Labor and Capital Dynamics under Financing Frictions

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Abstract

We assemble a new, quarterly panel dataset of U.S. firms that links firms’ investment and financing decisions to their employment and wages. We find that wages and leverage are strongly negatively related, both cross-sectionally and within firms, while the negative link between employment and leverage is smaller and less robust. We interpret these facts in a model that integrates a theory of costly debt and equity financing with rich firm-level dynamics, including labor and capital adjustment frictions and wage setting. Estimation of the model’s parameters shows that the model can reconcile several moments relating to debt, wages, employment, and investment. We find that both financing frictions and labor bargaining are important for inducing a negative relation between debt and leverage, both qualitatively and quantitatively. Our counterfactuals show that raising financing costs reduces employment and wages, in line with recent reduced-form evidence.

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1. Introduction

How do employment, wage setting, and financial frictions interact, and what forces drive these interactions? We address these questions in two complementary ways. First, we examine the connections in the data between a firm’s credit and labor market activities. To this end, we assemble a new, quarterly panel dataset that links U.S. firms’ investment and financing decisions to their employment and wages. In our data, we find a strong negative relation between leverage and average labor earnings, which is larger for firms likely to face financial constraints. In contrast, we find only a weak negative link between leverage and employment.

Second, we seek to rationalize and illuminate the mechanisms behind these results in the context of a dynamic model of labor and capital demand in the face of financial frictions. In the model, firms bargain with workers and exploit higher leverage as a means to restrain wages. This mechanism induces a quantitatively relevant negative relation between leverage and labor earnings. At the same time, factor adjustment frictions limit the comovement of employment and leverage.

While this explanation for our empirical results is interesting in its own right, we also wish to use our model to rationalize the extant evidence on the relation between employment and finance. In particular, we compare the model’s implications for the response of employment to increased financing costs with the evidence of a sharp negative response in Chodorow-Reich (2014). We find that exogenous changes in financing costs can, perhaps surprisingly, influence labor demand significantly, even though the reduced-form association between employment and leverage is rather weak in our model. We show that two parameters in our model, bargaining power and deadweight default costs, play a crucial role in mediating the link between financing costs and factor demand.

Our results are of interest along several dimensions. Although a vast body of research has taught us that financial frictions are important for firm-level investment, research linking financial frictions with labor markets is thinner. Striking evidence of a link between employment and finance is documented in Chodorow-Reich (2014) and Duygan-Bump, Levkov, and Montoriol-Garriga (2015), both of whom examine the enormous uptick in job loss immediately following the failure of Lehman Brothers in 2008. In addition, several other studies, such as Cantor (1990), Sharpe (1994), Bakke and Whited (2012), and Benmelech, Bergman, and Enriquez (2012), have shown that financing frictions affect labor demand and wage setting outside of extreme credit market failures. Interestingly, all of
these studies focus on the estimation of elasticities, thus leaving room for a deeper understanding of any underlying economic mechanisms. In addition, much of this work focuses on small data sets, which limits its scope. We enter this picture with a new, broad data set and a new model, both of which illuminate the forces that link employment, wages, and finance.

Understanding our results more deeply requires more detail about the data and the model. Our dataset is a quarterly, firm-level panel constructed by merging two sources of data. The first source is Compustat, which includes quarterly investment and balance-sheet data. However, the Compustat data only contain annual observations on employment and virtually no data on wages. We fill in these missing pieces with the Bureau of Labor Statistics’ Longitudinal Database of Establishments (LDE), which provides quarterly observations on establishments’ total wage bill and employment. The quarterly frequency is important, as significant fluctuations in employment regularly occur at a greater than annual frequency. Moreover, the information on the wage bill is especially important and novel. To our knowledge, studies of the interaction between financing frictions and labor have lacked a dataset of this scope at this frequency.

