When we control for outlet-year fixed effects in column 5, the effect is 12.35 percentage points higher (increased from 29.58 percent to 41.93 percent), while controlling for outlet-year-season fixed effects in column 6 yields an estimated effect of 9.34 percentage points (increased from 17.26 percent to 26.60 percent).[18]

As for revenue, estimates in column 4 with outlet fixed effects imply that a one standard deviation increase in log revenue (0.69) is associated with a 23.46 percent (0.69*[0.34]) increase in labor cost in countries with the mean level of regulation. In a country with labor regulation one standard deviation above the mean a one standard deviation increase in log revenue is associated with a 17.17 percent (0.69*[0.34 - 0.57*0.16]) increase in labor cost. Thus the effect of a one standard deviation change in revenue on labor cost is 6.29 percentage points lower in a country that has the regulation index one standard deviation above the mean. This effect is 5.40 percentage points (a reduction from 24.77 percent to 19.37 percent) under the specification in column 5, with outlet-year fixed effects, and 4.58 percentage points (a reduction from 26.91 percent to 22.33 percent) when we control for outlet-year-season fixed effects in column 6.

[17] The reduction in the coefficient of lagged labor as we include more fixed effects is not surprising given the downward bias of within estimators for the coefficient of lagged dependent variables in shorter panels. See discussion in section 5.4.

[18] Again, the decreased effects as we include more detailed fixed effects is likely due at least partly to the downward bias of within estimators for coefficients on lagged dependent variables. Still, to remain conservative, we rely on these estimates in many of our calculations below.

In sum, in all specifications, we find that labor regulation has a statistically significant and economically important impact on labor cost hysteresis and the elasticity of labor cost with respect to revenue. The proportional impact is higher for lagged labor (e.g., 9.34 percentage points relative to 17.26 percent at the mean), but it is also sizable for sales revenue (4.58 percent relative to 26.91 percent). We interpret the results as strong evidence that differences in labor market rigidities across countries have real effects on the weekly operations and labor decisions of the individual fast-food outlets that comprise the Company.

4.2 Robustness to alternative measure of labor rigidity

The index of labor regulation used in our baseline specification, from Botero et al. (2004), was constructed by examining the details of laws and regulations that affect the flexibility of hiring and firing employees. As mentioned earlier, a key advantage of this index, then, is that it is assessed on a similar basis across countries. Not surprisingly, a number of authors have relied on this measure of labor regulation in their analyses (e.g., Caballero et al., 2004). However, one potential disadvantage of the Botero et al (2004) measure is that the enforcement of legal rules may vary across countries, either due to lack of resources or to lobbying by business or labor interest groups. Also, in reality, some non-regulatory factors, such as the strength of labor unions for example, could affect the flexibility in scheduling as well as hiring and firing.

We address these concerns by verifying the robustness of our results to an alternative measure that is meant to capture the operational reality relating to the flexibility in hiring and firing faced by businesses. This measure is from the 2002 Global Competitiveness Survey, which polls executives regarding business conditions in their country.[19] One of the questions asked is whether the hiring and firing of workers is impeded by regulations or flexibly determined by employers. Responses are given on a scale from one to seven, with a higher score reflecting a higher degree of labor market flexibility. We use the responses to this question to construct an index of the inflexibility of the labor market, which for a particular country j is the minimum reported flexibility score, across all countries, divided by the flexibility score for country j. (Note that this sets the maximum value of the inflexibility index equal to one.) One potential drawback of this and similar measures based on surveys of managers in different countries is that the ratings across countries are not done on a common basis, and hence may suffer from pessimism or optimism biases.[20] Data on this second measure, once demeaned, are also shown

[19] The survey is used to prepare the *Global Competitiveness Report* (GCR), published by the World Economic Forum in collaboration with the Center for International Development (CID) at Harvard University and the Institute for Strategy and Competitiveness, Harvard Business School. We thank Richard Freeman for providing access to these data.

[20] For example, managers in one country may rate the flexibility of labor practices in their country low, even if it is higher than that in another country where managers rated their system as highly flexible. (The source of

in Table 1. The two measures are positively correlated but they do differ importantly for many countries, possibly for the reasons described above.

Results obtained with this alternative measure of labor rigidity, in Table 5, are very consistent with those obtained with the Botero et al. (2004) index. Here again we find that in markets with higher perceived inflexibility in hiring and firing, the elasticity with respect to lagged labor is higher, and the elasticity of labor demand with respect to revenue is lower, than in markets with more flexibility in hiring and firing. Moreover, the magnitude of the effects we find with this alternative measure is comparable to the effects shown in Table 4. Specifically, as shown in the bottom panel of Table 5, our estimates imply that the effect of a one standard deviation increase in lagged labor cost on labor demand is increased – as a result of an increase in the index of hiring/firing inflexibility – by 13.46, 12.44 and 9.68 percentage points when we include outlet fixed effects, outlet-year effects, and outlet-year-season fixed effects respectively. The equivalent calculations for the impact of a one standard deviation change in revenue imply decreases of 8.14 , 7.93 and 7.05 percentage points. Thus the estimated impact of a one standard deviation increase in the index of inflexibility is greater than for the index of labor regulation used in the baseline case (as reported in Table 4) when we look at the effect of revenue changes, but somewhat smaller for labor cost hysteresis. In all cases, the effects are of similar importance, however.

5 Identification issues & other robustness checks

To understand potential identification issues in our analyses above, define the full error term in equation (2) as $e_{it} = \eta_{is} + \varepsilon_{it}$, or

$$e_{it} = (1 - a_0 - a_1 \tau^j) \log \left(\alpha_{it} \left(1 + \frac{1}{\mu_{it}} \right) \right) \tag{3}$$

where we again use j to index the country where outlet i is located. Given this error structure and the assumptions of our model, there are five main potential sources of bias. In each case, it is important to note that the potential bias is controlled for to a large extent by the outlet-period fixed effects that we include in our model. Moreover, our parameters of interest, namely those on the interaction terms, are affected only if biases are systematically related to the differences in labor regulation, which we have no a priori reason to expect.[21]

First, the production function parameter α, and the demand elasticity parameter μ, could vary across countries, or even between outlets within a country. Second, industry insiders suggest that in the fast-food sector, staffing and labor scheduling decisions, and materials purchases

the bias could be cultural differences or could be recent macroeconomic events.)

[21]For a more detailed discussion of these issues, see the older working paper version of this paper at http://webuser.bus.umich.edu/jagadees/papers/LafSiv_fin_all.pdf.

decisions, are typically set just one or two weeks ahead. Assuming that that demand is subject to unanticipated shocks, the error term e_{it} in equation (2) would include a prediction error term, which would induce a negative correlation between the error term in equation (2) and the revenue variable, biasing the coefficient on the revenue variable downward.[22,23] Third, model mis-specification could be a source of bias. In particular, if the production function had a more general CES form, $Q_t = (\alpha L_t^{\frac{\sigma-1}{\sigma}} + \beta M_t^{\frac{\sigma-1}{\sigma}})^{\frac{\sigma}{\sigma-1}}$, where σ is the elasticity of substitution between labor and materials, the error term in equation (3) would include output and input prices, which would be correlated with the regressors (revenue and lagged labor cost), leading to biased estimates. Fourth, as in all models with a lagged dependent variable, (see e.g. Heckman and Pagés, 2004), autocorrelation in the error term in equation (2) could induce an upward bias in the coefficient on lagged labor. Finally, other country-specific fixed effects potentially correlated with cross-sectional variation in labor regulation could bias our comparisons. For example, if demand characteristics for the Company's products are systematically different in countries with higher levels of regulation, that could affect our results.

As mentioned above, the outlet-year-season fixed effects that we include in our regressions should control for most of these sources of bias, including omitted supply and demand parameters, country or outlet-specific prediction errors, the main sources of persistence in the labor demand equation (e.g. seasonal variations in taste), as well as country-specific characteristics that may affect labor demand. However, there may be omitted factors that affect labor's responsiveness to sales or hysteresis in labor, and hence potentially bias our results. We verify the robustness of our results to these potential sources of bias in four ways. First, we run comparable regressions for material costs; second, we examine the sub-sample of OECD countries or introduce interaction terms to control for other country-level characteristics; third, we rely on information concerning changes in regulation affecting labor rigidity within countries; and fourth, we use a GMM approach, based on Arellano and Bond, 1991 and Blundell and Bond, 1998. We also briefly discuss some other identification concerns and a number of alternative robustness tests in Section 5.5.

[22]The intuition for this downward bias is straightforward – since labor is chosen early, when actual quantity is below predicted levels due to unanticipated negative demand and/or productivity shocks, the labor variable is "too high" for the low quantity and hence low revenue realization. Thus large positive residuals in labor costs are correlated with low revenue values and vice versa. This is similar to the errors in variables model – see e.g. Griliches and Hausman (1986). However, since lagged labor costs are set in by $t-1-h$, this variable is orthogonal to the prediction error term.

[23]Similarly, unanticipated changes in wage rates could affect equation (2), as could unanticipated voluntary quitting by workers. If shocks to wages and unanticipated quitting are uncorrelated with output quantity and prices once we control for outlet and outlet-period fixed effects, they will not induce bias in our estimation. Moreover, they will not induce bias in our coefficients of interest so long as the shocks are not systematically greater in more regulated labor markets.

5.1 Robustness check: Material costs specification

If the estimates of δ_r and δ_b in our equation (2) are driven by the effects of labor regulation on the adjustment costs for labor, our theory predicts that the corresponding coefficients in a regression for material costs should be statistically insignificant. That is, in the regression:

$$f_{it} = \beta^f f_{i,t-1} + \gamma^f r_{it} + \delta_b^f \tau^j f_{i,t-1} + \delta_r^f \tau^j r_{it} + \eta_{is}^f + \varepsilon_{it}^f \quad (4)$$

where f_{it} stands for material costs, we expect $\delta_r^f = 0$ and $\delta_b^f = 0$ (and $\beta^f = 0$).[24] If our baseline results are biased, however, because unanticipated demand or productivity shocks are systematically greater in countries with more rigid labor regulation, then the coefficient on revenue interacted with labor regulation would be biased downward in the material costs regressions as well since the bias here is the same as for equation (2). Similarly, model mis-specification would produce similar biases on the coefficient of revenue and lagged materials cost here as in our labor cost regressions. Moreover, if the greater hysteresis in labor demand in more highly regulated labor markets is driven by a greater autocorrelation of the error term in countries with a larger labor regulation index, this should have a similar effect on the material costs specification if this is induced by unobserved persistence in demand or productivity shocks. Finally, a number of country-specific factors that affect responsiveness to sales or hysteresis in labor costs are also likely to affect material costs in a similar way. For example, poor telecom infrastructure could affect negatively the firms' ability to coordinate with their workers, but the same issue would also likely affect the firm's ability to coordinate with the suppliers of its material inputs.

The results from estimating (4), which are shown in Table 6, imply that the impact of labor regulation on materials demand (columns 4, 5 and 6) is not statistically significant, except for the impact on the responsiveness of materials demand to revenue, which is significantly negative in the specification with store-year-season fixed effects. But, even in this case, the economic magnitude of the effect is very small, as evident from the bottom panel of Table 6. Specifically, the impact of a one standard deviation increase in the labor regulation index on the response of material costs to a one standard deviation change in revenue is -0.22, -0.04, and -0.83 percentage points in our specifications with outlet, outlet-year and outlet-year-season fixed effects respectively. Turning to the impact of regulation on the response to changes in lagged materials costs, again we find that the coefficients are insignificant. The magnitude of

[24] With strong complementarity between the inputs, adjustment costs to one input could affect the demand for the other input. In the extreme case, with a Leontief production function, if the first order condition for labor input was binding, the demand function for materials would simply be a scalar function of the demand for labor. Based on our understanding of the production process of the Company and examination of the raw data, there does not appear to be such a strong complementarity in the production function of the Company, and hence we predict a lower or zero effect of labor regulation on the materials demand function. Our results for materials costs show that the complementarities are not that strong.

the effects are slightly larger, but they remain quite small – at 2.86, 2.28, and 1.21 percentage points, respectively, for our three specifications. Moreover, contrary to the case of labor demand where we found increased hysteresis, here we find decreased hysteresis when labor regulation becomes more rigid. This may reflect a more careful optimization of material costs when labor flexibility is low; however, as noted above, these effects are not statistically significant.[25]

In summary, the results from the material costs specification suggest that the estimated effects of labor regulation on labor costs are not driven by biases such as spurious correlation between unexpected demand/productivity shocks or persistence in demand/productivity shocks and the regulation index, but rather reflect real effects of increased regulation on labor costs.

