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The Stability of Dividends and Wages: Effects of Competitor Inflexibility

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Keywords: risk-sharing within firms, payout stability, wage stability, competitor inflexibility

JEL Classifications: D22, G35, J33, J41, L13, L94

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1 Introduction

One of the main theories of the firm is based on the idea of insurance: Firms provide insurance to employees against productivity shocks. In Knight (1921) or in Kihlstrom and Laffont (1979) entrepreneurs or shareholders bear the full residual risk and workers obtain a riskless wage. More generally, however, the extent to which firms' owners provide risk sharing for their employees will depend on several factors, such as on the risk aversion of shareholders and employees, on the amount of systematic versus idiosyncratic risk a firm is exposed to, on the degree of competition in the product and in the labor market, on the persistence of industry demand shocks, and on other institutional features of the industry, such as regulation.[1] Given this plethora of influencing factors, it is hard to identify the degree of insurance that shareholders provide to employees based on a broad cross-section of firms.

In this paper we mitigate this problem by focusing on firms from a single industry, namely the electricity industry. To analyze risk-sharing between firms' shareholders and workers, we exploit a novel source of variation in risk exposures across firms due to variation in competitor behavior. The latter is determined by the competitors' production technologies. If an electricity producer's competitors use mostly low-cost technologies, such as nuclear power, then this producer will be affected more severely by an adverse industry demand shock since its competitors have less incentive to reduce output. We refer to this as competitor inflexibility. In this paper, we analyze how much of the modulation of sales revenue risk due to competitor inflexibility is borne by the shareholders and how much by the employees of a firm. Our results are striking. We find that extra sales variation due to competitor inflexibility is borne by the shareholders but it does not affect wage stability. While wages are significantly correlated with firms' sales, there is no evidence that they respond to sales variation induced by competitor inflexibility. This sales variation does, however, compromise the stability of firms' payouts to their shareholders. Rather than sharing systematic risk due to competitor inflexibility with their employees, firms seem to prioritize wage stability over payout stability.

Our choice of industry focus is motivated by a number of observations. First, electricity is a

[1] Contributions to the literature on the theory of the firm based on risk sharing with employees are, e.g. Knight (1921), Baily (1974), Azariadis (1975), Kihlstrom and Laffont (1979), Berk, Stanton, and Zechner (2010), and Berk and Walden (2013). Evidence on the cross-industry variation of employees' risk exposure is provided by Lagakos and Ordoñez (2011).

key resource in any economy and thus demand fluctuations are likely to represent at least partly systematic risk. Second, electricity generation is an industry in which firms supply local markets with a particularly homogeneous output. Third, while electricity is a homogeneous good, it is produced via a very wide range of technologies. In choosing from the technological options, firms face a trade-off between fixed and variable costs of production. Once the choices are made, a firm's response to a drop in the electricity price depends on the extent to which it keeps plants running because the plants can produce output at a relatively low marginal cost. We can therefore measure a firm's (in-)flexibility in responding to price changes based on the fraction of its production capacity coming from low-cost plants. The higher this fraction, the less the firm adjusts its output to a given change in price. Competitor inflexibility can be measured in a similar way as the fraction of the production capacity of a firm's competitors that comes from low-cost plants.

To define the group of competitors of a given firm, we use data about the locations of firms and power plants since electricity is traded in local markets. In fact, electricity markets are subject to a surprisingly high degree of market segmentation at the country-level, so that a country's electricity supply will typically come from power plants in this country.[2] For each firm in our estimation sample, we therefore measure competitor inflexibility based on data about the production capacities and technologies of power plants in the country in which the firm is headquartered. We ignore the firm's own plants, and compute the capacity share of plants with low variable production costs among all competing plants.[3] This defines our measure of competitor inflexibility. We also compute the share of each firm's own capacity associated with low-cost plants in order to use it as a control variable. While this control variable is potentially endogenous, it is largely pre-determined by technological choices that the firms in our sample made long before the start of the sample period (2001-2014).[4]

Our regressions focus on three dependent variables: firm-level sales, wages, and payouts to shareholders through dividends and share repurchases. Specifically, we measure elasticities of these variables with respect to changes in the aggregate sales of a firm's competitors. The firms in our

[2] Oseni and Pollitt (2014) report that global exports of electricity are still only about 3% of total production.

[3] Our baseline estimates result from considering nuclear, hydro, and geothermal power plants as low-cost plants. In a robustness check, we also include low-cost plants based on intermittent energy sources, i.e. solar- and wind-powered plants.

[4] In robustness checks we find that our results do not depend on whether one controls for firms' potentially endogenous own technological choices.

estimation sample have sufficiently many competitors and sufficiently low market share that the competitors' aggregate sales can be regarded as exogenous. We test whether competitor inflexibility modulates the elasticities of our dependent variables with respect to variation in competitors' aggregate sales. If one of the elasticities increases in competitor inflexibility, we detect a negative effect of competitor inflexibility on the stability of the respective dependent variable.

We first test the prediction that competitor inflexibility destabilizes firms' sales revenues. This prediction results from a Cournot-Nash model, presented in section 2 in which firms face heterogeneous production costs and each firm chooses its output optimally, taking the other firms' output as given. The theoretical analysis shows that a firm's risk exposure depends on the production costs of its competitors: If the competitors can produce at lower marginal cost, then the firm is more exposed to demand shocks because the competitors respond less to these shocks. Our empirical analysis yields strong evidence that this is indeed the case. We find that the sales of firms with lower-cost (i.e. inflexible) competitors vary more strongly in response to aggregate sales variation.

Our theoretical analysis also yields predictions regarding the stability of firms' wages and payouts to shareholders. Focusing on effects of systematic risk, we show that both wage and payout stability should be compromised by competitor inflexibility if firms efficiently use the risk-bearing capacities of their shareholders and workers. Testing this prediction is the main task of our empirical analysis.

With respect to payout stability, we find strong empirical evidence for the predicted effect of competitor inflexibility. Shareholders of firms with more inflexible competitors receive substantially less stable payouts. According to our most conservative empirical estimates, the payout elasticity increases by about 20 percentage points when competitor inflexibility increases from its first quartile value to its third quartile value. This effect is sizeable both in absolute terms and also relative to the elasticity with which firms' payouts respond to changes in their own sales (estimated at 29 percentage points).

Contrastingly, we fail to find evidence that competitor inflexibility compromises wage stability. Rather than striking a balance between the risk exposures of their workers and their shareholders, the firms in our sample seem to prioritize wage stability.

In light of the theoretical model in Section 2, there are two possible interpretations of our results. First, the risk due to competitor inflexibility could be pure idiosyncratic risk that can be diversified away at the shareholder level and should therefore be fully borne by shareholders. However, this possibility can be essentially ruled out since competitor inflexibility modulates industry-wide demand shocks. Clearly, aggregate electricity demand fluctuations at least partly reflect systematic risk. In fact, most developed countries regulate retail electricity prices so that they compensate electricity firms' shareholders explicitly for bearing systematic risk (see, e.g., Lazar (2016) and Perrin (2013)).

The second interpretation of the result is based on a hypothesis regarding firms' *perception* of their shareholders' risk preferences, i.e. that firms ignore any changes of their shareholders' risk-neutral probabilities due to wage contracting. This behavior can be compared to that of a firm which ignores its effect on the output's market price because it perceives its market share to be negligible. The analogy is that, in wage contracting, the firm perceives that the resulting change in the risk characteristics of its stock has a negligible effect on its shareholders' preferences. We show in Section 2 that such a "preference-taking" firm would in fact prioritize wage stability over payout stability, rather than striking a trade-off between the systematic risk exposures of its shareholders and workers. This hypothesis is consistent with our empirical evidence.

Interestingly, we do find that wages are correlated with the total change in the firm's own sales, even though they do not respond to sales variation induced by competitor inflexibility. One must, however, be cautious when interpreting this correlation as a measure of workers' risk exposure. Factors affecting a firm's sales may change over time, but it is not clear to what extent these changes were predictable ex ante. Thus, wages may vary with the firm's sales, but this may not reflect risk-sharing between workers and shareholders. While competitor inflexibility may modulate wages' response to both predicable and unpredictable industry-level sales variation, in the data it does not affect either one.

To the best of our knowledge, this paper presents the first industry study of risk-sharing between firms' workers and shareholders. As discussed above, the industry focus is a key advantage of our research strategy, but it also raises specific concerns regarding the robustness and external validity of our results. By focusing on electricity generation, we analyze an industry that is largely characterized by market segmentation along countries' borders. Therefore our baseline specification is based on the assumption that markets correspond to countries. In a robustness test, however, we take into account that within-country electricity markets may also be partially segmented due to transmission costs. We therefore analyze a subsample of firms in countries for which we can obtain precise data about the locations of power plants. While this subsample differs from the baseline sample, the analysis confirms that our main result survives if local markets are defined based on transmission costs.

The industry focus could also raise concerns regarding possible effects of regulation. Although we are not alone in analyzing data of firms in the electricity sector,[5] firms in this sector are sometimes excluded from empirical analyses because they may be subject to specific regulation. To address the issue of regulation, we analyze data from three different subsamples. In the first we simply exclude firms with market shares above 50%. These firms are particularly likely to be regulated as they exhibit a dominant market position. The second robustness check is based on the subsample of firms headquartered in countries with rules for "ownership-unbundling" that separate the electricity generation business from the heavily regulated business of electricity transmission. A third robustness analysis focuses on the subsample of firms in countries with liquid wholesale electricity markets. This is motivated by the observation that such markets are typically introduced in the process of electricity sector deregulation. We find that our results all survive these robustness tests.

We also test whether our results change if we alter the set of fixed effects included in our regressions, and find only small effects on the economic magnitude and statistical significance of our estimates. In horse-race specifications, we rule out that the results are driven by our measure of competitor inflexibility proxying for other cross-sectional differences, such as those between firms with/-out publicly listed stocks or firms with different levels of leverage. These cross-sectional differences matter[6], but it turns out that competitor inflexibility has a robust positive and statistically significant effect on the elasticity of firms' payouts to shareholders with respect to the aggregate sales of competing firms. In terms of economic magnitude, the payout-destabilizing effect of competitor inflexibility mostly depends on the way we define local markets.

Our paper is related to contributions regarding effects of product market competition on em-

[5] For recent contributions, see Pérez-Gonzáles and Yun (2013) and Reinartz and Schmid (2016).

[6] In particular, our results regarding effects of leverage are consistent with the theoretical predictions of Berk, Stanton, and Zechner (2010) who predict that leverage compromises wage stability in the presence of limited liability since it is in the interest of employees to share risks with shareholders in order to avoid financial distress. Consistent with this, we find that leverage indeed destabilizes wages, and also find a (marginally significant) stabilizing effect on payouts. See Section 6.2.

ployment relationships. In labor economics, Bertrand (2004) analyzes how import competition affects the elasticity of wages to unemployment rates and provides evidence that competitive pressure causes firms to change their wage-setting policies so that workers receive less insurance against changes in their outside options. Cuñat and Guadalupe (2009) extend Bertrand's identification strategy and analyze how import penetration affects CEO compensation, while instrumenting import penetration using exchange rates and tariffs. They find that more foreign competition is associated with a higher sensitivity of CEO pay to performance. Our contribution differs from this literature since it focuses on firms' technological choices and the *nature* of competition, i.e. the way competing firms respond to risk. Moreover, we explicitly analyze risk-transfers between firms' owners and workers by comparing the effect of competitor inflexibility on payments to *both* groups of stakeholders. We thus focus on the issue of "insurance within the firm" and contribute to the literature following the seminal contribution by Guiso, Pistaferri, and Schivardi (2005). Our contribution is an analysis of risk-sharing within firms based on a measure of firms' exposure to industry-level shocks which, at least to a significant extent, represent non-diversifiable risk.[7] This measure is competitor inflexibility.

Our paper is also related to the large finance literature on payout policy, recently surveyed by Farre-Mensa, Michaely, and Schmalz (2014) who note that payout policy is usually analyzed in isolation, i.e. without taking potential links to other corporate policies into account. Against this backdrop, our paper stresses the trade-off between using corporate revenues to finance payouts or wages. Findings of Brav, Graham, Harvey, and Michaely (2005) suggest that this trade-off is indeed relevant: They report that managers of public firms consider it a high priority to maintain stable dividends, and that some even consider laying off employees in order to avoid dividend cuts. Related evidence appears in Almeida, Fos, and Kronlund (2016) who find that managers are willing to cut employment in order to meet earnings forecasts. In the Internet Appendix, we also analyze the stability of employment, but we find no significant effects of competitor inflexibility in this respect.