With these data, we first characterize firms’ observed factor demand policies, focusing on the association between labor earnings per worker, employment, and leverage. Some of our findings reassuringly confirm well-documented evidence from the labor economics literature. For example, we find that average labor earnings covary positively with sales (Roys 2016). However, our two most interesting descriptive findings are new. First, labor earnings per worker covary negatively with leverage, both in the cross-section and within firms. A non-zero correlation is prima facie evidence that financial frictions exist, as this correlation should be zero in a Modigliani-Miller world. Moreover, the within-firm covariance is larger in firms without bond ratings, suggesting even more strongly a link between this covariance and financial frictions. Second, our evidence linking employment with leverage is weaker, with no significant relation at the quarterly frequency. Although we do find a negative correlation when we move to an annual frequency, the statistical significance is marginal.

Next we seek to understand the primitive economic forces behind these observed employment, wage, and financial policies by formulating a dynamic model of factor demand and financing frictions. A firm in our model makes investment, hiring, and financing decisions. In so doing, the firm encounters factor adjustment frictions. We assume in particular that the firm is subject to per-capita costs of hiring, following a literature dating back to Oi (1962). With respect to capital demand,
we assume that if a firm chooses to disinvest, it cannot recover the full purchase price. In other words, investment is only partially reversible, consistent with evidence in Ramey and Shapiro (2001), Cooper and Haltiwanger (2006), and Bloom (2009).

The firm can finance its factor demands in many ways. First, it can write a standard debt contract, which takes the form in Townsend (1979) and Bernanke and Gertler (1989). The firm makes a non-contingent payment to the lender if its productivity exceeds a certain threshold. Otherwise, the firm defaults, and the lender receives a share of the firm’s assets, where this share can be interpreted as collateral. The contractual loan rate is the price that equates the risk-free return to the expected return from defaultable debt, thereby leaving the lender indifferent. Alternatively, the firm can raise external funds by issuing equity, which incurs underwriting costs. In the model, these costs give rise to equity issuances that are as infrequent as those observed in the data. Indeed, in our setting, issuing equity is the financing option of last resort. Lastly, the firm can attempt to circumvent these financing constraints by accumulating liquid assets and deploying them to finance factor demands. This feature is important, given the point in Midrigan and Xu (2014) that firms can mitigate financing constraints by accumulating savings during good economic times.

A novel aspect of the model is the treatment of wage setting. A bargaining problem arises in our model because the costs of employment adjustment imply the existence of rents to ongoing firm-worker matches. We assume these rents are divided according to the bargaining protocol developed in Stole and Zwiebel (1996), and also used by Elsby and Michaels (2013). We build upon this work by extending this surplus sharing rule to a model where payroll can be financed using risky debt. The intuitive outcome is that too much debt limits the surplus to be shared with labor in bad states of the world, thus depressing labor earnings. This relation bears an intuitive connection to the debt overhang problem in Hennessy (2004). Conversely, when labor has a great deal of bargaining power, firms have an incentive to lever up to keep the wage bill in check, especially in low productivity states. Enabling the firm to bargain a lower wage after adverse productivity realizations represents a potentially important margin of adjustment in models with financial frictions, because the firm’s desired payroll influences its demand for external funds.

This integration of external finance with both labor and capital demand is unique in the literature. For instance, most of the models of financial frictions surveyed in Strebulaev and Whited (2012) abstract from capital adjustment costs. Further, all assume that workers are hired in a spot market and
are remunerated concurrently with production. Under these conditions, a firm can always implement the static optimum, so financial constraints have no independent effect on employment (Ejarque 2002). By the same token, in prominent models of factor adjustment, such as Bloom (2009) and Cooper, Haltiwanger, and Willis (2007), external financing is frictionless, that is, it can be obtained at the same rate that the firm discounts its cash flows.

We estimate the model’s parameters using a simulated minimum distance estimator in which the structural parameters are chosen to fit a wide-ranging set of facts on factor accumulation and external funds, such as moments of leverage, employment growth, and capital investment. Even though our estimation is overidentified, we find that the model fits well. Accordingly, it can serve as a useful laboratory to understand our empirical results.