5.2 Robustness check: Sub-sample and interaction effects

In this section, we address potential bias from omitted country level variables using both sub-sample analyses and interaction terms that control for the potential effect of other country-level characteristics. The results are summarized in Table 7.

We first address the concern that labor regulation may be correlated with the level of development, which may independently impact labor demand (particularly the responsiveness to demand shocks and hysteresis). We begin by examining results from limiting our sample to 19 developed economies, all members of the Organization of Economic Cooperation and Development (OECD). We find that the baseline results hold for this sample as well (see column 1), suggesting that our baseline results are not driven by differences in levels of development among the countries in which the firm operates. Next, we rerun our baseline specification, adding interaction terms for GDP per capita. Results, in column 2, show that the introduction of these additional interaction terms reduces our coefficients of interest. While the impact of regulation on hysteresis continues to be significant, the impact of regulation on the revenue elasticity of labor costs becomes insignificant. (Note that the GDP interaction terms have highly significant coefficients whose signs suggest that per capita GDP is negatively correlated with the labor regulation measure; in the sample, this is indeed the case, with a correlation of -0.51.)

In columns 3 to 5, we report results with interaction terms for particular country specific regulations/characteristics. Specifically, in column 3, we proxy for entry barriers using the log of the number of days to start a business according to the World Bank's *Doing Business in 2003* report. We find that barriers to entry affect labor cost hysteresis and dampen adjustments to revenue fluctuations in the same way as labor regulations do generally; this is not surprising as the entry barrier measure and labor regulation are positively correlated in the sample (correlation of 0.47). The effect of labor regulation on hysteresis remains positive and significant in this

[25]We find very similar effects using our alternative measure of labor market inflexibility (from the 2002 Global Competitiveness Survey). See the web appendix to this paper for these results.

regression. The effect of labor regulation on the elasticity of labor cost to revenue remains negative, and but is significant only at the 15% level.

Finally, since we use a measure of labor cost rather than labor input (e.g. actual hours worked), it is possible that inflexibility in adjusting wages in response to shocks could impact the labor cost specifications that we use. As a measure of wage inflexibility, in column 4, we use data from the Global Competitiveness Report for 2004 on a question that asks respondents to rate the extent to which wages are determined by centralized bargaining versus set by individual firms, with higher scores indicating more flexibility. We find that this variable has no effect on labor cost adjustments, and that our coefficients of interest are largely unaffected by the presence of these interaction terms.

In column 5, we look at a measure that captures the nature of labor-employer relationships and hence the possible impact of hostile relations (potentially due to militant labor unions) on labor demand. This measure is based on a question that asks respondents to rate whether labor-employer relationships are confrontational or cooperative, with higher scores indicating a more cooperative environment. We find only very small and insignificant effect of the labor relation measure, while our baseline results of the impact of labor regulation remain largely unchanged.

We find the robustness of our baseline findings to restricting our analyses to the OECD sub-sample particularly reassuring. More generally, we conclude that our baseline results regarding the impact of labor regulation on labor cost hysteresis are very robust. The results for the impact of labor regulation on the elasticity of labor cost with respect to revenue are less robust. While always of the same sign as in our base case, they are smaller and insignificant when we include interactions for GDP per capita and entry barriers. Because of the high degree of correlation between the regulation index and GDP per capita (as well as the entry barrier variable), and because the regulation measure is inexact (as it is a composite of a number of underlying regulation measures), it is difficult to separate out the impact of the labor regulations using cross-sectional data. An alternative and potentially more robust approach is to look at changes in regulations within countries, as we do below.

5.3 Robustness check: Within country changes to labor rigidity

In this section, we again address the concern that other country-specific fixed effects potentially correlated with cross-sectional variation in labor regulation could bias our comparisons, but we do so by comparing outcomes before and after a change in labor rigidity. This approach is appealing in that it directly controls for a number of country-specific factors (such as relative wage and income levels, infrastructure, etc) as long as these remain fixed during the period of analysis. Most countries, however, do not change regulation regimes very often. Moreover, indexes that are developed to capture the degree of regulation are not necessarily updated over time. Such is the case, for example, for the Botero et al. (2004) index. As a result, there is no useful variation in this index for us to explore.

Given this, we gathered data on changes in labor flexibility in two ways. First, we looked at changes in the index constructed using the Global Competitiveness Surveys of 2002 and 2004. Given that the surveys were published in those years, we interpret them as reflecting conditions in 2001 and 2003 respectively. Second, we examined a number of secondary data sources on labor laws for countries in our dataset and identified important regulatory changes affecting labor flexibility in one of them, South Korea, over the period 1996 to 1998.[26]

5.3.1 The effect of changes in the inflexibility index

The labor market inflexibility index, as captured by the GCS, not surprisingly does not change much over a 2-year period; there are significant changes only for a small number of countries. In order to minimize the effect of measurement error in the index, we focus on countries with the largest changes. We adopt a difference-in-difference approach, comparing labor costs adjustments for outlets in countries that experienced the largest increase in the inflexibility index to outlets in countries with the largest decrease.[27] We then use our data for 2001 and 2003 and run the following regression:

$$\begin{aligned} b_{it} &= \beta b_{i,t-1} + \gamma r_{it} + \delta_1 D_{03} + \delta_2 D_{03} b_{i,t-1} + \delta_3 D_{03} r_{it} + \delta_4 D_{03} D_{90} + \\ &\quad \delta_5 D_{90} b_{i,t-1} + \delta_6 D_{90} r_{it} + \delta_7 D_{03} D_{90} b_{i,t-1} + \delta_8 D_{03} D_{90} r_{it} + \eta_{is} + \varepsilon_{it} \end{aligned}$$

where D_{03} is a dummy variable for 2003 and D_{90} is a dummy variable for observations belonging to countries in the top decile of changes in the inflexibility index. The omitted group are observations belonging to countries in the bottom decile of the change in inflexibility. The key coefficients of interest are δ_7 and δ_8, as these reflect the differences in hysteresis and in responsiveness to sales, for the top decile countries relative to the bottom decile countries. Thus δ_7 and δ_8 are difference-in-difference estimates of the effect of increasing inflexibility, controlling for country specific fixed effects as well as common cross-country trends. In addition, while the level of development and other institutional factors are likely to be fixed in the short interval

[26] We did not find another country where there was a significant, unambiguous change in the labor regulation for the periods for which we have data from the Company. In some countries there were brief periods of reform that were then reversed. Another country for which we found some amount of regulatory change in labor rigidity was Australia; the data we were able to obtain on the regulatory changes were less clear, so that the results we obtained in this case were slightly weaker but otherwise similar to what we find for Korea.

[27] Since the responses in the surveys are on a Likert scale, we focus on relative changes - specifically changes in rankings. The observations in the sample that see a large ($> p90$) increase in the inflexibility index are for outlets in Sri Lanka and Venezuela, while the largest decreases ($< p10$) occur for outlets in Chile, Colombia, Dominican Republic and Malaysia.

between 2001 and 2003, it is possible that the periods we look at (2001 versus 2003) are years in which the business cycle effects (GDP growth) were systematically correlated with the observed changes in inflexibility. For this reason, though not shown in the equation above for space reasons, we include interactions for the changes in GDP growth rates between the two periods in our regressions.[28] We also examine the same specification for material costs, to rule out non-regulation related factors that could affect input demand.

Results are summarized in Table 8.[29] Consistent with our theory and earlier results, δ_7 is positive and significant, confirming that hysteresis increases following an increase in labor inflexibility. Similarly, we find that δ_8 is negative and significant in all specifications, suggesting a decrease in responsiveness to sales with increases in labor inflexibility.

Moreover, both coefficients of interest are of similar magnitudes as those found earlier. Finally, if changes for labor costs are indeed driven by changes in rigidity rather than other factors, we would predict that material costs would be unaffected by the same change in regulation. The results for material costs (columns 3 and 4) confirm that this is the case. While there is some evidence of a decrease in responsiveness to sales revenue in column 3, this is reduced in size and significance when outlet-year-season fixed effects are included in column 4. As for lagged material costs, we find a significant, but negative and small effect in column 4, suggesting again that the positive and significant effects for lagged labor costs are in fact driven by the change in labor regulations.

5.3.2 The effect of the 1995-96 labor reform in South Korea

The South Korean government introduced legislation in 1996 to significantly relax labor laws, but modified these in 1997 in the face of strong resistance from labor unions (Kim, 1998). Following the Asian financial crisis in late 1997 and a "bail out" by the IMF, however, further flexibility was introduced in the Labor Standards Act (LSA) in 1998 (Kim, 2005). The LSA increased labor market flexibility in a number of ways, including by allowing flexible layoffs, flexible work hours, the hiring of substitute workers during disputes, and not compensating workers for wage losses due to strikes and multiple unions (Kim 1998). (See Appendix 2b (from Table 3 in Kim, 1998) for more information on the key changes in labor regulation.)

Results from our analyses of the Company's South Korea operations are shown in Table 9. In columns 1 and 2, we look at the labor demand in South Korea before and after the passage of liberalized labor laws. Since the years 1996, 1997 and 1998 witnessed changes to the labor laws,

[28]We thank a reviewer for suggesting that we include such interaction terms. The results were similar when we did not include these.

[29]Note that since we focus on changes over time for a small number of countries with the largest shifts in the inflexibility index, standard errors in this table are clustered at the outlet level.

we define the pre-reform period as the years 1994 and 1995, and the post-reform period as 1999 and 2000.[30] In columns 3 and 4, we again show equivalent results for materials costs, to assess whether other contemporaneous changes may have affected input demand. In columns 5 and 6, we show the difference-in-difference impact on labor costs in South Korea relative to that in other Asian countries in the Asia-Pacific region (as defined by the Company), an approach that helps address potential biases from contemporaneous macroeconomic changes that affected the whole region (e.g. the Asian crisis in 1997). The relevant countries include (in order of Company presence in this period) Japan, Taiwan, Philippines, India, Guam, China and Malaysia. Finally, in columns 7 and 8, we look at the difference-in-difference specification for materials costs.

We find that the responsiveness of labor cost to revenue increased, and the hysteresis in labor costs decreased, significantly after the reforms. Strikingly, there is no impact of the labor law liberalization on materials cost, either in the before-after or the difference-in-differences specifications.

We interpret the consistency of the difference-in-difference estimates in Table 8, and of our case study results for South Korea in Table 9, with our baseline findings as evidence that labor rigidity does have a strong impact on labor decisions, as predicted by theory.

5.4 Robustness check: GMM specification

As discussed in Bond (2002), while fixed-effects estimation usefully addresses the issue of cross-sectional heterogeneity in analyses such as ours, in an autoregressive model such as equation (2), there could be a bias when we rely on our more detailed outlet-period fixed effects.[31] Another issue arises from the potential endogeneity of the regressors (e.g. due to possible mis-specification error, as discussed above).

The GMM approach, formulated by Arellano and Bond (1991) and refined by Blundell and Bond (1998), provides a potential solution to these problems. This approach also addresses the

[30] Also, eliminating 1997 and 1998 reduces potential biases from the 1997 Asian financial crisis. Potential bias arising from the crisis is also controlled for by comparing to other Asian countries. Further, we examined a number of aggregate variables for the Company's operations in South Korea during this time frame (1994 to 2000) and found no significant discontinuity in these or in our data around 1997, suggesting that the financial crisis did not directly impact the sales or operations of the fast-food outlets that we study. South Korea's real GDP growth rates were similar in the two periods: 8.29% and 7.72% in 1994 and 1995 respectively, and 9.87% and 7.77% in 1999 and 2000 respectively (as per the Penn World Tables data).