By analyzing how the stability of firms' payouts depends on competitors' technological choices, we add to a small literature regarding the effects of competition on payout policy, but where the

[7]Guiso, Pistaferri, and Schivardi (2005) focus on firm-specific risk. However, it is particularly important to understand how wages respond to systematic risk. For example, the extent of systematic wage variation matters for monetary policy aimed at price stability.

focus is mostly on the level of payouts, rather than on payout stability. Hoberg, Phillips, and Prabhala (2014) use a novel measure of product market competition ("fluidity") to show that firms facing competitive threats are less likely to pay dividends or repurchase shares, and also pay lower dividends. Grullon and Michaely (2014) also analyze effects of product market competition on payout policy based on data about U.S. firms and standard measures of competition. They find that the relation between industry concentration and dividend payout ratios became more negative after the passage of business combinations laws.

The rest of the paper is organized as follows: the next section presents the theoretical foundations of our empirical analysis. Section 3 lays out the empirical analysis, followed by a description of our data in Section 4. Section 5 presents our results, and Section 6 discusses various robustness checks. Section 7 concludes.

2 Theoretical foundations

In this section, we consider a firm which is exposed to risk in an output market with Cournot competition. We show that the firm's risk exposure depends on the production costs of competing firms, and we analyze efficient risk sharing between a representative shareholder and a representative worker of the firm. We thereby obtain a framework for discussing the results and the power of our empirical analysis.

We consider a firm f with n competitors. The firms produce a homogeneous output at different constant marginal costs. For our purposes, it suffices to distinguish between the marginal production cost of firm f, denoted by c_f, and the average marginal production cost of the competing firms, denoted by $\bar{c}_c$. The relative difference between firm f's production cost and the competing firms' average production cost, x, is given by:

$$x := \frac{c_f - \bar{c}_c}{\bar{c}}, \tag{1}$$

where $\bar{c}$ is the average production cost of all firms in the industry: $\bar{c} := (c_f + n\bar{c}_c)/(n+1)$.

The output price is given by a linear inverse demand function: $p(Y) := a - bY$, where Y is the firms' aggregate output. The firms play a Cournot-Nash game in which each firm chooses its output optimally, taking the other firms' output as given.[8] It is straightforward to show that firm f optimally produces a positive output if the intercept of the inverse demand function a exceeds the industry's average production cost $\bar{c}$ by a sufficiently high percentage:

$$m := \frac{a - \bar{c}}{\bar{c}} > x \frac{n(n+2)}{n+1}. \tag{2}$$

We assume that the above-stated condition holds, and refer to the parameter m as the mark-up parameter. Cournot analysis yields that firm f's equilibrium profit is:

$$\pi(m) := \frac{(a(m) + n(\bar{c}_c - c_f) - c_f)^2}{b(n+2)^2} = \frac{(\bar{c}(1+m) - n\bar{c}x - \bar{c}(1 + xn/(n+1)))^2}{b(n+2)^2}, \tag{3}$$

where $a(m) := \bar{c}(1+m)$, and we have used the facts that $\bar{c}_c - c_f = -\bar{c}x$ and $c_f = \bar{c}(1+xn/(n+1))$.

We next analyze firm f's exposure to changes in the mark-up parameter.[9] Suppose that the firm chooses its output conditional on observing one of two possible values of the mark-up, $\{m_+, m_-\}$, where $m_\pm = m_0(1 \pm g/2)$, $g > 0$, and the values of g and m_0 are set so that both values of m satisfy assumption (2). Then the mark-up variation induces the following variation in firm f's profit:

$$\Delta\pi := (\pi(m_+) - \pi(m_-)) \approx g\, \pi(m_0)\, \eta(x), \tag{4}$$

where $\eta(x)$ measures the elasticity of firm f's profit with respect to the mark-up parameter:[10]

$$\eta(x) := d\log(\pi(m))/d\log(m)|_{m=m_0} = \frac{2m_0}{m_0 - x\frac{n(n+2)}{n+1}} \approx 2\left(1 + \frac{x}{m_0}\frac{n(n+2)}{n+1}\right). \tag{5}$$

The above-stated expressions formalize the idea that a firm's risk exposure depends on the production costs of competing firms. In our model, a lower value of competitors' average production cost corresponds to a higher value of the parameter x, defined in expression (1). If firm f's competitors can produce at lower cost, the firm's profit will respond to the mark-up variation with

[8] See the literature started by Kreps and Scheinkman (1983) for foundations of Cournot analysis in terms of a game in which firms compete in prices after choosing production capacities.

[9] Similar results can be derived for other model parameters. We focus on the mark-up parameter m because marginal changes in the industry's average cost $\bar{c}$ or in the slope of the inverse demand function, b, cause percentage changes in firm f's output that do not depend on x.

[10] The approximation will be used in expression (9).

a higher elasticity $\eta(x)$.[11] Intuitively, a change in the mark-up parameter m causes a larger change in firm f's profit if the firm's competitors can produce output at lower cost because the competitors will then respond less to the shock, aggravating its effect on firm f.

In our empirical analysis we will draw on the idea that a firm's risk exposure depends on the production costs of competing firms. Like the parameter x in the model above, our empirical index of competitor inflexibility decreases in the production costs of a firm's competitors.[12] In the remainder of this section, we refer to the parameter x as competitor inflexibility.

We next analyze the effect of competitor inflexibility on the risk-sharing between firm f's representative shareholder and its representative worker. The risk-sharing between the two parties will be specified in their wage contracting and will depend on their risk aversion, and their access to financial markets. We assume that firm f's shareholder has access to financial markets, while the firm's worker cannot use these markets.[13]

We now relate the variation in the mark-up parameter to a systematic risk factor which can be thought of as a return that firm f's shareholder earns by holding the market portfolio. We focus on variation due to systematic risk, since variation due to idiosyncratic risk will not affect the shareholder's total return in a large economy due to diversification.[14] We model the shareholder's income from investing in the market portfolio as an endowment with two possible realizations $\{e_+, e_-\}$, where $e_\pm := 1 \pm \sigma/2$ and the subscripts indicate the two states of our model.[15] The return of the market portfolio is associated with systematic variation in the growth rate of the mark-up parameter that we specify by setting $g := \beta\sigma > 0$, so that $m_\pm = m_0(1 \pm \beta\sigma/2)$. Substituting for g in expression (4) yields the systematic variation in firm f's profit.

Wage contracting determines how the systematic profit variation translates into variation in the payoffs of firm f's shareholder and worker. A wage contract specifies a pair of wages (w_+, w_-) that

[11] By focusing on changes in the parameter x, we summarize similar results that would be obtained if we separately changed the competitors' average production costs $\bar{c}_c$ or firm f's production cost c_f, rather than changing the parameter x which measures the difference $c_f - \bar{c}_c$.

[12] To avoid endogeneity problems, we will however measure each firm's competitor inflexibility without considering the firm's own production costs.

[13] This assumption is a coarse, yet standard, way to rationalize risk-transfers from firms' workers to their owners. See Danthine and Donaldson (2002) and Guvenen (2009). Berk and Walden (2013) analyze a model in which limited market participation arises endogenously in a general equilibrium in which firms' shareholders and workers engage in efficient risk sharing. We also focus on efficient risk sharing, but we analyze a partial equilibrium.

[14] Recall that, as the weight of each firm in the market portfolio goes to zero, the contribution of any given firm i to the risk of the market portfolio, σ_M^2, is $\beta_i\sigma_M^2$ if returns are jointly normal.

[15] The endowment is based on an investment into the market portfolio with a (normalized) value of one.

the worker receives in the two states. Given these wages, firm f's shareholder receives a (liquidating) dividend $d_{\pm} := \pi_{\pm} - w_{\pm}$, where $\pi_{\pm} := \pi(m_{\pm})$ denotes firm f's profit. The shareholder's total payoff is the sum of the dividend and the payoff from investing into the market portfolio, $e_{\pm}$.

To derive an optimal wage contract, we next specify the preferences of firm f's shareholder and its worker in terms of risk-neutral probabilities which determine their certainty equivalent payoffs. The certainty equivalent payoffs of the two parties are given by:

$$\begin{aligned} W &:= q_w w_+ + (1 - q_w) w_-, \\ D &:= q_s(d_+ + e_+) + (1 - q_s)(d_- + e_-), \end{aligned}$$

where W is the certainty equivalent that firm f's worker assigns to the firm's wages, D is the certainty equivalent payoff that the firm's shareholder receives, and q_w and q_s are risk-neutral probabilities. The risk-neutral probabilities are specified as follows:[16]

$$\begin{aligned} q_w &:= \psi - \gamma_w \Delta w, \\ q_s &:= \psi - \gamma_s(\Delta d + \Delta e), \end{aligned} \tag{6}$$

where ψ denotes the probability of state "+", $\Delta w := w_+ - w_-$ and $\Delta d := d_+ - d_-$ denote systematic variation in firm f's wage bill and its dividend, $\Delta e := e_+ - e_- = \sigma$ depends on the volatility of the market portfolio, and γ_w and γ_s are parameters that depend on the risk-aversion of the firm's worker and its shareholder, respectively.

Efficient risk-sharing between firm f's worker and shareholder requires equating the agents' marginal rates of substitution between their payoffs in the two states. The resulting wage variation is given by:

$$\Delta w = (\sigma + \Delta\pi)\frac{\gamma_s}{\gamma_s + \gamma_w}. \tag{7}$$

This expression shows that the wage difference Δw increases in the systematic variation of firm f's profit, $\Delta\pi$, and in the return volatility of the market portfolio. The ratio $\gamma_s/(\gamma_s + \gamma_w)$ measures

[16] This specification results from an approximation of marginal utility as a linear function of the difference between the payoff that an agent receives in a state s, and the agent's expected payoff. For example, the worker's marginal utility in the high-wage state is $MU_+ := \psi - \kappa_w(w_+ - \bar{w})$, where κ_w measures the worker's risk aversion, and $\bar{w} = \psi w_+ + (1-\psi)w_-$ is the expected wage paid by firm f, where ψ is the probability of state "+". The risk-neutral probability q_w is defined as follows: $q_w := \psi(MU_+/\bar{MU})$, where $\bar{MU}$ denotes the worker's expected marginal utility. Then, $q_w = \psi - \gamma_w \Delta w$ with $\gamma_w := \kappa_w \psi(1-\psi)$. q_s is defined similarly, and $\gamma_s := \kappa_s \psi(1-\psi)$, where κ_s measures the risk aversion of firm f's shareholder.

the risk aversion of the firm's shareholder relative to that of the firm's worker. The higher this risk aversion, the more systematic risk will be borne by the firm's worker. If $\gamma_s > 0$ and $\gamma_w > 0$, firms will strike a trade-off between wage stability and dividend stability.

To interpret the empirical results on wage variation that follow it is instructive to consider equation (7) more closely. Note that the risk-neutral probability of firm f's shareholder, q_s, depends on the systematic variation in the firm's dividend. This implies that the variation of the wage across the two states affects both the worker's and the shareholder's risk-neutral probabilities in expression (6): $\Delta d = \Delta\pi - \Delta w$.

Alternatively, one could argue that the shareholder's risk neutral probability q_s can be treated as given in wage contracting, since firm f regards its dividend variation as a negligible component of its shareholder's payoff variation. If the firm's dividend variation Δd does not affect the probability q_s, we would obtain an expression like in (7), but without $\Delta\pi$ appearing on the right-hand side:

$$\Delta w \quad = \sigma \tfrac{\gamma_s}{\gamma_s + \gamma_w}. \tag{8}$$

This result supports the notion that wage stability has priority over dividend stability because the systematic variation in firm f's profit is now fully borne by the firms' shareholder through variation in the firm's dividend. While the last result differs from that in expression (7) in terms of the wage variation induced by firm f's profit variation, both results suggest that wages should respond to variation in the shareholder's income from sources other than firm f's dividend. This interpretation of the results is perhaps too literal. Instead, our model simply allows for effects of shareholder risk aversion on wage contracting by allowing for an exogenous difference between the risk-neutral probability q_s and the physical probability ψ. To fix ideas, we specify this difference in terms of the return volatility of the market portfolio, measured by σ. Thus, we implicitly assume that firm f knows its cost of equity capital, and we allow for this cost to differ from the risk-free rate. While we maintain this assumption throughout the analysis, the result in expression (8) differs from that in expression (7) since the former is based on the additional assumption that, in wage contracting, the firm ignores the effect on its shareholder's risk preferences. However, this does not imply that firms act as if shareholders were risk-neutral.