To this end, we first show that the model replicates the empirical correlations between leverage, employment, and average labor earnings that we observe in our data, even though we do not target these correlations in our estimation. Indeed, at a level of -0.17, the (semi)elasticity of average labor earnings with respect to leverage is remarkably close to its empirical counterpart of -0.14. In the model, financial frictions are a necessary, but by no means sufficient condition for generating this result. We show that both bargaining power and financial frictions are quantitatively important for the magnitude of this elasticity. Finally, we demonstrate that both labor and capital adjustment costs are necessary for a muted correlation between employment and leverage.

Finally, we shed light on the effect of financial frictions on real decisions by mimicking the setting in Chodorow-Reich (2014) of a firm facing higher borrowing costs. In our model, we implement this experiment by subjecting a random sample of firms in our simulations to an unexpected increase in the cost of external funds. We then compare the outcomes of these treated firms with those firms that continue to have access to lower-cost lenders. We find marked effects of this shock on labor demand, and parameters that govern both the real and financial sides of the model have pronounced effects on this response. For instance, worker bargaining power is crucial to this result. Intuitively, higher bargaining power enables workers to grab more of the bargaining surplus. The firm can mitigate this outcome by increasing leverage and threatening default. However, as a consequence, firms are more highly levered when the shock hits, which amplifies its effect. The role of bankruptcy costs is similar: the lower the cost of default, the higher is leverage, which again amplifies the effect of a shock.

Our interest in an integrated treatment of costly factor adjustment and external finance is perhaps
most closely related in recent literature to DeAngelo, DeAngelo, and Whited (2011) and Warusawith-arnaa and Whited (2016), both of whom model rich capital adjustment costs in models with financial frictions. However, their technological assumptions imply a static, frictionless labor choice. Two additional papers are important antecedents to our study. Monacelli, Quadrini, and Trigari (2011) consider a related wage bargaining problem in the presence of financing constraints. We generalize their setting in several ways. First, we include both capital and labor in our model. Including capital in a model of financial frictions is crucial because capital can serve as collateral, while workers cannot. In addition, we assume decreasing returns, which ensures a well-defined notion of firm size that is essential for our empirical analysis. Finally, separations (firing) are endogenous in our setting, whereas they occur at an exogenous rate in Monacelli et al. (2011). Although their model includes a few features that we omit, such as infrequent wage renegotiation, they find this infrequent renegotiation does not notably affect employment dynamics. Quadrini and Sun (2014) estimate the effects of costly external finance on worker bargaining in a dynamic model. Again, however, they do not model capital. Further, although they estimate some of their model parameters, they do not have the rich employment and wage data that we use.

The rest of the paper proceeds as follows. Section 2 describes our new quarterly data set on employment, wages, and firm balance sheet and income statement information. Section 3 presents and analyzes the model. Section 4 describes our estimation procedure and presents our results. Section 5 presents our counterfactual experiments, and Section 6 concludes. The Appendix contains details about data construction and the model.

2. Data

In this section, we describe the construction of our data set. We also provide summary statistics and document the dynamic relations between employment, capital, labor earnings, and leverage.

2.1. Data construction

Our quantitative analysis of the theory is made possible by our assembly of a new firm-level dataset that connects observations on employment and labor earnings at the establishment level with information on investment and the balance sheet at the firm level.\(^1\) We merge three data sources.

\(^1\)See Appendix A for further details regarding the sample construction and detailed variable definitions.
Information on standard balance sheet and income statement items, such as sales, operating income, capital investment, and the stock of debt is from the nonfinancial and unregulated firms in the 2013 quarterly Compustat industrial files. Because equity issuance data in Compustat contains a great deal of employee stock option exercise, we obtain equity issuance data from the SDC Platinum Global New Issuance database. We include secondary equity offerings (SEOs) by nonfinancial firms in the United States. We exclude rights issues and unit issues, as well as observations with missing values for total proceeds or a launch date. We obtain data on issuance, the total underwriting fee, the CUSIP number, and ticker symbol of the ultimate parent of the issuer.