[31] In general, the within (fixed effects) estimator is downward biased in short panels (Nickell 1981). This is because the transformed lagged dependent variable is $(b_{i,t-1} - \frac{1}{T-1}\sum_{t=1}^{T-1} b_{i,t})$ and the transformed error term is $(\epsilon_{i,t} - \frac{1}{T-1}\sum_{t=1}^{T-1} \epsilon_{i,t})$. The term $\frac{-b_{i,t}}{T-1}$ in the former is correlated with $\epsilon_{i,t}$ in the latter. Thus, the bias is decreasing in the length of the panel T. (Other cross terms induce bias too, but these are smaller as they are divided by terms of the order of T^2.) In our estimates using outlet fixed effects, the panel length for most of the outlets is close to 208 (52*4). Thus our panel is long enough that this bias is unlikely to be severe in these regressions. The length is shorter with outlet-year (52) and outlet-year-season fixed effects (13), and so the within estimator coefficient is more likely to be biased downward in the latter. Note that our parameter of interest is the coefficient of lagged labor interacted with regulation, which may not be systematically biased due to this.

possibility of autocorrelated error terms in such models, and proposes suitable autocorrelation tests to confirm the validity of instruments in the presence of possible autocorrelation.

Specifically, Arellano and Bond suggest first-differencing variables to eliminate the individual effects in the data, and then using suitably lagged levels of the endogenous variables as instruments. Blundell and Bond then propose augmenting this "difference" estimator with regressions in level using suitably lagged differences of endogenous variables as instruments. The moment conditions from the differenced equations, combined with the moment conditions for the levels equations, then yield a "system" estimator.

One attractive feature of this GMM approach is that in sufficiently long panels, a number of lags are available as potential instruments. Thus the model is generally overidentified, allowing for tests of the overidentifying restrictions using the Sargan/Hansen test.[32] In general, lags of order 2 and greater are available as instruments for the lagged (differenced) endogenous variable, while lags of order 1 and greater are available for other endogenous regressors. However, the validity of the lagged variables as instruments depends on the degree of autocorrelation in the error term (excluding the individual effects). [33]

We examined a number of alternative GMM specifications and approaches (differenced, level and system).[34] In addition to the lagged labor cost and lagged revenue, we also used lagged materials cost as possible instruments. We found our results to be generally consistent with those from our baseline specifications. However, most specifications failed either the Hansen/Sargan tests, or the autocorrelation tests, or both. Shorter lags (of order less than 5) were invalid as instruments as the error term appears to have a high degree of autocorrelation. This is not surprising given the high frequency data that we use – residual shocks may be highly persistent and hence correlated across many weeks.

A level GMM specification using lags 5, 6 and 7 of the differenced endogenous variables (revenue, lagged labor, materials cost and these variables interacted with the regulation index) as instruments, passed the overidentification test as well as the autocorrelation tests. The results for this specification are shown in Table 10. Here again the elasticity of labor cost with respect to revenue is significantly lower in countries with a larger regulation index, as seen from the negative and significant coefficient on the product of the regulation index and revenue. Similarly, we again find evidence of greater hysteresis in countries with more rigid labor regulations. Moreover, the

[32]This advantage is somewhat offset by the fact that with too many instruments, the Sargan/Hansen test is considerably weakened (Roodman 2006). In our estimations, we limit the number of lags used as instruments.

[33]For example, for the first-difference transformation of equation (2), $b_{i,t-2}$ is valid as an instrument for $\Delta b_{i,t-1}$ only if $\epsilon_{i,t}$ is not autocorrelated. If $\epsilon_{i,t}$ is order 1 serially correlated, then $b_{i,t-3}$ and longer lags can be used as instruments.

[34]To implement the GMM approach, we use the Stata xtabond2 procedure developed by Roodman (2006). We use the two-step procedure, with standard errors corrected as per Windmeijer (2005).

coefficients on both interaction terms are similar in magnitude and significance levels to those in our baseline analyses above.[35] Note that the autocorrelation tests reported in Table 10 are Arellano-Bond tests applied to the residuals in differences; to test for serial correlation of order l in levels, we look for correlation of order $l+1$ in differences (Roodman, 2005). As expected, the AR(1) test fails, given that, by construction, the differenced error terms are AR(1). However, since the AR(6), AR(7) and AR(8) tests have p values greater then 0.1, there is no evidence of autocorrelation of orders 5, 6 or 7, implying that the use of these lags of the differenced endogenous variables as instruments for the levels of the endogenous variables is valid.

We conclude that the potential endogeneity of revenue and lagged labor cost in our baseline regressions is not a significant source of bias for the estimates on the parameters of interest in our baseline regressions.

5.5 Further robustness checks

In this section, we briefly discuss results from a number of additional tests that we undertook. While we do not show the actual results for the sake of brevity, these are available (along with several others) in an online web appendix.[36]

First, we verified whether the effects we estimate were related in some way to the type of ownership of the outlets. Outlets owned by local franchisees, for example, may be able to respond to demand and productivity shocks in a different way than outlets owned by the company or a master (regional) franchisee. This could arise because labor regulations in certain countries do not apply to smaller operations, allowing them to adjust labor more freely, or because franchisees are better able to predict local demand variations. We indeed found evidence of a somewhat lower, but still significant, impact of regulation on labor costs hysteresis and on the response of labor costs to revenue changes for franchisee-owned outlets. We view this result as further evidence that regulations governing labor flexibility are important in this industry. Indeed, given the endogeneity of the decision to franchise units, this result suggests that getting around these rules may be a factor leading firms to franchise, at least in some jurisdictions. [37]

Second, as an alternative to the GMM approach, we undertook a simple Vector Autoregression (VAR) analysis with labor cost and revenue treated as endogenous variables, including four lags of each of these variables. Consistent with our baseline results, we found that the impact of a unit revenue impulse on labor cost was much less pronounced in countries with higher levels

[35] Even in specifications that fail one or the other specification tests, the results are in general very similar to what we report. Results from alternative specifications are available on request from the authors (some also are included in the web appendix to this paper).

[36] We thank the two anonymous referees and the two editors for suggesting many of the analyses discussed here.

[37] This conclusion is subject to the caveats that the sample of countries with franchisee owned stores is smaller. A complete analysis of the effect of organizational form that would address its endogeneity is beyond the scope of the present paper.

of labor regulation. Also in line with our other results, we found the impact of a unit labor cost impulse to be larger and more persistent in countries with a higher index of labor regulation.[38]

Third, we addressed the possibility that the labor regulations could affect upward and downward labor costs adjustments differently. In other words, it is possible that labor regulation might make it harder to adjust labor downward rather than upward, or vice versa. We addressed this by estimating our regression equation separately for two sub-samples, one that includes all observations where revenues are increased relative to the prior period, and another consisting of all observations where revenues go down at time t compared to $t-1$. We found that labor regulations affect labor costs in a way that is consistent with our baseline results in both sub-samples. However, we also found evidence of stronger impacts of regulation for the sub-sample of revenue decreases, suggesting higher distortions on firing than on hiring decisions.

Fourth, we verified that our baseline results are robust to excluding labor regulation outliers (i.e. observations in the top and bottom deciles of the labor regulation distribution). We found the results to be somewhat noisier, but nonetheless significant and of similar magnitudes for both the relevant interaction terms.

Fifth, we examined patterns of changes in revenue, labor costs and materials for different countries. In particular, we examined the fraction of observations with no reported change in the variable compared to the prior period. We found basically no persistence in revenue or material costs from week to week. For labor costs, however, we found that in a handful of countries, outlets reported the same labor costs from week to week. This does not appear to be caused by non-reporting, as data on revenue and materials costs changed in these as in other countries. Nevertheless, we checked and found our baseline results robust to excluding these countries from our analyses. In fact, as reported in the web appendix, excluding the 5 countries with the most unusual pattern of labor costs strengthened the results in both Table 4 (baseline regressions) and Table 7 (including interaction terms).

Finally, to verify whether the severity of minimum wage regulations impact our results, we defined a minimum wage index as the ratio of minimum wage to average wage (for 2000) (using data from Neumark and Wascher 2004) for the subset of OECD countries in their data also covered in our sample (14 of them). We then included interaction terms for this index with lagged labor and revenue. We found that our baseline results were robust to the inclusion of these interaction terms.

[38]In the case of the revenue impulse, we found that the response function for the top quartile of the labor regulation index converged to that for countries in the bottom quartile in about 4 periods. For the labor cost impulse, there was some convergence over the first three periods, but a more persistent difference between high and low labor regulation countries extending into the sixth period.

6 Estimated adjustment dampening and gross misallocation

In this section we take our estimates more seriously, and translate these into parameters of the simple model set forth in Section 2.1.[39] This allows us to (1) assess the implied dampening in labor adjustment induced by rigidities in labor regulation, and (2) measure the optimal labor costs implied by the model, and, accordingly, the extent of misallocation of labor at each outlet.

6.1 Assessing the implied dampening of labor adjustment

Our simple model in Section 2.1 yields the following relationship between actual and optimal labor cost adjustments:

$$\frac{b_t - b_{t-1}}{b_t^* - b_{t-1}} = (1 - \omega^j), \tag{5}$$

where b_t is the actual labor cost and b_t^* is the optimal labor cost in the absence of adjustment costs. Since b is the log of labor costs, the expression on the left-hand side is approximately the observed percentage change in labor costs divided by the percentage change in labor costs that would have occurred if there were no adjustment costs. Since $0 < \omega^j = \frac{\gamma_a^j}{\gamma_a^j + \gamma_o} < 1$, the RHS of equation (5) also is between 0 and 1. The expression $(1 - \omega^j)$, which we call the "dampening factor," provides a measure of the extent to which labor adjustments are reduced by the labor regulations. Because we can obtain estimates of a_0 and a_1 from the coefficients in our regressions, we can estimate $\omega^j (= a_0 + a_1 \tau^j)$ and, hence, the dampening factor.

Table 11 presents alternative estimates of the dampening factor at different percentiles of the distribution of labor regulation (per the Botero et al. index). In panel 1, we use estimates from column 6 of Table 4 to measure a_0 and a_1. The estimated dampening factor is larger when we use the coefficients on the lagged labor variables compared to using the coefficients on the revenue variables. From row 3 of panel 1, where we rely on the average of the coefficients attached to revenues and lagged labor, we find that labor regulations dampen adjustments in labor by a factor of 0.68 at the 25th percentile of the labor regulation index, and 0.50 at the 75th percentile of the labor regulation index, a reduction of about 25% in labor cost adjustments. In panel 2, we use estimates derived from the OECD sample (Column 1 of Table 7). Here we find similar estimates of the dampening factor at the 25th percentile, but higher estimates at the 75th percentile, so that the measured impact of regulation is lower. Specifically, in row 3 of panel 2, the dampening factor changes from 0.70 to 0.57, a reduction of about 18.6%.[40]

[39] Note that while our model is very simple, our estimates are consistent with many of its assumptions. For example, in most of our specifications, we cannot reject the hypothesis that $\delta_r = -\delta_b$, an implication from our very simple model.

[40] Note that in Panel 2, we use the percentiles of the regulation distribution within the OECD sample.

6.2 Assessing labor misallocation

Our simple model in Section 2.1 yields an alternative way to calibrate the effects of the regulations. Specifically, equation (5) implies the following optimal labor choice for each outlet:

$$b_t^* = b_{t-1} + \frac{b_t - b_{t-1}}{1 - \omega^j}.$$

We can therefore estimate the inefficiency of holding too little or too much labor by defining the "gross labor misallocation," ρ_t, as:

$$\rho_t \equiv |b_t^* - b_t|$$

which can be readily calculated using our estimates.[41] Since this is a difference in logs, it can be thought of as the percentage difference between optimal and actual labor costs.[42]

To assess how the magnitude of misallocation relates to labor regulation, we estimate the decrease in gross misallocation that would result from a hypothetical decrease in labor regulation from its p75 to its p25 value, a decrease of 0.31 in the baseline sample in Table 4. We do this for all the outlets operating in countries in the top quartile of the labor regulation index, in three steps. First, for outlet i in country j in period t, we estimate the optimal labor choice $b_{i,t}^*$ using the estimated ω^j (given the actual regulation index τ^j for country j) along with actual $b_{i,t}$ and $b_{i,t-1}$. Next we estimate what labor cost ($b'_{i,t}$) would have been chosen if the regulation index had been lower by 0.31 points (by recalculating ω^j for the hypothetical lower regulation index and using the relationship between $b_{i,t}$, $b_{i,t-1}$, $b_{i,t}^*$ and ω^j in equation (5)). Finally, we measure the difference between the gross misallocation at the current regulation index ($|b_{it}^* - b_{i,t}|$) and gross misallocation at the hypothetically lower regulation index ($|b_{it}^* - b'_{i,t}|$).