Expressions (7) and (8) constitute a framework for interpreting the results of our empirical analysis regarding wage stability. The latter expression implies that wage stability should not depend on variables which modulate firm f's systematic profit variation $\Delta\pi$, while the former implies that it does. In our empirical analysis, the modulating variable of interest will be competitor inflexibility. We will test whether competitor inflexibility affects the stability of firms' wages, and their payouts to shareholders through dividends and share repurchases. The wage setting described in expression (7) allows for both effects since it implies that firm f's shareholder and its worker share the systematic risk of the firm's profit. If wages are however set as in expression (8), then competitor inflexibility will only compromise dividend stability, but not wage stability.

By using expression (4) to substitute for $\Delta\pi$ in expression (7), we obtain the following specification regarding the effects of competitor inflexibility on firm f's wage- and dividend-variation:[17]

$$\begin{aligned} \Delta w &\approx \tfrac{\gamma_s}{\gamma_s+\gamma_w}\Delta\pi_0 + \theta_w \Delta\pi_0\, x + \tfrac{\gamma_s}{\gamma_s+\gamma_w}\sigma, \\ \Delta d &\approx \tfrac{\gamma_w}{\gamma_s+\gamma_w}\Delta\pi_0 + \theta_d \Delta\pi_0\, x - \tfrac{\gamma_s}{\gamma_s+\gamma_w}\sigma, \end{aligned} \tag{9}$$

where the approximations are based on the approximation for the elasticity $\eta(x)$ stated in expression (5), $\Delta\pi_0 := \beta\sigma\,\pi[m_0]\eta(0)$ denotes the profit variation that an average-cost ($x = 0$) firm would experience due to the variation in the mark-up parameter, and θ_w as well as θ_d are coefficients defined as follows:

$$\theta_w := \frac{n(n+2)}{n+1}\frac{1}{m_0}\frac{\gamma_s}{\gamma_s+\gamma_w}, \text{ and } \theta_d := \frac{n(n+2)}{n+1}\frac{1}{m_0}\frac{\gamma_w}{\gamma_s+\gamma_w}. \tag{10}$$

The results in expression (9) are the theoretical counterparts to the regressions in our empirical analysis below. The coefficients θ_w and θ_d describe the trade-off that firms strike between wage and dividend stability so that workers and shareholders share risks associated with competitor inflexibility. In the next section, we discuss our strategy to identify this trade-off.

[17] The precise results are: $\Delta w = (\beta\sigma\,\pi(m_0)\,\eta(x) + \sigma)\gamma_s/(\gamma_s+\gamma_w)$, $\Delta d = (\beta\sigma\,\pi(m_0)\,\eta(x) - \sigma\,\gamma_s/\gamma_w)\gamma_w/(\gamma_s+\gamma_w)$.

3 Empirical analysis

3.1 Research strategy

We now describe the empirical analysis, starting with a discussion of our research strategy. Formal definitions of the main variables appear in Section 3.2.

Our regressions explain three dependent variables, i.e. firm-level sales, wages, and payouts to shareholders via dividends and share repurchases. We estimate elasticities of these dependent variables with respect to changes in the aggregate sales of a firm's competitors, while allowing for the elasticities to vary in a measure of competitor inflexibility that depends on the competitors' technological choices and proxies for the competitors' average production cost. The structure of our regressions follows from the results in expression (9). The variation in the aggregate sales of a firm's competitors is a proxy for the variation denoted by $\Delta\pi_0$.[18] Our central explanatory variable is the product of the variation in competitors' aggregate sales and the measure of competitor inflexibility, defined below. This interaction term corresponds to the interaction $\Delta\pi_0 x$ in expression (9).

We estimate the regressions based on annual data for firms that are subject to similar risk factors because they produce a homogeneous output: electricity. The industry focus eliminates cross-industry variation which could bias our results in ways that are not easily addressed by means of adding industry fixed effects.[19] For example, industry fixed effects would not suffice to absorb cross-industry variation in the regression coefficients of the main explanatory variable, i.e. the interaction of competitor inflexibility and the variation in competitors' aggregate sales. Our theoretical analysis suggests that these coefficients should indeed vary across industries since their theoretical values θ_w and θ_d depend on industry characteristics, such as the industry mark-up m_0. Cross-industry variation in mark-up levels would be a concern if we used data from firms in different industries to measure effects of competitor inflexibility. For example, it is quite plausible that mark-ups are correlated with industry-level determinants of competitor inflexibility because mark-ups should contain risk premia for industry-specific risk factors that also affect industries'

[18] Instead of using competitors' aggregate sales, we could use their average sales as a proxy for $\Delta\pi_0$. We prefer to use aggregate sales since there is considerable variation in data availability regarding small firms, and this variation has a stronger effect on average sales than on aggregate sales. By using aggregate sales instead of average sales, we obtain regression coefficients that are effectively normalized by the number of firms in a market, n. This normalization is desirable because the "raw" coefficients θ_w and θ_d are roughly linear in n (since $n(n+2)/(n+1) \approx n$).

[19] See MacKay and Phillips (2005) for a discussion of the limits of industry fixed effects.

technological choices.[20]

While the equations in expression (9) concern variation across states of our one-period model, our empirical analysis will be based on time (i.e., annual) variation of firms' wages, dividends, etc. This variation can be interpreted as resulting from different realizations of the model's state variables at different points in time. Given that we are mainly interested in the coefficients of the interaction of competitors' aggregate sales with competitor inflexibility, we can use year or country-year fixed effects as control variables. The year fixed effects can be interpreted as controls for variation in the market portfolio return (σ), and country-year fixed effects allow for country-specific market portfolios. The country-year fixed effects also control for a host of country-level determinants of workers' and shareholders' willingness to bear risk. Alternatively, we can add suitable country-level control variables.[21]

The following regression illustrates our baseline specification:

$$\begin{aligned} \Delta POUT_{i,c,t} = \quad & \beta_1 \Delta AGG\,SALES_{-i,c,t} + \beta_2 \Delta AGG\,SALES_{-i,c,t} \times CINFLX_{i,c,t} \\ & + \beta_3 CINFLX_{i,c,t} + \gamma \boldsymbol{X}_{i,c,t} + \nu_i + \tau_t + \epsilon_{i,c,t}, \end{aligned} \tag{11}$$

where i indexes firms, c indexes countries, and t indexes years. The dependent variable is the growth of firm i's total payout to shareholders (via dividends and share repurchases) from year $t-1$ to year t. The explanatory variables are: growth in aggregate sales of electricity generation companies that compete with firm i in country c of the firm's headquarters, $\Delta AGG\,SALES_{-i,c,t}$, a measure of competitor inflexibility denoted as $CINFLX_{i,c,t}$ (defined below), and control variables, $\boldsymbol{X}_{i,c,t}$. ν_i and τ_t are fixed effects at the firm- and year-level, and $\epsilon_{i,c,t}$ denotes an error term.

The above specification is motivated by stylized facts concerning our sample. By using a sample of firms in electricity generation, we focus on firms that supply local markets. In our baseline regressions, we regard firms in different countries as firms that compete in different output markets. This specification is motivated by evidence that electricity trading is subject to a high degree of market segmentation at the country-level.[22] Oseni and Pollitt (2014) report that, at the end of

[20] This argument also suggests that competitor inflexibility should be defined in terms of differences between firms in an industry. To avoid endogeneity issues, we use a measure that is only based on the technologies used by a firm's competitors, rather than data from the firm itself. But, we control for firms' own technological choices. This approach allows us to test whether our results change if we exclude potentially endogenous control variables from our regressions.

[21] See Table IA4 in Internet Appendix B.

[22] The US will be treated as an exceptional case: We will assign US states to three virtual countries as-

our sample period, global exports of electricity were still only about 3% of total production.[23] By simply treating different countries as different markets, we abstract from costs of within-country electricity trading. These costs will be taken into account in Section 6.3, where we define local markets based on data about the precise locations of power plants.

Our measures of competitor inflexibility and competitors' aggregate sales growth will be defined below. For now, it suffices to note that these variables will be regarded as exogenous variables, based on the notion that any firm i takes competitor behavior as given. To be included in our baseline sample, a firm must have at least 5 competitors. In robustness checks, we double this cutoff and also test whether our results are driven by markets featuring firms with market shares above 50%. But, even in the baseline sample, the aggregate sales of firms' competitors are computed using data about 35 firms on average.

Our key explanatory variable is the interaction of aggregate sales growth $\Delta AGG\ SALES_{-i,c,t}$ and competitor inflexibility $CINFLX_{i,c,t}$. We will test whether the interaction term enters the regression with a significantly positive or negative coefficient β_2. If we obtain a positive estimate, then higher values of competitor inflexibility are associated with a more positive elasticity of the dependent variable with respect to aggregate sales growth. An increasing elasticity indicates that competitor inflexibility destabilizes the respective dependent variable. To measure economic significance, we will compare point estimates of the elasticity given the first and third quartile value of competitor inflexibility.[24]

Regressions similar to that in expression (11) will be used to analyze the effects of competitor inflexibility on two other dependent variables: firms' sales and wage payments. In Internet Appendix A, we also distinguish between employment growth and the growth of the average wage of a firm's workers. Moreover, we test whether the average wage depends on competitor inflexibility. This test is motivated by the idea that wages may contain risk premia which compensate workers for

sociated with the three main interconnections, i.e. the Eastern, Western, and Texas Interconnect. We distinguish between these three networks because they still operate largely independently from each other. See *www.eia.gov/todayinenergy/detail.php?id=27152* for further details (Link as of 05/18/2018).

[23] Oseni and Pollitt (2014) and Bahar and Sauvage (2013) discuss possible reasons for the lack of international trade in electricity. The reasons include insufficient cross-country transmission capacity (and system operators' incentives to push congestion towards a country's borders), the problem that promoting trade may require the abolition of energy subsidies, a reluctance to export electricity in countries in which electricity is a main input of other industries, etc..

[24] Whenever our set of control variables includes interactions of the aggregate sales shocks with variables other than competitor inflexibility, we set those variables to their median values when we estimate elasticities for different quartiles of competitor inflexibility.

effects of competitor inflexibility on the workers' risk exposure. Unfortunately, we cannot measure the effects of competitor inflexibility on individual workers.

We end this section by revisiting the theoretical foundations of the empirical analysis to highlight its potential contributions. At the most basic level, the analysis can be seen as testing whether firms strike a trade-off between wage stability and the stability of their payouts to shareholders, rather than prioritizing wage stability. We first test whether competitor inflexibility increases the elasticity of firms' sales with respect to variation in the aggregate sales of competing firms. If so, then the destabilizing effect of competitor instability on firms' sales should affect the stability of firms' payouts to their workers and shareholders, as stated in expression (9), because the two groups should efficiently share systematic risk driving the aggregate sales variation.

The power of our analysis clearly depends on the extent to which competitor inflexibility modulates firms' exposure to systematic, rather than diversifiable, risk. Given our focus on firms in electricity generation, we expect that the firms in our sample are subject to systematic risk. In fact, the systematic risk of electricity generation is regularly measured in many countries as an input of rate-of-return regulation of electricity pricing.[25]

Another driver of the power of our analysis is the extent to which firms' workers and shareholders are distinct groups of stakeholders. This is supported by evidence regarding the low direct stock market participation of workers.[26] However, one could argue that workers may be exposed to systematic risk through their retirement saving or non-wage compensation, and this risk exposure may affect their risk-bearing capacities with respect to wage risk. Potential cross-sectional variation in workers' and shareholders' risk bearing capacities is an issue that will be addressed by means of robustness checks in which we will distinguish between listed and non-listed firms. These two groups of firms may strike different trade-offs between wage stability and the stability of their payouts to shareholders because their workers may be among their shareholders.[27]

While the focus of our analysis is on the elasticities of firms' wages and payouts to shareholders with respect to aggregate sales variation, we will also test whether wages and payouts are correlated

[25] See Lazar (2016) and Perrin (2013) for discussions of return calculations in the US and in Europe.

[26] See Table 2 in Poterba (2000).