Compustat also lacks high-frequency data on employment and wages. Indeed, data on labor earnings are largely missing, with only 5% of nonfinancial firms consistently disclosing labor earnings (item XLR) in Compustat during our sample period. To deal with this issue, we employ the BLS’ Longitudinal Database of Establishments (LDE). This panel dataset is assembled from the Quarterly Census of Employment and Wages, which is compiled from employers’ unemployment insurance (UI) files. These files provide a monthly record of the level of employment and the total wage bill at each UI-covered employer in the United States. The LDE is available from 1992 to the present. Although monthly data are available, we aggregate observations over the quarter from the LDE to conform with the structure of the Compustat quarterly files.

The most significant challenge in merging the LDE data with the Compustat data is that Compustat is a panel of firms, whereas the LDE is a panel of establishments. It can therefore be difficult to identify a parent firm’s establishments in the LDE. Only in special cases can this matching be done using solely the identifying information available in Compustat and LDE. Each establishment in the LDE reports an employer identification number (EIN), which is assigned to it by the Internal Revenue Service. If the individual establishment reports the same EIN that the parent firm uses in its public disclosures, then one can match it to its parent firm’s information in Compustat. However, it is common for parents to operate under different EINs in different states (Haltiwanger, Jarmin, and Miranda 2013). Hence, there can be many EINs associated with a parent firm that operates across multiple states. This problem means that merging on EINs alone is inadequate.

These issues force us to use an auxiliary data source that provides a list of establishments associ-
ated with each parent firm. Infogroup is a private data collection company that maintains a database known as ReferenceUSA, which records the names and addresses of individual establishments in the United States. For each establishment, ReferenceUSA records the parent firm and, if applicable, the subsidiary of the parent under which the establishment operates.

Using ReferenceUSA as a bridge, the merge of Compustat and LDE data can be done in two steps. First, we merge a list of establishments from ReferenceUSA to their corresponding entries in the LDE, using a character-matching algorithm. The second step aggregates employment and wages across all (matched) establishments within each parent firm. We then merge the aggregated data with the Compustat data. This last merge is straightforward because Infogroup includes the parent name, as recorded in Compustat, alongside each of the establishments in its list.

Because the ReferenceUSA data are prohibitively costly, we do not carry out this merge for the universe of Compustat firms. Instead, our dataset consists of a random sample of 577 firms listed in Compustat and covers 2006–2012. The sample is tilted slightly toward smaller firms, as we exclude large multinationals, for two reasons. First, they are less likely to inform us about financial constraints, the topic of our study. Second, because the BLS data cover only U.S. establishments, we want to match domestic employment dynamics to largely domestic operations in Compustat.

2.2. Characteristics of the sample

We describe the characteristics of our dataset in this subsection. Our goal is twofold. First, a comprehensive dataset on employment, labor earnings, investment, and finance is new to the literature, so we first simply examine basic reduced-form correlations. Second, this investigation gives us a set of stylized facts upon which our model can shed light.

We report a few sample characteristics in Table 1. First, we show the differences between our sample and the rather select sub-sample of Compustat firms that disclose total labor earnings. Ballester, Sinha, and Livnat (2002) report that few firms in Compustat disclose total labor earnings, and those firms that do disclose consist disproportionately of large firms in more regulated industries. Table 1 updates their results, using our sample period of 2006-2012. We define a disclosing firm in Compustat as one that reports positive labor earnings data in each year of this period. There are 468 disclosing firms, out of a universe of 9,309 nonfinancial firms. Table 1 shows that both average employment,

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3We thank Dominic Smith (see Bayard, Byrne, and Smith 2013) for providing the matching code.
revenue, and assets among disclosing firms are about three times that of non-disclosing firms. In addition, 27% of disclosing firms are classified in the relatively highly regulated transportation and utilities sector, compared to 10% of non-disclosing firms.