Using estimates from the baseline regression results in Table 4, we find that for the sample of outlets in the top quartile of the regulation index, a hypothetical decrease in the labor regulation index by 0.31 points (p75 - p25) would result in a mean reduction in gross misallocation of about 4.1 percentage points. For outlets in the bottom quartile of the labor regulation index, an increase in the labor regulation index by the same 0.31 points would result in a mean increase in gross misallocation of about 2.4 percent. Using estimates for the OECD sample instead, we find that gross misallocation decreases (increases) by 2.6 (1.7) percentage points for the top (lower) quartile of firms following a 0.33 (p75 - p25) decrease in the regulation index for this sample.

[41] Note that per our model, optimal labor choice is always higher (lower) than actual if labor levels are increased (decreased) relative to the prior period. Thus the net effect on employment is ambiguous – if the productivity and demand shocks across outlets and over time are mean zero, the mean net misallocation could well be about zero within countries. In fact, we find that this is the case generally in our data.

[42] This interpretation is only an approximation, which holds better when the differences are small. However, redefining the reallocation term precisely as the percentage difference between optimal and actual labor levels (i.e., $\rho_t = \frac{B_t^* - B_t}{B_t}$), yields very similar estimates.

6.3 Discussion

We interpret our results on the dampening factor in Section 6.1 as indicating a large effect of the regulation on labor adjustment in the fast-food outlets of the Company. Our estimates imply that, when the labor regulation index is relatively low (at the 25th percentile), outlets adjust labor costs each week more than two-thirds of the way towards what would be optimal with zero adjustment costs. At the 75th percentile of regulation, they only adjust half of the way towards what is optimal. The reason these large dampening factors translate to relatively small estimates of gross misallocation (2.4 to 4.1 percent for the overall sample) is that the average optimal week to week gross adjustment is relatively small, roughly about 15 percent of labor cost in our data. Thus the "misallocation" due to an increase in regulation from the 25th to 75th percentile can be expected to be about 2.6 percent ([0.676-0.505]*0.15).

Although our data are of a very different type, it is interesting that the magnitudes of the effects documented here are qualitatively similar to the findings from two related papers. This is so even though our definition of the dampening factor and gross misallocation are not directly comparable to the constructs examined by these authors. Our finding of a 25 percent increase in the dampening of adjustment when we move from the 25th to 75th percentile of labor regulations is of similar import as the 33 percent reduction in the speed of adjustment that Caballero et al, (2004) find for a change in the same labor regulation index from the 20th to the 80th percentile. Similarly, our estimates of the lower bounds of gross misallocation, in the range of 1.7 to 4.1 percent, is in line with some of the effects calibrated by Hopenhayn and Rogerson (1993) for variables that could be interpreted similarly. They find that a severance pay equal to 6 to 12 months of wages results in a reduction in net employment of 1.7 to 2.5 percent, and a layoff cost to wage bill ratio of 2.6 to 4.4 percent respectively.

Of course, the results in this section are obtained by taking the simple model set forth in Section 2.1 seriously. In particular, the optimal labor choice is driven by the assumptions of symmetric quadratic (convex) costs. In a more general model, where costs are not strictly convex, adjustments would be lumpy, and hence the optimal labor levels would be more difficult to recover.

There is also a "speed-of-adjustment" or "half-life" interpretation to the coefficient on lagged labor (Hamermesh 1993, Chapter 7) that does not rely so much on the specifics of our model. The median length of the time taken for the system to move halfway to the eventual equilibrium in response to a shock can be calculated as the log(0.5)/log(coefficient on lagged labor). We find that the half-life estimates at the mean labor regulation level are quite low in our context, ranging from less than half a week (from column 6 of Table 4) to 1.1 weeks (column 4 of Table 4). The estimates are higher in the GMM specification (Table 10), at about 2.6 weeks.

There are several potential explanations for the much higher speeds of adjustment that we document here compared to other estimates in the literature. First, as discussed by Hamermesh (1993), studies that use temporally aggregated (low frequency) data generally find much slower speeds of adjustment, probably because aggregation conceals higher frequency changes. Second, also noted by Hamermesh, the industry studied could have important implications. We study a firm in the retail food sector, where number of employees and hours worked by employees change much more rapidly than in some other sectors. In fact, from our discussions with industry insiders, labor schedule changes and flexibility in hours per week per worker are among the most important margins that managers have at their disposal to keep production costs down. Also, related to the above, and again as pointed out by Hamermesh, studies that focus on number of workers miss out on the important margin of hours per worker, which firms can use to adjust to shocks. Our labor cost measure effectively captures changes to hours worked, a margin that is especially important in the industry we focus on. Finally, our analysis includes very detailed store-time fixed effects. Thus, we have conditioned out macro or firm specific seasonal shocks that could potentially have persistent effects. The fact that we obtain much lower half-life estimates when we use the most detailed fixed effects suggests that controlling for these can have a large impact on these estimates.

7 Conclusion

In this paper, we ask whether rigidities associated with labor regulation, as measured by an index of statutory requirements (constructed by Botero et al., 2004) or through surveys of executives, have a measurable impact on the day-to-day operations of firms. We address this question using very micro-level data from a single fast-food chain with operations around the world. We find strong evidence that labor regulations dampen the responses to demand/supply shocks. To our knowledge, ours is the first establishment-level cross-country study to document such an effect.

We believe that our data present several unique advantages for the type of analyses we carry out and thus strengthen our results in important ways. First, the fact that our data are from a single firm doing basically the same thing in all the countries where it operates implies that our results are not driven by differences in output decisions or technology and production function parameters across countries. Second, the use of data from a single firm also implies that we are holding constant a number of factors, including for example headquarters' policies, that could confound comparisons of labor usage across countries in other studies. Third, our data are available at very high frequency (weekly) for a long period of time (four years), which has significant advantages relative to annual frequency firm level or aggregate data where considerable within-year or establishment-level variation may go unmeasured (Hamermesh, 1989;

Hamermesh and Pfann, 1996). The very high frequency of our data moreover allows us to adopt estimation strategies involving outlet, outlet-year or even outlet-year-season fixed effects, and thereby control for many factors that might bias estimates otherwise. Finally, according to industry insiders, firms in this industry rely heavily on flexible hours for employees as a way to keep labor costs low. This in turn implies that the type of regulations we focus on are likely to be particularly important to these firms. It also highlights the importance of using a labor measure (such as the labor cost measure we use) that reflects changes in underlying labor hours rather than only in number of workers (which is often the only available data).

We have shown evidence that within existing outlets, decreasing the index of regulation from the 25th to the 75th percentile leads to a decrease in gross misallocation of labor equivalent to about 2.4 (for the OECD sub-sample) to 4.1 (for the overall sample) percent of labor costs for the outlets in the top quartile of the regulation index. Past research (e.g., Foster, Haltiwanger and Krizan, 1998) has highlighted the importance of the reallocation of resources from less productive to more productive firms as a source of aggregate productivity growth, and hence national output growth and welfare. Our results suggest that labor regulations reduce the ability of firms to adjust labor levels in response to demand or productivity fluctuations, thus hampering the reallocation of resources and potentially impeding an important channel for aggregate productivity growth. [43]

Of course, a major goal of such labor regulation is to protect labor. Our findings are consistent with the idea that incumbent workers benefit from the regulation, as the outlets do not reduce labor as much as they would otherwise when facing negative shocks. Thus incumbent workers may benefit from longer employment tenure, reduced uncertainty and protection against job loss during downturns. From a policy perspective, the misallocation costs described above must be weighed against these benefits for incumbent workers.[44]

[43] Our findings of a negative impact of labor market rigidities on labor adjustment in fast-food outlets contrasts with the findings of zero impact of increased minimum wage laws on employment in fast-food stores documented by Card and Krueger in a number of studies (see Card and Krueger, 1997). The indices we focus on capture difficulties in adjusting labor levels due to labor regulations that are distinct from minimum wage laws. Also, while our results suggest a definitive impact of these labor regulations on labor choice as predicted by economic theory, our findings relate to dampening of adjustments rather than net employment effects.

[44] In results available in an earlier working paper version, we also found some evidence that the Company has delayed entry and operates fewer outlets – conditional on the per capita income, population, entry barriers for new firms, and distance to the United States – in countries with more rigid labor regulations. This, in turn, implies a reduction in labor usage by the Company quite apart from the adjustment costs we focused on in this paper. See also Lafontaine and Sivadasan (forthcoming) for analyses of the productivity and labor choice decisions of the Company.

References

[1] Abraham, Katharine and Susan Houseman. 1994. "Does Employment Protection Inhibit Labor Market Flexibility: Lessons From Germany, France and Belgium." In Rebecca M. Blank, ed., *Social Protection Versus Economic Flexibility: Is There a Tradeoff?* (Chicago: University of Chicago Press).

[2] Addison, John and Paulino Teixeira. 2001. "The Economics of Employment Protection." IZA Discussion Paper No. 381. Institute for the Study of Labor, Bonn, Germany.

[3] Aguirregabiria, Victor and Cesar Alonso-Borrego. 2004. " Labor Contracts and Flexibility: Evidence from a Labor Market Reform in Spain." Working Paper. University of Toronto, Toronto.

[4] Anderson, Patricia M. 1993. "Linear Adjustment Costs and Seasonal Labor Demand: Evidence from Retail Trade Firms." *The Quarterly Journal of Economics*, 108, no. 4 (November): 1015 - 42.

[5] Arellano, Manuel, and Stephen Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* 58, no. 194 (April): 277-97.

[6] Besley, T., and R. Burgess, 2004, "Can labor regulation hinder economic performance? Evidence from India," *Quarterly Journal of Economics* 119, 91-134.

[7] Blanchard, Olivier and Justin Wolfers. 2000. "The Role of Shocks and Institutions in the Rise of European Unemployment," *Economic Journal*, 116(510) 1-33.

[8] Blundell, Richard and Stephen Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87, no. 1 (November): 115-43.

[9] Bond, Stephen. 2002. "Dynamic panel data models: a guide to microdata methods and practice." *Portuguese Economic Journal*, Vol. 1, pp. 141-162

[10] Bond, Stephen and John Van Reenen. Forthcoming. "Microeconometric Models of Investment and Employment." In James J. Heckman and Edward E. Leamer, eds., *Handbook of Econometrics*, Vol 6. (Amsterdam: Elsevier).

[11] Botero, Juan C., Simeon Djankov, Rafael La Porta, Florencio Lopez-de-Silanes and Andrei Shleifer. 2004. "The Regulation of Labor." *Quarterly Journal of Economics* 119, no. 4 (November): 1339-82.

[12] Cabellero, Ricardo J., Kevin N. Cowan, Eduardo M.R.A. Engel and Alejandro Micco. 2004. "Effective Labor Regulation and Microeconomic Flexibility." *Economic Growth Center Discussion Paper No 893*. Yale University, New Haven, CT.

[13] Caballero, Ricardo J., Eduardo M.R.A. Engel and John Haltiwanger. 1997. "Aggregate Employment Dynamics: Building from Microeconomic Evidence." *American Economic Review* 87, no. 1(March): 115-37.

[14] Card, David and Alan B. Krueger. 1997. *Myth and Measurement: The New Economics of the Minimum Wage*, Princeton University Press.

[15] Cooper, Russell and Jonathan L. Willis. 2004. "A Comment on the Economics of Labor Adjustment: Mind the Gap," *American Economic Review* 94, no. 4 (September): 1223-37.