[27] Besides the obvious liquidity argument favoring employee stock ownership in listed firms, issues of taxation may also be relevant. For example, "ESOPs not much of celebration for employees of unlisted companies; here's why" under *http://www.business-standard.com/article/companies/esops-can-be-taxing-for-employees-of-unlisted-companies-117100800673_1.html* (Link as of 05/18/2018).

with firm-level sales. If so, then it is reasonable to expect that the aggregate sales variation also induces variation in wages and payouts, so that our analysis should not suffer from a lack of power. In fact, it is reasonable to expect that the aggregate sales variation has a stronger effect on wages than firm-level variation in sales because the latter variation should be partly due to diversifiable risk which should not be borne by workers.

3.2 Main variables

We now describe the construction of our main variables. The variables are based on balance sheet data about firms in electricity generation that we link to an extensive dataset regarding power plants. The underlying data work will be described in Section 4.

3.2.1 Dependent variables

We use three sets of dependent variables in our main analysis: Firm-level sales growth, growth in total wage payments, and growth in total payouts. We include both dividend payments and share repurchases in our measure of total payouts. Growth rates are defined as first differences between log-values of two consecutive annual observations. We exclude observations with values below the 5%-ile or above the 95%-ile to avoid spurious results due to outliers.

3.2.2 Competitor inflexibility.

Our measures of competitor inflexibility are inspired by the results in expressions (4) and (5). These results show that the lower the average marginal production cost of a firm's competitors, the more will the firm's profit respond to mark-up variation because the competitors' aggregate output responds less to such variation if they can produce at lower cost.

To bring this concept of competitor inflexibility to our data from firms in electricity generation, we classify power plants according to the variable costs at which they can produce electricity. We then compute the fraction of competitors' total production capacity coming from plants that can produce electricity with low variable costs. The result is our measure of competitor inflexibility.

As an alternative to classifying power plants based on production costs, one could classify the plants based on costs of shutting-down or restarting them. We believe that our classification is more consistent with our focus on risk-sharing between the owners and workers of power plants since the underlying risks concern relatively persistent changes in worker productivity. Costs of exercising real options mainly determine the speed with which firms respond to temporary productivity shocks, but such shocks should have small effects on workers.

To classify power plants based on production costs, we use information provided by the U.S. Energy Information Administration (EIA) about the fixed and variable costs of operation and maintenance of different types of plants.[28] The information is summarized in Table 1. Variable costs of operation and maintenance include fuel costs. Costs of capital are separately reported. The final two columns list the ratio of variable costs to the sum of variable and fixed costs, and the ratio of variable costs to the sum of variable, fixed, and levelized capital costs.[29]

[Table 1 about here.]

We will consider a power plant as a "low variable cost" (LVC) plant if the source of energy is nuclear, hydro, geothermal, wind or solar power. Table 1 shows that, for these energy sources, the variable costs of operation and maintenance of power plants account for a relatively small share of total costs compared to, say, coal- or gas-powered plants. We further distinguish between power plants based on intermittent energy sources (wind and solar power) and plants whose capacity is continuously available. Our baseline estimates result from considering nuclear, hydro, and geothermal power plants as LVC plants, but we add solar and wind-power plants in a robustness check that appears in Internet Appendix B (Table IA6). In this robustness check, we also test whether our results are robust to classifying coal plants as LVC plants.

We will use two different measures of competitor inflexibility. The first measure is motivated by the observation (discussed in the opening paragraph of this section) that the volume of electricity trade within countries dwarfs that of such trade between countries. Given this observation, we assume that different countries represent segmented markets, but all power plants in any given country supply the same market. Our second measure of competitor inflexibility takes into account that within-country transmission of electricity is costly, so that any given plant only competes with nearby plants in the same country.

[28]See Table 1 on the page *http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf* which is based on the EIA's Annual Energy Outlook 2014.

[29]Levelized capital costs are the cost of capital required to build and operate a power plant over its lifetime divided by the total power output of the plant over that lifetime.

For a firm i headquartered in country $c(i)$, our first measure of competitor inflexibility is defined as follows:

$$CINFLX_{i,c(i),t} = \frac{\sum_{u \in U_{c(i),t} \setminus U_{i,t}} CAPACITY_u \times 1_{u=LVC}}{\sum_{u \in U_{c(i),t} \setminus U_{i,t}} CAPACITY_u}, \tag{12}$$

where u indexes power plant units (e.g. a turbine),[30] $CAPACITY_u$ is the capacity (measured in mega watts) of unit u, $U_{c(i),t}$ is the set of all units in country $c(i)$ (based on all of our plant-level data for the year t), $U_{i,t} \subset U_{c(i),t}$ is the subset of units owned by firm i, and $U_{c(i),t} \setminus U_{i,t}$ is the subset of units with other owners. As discussed above, the indicator variable $1_{u=LVC}$ equals one for nuclear, hydro and geothermal power units in our baseline specification.

We compute the above-stated measure of competitor inflexibility based on all data for power plants that are available for a given country-year through the WEPP database, described in Section 4. As a consequence, this measure of competitor inflexibility does not depend on the extent to which we can match power plants to firms for which we have balance sheet data. Moreover, this measure will be available for a large number of countries because it can be computed without use of data regarding plant locations within countries. Given that we have ample data about power plants, we can also test the robustness of our result with respect to using lagged data. In Internet Appendix B (Table IA5), we report a robustness check based on measuring competitor inflexibility as described above, but only based on power plants that started to operate before the year 1996, i.e. well before our sample period (2001-2014).

We next turn to our second measure of competitor inflexibility. As discussed above, this measure takes into account that, due to costs of electricity transmission, two firms are more likely to compete with each other if they own power plants that are sufficiently close to each other. More specifically, we assume that two power plants must be less than 300 miles apart so that they can both supply the same customers via a medium length line.[31] This assumption is formalized in terms of the following measure of competitor inflexibility:

$$CINFLX_{i,m(i),t} = \frac{\sum_{u \in U_{m(i),t} \setminus U_{i,t}} CAPACITY_u \times 1_{u=LVC}}{\sum_{u \in U_{m(i),t} \setminus U_{i,t}} CAPACITY_u}, \tag{13}$$

[30] A power plant may contain several power-generating units. We exclude all units that are marked in our data as units which are either retired, planned, still in design, or under construction. For simplicity, we refer to power plant units as power plants.

[31] For a classification of power transmission lines, see Grainger and Stevenson (1994). The 300 mile distance is twice the maximum length of a medium line, i.e. 240 km (150 miles).

where $U_{m(i),t}$ is the set of all power generating units in firm i's country $c(i)$ which are no further than 300 miles away from any of firm i's units. We refer to this region as firm i's market $m(i)$.

To determine distances between power plants, we first link plant locations with their respective coordinates. The WEPP database contains city, state, and country information, which we map to the GeoNames geographical database to obtain coordinates.[32] These can then be used to calculate the shortest distance between any two plant locations.[33] Because our matching is done by hand, we focus on countries for which we have more than 150 sales observations and sufficient data for matching at least 40 % of the plant locations to their respective coordinates. The resulting sample consists of electricity generating firms from 16 countries.

From an econometric perspective, the main advantage of using the second measure of competitor inflexibility is that this measure can be used with country-year fixed effects since it varies to a sufficient extent within country-years. However, it is less exogenous than the first measure (because power plant locations may be endogenously chosen), and it is only available for a relatively small subsample. We therefore use the first measure of competitor inflexibility as our baseline measure, while using the second measure in robustness analyses.

Besides measuring competitor inflexibility, we also construct a variable which describes firms' own production technologies. This variable will be used as a control, and will be referred to as "own inflexibility". It is defined as follows:

$$OINFLX_{i,t} = \frac{\sum_{u \in U_{i,t}} CAPACITY_u \times 1_{u=LVC}}{\sum_{u \in U_{i,t}} CAPACITY_u}. \tag{14}$$

3.2.3 Competitors' aggregate sales

We combine our two measures of competitor inflexibility with measures of competitors' aggregate sales. Given our definition of local markets, we compute the aggregate sales of all firms in these markets for which we can find the requisite sales data. Like our baseline measure of competitor inflexibility, our baseline measure of competitors' aggregate sales is defined at the country-level: For each year t and for each firm i in our sample, we collect the aggregate sales of all competing firms in firm i's country $c(i)$, for which sales data are available. The competing firms are all firms

[32]GeoNames contains names of places and their coordinates. See www.geonames.org for further details.
[33]We define distance as the geodetic distance on the WSG 1984 earth ellipsoid.

classified as electricity generation businesses in Worldscope or Amadeus (Worldscope: SIC code 4911– Electric Services, Amadeus: NAICS code 2211: Electric Power Generation, Transmission and Distribution). Our baseline results are obtained by restricting the sample to country-years for which we have sales data for at least 6 firms, so that we can measure the aggregate sales of a firm's competitors based on data about at least 5 competing firms. In the average country-year included in our sample, we use sales data for 39 firms when we examine payouts and wages, and sales data for 35 firms when we examine firm-level sales. Hence, competitors' aggregate sales can be regarded as an exogenous variable. In various robustness checks, we exclude markets (country-years) with few competitors or dominant firms and also address concerns regarding vertical integration and electricity market regulation (see Table 4 and Internet Appendix B, Tables IA2 and IA3).

Given the aggregate sales of a firm i's competitors in two years t and $t+1$, we compute the variable that is included in our regressions: $\Delta AGG\ SALES_{-i,c(i),t} = \log(AGG\ SALES_{-i,c(i),t}) - \log(AGG\ SALES_{-i,c(i),t-1})$. Whenever this variable takes a value below its 5%-ile or above the 95%-ile, we treat this value as an outlier and remove the corresponding observation from our regressions.

When we use our second measure of competitor inflexibility, we compute competitors' aggregate sales based on the sales of all firms with at least one plant no further than 300 miles away from a plant of any given firm's portfolio of plants. This adjusted measure of competitors' aggregate sales is based on the same definition of local markets as our measure of competitor inflexibility defined in expression (13).

3.3 Control variables

Our choice of firm-level control variables is inspired by Ellul, Pagano, and Schivardi (2018), and we also follow their approach by using lagged values of these control variables to avoid endogeneity. Thus, we control for the logarithm of firm-level total assets (Size), the ratio of long-term debt to total assets (Leverage), the ratio of operating profits to total assets (Profitability), and the ratio of fixed assets to total assets (Tangibility).[34]

In addition, we use three control variables that are based on our data about power plants.

[34] Given our research question, it is particularly important that we control for leverage because firms' technological choices may correlate with their financial structures. See Reinartz and Schmid (2016).

The first is a Herfindahl-Hirschman index (HHI) measuring market concentration based on power plant capacities. Controlling for HHI raises no additional concerns about endogeneity so that we include this control variable and its interaction with competitors' aggregate sales growth in all of our regressions. The interaction term controls for potential effects of market concentration on the elasticities of our dependent variables with respect to competitors' aggregate sales growth.

The second variable is the growth of firm-level electricity generation capacity (Own Capacity Growth), which is likely to be associated with firm-level sales and employment growth. The third variable is our measure of own inflexibility, defined in expression (14). We use this variable to address the concern that the technological choices of firm i's competitors (that determine competitor inflexibility) are correlated with those of firm i, and that such correlation could bias our estimates of the regression coefficients associated with competitor inflexibility.

Since several of the firm-level control variables may not be fully exogenous, we check the robustness of our main results across specifications with and without these control variables. In a robustness check in Internet Appendix B (Table IA4), we add country-level control variables that should measure determinants of workers' demand for wage and employment stability. The inspiration for using these control variables again comes from Ellul, Pagano, and Schivardi (2018). Moreover, we check whether our results are robust to controlling for country-year fixed effects.

4 Data and descriptive statistics

4.1 Data sources

Firm-level financial data. For balance sheet data, we rely on three different data sets. Global data on public firms is obtained from Thomson Reuters Worldscope. We use all firms that are classified as Electric Services (SIC code 4911). For a subset of US firms, we hand-collect additional wage data from filings with the Federal Energy Regulatory Commission (FERC).[35] In particular, we extract the line item "Total Salaries and Wages" from the respective table in FERC Form 1 Annual Reports. The third data source is Bureau van Dijk's Amadeus database. We obtain data on European private firms with the industry classification "Electric Power Generation, Transmission and Distribution" (NAICS code 2211). We download firm-level financial data for the period 2000

[35]Our matching is based on firm names in FERC's online eLibrary.

- 2014.