Table 1 also compares the Compustat universe and our merged sample. Firms in our panel are similar to the non-disclosing universe in terms of sales and employment. We also present a rough industry breakdown, finding that manufacturers make up a larger share in our sample than in Compustat, and natural resource firms are under-represented. This under-representation reflects, in part, our omission of many large multinational firms in the extraction industry (oil). We also highlight that in our merged sample, transportation and utilities contribute a share more in line with that in the non-disclosing universe.4

Next, it is instructive to compare employment in our merged sample with Compustat’s measure of employment for the firms in our sample. To this end, we use the end-of-fiscal-year observations in our merged sample because employment data are only available annually in Compustat. We first regress log employment in our sample on log Compustat employment. Table 2 reports the results. The coefficient on Compustat employment is 0.87, and the $R^2$ is 0.82. Next, we restrict the sample to firms that are domestically oriented, and report the results in column (2). This sub-sample consists of about 450 firms that appear to have the vast majority of their activities in the United States, based on their annual reports. The coefficient on log Compustat employment increases to almost 0.94, and the $R^2$ rises to 0.90.

These results are based on a pooled sample and reflect, at least in part, cross-sectional variation in firm size. If we include firm fixed effects and thus restrict attention to within-firm variation, the quality of the fit naturally deteriorates. As seen in column 4 of Table 2, in the sample of domestically oriented firms, the coefficient on Compustat employment falls to about 0.65. This degree of comovement is consistent with the analysis of employment growth rates in Census and Compustat data in Davis, Haltiwanger, Jarmin, and Miranda (2006). One reason for the low correlation we find is noise in Compustat’s measure of annual employment. For example, Baumol, Blinder, and Wolff (2005) caution against using Compustat data to study corporate downsizing, because Compustat’s measure of the change in employment “did not match up well with census administrative” data. An additional source of discrepancy between Compustat and our merged LDE data, specifically, is that

4We have also done our analysis without regulated utilities, finding nearly identical results.
we lack data for several large states, as noted in Appendix A.

2.3. Labor earnings behavior

In this subsection, we describe the relation between average labor earnings and other firm characteristics, especially leverage. We calculate average labor earnings as total payroll divided by employment. We refer to this variable as labor earnings instead of the wage because we do not have data on hours.

Table 3 presents summary statistics. Panel A shows the coefficients from regressing log labor earnings on dummies for a firm being in the top, middle, or bottom leverage tercile, with the coefficient on the middle tercile normalized to zero. We see that more highly levered firms pay lower labor earnings. In particular, firms whose average leverage is in the bottom tercile of the distribution pay almost 9% higher labor earnings relative to firms in the middle tercile of the leverage distribution. But the gradient flattens at high leverage: firms in the top tercile of the leverage distribution pay only slightly lower labor earnings than firms in the middle tercile.

In Panel B of Table 3, we summarize the relation between labor earnings and assets in an exactly analogous way. We find that larger firms, as measured by their average assets, pay higher labor earnings. In particular, firms in the top tercile of the assets distribution pay 15% higher labor earnings than firms in the middle tercile. Interestingly, the smallest firms in the bottom tercile of the asset distribution also pay 6.5% higher labor earnings than those in the middle tercile.

To distinguish between the effects of size and leverage, we regress average labor earnings on two dummy variables and their interaction. The first dummy variable equals 1 if a firm’s average assets are less than the median, and the second equals 1 if a firm’s average leverage exceeds the median. The coefficient on the interaction then measures log average labor earnings at firms whose leverage is high (greater than the median) and whose assets are low (less than the median). It follows that the coefficient on the leverage dummy measures log average labor earnings at firms whose leverage is high but whose assets are also high, and the coefficient on the size dummy measures log average labor earnings at firms whose leverage is low but whose assets are also low. Finally, the intercept measures log average labor earnings at firms whose leverage is low and whose assets are high. This last group is the reference point; all other groups’ labor earnings are expressed relative to this reference.

Panel C of Table 3 reports the results. Looking down the right column and comparing average labor earnings among larger firms (that is, controlling for size), we find that the more highly levered
firms pay 7.6\% lower labor earnings. Thus, higher leverage is associated with lower average labor earnings, even within the large firms. Next, looking across the top row and comparing average labor earnings among less levered firms (that is, controlling for leverage), we find that smaller firms pay 5.4\% lower labor earnings. Last, as shown in the southwest quadrant of Panel D, we find that small, highly levered firms are a strongly selected sample. Small firms that also choose to be highly levered actually pay average labor earnings comparable to their larger, less levered counterparts. This pattern occurs even though we see depressed average labor earnings in small firms, controlling for leverage, as well as in highly leveraged firms, controlling for size. This finding likely reflects high profitability in some small firms, which both supports debt issuance and is partly shared with workers.