[16] Foster, Lucia, John Haltiwanger and C.J. Krizan. 1998. "Aggregate Productivity Growth: Lessons from Microeconomic Evidence." NBER Working Paper No. W6803. National Bureau of Economic Research, Cambridge, MA.

[17] Griliches, Z., and J. A. Hausman. 1986. "Errors in variables in panel data," *Journal of Econometrics*, 31, 93-118.

[18] Haltiwanger, John, Stefano Scarpetta and Helena Schweiger. 2006. "Assessing Job Flows Across Countries: The Role of Industry, Size and Regulations." Policy Research Working Paper No. 4070. World Bank, New York.

[19] Hamermesh, Daniel S. 1989. "Labor Demand and the Structure of Adjustment Costs." *American Economic Review* 79, no. 4 (September): 674-89.

[20] Hamermesh, Daniel S. 1993. *Labor Demand.* Princeton: Princeton University Press.

[21] Hamermesh, Daniel S. and Gerard A. Pfann. 1996. "Adjustment Costs in Factor Demand." *Journal of Economic Literature* 34, no. 3 (September): 1264-92.

[22] Heckman, James J. and Carmen Pagés. 2004. "Law and Employment: Lessons from Latin America and the Caribbean – An Introduction." *Law and Employment: Lessons from Latin America and the Caribbean.* Chicago: University of Chicago Press.

[23] Holt, Charles C., Franco Modigliani, John F. Muth and Herbert Simon. 1960. *Planning Production, Inventories,and Work Force.* Englewood Cliffs, NJ: Prentice-Hall.

[24] Hopenhayn, Hugo and Rogerson, R.. 1993. "Job Turnover and Policy Evaluation: A General Equilibrium Analysis." *The Journal of Political Economy*, 101(5): 915-38.

[25] Jaramillo, Fidel, Fabio Schiantarelli and Alessandro Sembenelli. 1993. "Are Adjustment Costs for Labor Asymmetric? An Econometric Test on Panel Data for Italy." *Review of Economics and Statistics*, 75, no. 4 (November): 640-48.

[26] Kim, S. 2005. "The Legal Regulation of Wrongful Dismissal in Korea." *Comparative Labor Law and Policy Journal*, Vol 25, no. 4: 535-60.

[27] Kim, Y.C. 1998. "Industrial Reform and Labor Backlash in South Korea: Genesis, Escalation, and Termination of the 1997 General Strike." *Asian Survey*, Vol 38, no. 12 (December): 1142-1160.

[28] Lafontaine, Francine and Jagadeesh Sivadasan. Forthcoming. "Within-firm Labor Productivity across Countries: A Case Study." In Richard Freeman and Kathryn L. Shaw, eds., *International Differences in the Business Practices and Productivity of Multinational Firms: A Case-Based Approach*. Chicago: University of Chicago Press.

[29] Lazear, Edward. 1990. "Job Security Provisions and Employment." *Quarterly Journal of Economics*, 105, no. 3 (August): 699-726.

[30] Neumark, David, and William Wascher, 2004, "Minimum Wages, Labor Market Institutions, and Youth Employment: A Cross-National Analysis," *Industrial and Labor Relations Review*, January, pp. 223-48.

[31] Nickell, S. 1981. "Biases in Dynamic-Models with Fixed Effects." *Econometrica*, 49(6), pp. 1417-26.

[32] Petrin, Amil and Jagadeesh Sivadasan. 2006. "Job Security Does Affect Economic Efficiency: Theory, A New Statistic, and Evidence from Chile." NBER Working Paper No. W12757. National Bureau of Economic Research, Cambridge, MA.

[33] Pfann, Gerard A. and Franz C. Palm. 1993. "Asymmetric Adjustment Costs in Non-linear Labour Demand Models for the Netherlands and U.K. Manufacturing Sectors. *Review of Economic Studies*, 60, no. 203 (April): 397-412.

[34] Piketty, Thomas. 1997. "Les créations d'emplois en France et aux États-Unis: "services de proximité" contre "petits boulots?" Paris: Notes de la fondation saint-simon, numéro 93.

[35] Roodman, David. 2006. "How to do xtabond2: An Introduction to "Difference" and "System" GMM in Stata." Working Paper No 103, Center for Global Development.

[36] Rota, Paola. 2004. "Estimating Labor Demand with Fixed Costs." *International Economic Review*, 45, no. 1 (February): 25-48.

[37] Stock, James H. and Motohiro Yogo. 2002. "Testing for Weak Instruments in Linear IV Regression." NBER Technical Working Paper No. T0284. National Bureau of Economic Research, Cambridge, MA.
http://www.nber.org/papers/T0284.

[38] Stokey, Nancy, Robert E. Lucas, Jr. and Edward Prescott. 1989. *Recursive Methods in Economic Dynamics* (Cambridge, MA: Harvard University Press).

[39] Windmeijer, F. 2005. "A Finite Sample Correction for the Variance of Linear Efficient Two-step GMM estimators." *Journal of Econometrics* 126: 25-51

Appendix 1: A stochastic dynamic programming model of adjustment costs

In this appendix, we present a stochastic dynamic programming model of labor adjustment in the presence of adjustment costs. We numerically solve the model for a set of parameter values, and then simulate data to assess the effect of increased adjustment costs on two properties of the optimal labor choice: (1) the observed elasticity of labor demand with respect to output, and (2) the elasticity of labor choice with respect to the previous period's labor choice.

A Model setup

The production function of the optimizing producer (here each outlet of the multinational firm) uses a single variable input, with the following form:

$$Q_t = f(L_t) = \Theta L_t^{\alpha}, \tag{6}$$

where Q is output, L is labor input, Θ is a productivity shock faced by the outlet, α is a production function parameter, and t the denotes time period. We assume that each outlet faces a downward sloping iso-elastic demand curve:

$$P = \Lambda_t \cdot Q_t^{\frac{1}{\mu}},$$

where Λ_t represents demand shocks in period t. Each outlet faces perfectly elastic labor supply at wage level W and a cost of adjusting labor from one period to the next, $g(\Delta L_t)$. Productivity (Θ) and demand (Λ) shocks are revealed to the outlet at the beginning of the period, and then the outlet chooses the labor level for that period. Thus the objective function of the outlet in period 1 is:

$$\max_{\{L_t\}_{t=1}^{t=\infty}} \left\{ \phi_1 L_1^{\alpha'} - WL_1 - g(\Delta L_1) + E_1 \left[\sum_{t=2}^{\infty} \beta^t \left(\phi_t L_t^{\alpha'} - WL_t - g(\Delta L_t) \right) \, |\phi_1 \right] \right\}, \tag{7}$$

where $\phi_t = \Lambda_t \Theta_t^{\left(1+\frac{1}{\mu}\right)}$ and $\alpha' = \alpha\left(1 + \frac{1}{\mu}\right)$.

The productivity and demand shocks (and therefore the combined productivity and demand shock parameter ϕ) follow a first-order Markov process. Then equation (7) in the Bellman equation form is:

$$V(\phi, L) \quad = \quad \max_{\{L'\}} \left\{ \phi L'^{\alpha'} - WL' - g(\Delta L') + \beta E[V(\phi', L') \; |\phi] \right\}. \tag{8}$$

The impact of labor regulations is modelled as affecting the adjustment costs. We model the labor regulations as imposing one of three types of adjustment costs:

1. Symmetric, quadratic adjustment costs: $g(\Delta L_t) = c_s \cdot (\Delta L_t)^2$, where $\Delta L_t = L_t - L_{t-1}$;
2. Asymmetric, linear adjustment costs: $g(\Delta L_t) = c_a \cdot (\Delta L_t) \cdot D_t$, where D_t is an indicator function for firing defined equal to 1 if $\Delta L_t < 0$ and 0 otherwise;
3. Fixed or lump sum adjustment costs: $g(\Delta L_t) = c_f \cdot D_t$, where D_t is an indicator function for any change in labor (hiring or firing), that is D_t is equal to 1 if $\Delta L_t \neq 0$ and 0 otherwise.

The assumption of quadratic symmetric adjustment costs is invoked in a number of early theoretical papers on labor adjustment costs. However, Jaramillo et al. (1993) and Pfann and Palm (1993) suggest that labor adjustment costs are asymmetric. Our specification of asymmetric firing costs is consistent with regimes with mandated severance payments. The fixed adjustment cost regime reflects the possible non-convexities in adjustment costs, as suggested in the literature (e.g. Hamermesh 1989, Davis and Haltiwanger 1992, Cooper and Willis 2004, Caballero et al. 1997; Rota 2004).

The sufficient condition for equation (8) to be a contraction mapping is that the objective function be concave, which is fulfilled if $\alpha' < 1$ (see Stokey, Lucas and Prescott, 1989). However, the equation does not yield closed form solutions for the value function $V(\phi, L)$ or the policy function $L'(\phi, L)$. To obtain numeric solutions, we need to make assumptions regarding parameter values, which we discuss in the next section.

B Selecting parameter values

We make the following parametric assumptions to derive a numeric solution to the dynamic programming problem in equation (8):

- $\alpha' = 0.216$, assuming $\alpha = 0.36$ and demand elasticity μ = -2.5.[45]
- $\phi \in [0, 1]$. (The evolution of ϕ over time is discussed below.)
- $\beta = \frac{1}{1.08}$, based on an 8 percent required rate of return for outlet owners.
- Wage W is set to 0.03552, to obtain an upper bound on labor of exactly 10.

With these assumptions, the per period labor choices are bounded between 1 and 10, since $L_{min} = \left[\frac{\alpha'\phi_{min}}{W}\right]^{\frac{1}{(1-\alpha')}} = 0$, and $L_{max} = \left[\frac{\alpha'\phi_{max}}{W}\right]^{\frac{1}{(1-\alpha')}} = 10$. Correspondingly, the output level and value functions are also bounded, which implies that the sufficient conditions for equation (8) to be a contraction mapping hold. We assume that ϕ follows a discrete Markov chain, with 10 states ($s_1 = 0.1, s_2 = 0.2, ..., s_{10} = 1.0$). We examine two types of shock processes: (i) IID, captured by setting $T_{ii} = T_{ij} = 0.1$, where T_{ij} is the probability of transition from state s_i to s_j; and (ii) persistent, captured by setting $T_{ii} = 0.5$, and $T_{ij} = 0.5/9 = 0.0555$.

C Solving the model and simulating data

Our simulations are intended to capture the effect of varying the cost of labor adjustment parameter (c_s, c_a, and c_f) on the relationship between labor demand, measured output (revenue) and lagged labor demand. We undertake the following 2-stage procedure:

C.1 Stage 1: Obtaining optimal policy functions

In this stage, we solve and store the optimal policy function for 45 separate regimes. The adjustment cost parameter c_s varies from 0 to 1 in 44 equal increments in the quadratic case, while c_a and c_f vary from 0 to 8 period's (week) wage in 44 equal increments in the asymmetric and fixed cost cases. Standard errors are clustered at the regime (country) level.

Since standard regularity conditions hold, the Bellman equation (8) can be solved numerically. We find that the estimated optimal value function converges well in about 4 to 6 iterations. We obtain the optimal policy functions for four scenarios: (1) A benchmark case with zero adjustment costs; (2) Symmetric, quadratic adjustment costs; (3) Asymmetric, linear adjustment costs; and (4) Non-convex (fixed or lump sum) adjustment costs.

C.2 Stage 2: Simulating data

In the second stage, we simulate data for 75 outlets in each of the 45 adjustment cost regimes, for the two shock processes in each of the four scenarios. For each outlet i, we draw period 0 labor levels (l_{i0}) from a uniform distribution over [0, 10], and period 0 combined demand/productivity shocks (ϕ_{i0}) from a uniform distribution over [0, 1]. Draws of ϕ for period t(ϕ_{it}) are based on the prior period shock and the transition probability matrix. Labor choice in period t is based on the optimal policy function (solved in stage 1 above).

First, we simulate the model for an initial 50 periods to allow the distribution of shocks and labor levels to reach steady state. We then simulate 104 periods (2 years of 52 weeks each) of data for each outlet, for each of the four scenarios.

[45]The production function parameter α and demand elasticity are backed out from an estimate of the production function and the observed material share of revenue. See Lafontaine and Sivadasan (forthcoming) for more details.