Power plant data. The data on electric power generating units comes from the UDI World Electric Power Plants Database. The database covers nearly 196,000 units in more than 230 countries. We obtained 14 editions of the data for the period 2001 to 2014. Each edition contains data for a number of plant characteristics such as plant operator, generation technology, fuel type, installed electricity production capacity, and plant location. Many power plants consist of multiple power generation units. For each of these, the database separately reports fuel type, generator technology, and production capacity.

Data link. We rely on company names and addresses to establish a link between our plant- and firm-level data. Our primary link results from a manual matching of company names in both databases. We also use corporate websites to identify subsidiaries, and then we remove subsidiaries from our database by assigning their power plants to their parent companies. Overall, we are able to identify 1,019 firms for which we also have financial data. The firms operate in 47 countries and own 42 percent of the total electricity generation capacity of all plants located in these 47 countries (according to our plant-level data). Unlike other countries, we divide the US into separate systems of electricity distribution grids ("interconnections") into which energy producers can feed their produced capacities.[36]

4.2 Descriptive statistics

Table 2 provides summary statistics for our sample of electricity producers. To be included in the sample, an observation must have all data required for our regressions. Additionally, we require that growth in aggregate sales can be measured based on data about at least 5 competing firms (see Section 3.2.3).

For each variable, the table reports mean, median, standard deviation, and the number of firm-years. The first 3 rows summarize our dependent variables. These are the first differences between log-values of firm-level sales (Δ SALES), total wage payments (Δ WAGES), and total payouts (Δ POUT). The averages of these growth rates are all positive and slightly above 8 percent.

The next few rows summarize the explanatory variables of our regressions. The main explana-

[36] See Lazar (2016) p.15. California, Nevada, Arizona, Montana, Washington, Oregon, Idaho, Utah, New Mexico, Colorado, and Wyoming form the Western Interconnection. Texas is the only state in the Texas Interconnection. With the exception of Hawaii and Alaska, the remaining US states belong to the Eastern Interconnection.

tory variables are the first difference between log-values of aggregate sales in a firm's market (Δ AGG SALES), and measures of competitor inflexibility (CINFLX), industry concentration (HHI), and own inflexibility (OINFLX).

[Table 2 about here.]

The mean of Δ AGG SALES is 7.8 percent. Mean competitor inflexibility is 42 percent, i.e., on average, 42 percent of a firm's competitors' capacity is generated by plants which can produce electricity at a low variable cost. Our measure of market concentration is slightly above 0.11. This value is low relative to common cutoffs used to classify markets as concentrated.[37] Firms' average own inflexibility (OINFLX) is about 4 percentage points lower than competitors' average inflexibility. This difference is due to the fact that we measure competitor inflexibility using all plant-level data, but we only measure firms' own inflexibility when we have balance sheet data available. It seems that firms' technological choices correlate with the availability of balance sheet data.

Table 2 also reports summary statistics for the control variables. Given that we use one-period lagged values for all control variables in our regressions, the summary statistics also refer to the lagged values. The control variables are firm-level measures of the logarithm of total assets (Size), the ratio of long-term debt to total assets (Leverage), the ratio of operating profits to total assets (Profitability), the ratio of fixed assets to total assets (Tangibility), and the logarithm of firm level growth in installed power generation capacity (Own Capacity Growth). By requiring sales data about at least 6 firms in each country, we obtain a sample in which the average firm is somewhat larger, more strongly invested in tangible assets, and with a higher level of profitability than the average firm in the industry. The average level of leverage and own capacity growth are comparable to average industry counterparts. Listed firms represent around 45 percent of the firms in our sample.

The last two rows present summary statistics for wages-to-sales ratios and payouts-to-sales ratios. The average wages-to-sales ratio is 11.5 percent, and the average payouts-to-sales ratio is 5.6 percent. Wages account for a substantially higher portion of firms' sales than payouts so

[37] The U.S. Department of Justice and the Federal Trade Commission generally consider markets with an Herfindahl-Hirschman Index below 1500 (i.e. 0.15) as unconcentrated markets. See U.S. Department of Justice & FTC, *Horizontal Merger Guidelines* §5.3 (2010) for details.

that variation in wages could be used to stabilize the availability of internal funds for payouts to shareholders.

[Table 3 about here.]

We conclude this section by presenting more detailed statistics regarding our two measures of competitor inflexibility in Table 3. The average share of competitor capacity coming from LVC plants is 41.8 percent according to our baseline measure (CINFLX). The equivalent average for our alternative measure (CINFLX 300 miles), which assumes within-country segmentation of energy markets and is available for 16 countries, is 32.3 percent. A closer look at the between and within variation of the two measures shows that they differ substantially in terms of variation within/across countries. If competitor inflexibility is measured according to expression (12), one obtains limited within-country variation. Such variation is largely absent because of our focus on countries in which electricity generation is a sufficiently competitive business, with many competitors and power plants and no dominant firms. With this focus, we can argue that competitor inflexibility is a largely exogenous variable at the firm-level, but different firms will face similar groups of competing firms / power plants.

By relaxing the assumption that countries are fully integrated markets, the second measure of competitor inflexibility allows for more within-country variation in the set of competitors of different firms. As a consequence, this measure of competitor inflexibility (defined in expression (13)) varies more strongly within countries than our first measure.

5 Main results

We start the empirical analysis by testing whether competitor inflexibility indeed reduces the stability of firms' sales, as predicted by the model in Section 2. If so, then the sales-destabilizing effect of competitor inflexibility may also compromise the stability of firms' payouts to workers and shareholders. This hypothesis will be tested in the second part of this section which contains our main results.

5.1 The stability of firms' sales

This section presents a sanity check of the notion that competitor inflexibility destabilizes firms' sales. Table 4 presents regressions of firm-level sales growth on the growth of the aggregate sales of firms' competitors and its interaction with competitor inflexibility. The interaction term measures changes in the elasticity of firm-level sales with respect to aggregate sales.

[Table 4 about here.]

Column (1) of Table 4 presents our baseline results. The main coefficient of interest is the one related to the interaction of competitors' aggregate sales growth and competitor inflexibility. Given that this coefficient is significantly positive, we find that the sales of firms with more inflexible competitors exhibit a significantly higher elasticity with respect to competitors' aggregate sales. This finding is consistent with the idea that competitor inflexibility destabilizes firms' sales. To assess the economic magnitude of this effect, we estimate the overall elasticity of firm-level sales to aggregate sales given the first and third quartile value of competitor inflexibility (and median industry concentration and median own inflexibility). The estimates are stated in the bottom of Table 4, in the rows labeled $Q1(CINFLX)$ and $Q3(CINFLX)$. We find that an increase in competitor inflexibility by one interquartile range is associated with a substantial increase in the elasticity of firm-level sales to aggregate sales. This elasticity increases from 24% to 45% (column (1)).

The estimates in column (1) result from the sample of firms for which we can compute the aggregate sales growth of firms' competitors based on data about more than 5 competitors. While the average observation in this sample is based on sales data about 35 competitors, it is possible that our results are driven by firms with the ability to influence competitor behavior, rather than taking the output of their competitors as given. We therefore check whether our results change if we exclude firms with few competitors or dominant market positions. Column (2) of Table 4 shows that the results in column (1) are not driven by firms in small markets: We obtain similar results if we double the cut-off regarding the number of competitors and only consider firms for which we can compute the aggregate sales growth of firms' competitors based on data about more than 10 competitors.[38] Column (3) presents estimates obtained by excluding firms whose market shares

[38] We also tried other cutoffs (15 and 20) and obtained similar results.

exceed 50%. Again, the results are similar to those in column (1).[39]

We next turn to another potential concern regarding our evidence for a sales-destabilizing effect of competitor inflexibility, i.e. that we may be measuring effects of vertical integration and electricity market regulation. Our measure of competitor inflexibility may be a proxy for vertical integration of electricity generation businesses, and some electricity producers may be vertically integrated with heavily regulated electricity transmission companies. This concern motivates two robustness checks which appear in columns (4) and (5) of Table 4.

The estimates in column (4) are based on the subsample of firms in country-years with "ownership unbundling" regulation, i.e. rules requiring that the ownership and control of transmission grids is separated from the ownership and control of electricity generation businesses.[40] Our focus on this subsample is motivated by the idea that the case for regulation is much stronger for electricity distribution than for electricity generation, so that ownership-unbundling regulation should lighten the regulation of electricity generation businesses by preventing vertical integration with electricity distribution. We find that, within the subsample, competitor inflexibility has a similar sales-destabilizing effect as in our baseline sample.

Column (5) reports a second robustness check motivated by concerns about regulation. In this column, we present estimates obtained by restricting the sample to firms that operate in the presence of liquid wholesale electricity markets. The focus on this subsample is motivated by the idea that wholesale markets are typically introduced when countries deregulate their electricity sector.[41] Our results are again consistent with the baseline coefficients reported in column (1).

Given the evidence in Table 4, we conclude that competitor inflexibility destabilizes firms' sales. We next measure effects of competitor inflexibility on the stability of firms' wages and their payouts to shareholders through dividends and share repurchases.

5.2 The stability of firms' wages and payouts to shareholders

In this section, we present the main results of our empirical analysis, i.e. our regressions concerning the stability of firms' wages and their payouts to shareholders through dividends and

[39]We also tried a 25% cutoff and obtained similar results.

[40]Unbundling regulations have been adopted by many countries over the last 20 years. An overview is provided by Nagayama (2007). Gugler, Rammerstorfer, and Schmitt (2013) show that ownership unbundling resulted in increased competition within 16 European countries over the period 1998 - 2008.

[41]By focusing on countries with liquid wholesale electricity markets, we follow Reinartz and Schmid (2016).

share repurchases. The research strategy behind our regressions was discussed in Section 3.1, based on the underlying theoretical results in expression (9). The regressions explain wage and payout growth. As in Section 5.1, the main explanatory variables are the growth of the aggregate sales of firms' competitors, and the interaction of this aggregate sales growth and competitor inflexibility. This interaction term is our central explanatory variable and corresponds to the interaction $\Delta\pi_0 x$ in expression (9). Its coefficient reveals the effect of competitor inflexibility on the stability of our dependent variables in terms of changes in these variables' elasticities with respect to the aggregate sales growth of firms' competitors.

Table 5 presents our baseline results. Columns (1), (3) and (5) report tests regarding effects of competitor inflexibility on the stability of firm-level wage growth while columns (2), (4) and (6) report similar tests regarding the stability of payout growth. We report results obtained without using potentially endogenous firm-level control variables (columns (1) and (2)),[42] results of regressions in which we control for firms' own inflexibility (columns (3) and (4)), and results of regressions based on the full set of control variables (columns (5) and (6)). We include our measure of market concentration (HHI) in all regressions because this measure is based on the same data as our measure of competitor inflexibility so that it can be used without raising additional concerns about endogeneity.

We first discuss the regressions measuring wage stability. We generally obtain significantly positive estimates for the baseline elasticity of firms' wages with respect to the aggregate sales of competing firms, but significantly negative estimates for the coefficient of the interaction of aggregate sales growth with competitor inflexibility. To interpret these numbers, we use them to estimate the wage elasticities associated with the first and third quartile value of competitor inflexibility, denoted as $Q1(CINFLX)$ and $Q3(CINFLX)$ respectively. The resulting estimates show how firms' wages respond to competitors' aggregate sales given values of competitor inflexibility actually observed in the data.[43] All of the estimates are small in terms of economic significance and most are statistically insignificant. It appears that competitor inflexibility does not have an economically significant negative effect on wage stability, even though it clearly compromises the

[42] In unreported regressions, we also checked that the coefficient of $\Delta AGG\ SALES \times CINFLX$ in column (1) of Table 4 is robust to excluding potentially endogenous control variables.

[43] Given its definition, competitor inflexibility varies between zero and one, but these extreme values are never observed in the data. As a consequence, the baseline coefficients of $\Delta AGG\ SALES$ are extrapolations regarding the counter-factual case of a firm with zero competitor inflexibility.

stability of firms' sales as shown in Table 4. In fact, we find some evidence *against* a negative effect on wage stability since the elasticity of wages with respect to competitors' aggregate sales growth decreases in competitor inflexibility from a significantly positive baseline value.[44]

[Table 5 about here.]