Next, we explore the co-movement of average labor earnings with firms’ factor demands and financial positions. We begin by projecting log average labor earnings on one-period lagged log employment, lagged log capital, lagged leverage, and current log sales. We also include firm fixed effects and, if the period corresponds to a calendar quarter, seasonal dummies are included (unless otherwise noted). We motivate this specification as a linear approximation to the wage sharing rule we derive in Section 3.3. The use of empirical policy functions to motivate and estimate dynamic models has important precedents in the industrial organization literature (Bajari, Benkard, and Levin 2007), and Bazdresch, Kahn, and Whited (2016) use empirical policy functions as estimation inputs in a simulated minimum distance exercise. While we do not go as far as using these regression results as inputs into a structural estimation, we do use model policy functions to motivate our description of the data. In addition, below we use these observed policies as external validity tests of the model.

We summarize our findings in Table 4. Column (1) contains the baseline specification of our labor earnings regression. Lagged employment enters negatively, although with an imprecisely estimated coefficient. The point estimate implies that if a firm’s employment is temporarily high, average labor earnings are temporarily low, conditional on capital and productivity. This finding can therefore provide evidence consistent with decreasing returns.

In Column (1), we find that a 10\% increase in sales accompanies a 0.5\% rise in average labor earnings. The positive coefficient on sales is consistent with a rent-sharing arrangement in which the surplus from the worker-firm match is shared between the two. Card, Devicienti, and Maida (2014) stress, however, that these estimates are likely a lower bound on rent-sharing, because a good deal of high-frequency variation in sales does not pass to average labor earnings if labor earnings are
smoothed. Consistent with this observation, we find a higher loading on sales and thus a sharper inference when we use annual data, which smoothes out quarterly fluctuations.

Interestingly, the coefficient on capital in our baseline regression is also positive. Card et al. (2014) argue that this result is consistent with positive hold-up power among workers. Intuitively, after capital is sunk, workers who are complementary to capital can extract greater rents. Indeed, the surplus sharing protocol we use in our dynamic model incorporates this hold-up power.

Lastly, the coefficient on lagged leverage is negative and significant. To interpret this result, one can imagine comparing two points in time, each of which share the same productivity (sales) draw. However, at one of these points, the firm had anticipated much higher sales and levered up to fund its production. As a result, the firm finds itself highly levered relative to its realized productivity. In these states of the world, the firm pays lower average (labor) earnings. Quantitatively, this result implies that a 20 percentage point increase in leverage—roughly, a one standard deviation shift—is associated with average labor earnings that are lower by almost 3%. This result is prima facie evidence of a link between firm finances and wage setting, as this effect should be zero in the absence of financial frictions. We are not aware of comparable estimates in the literature of this reduced-form effect. Our result is nonetheless consistent with evidence from smaller samples that unions yield concessions when the firm is under pronounced financial distress, (e.g., Benmelech et al. 2012).

Columns (2) through (5) in Table 4 presents results for variants on our baseline specification. The results are largely unchanged. In the specification for column (2), we confine the sample to the domestically oriented firms but find that little changes. In the specification for column (3), we inspect whether the effect of leverage differs across sectors. We find that the negative association between average labor earnings and leverage appears to be slightly stronger in the service sector relative to the goods sector, which is defined as including mining, construction, and manufacturing (SIC categories 10–39). However, the difference is marginally significant. In the specification for column (4), we ask whether the effect of leverage is amplified at smaller firms (in terms of assets). We find that the interaction between leverage and size (assets) is positive, although imprecisely estimated. This result indicates that, on average, the negative association between leverage and average labor earnings weakens slightly in smaller firms, consistent with the observation from Table 3 that small firms that lever up are somewhat special. In the specification for column (5), leverage is interacted with log sales. This interaction is an especially salient addition to the regression. The point estimate
indicates that the marginal effect of higher sales weakens at highly levered firms. Put another way, high leverage attenuates the extent of rent-sharing. As we emphasize below, this finding appears to be consistent with our structural model, where high leverage predicts a higher probability of default. As a result, any given increase in sales is more likely to accrue to debtholders rather than workers and therefore has less of a positive effect on the wage.