D Regression analysis on simulated data

At the end of stage 2, we have 8 datasets (one for each of the two shock processes in the four adjustment cost scenarios), each containing data on $45 \cdot 75 = 3,375$ outlets for 104 weeks each ($3,375 * 104 = 351,000$ observations). To analyze the effect of changes in adjustment costs on the elasticity of labor demand to revenue and with respect to the previous period's labor demand, we run the following regression specification on the simulated data:

$$b_{it}^{j} \quad = \quad \beta r_{it}^{j} + \gamma b_{it-1}^{j} + \delta_r c^j r_{it}^{j} + \delta_b c^j b_{it-1}^{j} + \eta_{is}^{j} + \varepsilon_{it}^{j}, \tag{9}$$

where i indexes outlets, j indexes the 45 different adjustment costs regimes, and t indexes weeks. The log labor cost $b_{it}^{j} = \log(L_{it} \cdot W_{it})$. Labor choice is made by each outlet based on the optimal policy function (and depends on prior period labor and current ϕ shock). Log revenue r_{it}^{j} is defined as log of the product of price and quantity, which in this model is log $(\phi_{it}.L_{it}^{\alpha'})$. Finally, c^j represents adjustment costs (and is therefore analogous to the labor regulation index in the data), and η_{is}^{j} captures outlet or outlet-season fixed effects. The results from running the regression on the simulated data are presented in Table 2 and discussed in Section 2.2.

Appendix 2a: Definition of Employment Laws Index (from Botero et al., 2004)

Alternative employment contracts	Measures the existence and cost of alternatives to the standard employment contract, computed as the average of: (1) a dummy variable equal to one if part-time workers enjoy the mandatory benefits of full-time workers; (2) a dummy variable equal to one if terminating part-time workers is at least as costly as terminating full-time workers; (3) a dummy variable equal to one if fixed-term contracts are only allowed for fixed-term tasks; and (4) the normalized maximum duration of fixed-term contracts.
Cost of increasing hours worked	Measures the cost of increasing the number of hours worked. We start by calculating the maximum number of "normal" hours of work per year in each country (excluding overtime, vacations, holidays, etc.). Normal hours range from 1,758 in Denmark to 2,418 in Kenya. Then we assume that firms need to increase the hours worked by their employees from 1,758 to 2,418 hours during one year. A firm first increases the number of hours worked until it reaches the country's maximum normal hours of work, and then uses overtime. If existing employees are not allowed to increase the hours worked to 2,418 hours in a year, perhaps because overtime is capped, we assume the firm doubles its workforce and each worker is paid 1,758 hours, doubling the wage bill of the firm. The cost of increasing hours worked is computed as the ratio of the final wage bill to the initial one.
Cost of firing workers	Measures the cost of firing 20 percent of the firm's workers (10 percent are fired for redundancy and 10 percent without cause). The cost of firing a worker is calculated as the sum of the notice period, severance pay, and any mandatory penalties established by law or mandatory collective agreements for a worker with three years of tenure with the firm. If dismissal is illegal, we set the cost of firing equal to the annual wage. The new wage bill incorporates the normal wage of the remaining workers and the cost of firing workers. The cost of firing workers is computed as the ratio of the new wage bill to the old one.
Dismissal procedures	Measures worker protection granted by law or mandatory collective agreements against dismissal. It is the average of the following seven dummy variables which equal one: (1) if the employer must notify a third party before dismissing more than one worker; (2) if the employer needs the approval of a third party prior to dismissing more than one worker; (3) if the employer must notify a third party before dismissing one redundant worker; (4) if the employer needs the approval of a third party to dismiss one redundant worker; (5) if the employer must provide relocation or retraining alternatives for redundant employees prior to dismissal; (6) if there are priority rules applying to dismissal or layoffs; and (7) if there are priority rules applying to reemployment.
Employment laws index	**Measures the protection of labor and employment laws as the average of: (1) Alternative employment contracts; (2) Cost of increasing hours worked; (3) Cost of firing workers; and (4) Dismissal procedures.**

Appendix 2b: Key Changes to South Korean labor laws (1996-1998)

Source: Kim (1998), Table 3

Clause	Old labor laws	Laws enacted by NKP (December 1996)	Revised labor laws (March 1997)	New Labor Laws (February 1998)
Flexible work hours	Prohibited except in a few industries	Ban is lifted	No further change	No further change
Flexible layoffs	No clause; handled by court cases	Permitted flexible layoffs to cope with changing economic conditions, improve productivity, and adopt new technologies	Permitted only under corporate emergency; enforcement delayed for two years	Immediate implementation of the flexible layoffs
Hiring substitute workers during disputes	Prohibited	Allows employers to substitute striking workers and seek new sub-contractors	Allows employers to fill job slots vacated by striking workers with other striking workers in the same company but prohibits new sub-contractors	Allows hiring substitute workers for professional position for up to two years, for manual positions for up to six months
No work, no pay	No clause	Employers are banned from paying workers who participate in strikes	Employers have no obligation to compensate the wage losses incurred by strikes	No further change
Multiple unions	Prohibited	Allows multiple unions from the year 2000 at the industry and national levels and from the year 2002 at the plant level	Allows multiple unions immediately at the industry and national levels	No further change
Third party intervention	Prohibited	Ban is lifted	No further change	No further change
Union's political activities	Prohibited	Ban is lifted, but restrictions by election laws exist	Practically no change	Practically no restrictions (election laws revised in April 1998)

Table 1: Index of regulation of affecting labor hiring and firing flexibility

The Botero index of labor regulation is from Botero et al. (2004). The GCS index of hiring/firing inflexibility is constructed using data from the 2002 Global Competitiveness Survey. Both indices are de-meaned. Larger values indicate less flexibility in hiring and firing regular and temporary workers.

Country	Code	Botero Index	GCS Index	Country	Code	Botero Index	GCS Index
Russia	RUS	0.410	-0.156	Turkey	TUR	-0.015	-0.074
Portugal	PRT	0.391	0.233	Ecuador	ECU	-0.021	0.128
France	FRA	0.327	0.293	Bolivia	BOL	-0.045	0.010
Spain	ESP	0.327	0.185	Egypt	EGY	-0.049	N.A.
Netherlands	NLD	0.308	0.112	Australia	AUS	-0.066	-0.022
Germany	DEU	0.284	0.450	Colombia	COL	-0.074	0.129
Venezuela	VEN	0.233	0.083	Ireland	IRL	-0.075	-0.024
Poland	POL	0.222	0.023	South Africa	ZAF	-0.097	0.237
Panama	PAN	0.207	0.192	Singapore	SGP	-0.106	-0.218
Dominican Republic	DOM	0.179	-0.057	Israel	ISR	-0.129	-0.130
Mexico	MEX	0.177	0.092	United Kingdom	GBR	-0.135	-0.153
Denmark	DNK	0.155	-0.193	Morocco	MAR	-0.156	-0.048
Brazil	BRA	0.150	-0.121	Canada	CAN	-0.156	-0.127
Greece	GRC	0.101	0.077	Malaysia	MYS	-0.229	-0.008
Belgium	BEL	0.096	0.116	Hong Kong	HKG	-0.248	-0.225
Lebanon	LBN	0.085	N.A.	Japan	JPN	-0.254	0.107
Philippines	PHL	0.058	0.136	Jamaica	JAM	-0.255	0.021
Chile	CHL	0.056	0.077	New Zealand	NZL	-0.257	-0.005
Sri Lanka	LKA	0.051	-0.060	Honduras	HND	N.A.	0.070
Peru	PER	0.045	-0.080	Guatemala	GTM	N.A.	-0.062
Taiwan	TWN	0.036	-0.153	Costa Rica	CRI	N.A.	-0.117
Switzerland	CHE	0.034	-0.139	Haiti	HTI	N.A.	-0.132
Korea	KOR	0.028	-0.039	Nicaragua	NIC	N.A.	-0.142
India	IND	0.026	0.338	El Salvador	SLV	N.A.	-0.167
China	CHN	0.014	-0.098	Iceland	ISL	N.A.	-0.193

Table 2: Regression results from simulated data

The dependent variable is log labor cost from simulated datasets. The adjustment cost parameter *c* varies from 0 to 1 in 44 equal increments in the quadratic case, and from 0 to 8 periods' (weeks) wage in 44 equal increments in the asymmetric case as well as the fixed cost case. In the iid case, shocks are independent from period to period, with equal (10%) probability of facing 10 different shocks (0.1 to 1.0) ; in the persistent case, there is a 50% probability that the firm faces the same shock in the next period. Standard errors are clustered at the regime (country) level. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	Zero adjustment costs		**Symmetric quadratic adjustment costs**		**Asymmetric linear adjustment costs**		**Fixed (lump-sum) adjustment costs**	
	IID shocks	**Persistent shocks**	**IID shocks**	**Persistent shocks**	**IID shocks**	**Persistent shocks**	**IID shocks**	**Persistent shocks**
Log (Lagged labor cost)	-0.0001	0.036***	0.105**	0.231***	-0.039***	0.154***	-0.028**	-0.019***
	[0.0001]	[0.001]	[0.052]	[0.049]	[0.012]	[0.029]	[0.010]	[0.006]
Log (Revenue)	0.984***	0.914***	0.472***	0.563***	0.402***	0.541***	0.763***	1.02***
	[0.0002]	[0.001]	[0.075]	[0.060]	[0.11]	[0.088]	[0.075]	[0.033]
Adj. cost X Log (Lagged labor cost)	0.000	0.000	0.024***	0.016***	0.077***	0.014***	0.019***	0.010***
	[0.000]	[0.000]	[0.0031]	[0.0019]	[0.0048]	[0.0022]	[0.002]	[0.0006]
Adj. cost X Log (Revenue)	0.000	0.0001	-0.013***	-0.014***	-0.013***	-0.017***	-0.024***	-0.030***
	[0.000]	[0.0001]	[0.0026]	[0.0021]	[0.0037]	[0.0030]	[0.003]	[0.002]
Constant	-1.529***	-1.516***	-0.600***	-0.688***	1.211***	-0.804***	-1.012***	-1.342***
	[0.0001]	[0.001]	[0.058]	[0.022]	[0.16]	[0.10]	[0.074]	[0.020]
Fixed Effects	Outlet-year-season	Outlet-year-season	Outlet-year-season	Outlet-year-season	Outlet-year-season	Outlet-year-season	Outlet-year-season	Outlet-year-season
Observations	351,000	351,000	351,000	351,000	351,000	351,000	351,000	351,000
R-squared	1.000	0.920	0.790	0.920	0.550	0.850	0.770	0.840
Adjusted R-squared	0.999	0.923	0.794	0.922	0.553	0.851	0.767	0.843
Number of clusters	45	45	45	45	45	45	45	45

Table 3: Summary statistics

For comparability, labor cost, material cost and revenue are expressed in rescaled U.S. dollars, where the U.S. dollars were obtained originally using the average of the weekly exchange rates (reported in the Company dataset) for the year. The index of labor regulation is from Botero et al. (2004). The index of hiring/firing inflexibility is constructed using data from the 2002 Global Competitiveness Survey. The summary statistics are reported for the subsample of the dataset that appears in our baseline analyses (i.e., observations for which we have data on labor costs, lagged labor costs, revenue and the Botero et al., 2004) index of labor regulation. In Panel A, column 2 of the last row reports the total number of distinct outlets and column 3 shows the total number of distinct countries appearing at some point in the dataset during the four years of our data.