A different picture emerges from the results regarding firms' payouts to shareholders, in columns (2), (4) and (6) of Table 5. While we obtain no statistically significant estimates regarding the baseline elasticities of firms' payouts with respect to the aggregate sales of competing firms, the estimates for the coefficient of the interaction of aggregate sales growth with competitor inflexibility are significantly positive: Competitor inflexibility increases the elasticity of payouts with respect to aggregate sales. This result is consistent with the destabilizing effect of competitor inflexibility on firms' sales, and it clearly differs from our previous finding that wage stability is not compromised by competitor inflexibility. Instead, the sales-destabilizing effect of competitor inflexibility seems to compromise the stability of firms' payouts. To assess the economic magnitude of this effect, we again estimate elasticities associated with the first and third quartile value of competitor inflexibility, thus focusing on typical values of this variable in our data. Given the first quartile value, our point estimates for the elasticity of payouts with respect to aggregate sales are essentially zero, but column (6) reports a 65% estimate for this elasticity given the third quartile value of competitor inflexibility. This estimate is more than six times higher than all of our estimates regarding wage elasticities.

Overall, we obtain results that are inconsistent with the notion that, in insuring their workers against systematic risk, firms strike a trade-off between the stability of their wages and payouts to shareholders by setting wages as specified in expression (7). Instead, we only find evidence that the sales-destabilizing effect of competitor inflexibility (documented in Table 4) compromises the stability of firms' payouts to shareholders.

We next check the power of our analysis. Is the lack of evidence for a destabilizing effect of competitor inflexibility on wages due to wages simply not responding to firm-level sales variation, including that induced by competitor inflexibility? Table 6 displays the results of regressions of

[44] A somewhat puzzling estimate appears in the first column, i.e. a marginally significant negative estimate of the wage elasticity associated with the third quartile value of competitor inflexibility. While we sometimes observe statistically significant wage elasticities, these results are not robust and the elasticities are always small.

changes of firm-level wages and payouts to shareholders on firm-level sales changes and the control variables that we also considered in the last two columns of Table 5.

[Table 6 about here.]

The results in Table 6 show that firms' sales are in fact correlated with both their wages and their payouts to shareholders. While both correlations are highly significant, they differ in terms of economic magnitude. According to our point estimates, the elasticity of wages with respect to firm-level sales is less than half of the corresponding elasticity of payouts. This observation suggests that shareholders bear more risk than workers, but the significant correlation between wages and sales allows for the interpretation that workers also bear some risk. A definite conclusion is not possible because firms' sales will not only vary across time due to risk but also due to predictable changes in sales. Had we, however, found that wages do not depend on firms' sales, then it would have hardly been surprising that wage stability is not compromised by the sales-destabilizing effect of competitor inflexibility. Instead, it appears that the sales variation induced by competitor inflexibility – predictable or not – does not affect wage stability even though firms' wages are correlated with their sales. This result is particularly surprising because we exploit variation in competitor inflexibility in order to measure firms' exposure to sales variation that is arguably more systematic than the variation in their own sales. This more systematic sales variation (i.e., the variation in the aggregate sales of competing firms) has no significant effect on wages, even though wages are correlated with firms' own sales.

All in all, our results are inconsistent with theoretical arguments that workers and shareholders should share systematic risk. Instead, firms seem to shield their workers from extra systematic risk due to competitor inflexibility by prioritizing wage stability over the stability of their payouts to shareholders.

6 Robustness checks

In this section, we present a number of robustness checks. The first robustness check addresses the concern that our results cannot be interpreted as evidence regarding risk-sharing between firms' workers and shareholders because our results regarding wage stability and payout stability result from somewhat different samples of firms. We then turn to the issue of unobserved cross-sectional variation in the risk-bearing capacities of firms' workers and shareholders and check the robustness of our results across subsamples that should differ in terms of within-firm risk sharing. A final set of robustness checks explores the robustness of our results with respect to changing the way we measure competitor inflexibility.

6.1 Sample selection

Table 7 presents estimates obtained by restricting our sample so that it only includes firms for which we have data about both wages and payouts at the same point in time. Our previous estimates were based on substantially larger samples, but the overlap between these samples was relatively small. While we used 4,940 observations in the regressions explaining wages, and 1,840 observations in the regressions explaining payouts, only 1,085 of these observations contain data about both the wages and payouts of the respective firms.

To interpret our previous estimates as evidence concerning within-firm trade-offs between wage and payout stability, we must rule out that the estimates are biased due to sample selection. A selection bias could result from differences between the 1,085 observations with data about both wages and payouts and the other observations included in our previous regressions. In unreported t-tests, we checked whether there are significant differences and found no such differences in terms of our dependent variables (firm-level sales growth, wage growth, payout growth) and most control variables. But, the sample of complete observations differs significantly in terms of our main explanatory variables, featuring slightly higher aggregate sales growth, and slightly lower competitor inflexibility.

[Table 7 about here.]

Table 7 checks whether these differences affect our main results. The table shows estimates obtained by repeating our analysis based on the subsample of complete observations. It turns out that the estimates are qualitatively similar to our baseline estimates. We find no significant effect of competitor inflexibility on wage stability, but the estimates confirm that competitor inflexibility destabilizes firms' payouts to shareholders by increasing the elasticity of the payouts with respect to aggregate sales growth. We in fact observe a stronger payout-destabilizing effect of competitor inflexibility when we restrict the analysis to the subsample of complete observations since coefficients of the interaction of competitor inflexibility and aggregate sales growth are generally higher in Table 7 than in Table 5. Our baseline estimates thus appear to be more conservative than the estimates based on complete observations. This is also apparent in terms of the point estimates for the payout elasticity associated with the first/third quartile values of competitor inflexibility. In the last column of Table 7, we even obtain an third-quartile elasticity estimate that is higher than one (but not significantly different from one). The corresponding baseline estimate was 65%.

6.2 Cross-sectional heterogeneity

We next turn to the concern that our measure of competitor inflexibility may proxy for some other kind of cross-sectional heterogeneity in within-firm risk sharing than that we intend to measure. We check the robustness of our results with respect to two kinds of heterogeneity, i.e. differences between listed and non-listed firms, and differences associated with financial leverage.

Table 8 presents the robustness checks. The first two columns present estimates obtained from a horse-race-specification in which our measure of competitor inflexibility competes against financial leverage. The variable is denoted as LEV and it is added as part of an interaction with aggregate sales growth, so that it appears in the regressions in exactly the same way as our measure of competitor inflexibility, $CINFLX$.

The robustness check shows that highly levered firms differ from the other firms in terms of the elasticities of their wages and payouts to shareholders with respect to aggregate sales growth. Higher leverage increases the wage elasticity, and we also observe a marginally significant decrease in the payout elasticity. This finding is consistent with the prediction of Berk, Stanton, and Zechner (2010) that leverage compromises wage stability in the presence of limited liability. They show that it is in the interest of employees to share risks with shareholders in order to avoid financial distress.

The estimates also show that our measure of competitor inflexibility affects wage stability and payout stability in a robust way. We again find no significant effect of competitor inflexibility on wage stability, while the effect on payout stability is quite similar to that in our baseline specification. Compared to the baseline coefficient of the interaction of competitor inflexibility with aggregate sales growth, we even obtain a slightly higher coefficient when we add the interaction of aggregate sales growth with financial leverage to our explanatory variables. Given these estimates, the third quartile value of competitor inflexibility is associated with an 81% elasticity of payouts with respect to aggregate sales growth.

The remaining columns of Table 8 present robustness checks in which we distinguish between listed and non-listed firms because the two groups of firms may differ in terms of the risk-bearing capacities of the firms' workers and shareholders. Besides differences in averages, there should be different extents of within-group heterogeneity because the listed firms' stocks are more likely to be included in the portfolios of internationally diversified investors, which reduces the extent of cross-country variation in the risk-bearing capacity of the firms' shareholders. In addition, the two groups of firms may differ with respect to workers' willingness to accept variation in wages since listed and non-listed firms' workers may receive non-wage compensation to different extents. For example, employee stock ownership schemes may change workers' preferences with respect to wage stability.

We start with horse-race specifications in which our measure of competitor inflexibility competes against a dummy variable indicating firms with publicly listed stock. The dummy is denoted as $LISTED$ and it is added as part of an interaction with aggregate sales growth, so that it appears in the regressions in exactly the same way as our measure of competitor inflexibility, $CINFLX$.

Columns (3) and (4) of Table 8 present evidence that listed and non-listed firms differ in terms of the stability of their wages and payouts to shareholders. The wages and payouts of listed firms respond more strongly to aggregate sales variation. With respect to competitor inflexibility, the estimates are however quite similar to our baseline estimates.

The last two columns of Table 8 present a final robustness check inspired by potential differences between listed and non-listed firms. As discussed above, the latter group of firms is likely to be more heterogeneous with respect to the risk-bearing capacities of the firms' shareholders, and this heterogeneity could be associated with heterogeneity in wage and payout stability that gets picked up by our measure of competitor inflexibility. We therefore test whether our results change if we remove variation in the wages and dividends of the non-listed firms by adding country-year fixed effects that are estimated based on our data about these firms.[45] The resulting estimates should

[45] The specification also includes a year fixed effect, but this effect is now estimated based on our data about listed firms. Overall, the fixed effects structure can be interpreted as representing the idea that the listed firms are owned by an internationally diversified investor holding a global market portfolio while the shareholders of non-listed firms hold country-specific market portfolios. Estimates based on a full set of country-year fixed effects appear in the next subsection.

differ from our baseline estimates if competitor inflexibility proxies for cross-country variation in the stability of non-listed firms' wages or payouts to shareholders.

[Table 8 about here.]

Columns (5) and (6) of Table 8 show that adding the country-year fixed effects has little effect on our estimates. With respect to wages, the coefficients in the first two rows of column (5) of Table 8 are similar to the corresponding baseline estimates in column (5) of Table 5. Moreover, we again obtain small and insignificant estimates regarding the wage elasticities associated with the first and third quartile value of competitor inflexibility. With respect to payouts, we also see that our previous results are robust. We obtain a slightly wider range of point estimates regarding the elasticity of payouts with respect to competitors' aggregate sales across the inter-quartile range of competitor inflexibility. Our point estimate regarding the elasticity associated with the third quartile value of competitor inflexibility is now 69%. The corresponding baseline estimate is 65%.

6.3 Alternative measures of competitor inflexibility

We next test the robustness of our results with respect to varying the way in which we measure competitor inflexibility. Internet Appendix B (Table IA6) reports robustness checks in which we compute competitor inflexibility as defined in expression (12), while adding wind, solar, and coal powered plants to the set of LVC plants. They yield results that are similar to our baseline results.

A second type of robustness checks is based on a different way of measuring competitor inflexibility. Our baseline measure abstracts from costs of within-country electricity transmission. In order to take such costs into account, we repeat our analysis using the alternative measure of competitor inflexibility defined in expression (13). By allowing for within-country market segmentation, this measure varies sufficiently within countries that it can be used in a specification which includes a full set of country-year fixed effects. The requisite data are however, not available for all countries, so that we have to drop about 600 observations in 31 countries.[46] The remaining sample includes observations in 16 countries. Given the small number of countries remaining in our

[46]Here, we compare the number of observations in our payout specification, i.e. the difference between column (6) of Table 5 and column (2) of Table 9. Given the smaller number of observations, we use a less conservative outlier specification (excluding only 3% of the observations). Moreover, we treat consecutive observations of zero dividends as a case of zero payout growth.

sample, we have to change the way we compute standard errors. In our baseline analysis, standard errors were based on country-level clustering (with 49 clusters). In the robustness check, we instead use country-year clusters.[47]

Our results appear in Table 9. The first four columns are based on our alternative measure of competitor inflexibility (expression (13)) and a consistently defined measure of competitors' aggregate sales growth.[48] The last two columns present the estimates we obtain if we just use the alternative measure of competitor inflexibility, while sticking to the baseline measure of aggregate sales growth.

[Table 9 about here.]

We start by discussing the estimates in the first two columns of Table 9. These estimates result from a specification with a full set of country-year fixed effects that control for a host of country-level determinants of workers' and shareholders' willingness to bear risk. Given the substantial reduction in sample size, the estimates are less precise than our baseline estimates, but they confirm our findings: Competitor inflexibility has no effect on wage stability, but it destabilizes firms' payouts to shareholders by increasing the elasticity of the payouts with respect to the aggregate sales growth of competing firms. According to our baseline estimates, this elasticity increases by about 65 percentage points when competitor inflexibility increases from its first quartile value to its third quartile value. This estimate drops to about 23 percentage points when we use the coefficients obtained from our alternative measures of competitor inflexibility and aggregate sales growth.

We next check two potential explanations for the smaller economic magnitude of the payout-destabilizing effect of competitor inflexibility that we observe in column (2). The estimates in this column result from a specification that differs in three respects from our baseline specification, i.e. in the ways we measure competitor inflexibility and competitors' aggregate sales growth, and in the fixed effects specification. It is therefore possible that the results in column (2) differ from our baseline results because of the changes in the fixed effects specification and the measurement of competitors' aggregate sales growth. We first check the effect of switching back to year fixed effects and subsequently also switch back to our baseline measure of aggregate sales growth.

[47] Bertrand, Duflo, and Mullainathan (2004) document the effect of few clusters on rejection rates.

[48] As discussed at the end of Section 3.2.3, the latter measure is based on the sales data of a firm's competitors in the firm's local markets, defined by a 300 mile radius around the firm's power plants.

It turns out that the use of country-year fixed effects does not drive the reduction in the economic magnitude of the payout-destabilizing effect of competitor inflexibility. Column (4) of Table 9 shows the coefficient of the interaction of our alternative measures of competitor inflexibility and aggregate sales growth that we obtain if we use year fixed effects rather than country-year fixed effects. The point estimate is actually smaller than that in column (2) which is based on country-year fixed effects.

We next check the effect of using our baseline measure of competitors' aggregate sales growth, rather than the alternative measure. It appears that, by switching back to the baseline measure, we obtain results that are in line with our baseline results in Table 5 in terms of the economic magnitude of the payout-destabilizing effect of competitor inflexibility. Columns (5) and (6) of Table 9 report the estimates we obtain if we use the baseline aggregate sales growth and also stick to our baseline specification by using year fixed effects, while using our alternative measure of competitor inflexibility instead of the baseline measure. We now obtain a substantially higher coefficient of the interaction of competitor inflexibility and aggregate sales growth than in columns (2) and (4). The point estimate of this coefficient in column (6) is, in fact, quite similar to that in column (6) of Table 5. The specifications behind these estimates differ only in terms of the way we measure competitor inflexibility.

Overall, the robustness analysis yields the following take-aways. There is no evidence that competitor inflexibility destabilizes firms' wages, even though wages are correlated with firms' sales and competitor inflexibility destabilizes firms' sales. Regarding the payout-destabilizing effect of competitor inflexibility, we find that our baseline results are robust to using an alternative measure of competitor inflexibility while sticking to our baseline specifications in all other respects. Using this alternative measure of competitor inflexibility, we obtain a slightly narrower range of point estimates regarding the elasticity of payouts with respect to competitors' aggregate sales across the inter-quartile range of competitor inflexibility. In column (6) of Table 9, our point estimate for the third quartile value of competitor inflexibility is 53%. The corresponding baseline estimate is 65%. The slightly smaller estimate in column (6) is less precise, which is not surprising, given the reduction in sample size associated with switching to the alternative measure of competitor inflexibility. If we combine this alternative inflexibility measure with a corresponding alternative and narrower definition of competitors' aggregate sales growth, we obtain substantially smaller estimates. Column (4) reports our most conservative estimate, i.e. a 20% value of the payout elasticity associated with the third quartile value of competitor inflexibility. While smaller than our baseline estimate, this estimate still implies a sizeable effect of competitor instability on payout stability, especially in light of the fact that the elasticity of firms' payouts to their own sales is only 29 percent according to the estimates in Table 6. The 65% baseline estimate is, however, based on a much larger sample since our baseline measure of competitor inflexibility requires fewer data. While this measure cannot be used with country-year fixed effects, our robustness checks show that using country-year fixed effects does not yield qualitatively different results than using year fixed effects.

7 Conclusion

In this paper we analyze how risk-sharing between a firm's workers and shareholders depends on the inflexibility of competing firms in responding to industry-wide shocks. We construct measures of competitor inflexibility based on the production technologies of firms in electricity generation. If an electricity producer has competitors who predominantly use technologies with low variable costs of production, then they will respond less to industry demand changes and we refer to this as competitor inflexibility. It turns out that the sales of firms with more inflexible competitors vary significantly more strongly with changes in aggregate sales. Thus, competitor inflexibility destabilizes firms' sales with respect to the aggregate sales variation.

We then analyze how the increased risk due to competitor inflexibility compromises the stability of firms' payouts to their shareholders through dividends and share repurchases. We measure this effect in terms of the change in the elasticity with which payouts respond to aggregate sales variation. According to our most conservative estimate, this elasticity changes by 20 percentage points across the interquartile range of competitor inflexibility. This effect is sizeable both in absolute terms and relative to the elasticity with which firms' payouts respond to their own sales (29 percentage points). Thus, payouts to equityholders fluctuate substantially more as the firm's competitor inflexibility increases.

Next, we focus on the effect of competitor inflexibility on the stability of wage payments. The regression results reveal that competitor inflexibility has no effect on wage stability. Specifically, the elasticity with which wages respond to a variation in aggregate sales does not depend on competitor inflexibility. Thus, workers seem to be fully insured against increased sales variation due to competitor inflexibility. This is surprising because competitor inflexibility increases firms' exposures to aggregate sales changes. This increased exposure destabilizes firms' payouts to shareholders, but it is not passed on to firms' workers.

Our findings cannot be interpreted as evidence that shareholders simply insure workers against diversifiable risk, as documented by Guiso, Pistaferri, and Schivardi (2005). By measuring the stability of firms' wages and payouts with respect to variation in competing firms' aggregate sales, we focus on variation that is not driven by firm-specific risks, but instead results from industry-wide risk factors. The results can therefore be interpreted as more general evidence that firms prioritize wage stability over payout stability. This is consistent with a specification of firms' objective functions based on the notion that they take their shareholders' risk preferences as given when they adjust wage schedules for competitor inflexibility. This could be the case because they perceive that their payouts have a negligible effect on the shareholders' overall portfolio payoffs.

Our paper represents a first step towards a broader view of risk sharing between firms' workers and their owners. We consider such risk-sharing in a single-firm context, but take into account that a firm's risk exposure is subject to external effects rooted in competitors' production technologies. Future analyses could examine within-firm risk-sharing based on an industry equilibrium view which takes into account that, at the industry level, there is an optimal degree of heterogeneity in both within-firm risk-sharing as well as in firms' technological choices. Such analyses would extend an earlier literature focused on industry-level heterogeneity in firms' technological choices and their capital structures/financial leverage.[49] Rather than putting a focus on financial leverage, the focus would be on operating leverage associated with fixed wages.

[49] For example, see Maksimovic and Zechner (1991) or Maksimovic, Stomper, and Zechner (1999).

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Table 1:
Costs per MWH (in 2012 US$)

The table presents levelized capital costs, fixed costs of operation and maintenance (O&M) and variable costs of O&M for several types of power plants. The table reproduces data contained in Table 1 of *http://www.eia.gov/forecasts/aeo/pdf/electricity_generation.pdf* which is based on the Annual Energy Outlook 2014 published by the U.S. Electricity Information Association (EIA). The data is for plants entering service in 2019. Levelized capital costs are the cost of capital required to build and operate a power plant over its lifetime divided by the total power output of the plant over that lifetime. Variable costs of O&M include costs of fuel. Abbreviations: IGCC integrated gasification combined cycle, CCS carbon capture and storage, CC combined cycle, PV photovoltaic.

Plant type	(1) Levelized capital cost	(2) Fixed costs of O&M	(3) Variable cost of O&M	(4) Ratio $\frac{(3)}{(2)+(3)}$	(5) Ratio $\frac{(3)}{(1)+(2)+(3)}$
Natural gas:					
Convtl CC	14.3	1.7	49.1	96.7%	75.4%
Advcd CC	15.7	2.0	45.5	95.8%	72.0%
Advcd combstn turbine	27.3	2.7	70.3	96.3%	70.1%
Convtl combstn turbine	40.2	2.8	82.0	96.7%	65.6%
Advcd CC with CCS	30.3	4.2	55.6	93.0%	61.7%
Coal and biomass:					
Biomass	47.4	14.5	39.5	73.1%	39.0%
Convtl coal	60.0	4.2	30.3	87.8%	32.1%
Coal IGCC	76.1	6.9	31.7	82.1%	27.6%
Coal IGCC with CCS	97.8	9.8	38.6	79.8%	26.4%
Other:					
Advcd nuclear	71.4	11.8	11.8	50.0%	12.4%
Hydroelectric	72.0	4.1	6.4	61.0%	7.8%
Geothermal	34.2	12.2	0	0%	0%
Wind	64.1	13.0	0	0%	0%
Wind offshore	175.4	22.8	0	0%	0%
Solar PV	114.5	11.4	0	0%	0%
Solar thermal	195.0	42.1	0	0%	0%

Table 2:
Summary statistics: electricity generating firms

The table presents summary statistics of an unbalanced panel containing data about 1,019 electricity generation firms from 49 countries/markets over the period 2001-2014. The sample is based on all firms with available data for all explanatory variables and a link to the power plant database. The dependent variables are first differences between log-values of firm-level sales (Δ SALES), total wage payments (Δ WAGES), and total payouts (Δ POUT). The explanatory variables are first differences between log-values of aggregate sales in a firm's market (Δ AGG SALES) and measures of competitor inflexibility (CINFLX), industry concentration (Herfindahl Hirschman Index – HHI), and own inflexibility (OINFLX). Further control variables include firm size, leverage, profitability, tangibility, and a firm's own capacity growth. The variable Listed reports the fraction of listed firms in the sample. Wages-to-Sales and Payouts-to-Sales are firm-level ratios of total wages over sales and total payouts over sales.

Variable	Mean	Median	StDev	N
Δ SALES	0.083	0.064	0.208	6,492
Δ WAGES	0.081	0.049	0.169	4,940
Δ POUT	0.081	0.048	0.474	1,840
Δ AGG SALES	0.078	0.070	0.101	6,492
CINFLX	0.418	0.293	0.286	6,492
HHI	0.117	0.082	0.130	6,492
OINFLX	0.376	0.018	0.453	6,492
Size	6.483	6.239	3.338	6,492
Leverage	0.246	0.215	0.221	6,492
Profitability	0.024	0.000	0.052	6,492
Tangibility	0.661	0.711	0.222	6,492
Own Capacity Growth	0.063	0.000	0.475	6,492
Listed	0.445	0.000	0.497	6,492
Wages-to-Sales	0.115	0.096	0.089	4,642
Payouts-to-Sales	0.056	0.045	0.047	1,732

Table 3:
Measures of competitor inflexibility

The table presents summary statistics for our measures of competitor inflexibility. For each measure, we report mean, standard deviation, minimum, and maximum. In addition, we decompose variances in their between and within components, and report the corresponding standard deviations. CINFLX represents our capacity weighted baseline measure of low variable cost technologies for markets and firms (equation 12). CINFLX 300 miles refers to the modification of this variable that restricts the definition of a market to the area within 300 miles of a firm (equation 13). N refers to the number of available firm-years for which the variable, and control variables used in our regression, are available.

Measure	Variance	Mean	Std. Dev.	Min	Max
CINFLX	overall	0.4181	0.2857	0.0000	0.9798
	between		0.2918	0.0000	0.9725
N = 6492	within		0.0234	0.0958	0.5637
CINFLX 300 miles	overall	0.3226	0.2744	0.0000	0.9959
	between		0.2643	0.0024	0.9806
N = 1435	within		0.0522	0.0019	0.7503

Table 4:
Effects of competitor inflexibility on the stability of firm-level sales

The table presents estimates based on an unbalanced panel containing data about 1,019 electricity generation firms from 49 countries/markets over the period 2001-2014. The dependent variable is the first difference between log-values of firm-level sales (Δ SALES). Explanatory variables are the first difference between log-values of aggregate sales in a firm's market (Δ AGG SALES) and measures of competitor inflexibility (CINFLX), industry concentration (Herfindahl Hirschman Index – HHI), and own inflexibility (OINFLX). Further control variables include firm size, leverage, profitability, tangibility, and a firm's own capacity growth. These variables are defined in Section 3.3. The rows labeled Q1(CINFLX) and Q3(CINFLX) present estimates of elasticities for the first and third quartile value of CINFLX (and median OINFLX and HHI). Column 1 presents our baseline. In column 2, we drop all firm-years for which we have less than 10 observations per country-year to compute aggregate sales. In column 3, we drop all firm-years in which a firm's market share exceeds 50 percent. Column 4 is based on countries in which unbundling regulations are in place. Column 5 requires electricity to be traded in competitive wholesale markets. In each specification, we include firm and year fixed effects. Standard errors (in brackets) are clustered by country.