Panel A: Panel data characteristics

Year	Number of observations	Number of outlets	Number of countries
2000	80,430	1,721	39
2001	85,112	1,828	37
2002	74,201	2,147	38
2003	82,305	1,938	37
Total	322,048	2,526	43

Panel B: Summary statistics (variables in logs)

Variable	N	Mean	SD	P25	Median	P75	Min	Max
Log (Labor cost)	322,048	7.19	0.85	6.71	7.27	7.78	-5.05	10.25
Log (Revenue)	322,048	8.84	0.69	8.46	8.90	9.32	2.85	11.50
Log (Material cost)	318,748	7.72	0.66	7.37	7.78	8.16	-4.87	10.94

Panel C: Summary statistics (variables in levels)

Variable	N	Mean	SD	P25	Median	P75	Min	Max
Labor cost	322,048	1798.56	1391.18	819.84	1434.39	2390.95	0.01	322,048
Revenue	322,048	8485.46	5329.10	4730.65	7332.89	11156.81	17.30	322,048
Material cost	318,748	2706.78	1626.88	1590.34	2394.48	3481.41	0.01	318,748
Index of labor regulation	322,048	0.00	0.16	-0.15	0.03	0.16	-0.25	322,048

Table 4: Labor regulation and labor demand hysteresis

The dependent variable is the log of labor cost per week for each outlet. "Regulation" is the Botero et al. (2004) index of labor regulation, a measure of the rigidity of the labor market. Standard errors are clustered at the country level. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	(1)	(2)	(3)	(4)	(5)	(6)
Log (Lagged labor cost)	0.534***	0.360***	0.201***	0.501***	0.348***	0.203***
	[0.071]	[0.069]	[0.058]	[0.049]	[0.036]	[0.033]
Log (Revenue)	0.327***	0.354***	0.391***	0.340***	0.359***	0.390***
	[0.051]	[0.046]	[0.046]	[0.040]	[0.035]	[0.037]
Regulation X Log (Lagged labor cost)				**1.012*** **	**0.908*** **	**0.687*** **
				[0.29]	**[0.22]**	**[0.20]**
Regulation X Log (Revenue)				**-0.570*** **	**-0.489*** **	**-0.415*** **
				[0.14]	**[0.10]**	**[0.11]**
Constant	0.457*	1.468***	2.285***	0.626***	1.555***	2.313***
	[0.25]	[0.40]	[0.46]	[0.23]	[0.31]	[0.36]
Fixed Effects	Outlet	Outlet-year	Outlet-year-season	Outlet	Outlet-year	Outlet-year-season
Observations	320,574	320,574	320,574	322,047	322,047	322,047
R-squared	0.940	0.950	0.960	0.950	0.950	0.960
Adjusted R-squared	0.943	0.950	0.958	0.945	0.952	0.959
Number of clusters	43	43	43	43	43	43

Effect of a one standard deviation (0.85) increase in Log (Lagged labor) in percentage terms			
At Regulation = mean (0.00)	42.59	29.58	17.26
At Regulation = mean + sd (=0.16)	56.35	41.93	26.60
Impact of increase in Regulation	13.76	12.35	9.34
Effect of a one standard deviation (0.69) increase in Log (Revenue) in percentage terms			
At Regulation = mean (0.00)	23.46	24.77	26.91
At Regulation = mean + sd (=0.16)	17.17	19.37	22.33
Impact of increase in Regulation	-6.29	-5.40	-4.58

Table 5: Robustness to alternative measure of labor market flexibility

The dependent variable is the log of labor cost per week for each outlet. "Inflexibility" is the index of hiring/firing inflexibility, a measure of the rigidity of the labor market constructed using data from the 2002 Global Competitiveness Survey. Standard errors are clustered at the country level. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	(1)	(2)	(3)
Log (Lagged labor cost)	0.530***	0.371***	0.220***
	[0.053]	[0.041]	[0.034]
Log (Revenue)	0.355***	0.382***	0.417***
	[0.041]	[0.036]	[0.038]
Inflexibility X Log (Lagged labor cost)	**0.990*****	**0.915*****	**0.712*****
	[0.330]	**[0.290]**	**[0.230]**
Inflexibility X Log (Revenue)	**-0.737*****	**-0.718*****	**-0.639****
	[0.220]	**[0.220]**	**[0.260]**
Constant	0.244	1.137***	1.912***
	[0.24]	[0.32]	[0.36]
Fixed Effects	Outlet	Outlet-year	Outlet-year-season
Observations	338,659	338,659	338,659
R-squared	0.950	0.950	0.960
Adjusted R-squared	0.948	0.955	0.961
Number of clusters	48	48	48

Effect of a one standard deviation (0.85) increase in Log (Lagged labor) in percentage terms			
At Inflexibility = mean (0.00)	45.05	31.54	18.70
At Inflexibility = mean + sd (=0.13)	58.51	43.98	28.38
Impact of increase in Inflexibility	13.46	12.44	9.68
Effect of a one standard deviation (0.69) increase in Log (Revenue) in percentage terms			
At Inflexibility = mean (0.00)	24.50	26.36	28.77
At Inflexibility = mean + sd (=0.13)	16.36	18.43	21.72
Impact of increase in Inflexibility	-8.14	-7.93	-7.05

Table 6: Robustness check: Labor regulation and hysteresis in material inputs

The dependent variable is the log of material cost per week for each outlet. “Regulation” is the Botero et al. (2004) index of labor regulation, a measure of the rigidity of the labor market. Standard errors are clustered at the country level. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	(1)	(2)	(3)	(4)	(5)	(6)
Log (Lagged materials cost)	0.164***	0.116***	0.035	0.159***	0.112***	0.033*
	[0.043]	[0.041]	[0.021]	[0.038]	[0.036]	[0.019]
Log (Revenue)	0.846***	0.900***	0.942***	0.852***	0.901***	0.942***
	[0.030]	[0.021]	[0.009]	[0.027]	[0.020]	[0.008]
Regulation X Log (Lagged materials cost)				**-0.21**	**-0.168**	**-0.089**
				[0.20]	**[0.20]**	**[0.13]**
Regulation X Log (Revenue)				**-0.0201**	**-0.003**	**-0.075***
				[0.14]	**[0.09]**	**[0.043]**
Constant	-1.018***	-1.116***	-0.869***	-1.032***	-1.103***	-0.856***
	[0.12]	[0.17]	[0.18]	[0.085]	[0.13]	[0.13]
Fixed Effects	Outlet	Outlet-year	Outlet-year-season	Outlet	Outlet-year	Outlet-year-season
Observations	362,707	362,707	362,707	362,707	362,707	362,707
R-squared	0.950	0.950	0.960	0.950	0.950	0.960
Adjusted R-squared	0.947	0.953	0.96	0.947	0.953	0.96
Number of clusters	43	43	43	43	43	43

Effect of a one standard deviation (0.66) increase in Log (Lagged materials cost)			
At Regulation = mean (0.00)	13.52	9.52	2.81
At Regulation = mean + sd (=0.16)	10.66	7.24	1.59
Impact of increase in Regulation	-2.86	-2.28	-1.21
Effect of a one standard deviation (0.69) increase in Log (Revenue)			
At Regulation = mean (0.00)	58.79	62.17	65.00
At Regulation = mean + sd (=0.16)	58.57	62.13	64.17
Impact of increase in Regulation	-0.22	-0.04	-0.83

Table 7: Robustness check: OECD Sample and Interaction Terms

The OECD sample comprises countries that belong to the Organization of Economic Cooperation and Development. GDP is log GDP per capita in current $US. "Entry barriers" measured by the log of the number of days to start a business, obtained from the World Bank's "Doing Business in 2003" data. "Wage flexibility" is an index is obtained from the Global Competitiveness Survey 2004 data, based on the response to a query "Are wages in your country (set by a centralized bargaining process =1, set by each individual company=7)". "Labor relations" is an index obtained from the Global Competitiveness Survey 2004 data, based on the response to a query "Labor-employer relations in your country are (1=generally confrontational, 7=generally cooperative)". All regressions include outlet-year-season effects. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	(1) OECD	(2)	(3)	(4)	(5)
Log (Lagged labor cost)	0.179***	1.708***	-0.052	0.203	0.168
	[0.029]	[0.33]	[0.063]	[0.33]	[0.18]
Log (Revenue)	0.457***	-1.089***	0.640***	0.728***	0.643***
	[0.037]	[0.28]	[0.065]	[0.21]	[0.17]
Regulation X Log (Lagged labor cost)	**0.427*** **	**0.331** **	**0.380***	**0.687** **	**0.698*** **
	[0.14]	**[0.16]**	**[0.20]**	**[0.30]**	**[0.24]**
Regulation X Log (Revenue)	**-0.354***	**-0.0676**	**-0.224**	**-0.584*** **	**-0.541*** **
	[0.18]	**[0.11]**	**[0.15]**	**[0.15]**	**[0.14]**
GDP X Log (Lagged labor cost)		-0.157***			
		[0.033]			
GDP X Log (Revenue)		0.156***			
		[0.030]			
Entry barriers X Log (Lagged labor cost)			0.081***		
			[0.021]		
Entry barriers X Log (Revenue)			-0.078***		
			[0.025]		
Wage flexibility X Log (Lagged labor cost)				-0.000	
				[0.064]	
Wage flexibility X Log (Revenue)				-0.063	
				[0.038]	
Labor relations X Log (Lagged labor cost)					0.007
					[0.040]
Labor relations X Log (Revenue)					-0.053+
					[0.032]
Constant	1.994***	2.195***	2.272***	2.236***	2.290***
	[0.31]	[0.32]	[0.30]	[0.34]	[0.32]
Observations	236,290	322,045	265,839	321,566	321566
R-squared	0.96	0.96	0.96	0.96	0.96
Adjusted R-squared	0.96	0.96	0.96	0.96	0.96
Number of clusters	19	43	41	42	42

Table 8: Robustness check: Difference-in-difference comparison of top and bottom deciles of the change in Index of Inflexibility between 2002 and 2004

The sample here is all the observations in the top decile and bottom decile of the change in index of hiring/firing inflexibility between the 2002 and 2004 Global Competitiveness Surveys. "DInf_p90 " equals 1 for the countries that belonged to the top decile of the change in inflexibility index, i.e. the countries with the largest increases in inflexibility. The years are restricted to 2001 and 2003. DGDPGR is the change in growth rate of GDP between 2001 and 2003 and is intended to capture changes in the business cycle. Standard errors are clustered at outlet level. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	LABOR		**MATERIALS**	
	(1)	**(2)**	**(3)**	**(4)**
Log (Lagged input cost)	0.570***	0.358***	0.157***	0.0539***
	[0.032]	[0.057]	[0.022]	[0.016]
Log (Revenue)	0.153***	0.197***	0.897***	0.918***
	[0.038]	[0.053]	[0.022]	[0.021]
Year 2003	-0.475*		-0.138	
	[0.28]		[0.12]	
Year 2003 X Log (Lagged input cost)	-0.328***	-0.233***	-0.033	0.009
	[0.040]	[0.059]	[0.023]	[0.018]
Year 2003 X Log (Revenue)	0.321***	0.329***	0.0475*	0.0324
	[0.037]	[0.067]	[0.024]	[0.022]
DInf_p90 X Year 2003	1.440***		1.105***	
	[0.50]		[0.16]	
DInf_p90 X Log (Lagged input cost)	-0.142	-0.176	0.104***	0.104***
	[0.11]	[0.19]	[0.037]	[0.032]
DInf_p90 X Log (Revenue)	0.196	0.083	-0.0909**	0.009
	[0.17]	[0.20]	[0.045]	[0.044]
DInf_p90 X Year 2003 X Log (Lagged input cost)	**0.518*** **	**0.429** **	0.001	-0.0783*
	[0.13]	**[0.20]**	[0.053]	[0.043]
DInf_p90 X Year 2003 X Log (Revenue)	**-0.633*** **	**-0.722*** **	-0.125**	-0.077
	[0.10]	**[0.21]**	[0.057]	[0.060]
DGDPGR X Year 2003	15.52**		9.052***	
	[6.07]		[1.79]	
DGDPGR X Log (Lagged input cost)	-1.970***	-0.479	1.573***	1.077***
	[0.66]	[1.07]	[0.30]	[0.25]
DGDPGR X Log (Revenue)	1.409	0.341	-1.123***	-0.141
	[1.38]	[1.65]	[0.35]	[0.32]
DGDPGR X Year 2003 X Log (Lagged input cost)	1.879**	0.650	-2.275***	-2.105***
	[0.86]	[1.10]	[0.36]	[0.30]
DGDPGR X Year 2003 X Log (Revenue)	-3.563***	-4.089**	0.820**	0.192
	[0.82]	[1.78]	[0.36]	[0.38]
Constant	1.229***	1.969***	-1.226***	-1.039***
	[0.29]	[0.25]	[0.15]	[0.094]
Fixed effects	Outlet	Outlet-year-season	Outlet	Outlet-year-season
Observations	10,339	10,339	10407	10407
R-squared	0.800	0.840	0.970	0.980
Adjusted R-squared	0.799	0.839	0.974	0.981
Number of clusters	125	125	125	125