Dependent Variable Δ SALES	Baseline (1)	10 Firms (2)	50% Mkt SH (3)	Unbundle (4)	Wholesale (5)
Δ AGG SALES	0.149	0.156	0.162	0.121	0.040
	[0.112]	[0.120]	[0.115]	[0.124]	[0.119]
× CINFLX	0.427	0.416	0.452	0.529	0.619
	[0.163]	[0.185]	[0.174]	[0.157]	[0.165]
× HHI	0.019	−0.012	−0.050	0.091	−0.150
	[0.403]	[0.459]	[0.469]	[0.410]	[0.416]
× OINFLX	−0.146	−0.118	−0.167	−0.192	−0.166
	[0.108]	[0.117]	[0.107]	[0.125]	[0.131]
Controls	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F,Y	F,Y	F,Y	F,Y	F,Y
Cluster	C	C	C	C	C
N	6,492	6,108	6,399	4,722	4,769
R^2	0.082	0.081	0.082	0.090	0.085
Q1(CINFLX)	0.244	0.246	0.257	0.227	0.157
(p-value)	(0.003)	(0.007)	(0.002)	(0.019)	(0.090)
Q3(CINFLX)	0.452	0.452	0.476	0.506	0.489
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Table 5:
Effects of competitor inflexibility on firm's workers and owners

The table presents estimates based on an unbalanced panel containing data about 1,019 electricity generation firms from 49 countries/markets over the period 2001-2014. The dependent variables are first differences between log-values of total wage payments (Δ WAGES) and total payouts (Δ POUT). Explanatory variables are the first difference between log-values of aggregate sales in a firm's market (Δ AGG SALES) and measures of competitor inflexibility (CINFLX), industry concentration (Herfindahl Hirschman Index – HHI), and own inflexibility (OINFLX). Section 3.3 defines our standard set of further control variables. The rows labeled Q1(CINFLX) and Q3(CINFLX) present estimates of elasticities for the first and third quartile value of CINFLX (and median OINFLX and HHI). In each specification, we include firm and year fixed effects. Standard errors (in brackets) are clustered by country.

Dependent Variable	Δ WAGES (1)	Δ POUT (2)	Δ WAGES (3)	Δ POUT (4)	Δ WAGES (5)	Δ POUT (6)
Δ AGG SALES	0.142	−0.593	0.144	−0.582	0.107	−0.526
	[0.065]	[0.338]	[0.066]	[0.336]	[0.065]	[0.320]
× CINFLX	−0.325	1.297	−0.326	1.601	−0.297	1.553
	[0.101]	[0.462]	[0.124]	[0.499]	[0.122]	[0.512]
× HHI	−0.043	1.351	−0.040	1.336	−0.001	1.283
	[0.285]	[1.386]	[0.290]	[1.358]	[0.259]	[1.326]
× OINFLX			−0.001	−0.328	0.028	−0.140
			[0.090]	[0.309]	[0.080]	[0.310]
Controls	No	No	No	No	Yes	Yes
Fixed Effects	F,Y	F,Y	F,Y	F,Y	F,Y	F,Y
Cluster	C	C	C	C	C	C
N	5,302	1,992	5,302	1,992	4,940	1,840
R^2	0.034	0.030	0.034	0.032	0.041	0.044
Q1(CINFLX)	0.069	−0.220	0.070	−0.145	0.043	−0.102
(p-value)	(0.118)	(0.332)	(0.190)	(0.567)	(0.392)	(0.658)
Q3(CINFLX)	−0.089	0.411	−0.089	0.634	−0.102	0.654
(p-value)	(0.047)	(0.056)	(0.281)	(0.044)	(0.158)	(0.021)

Table 6:
Firm-level sales and firm's workers and owners

The table presents estimates based on an unbalanced panel containing data about 1,019 electricity generation firms from 49 countries/markets over the period 2001-2014. The dependent variables are first differences between log-values of total wage payments (Δ WAGES) and total payouts (Δ POUT). Our main explanatory variable is the first difference between log-values of firm-level sales (Δ SALES). Control variables include firm size, leverage, profitability, tangibility, a firm's own capacity growth, and measures of competitor inflexibility (CINFLX), industry concentration (Herfindahl Hirschman Index – HHI), and own inflexibility (OINFLX). These variables are defined in Sections 3.2.2 and 3.3. In each specification, we include firm and year fixed effects. Standard errors (in brackets) are clustered by country.

Dependent Variable	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT
	(1)	(2)	(3)	(4)
Δ SALES	0.139	0.293	0.137	0.290
	[0.026]	[0.064]	[0.026]	[0.064]
CINFLX			−0.025	−0.239
			[0.136]	[0.492]
HHI			0.426	0.512
			[0.112]	[0.432]
OINFLX			0.036	0.104
			[0.025]	[0.077]
Controls	Yes	Yes	Yes	Yes
Fixed Effects	F,Y	F,Y	F,Y	F,Y
Cluster	C	C	C	C
N	5,096	2,032	5,096	2,032
R^2	0.062	0.039	0.065	0.040

Table 7:
Robustness check: sample selection

The table presents estimates based on an unbalanced panel containing data about 175 electricity generation firms from 39 countries/markets over the period 2001-2014. The dependent variables are first differences between log-values of total wage payments (Δ WAGES) and total payouts (Δ POUT). Explanatory variables are the first difference between log-values of aggregate sales in a firm's market (Δ AGG SALES) and measures of competitor inflexibility (CINFLX), industry concentration (Herfindahl Hirschman Index – HHI), and own inflexibility (OINFLX). We require availability of data on sales, wages, and payouts for all our regressions. Section 3.3 defines our standard set of further control variables. The rows labeled Q1(CINFLX) and Q3(CINFLX) present estimates of elasticities for the first and third quartile value of CINFLX (and median OINFLX and HHI). In each specification, we include firm and year fixed effects. Standard errors (in brackets) are clustered by country.

Dependent Variable	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT
	(1)	(2)	(3)	(4)	(5)	(6)
Δ AGG SALES	0.130	−0.344	0.130	−0.334	0.185	0.057
	[0.081]	[0.321]	[0.080]	[0.314]	[0.086]	[0.365]
× CINFLX	−0.160	1.482	−0.152	1.868	−0.182	1.829
	[0.151]	[0.455]	[0.225]	[0.548]	[0.237]	[0.668]
× HHI	0.183	−0.741	0.183	−0.720	0.060	−1.262
	[0.358]	[1.314]	[0.357]	[1.279]	[0.412]	[1.230]
× OINFLX			−0.008	−0.416	−0.044	−0.667
			[0.143]	[0.320]	[0.170]	[0.380]
Controls	No	No	No	No	Yes	Yes
Fixed Effects	F,Y	F,Y	F,Y	F,Y	F,Y	F,Y
Cluster	C	C	C	C	C	C
N	1,440	1,440	1,440	1,440	1,085	1,085
R^2	0.029	0.040	0.029	0.041	0.050	0.071
Q1(CINFLX)	0.108	−0.074	0.110	0.022	0.150	0.366
(p-value)	(0.037)	(0.558)	(0.021)	(0.833)	(0.018)	(0.239)
Q3(CINFLX)	0.032	0.635	0.037	0.915	0.063	1.241
(p-value)	(0.110)	(0.132)	(0.237)	(0.063)	(0.230)	(0.001)

Table 8:
Robustness check: cross-sectional heterogeneity

The table presents estimates based on an unbalanced panel containing data about 1,019 electricity generation firms from 49 countries/markets over the period 2001-2014. The dependent variables are first differences between log-values of total wage payments (Δ WAGES) and total payouts (Δ POUT). Explanatory variables are the first difference between log-values of aggregate sales in a firm's market (Δ AGG SALES) and measures of competitor inflexibility (CINFLX), industry concentration (Herfindahl Hirschman Index – HHI), own inflexibility (OINFLX), a dummy variable that identifies listed firms (LISTED), and financial leverage (LEV). Section 3.3 defines our standard set of further control variables. The rows labeled Q1(CINFLX) and Q3(CINFLX) present estimates of elasticities for the first and third quartile value of CINFLX (and median values for OINFLX, HHI, and LEV). We include firm and a combination of country-year and year fixed effects. In the last two columns, we use country-year fixed effects for non-listed firms, and year fixed effects for listed firms. Standard errors (in brackets) are clustered by country.

Dependent Variable	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT
	(1)	(2)	(3)	(4)	(5)	(6)
Δ AGG SALES	0.073	−0.147	0.036	−1.605	0.129	−0.536
	[0.073]	[0.422]	[0.064]	[0.618]	[0.095]	[0.333]
× CINFLX	−0.312	1.597	−0.267	1.629	−0.219	1.628
	[0.121]	[0.477]	[0.119]	[0.532]	[0.248]	[0.577]
× HHI	−0.009	1.121	0.094	1.207	−0.063	1.141
	[0.284]	[1.305]	[0.297]	[1.322]	[0.300]	[1.300]
× OINFLX	0.030	−0.139	0.036	−0.129	0.037	−0.048
	[0.081]	[0.322]	[0.081]	[0.306]	[0.090]	[0.306]
× LEV	0.192	−1.465				
	[0.087]	[0.844]				
× LISTED			0.094	1.089		
			[0.049]	[0.505]		
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F,Y	F,Y	F,Y	F,Y	F,C-Y/Y	F,C-Y/Y
Cluster	C	C	C	C	C	C
N	4,886	1,816	4,540	1,840	4,516	1,817
R^2	0.041	0.047	0.043	0.046	0.010	0.018
Q1(CINFLX)	0.036	0.035	0.078	−0.080	0.077	−0.105
(p-value)	(0.483)	(0.895)	(0.142)	(0.730)	(0.148)	(0.653)
Q3(CINFLX)	−0.116	0.814	−0.052	0.713	−0.029	0.689
(p-value)	(0.109)	(0.008)	(0.494)	(0.014)	(0.789)	(0.022)

Table 9:
Robustness check: alternative measures of competitor inflexibility

The table presents estimates based on an unbalanced panel containing data about 176 electricity generation firms from 16 countries/markets over the period 2001-2014. The dependent variables are first differences between log-values of total wage payments (Δ WAGES) and total payouts (Δ POUT). Explanatory variables are the first difference between log-values of aggregate sales in a firm's market (Δ AGG SALES) or its alternative version (see Section 3.2.3), our alternative measure of competitor inflexibility (see Expression (13)), and measures of industry concentration (Herfindahl-Hirschman Index – HHI) and own inflexibility (OINFLX). Section 3.3 defines our standard set of further control variables. The rows labeled Q1(CINFLX) and Q3(CINFLX) present estimates of elasticities for the first and third quartile value of CINFLX (and median OINFLX and HHI). In the first two columns, we include firm and country-year fixed effects. In the remaining columns, we include firm and year fixed effects. Standard errors (in brackets) are clustered by country-year.

Alternative Measure	AGG SALES & CINFLX				CINFLX	
Dependent Variable	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT	Δ WAGES	Δ POUT
	(1)	(2)	(3)	(4)	(5)	(6)
Δ AGG SALES	−0.066	−0.144	0.020	−0.090	0.048	−0.381
	[0.051]	[0.099]	[0.039]	[0.083]	[0.090]	[0.309]
× CINFLX	0.090	0.728	−0.024	0.390	0.113	1.220
	[0.122]	[0.287]	[0.095]	[0.193]	[0.250]	[0.652]
× HHI	0.579	−1.852	0.135	0.217	−0.193	0.709
	[1.272]	[1.255]	[0.545]	[0.770]	[0.332]	[1.580]
× OINFLX	0.014	0.078	0.035	0.041	0.032	−0.237
	[0.071]	[0.149]	[0.065]	[0.124]	[0.133]	[0.455]
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	F,C-Y	F,C-Y	F,Y	F,Y	F,Y	F,Y
Cluster	C-Y	C-Y	C-Y	C-Y	C-Y	C-Y
N	1,061	1,226	1,061	1,226	1,619	1,471
R^2	0.248	0.231	0.076	0.056	0.061	0.048
Q1(CINFLX)	−0.004	−0.124	0.025	0.011	0.059	−0.068
(p-value)	(0.950)	(0.123)	(0.468)	(0.863)	(0.386)	(0.763)
Q3(CINFLX)	0.040	0.230	0.013	0.200	0.114	0.526
(p-value)	(0.602)	(0.065)	(0.828)	(0.041)	(0.437)	(0.158)

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