Table 9: Robustness check: Case study of labor reform in South Korea (1996-98)

This table examines changes in South Korea following labor reforms that increased labor market flexibility. The sample includes the years 1994 and 1995 (pre-reform years) and years 1999 and 2000 (post-reform years). "POST_REFORM" is a dummy equal to one for the post reform years (1999 and 2000). D_KOREA is a dummy equal to 1 for South Korea. The sample in the before-after regressions includes only South Korea, while the difference-in-difference regressions sample includes other Asian countries in the Asia-Pacific region. Standard errors are clustered at outlet level. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

	BEFORE-AFTER				DIFFERENCE-IN-DIFFERENCES			
	LABOR		MATERIALS		LABOR		MATERIALS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log (Lagged input cost)	0.766***	0.27***	0.33***	0.122***	0.271***	0.078***	0.079***	0.026***
	[0.049]	[0.058]	[0.039]	[0.024]	[0.022]	[0.017]	[0.009]	[0.008]
Log (Revenue)	0.205***	0.16***	0.719***	0.822***	0.462***	0.551***	0.951***	0.961***
	[0.034]	[0.041]	[0.034]	[0.026]	[0.013]	[0.013]	[0.010]	[0.010]
POST_REFORM X Log (Lagged input cost)	**-0.404*****	**-0.128****	-0.023	-0.018	0.194***	0.101***	0.051***	0.015
	[0.053]	**[0.064]**	[0.043]	[0.029]	[0.016]	[0.022]	[0.014]	[0.013]
POST_REFORM X Log (Revenue)	**0.335*****	**0.574*****	0.032	0.04	-0.17***	-0.156***	-0.04***	0.003
	[0.043]	**[0.049]**	[0.036]	[0.035]	[0.014]	[0.014]	[0.012]	[0.013]
D_KOREA X Log (Lagged input cost)					0.495***	0.192***	0.251***	0.097***
					[0.054]	[0.060]	[0.040]	[0.025]
D_KOREA X Log (Revenue)					-0.257***	-0.391***	-0.233***	-0.139***
					[0.037]	[0.043]	[0.035]	[0.028]
D_KOREA X POST_REFORM X Log (Lagged input cost)					**-0.598*****	**-0.229*****	-0.075	-0.033
					[0.056]	**[0.067]**	[0.046]	[0.031]
D_KOREA X POST_REFORM X Log (Revenue)					**0.505*****	**0.73*****	0.072*	0.036
					[0.045]	**[0.050]**	[0.038]	[0.037]
Constant	-0.128	0.512***	-1.242***	-0.713***	1.145***	2.157***	-1.437***	-1.125***
	[0.096]	[0.145]	[0.100]	[0.137]	[0.104]	[0.085]	[0.053]	[0.056]
	Outlet	Outlet-year-season	Outlet	Outlet-year-season	Outlet	Outlet-year-season	Outlet	Outlet-year-season
Observations	15,071	15,071	15,099	15,099	72,070	72,070	71,937	71,937
R-squared	0.850	0.890	0.940	0.960	0.980	0.980	0.97	0.980
Adjusted R-squared	0.854	0.894	0.944	0.963	0.977	0.984	0.97	0.978
Number of clusters	152	152	152	152	597	597	596	596

Table 10: Vector autoregression (VAR) model of labor cost and revenue

In this table we present results from a regression of log labor cost and log revenue on 4 lags of both variables, as well as interactions of the lags with the labor regulation index. All regressions include outlet-year-season fixed effects. * significant at 10 percent; ** significant at 5 percent; *** significant at 1 percent.

Dependent variable	Log (Labor cost)	Log (Revenue)
L.Log (Labor cost)	0.179***	0.019***
	[0.039]	[0.007]
L2.Log (Labor cost)	0.062***	0.008***
	[0.020]	[0.002]
L3.Log (Labor cost)	0.026***	-0.0005
	[0.008]	[0.003]
L4.Log (Labor cost)	0.031**	0.002
	[0.012]	[0.003]
L.Log (Revenue)	0.109***	0.345***
	[0.029]	[0.028]
L2.Log (Revenue)	0.033**	0.082***
	[0.015]	[0.021]
L3.Log (Revenue)	-0.003	-0.005
	[0.008]	[0.017]
L4.Log (Revenue)	0.01	0.033**
	[0.010]	[0.013]
Regulation X L. Log (Labor cost)	0.649**	0.0002
	[0.26]	[0.023]
Regulation X L2. Log (Labor cost)	0.383***	-0.020*
	[0.13]	[0.011]
Regulation X L3. Log (Labor cost)	-0.004	0.060***
	[0.042]	[0.019]
Regulation X L4. Log (Labor cost)	-0.005	0.035*
	[0.074]	[0.019]
Regulation X L. Log (Revenue)	-0.332*	-0.029
	[0.18]	[0.11]
Regulation X L2. Log (Revenue)	-0.126	0.181*
	[0.10]	[0.11]
Regulation X L3. Log (Revenue)	0.056	-0.020
	[0.055]	[0.097]
Regulation X L4. Log (Revenue)	-0.0004	-0.005
	[0.067]	[0.065]
Constant	3.771***	4.616***
	[0.31]	[0.43]
Observations	296400	296400
R-squared	0.96	0.95
Adjusted R-squared	0.96	0.95
Number of clusters	43	43

Figure 1a: Average impulse response functions for the top and bottom quartiles of the regulation index: Effect of period 0 revenue impulse

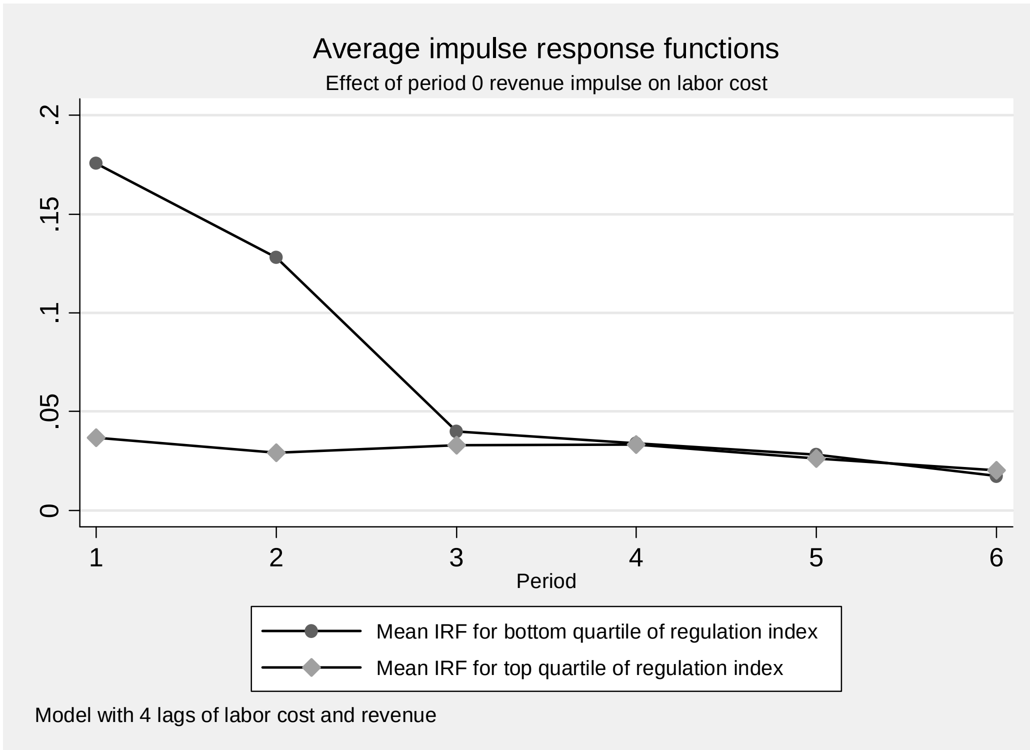

Figure 1b: Average impulse response functions for the top and bottom quartiles of the regulation index: Effect of period 0 labor cost impulse

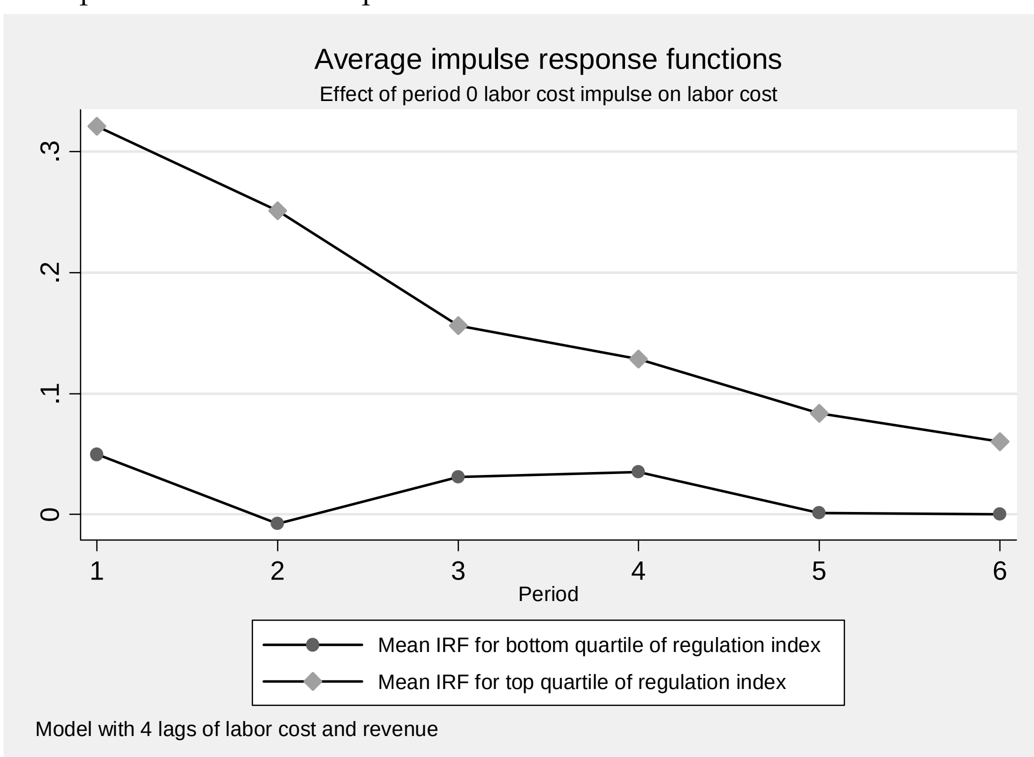

Table 11: Estimates of the dampening factor

This estimation uses an index of labor regulation (Botero et al., 2004) and results from Table 3, column 3. The dampening factor is the ratio of actual changes in labor costs to the change that would have occurred in the absence of adjustment costs.

Estimate of a_0		Estimate of a_1		Dampening factor estimate		
				Regulation		Change (percent)
				P25	P75	
Panel 1: Using baseline results (Column 6 of Table 4)						
Coefficient on Log (Lagged labor cost):	0.203	Coefficient on Regulation X Lagged labor cost:	0.687	0.900	0.687	23.7
1 - Coefficient on Log (Revenue):	0.610	-(Coefficient on Regulation X Revenue):	0.415	0.452	0.324	28.3
Average of above:	0.407	Average of above:	0.551	0.676	0.505	25.3
Panel 2: Using results from OECD sample (Column 1 of Table 7)						
Coefficient on Log (Lagged labor cost):	0.179	Coefficient on Regulation X Lagged labor cost:	0.427	0.885	0.743	16.0
1 - Coefficient on Log (Revenue):	0.543	-(Coefficient on Regulation X Revenue):	0.354	0.510	0.393	22.9
Average of above:	0.361	Average of above:	0.391	0.698	0.568	18.6