Table 4 includes two more specifications. In the specification for column (6), we add quarterly time dummies to control for aggregate fluctuations. This addition has relatively little effect on our results, which is indicative of the size of idiosyncratic relative to aggregate variation. The only coefficient that is notably affected is that on sales, which remains positive but is now estimated more imprecisely. In the specification for column (7), we use annual data, specifically, end of fiscal year observations. We include year effects again to control for aggregate fluctuations. Here, the coefficients are all of the same sign as in our baseline regression, and they are estimated more precisely. In particular, the coefficient on sales is significant, despite the presence of the year effects.

Next, we further explore the negative association between leverage and labor earnings, by stratifying the firms according to whether they have an investment grade bond rating, a junk bond rating, or no rating at all. The results are in Table 5. Interestingly, we find that the coefficient on lagged leverage is insignificantly different from zero for both groups of firms that have bond ratings. The coefficient even flips sign in the sample of junk-bond firms, although the sample size is tiny. In contrast, the coefficient in the sample of firms without bond ratings remains negative and significant. This finding is suggestive of a world in which financial frictions are important for the ways in which a firm’s leverage mediates its bargaining with labor.

We further buttress this point by examining how the results in Table 4 differ in our sample versus the sample of disclosing firms in Compustat. The disclosing firms are substantially larger firms and thus arguably more insulated from financial frictions. Accordingly, if the OLS coefficient on leverage reflects financial frictions, we expect to see a difference across these two samples in the association between leverage and average labor earnings, which we calculate for the disclosing firms by dividing item XLR (total staff expenses) by total employment.

The results from this comparison are in Table 6. In column (1), we restate column (7) in Table 4, which is from our merged panel with annual data. Next, we confine the Compustat data on disclosing firms to our sample period. However, because there are few disclosing firms, column (2) of Table 6
shows that all of the coefficients are insignificant. Extending the Compustat sample back to 1970 adds 14,000 observations. In this case, the coefficients on lagged capital and current sales are now each significantly positive, and the coefficient on lagged employment is significantly negative. Each of these findings parallels those from our merged panel. However, the coefficient on lagged leverage is positive and insignificantly different from zero. This result may reflect the fact that disclosing firms are vastly larger companies on average, where variation in leverage is less likely to make financial constraints bind.5

The high sensitivity of labor earnings to leverage likely reflects at least in part variation in hours per worker, which could be the margin on which firms move first when their debt capacity becomes more limited. Our data do not enable us to distinguish hours from hourly wage movements. Georgiadis and Manning (2014) confront the same issue in examining average firm-level labor earnings in the United Kingdom. They consider several reasons for the extent of high-frequency variation in labor earnings and conclude that some of it likely reflects flexibility in wage rates.

For the sake of completeness, we repeat our baseline labor earnings regressions with log employment as the outcome variable. Again, this specification can be thought of as a linear approximation to the employment policy function from the model. These results are shown in Table 7. The main difference between the employment and labor earnings results has to do with the role of leverage, which plays a far weaker role in accounting for high-frequency employment dynamics. We find two exceptions to this general pattern. First, quarterly employment does appear to decline in the goods sector when leverage is high, but the effect is marginally significant. Second, when we use annual data, the coefficient on leverage is negative and marginally statistically significant in the full sample. These findings suggest that adjustment frictions in employment dampen its reaction to leverage relative to the response of labor earnings.

3. Theory

In this section, we introduce the firm’s problem. We then discuss the determination of the interest and wage rates. Finally, we analyze the firm’s optimal policies.

5Using disclosing firms in Compustat, Chemmanur, Cheng, and Zhang (2013) also find a positive, statistically significant association. One reason for the difference in our results is that we construct leverage by netting off cash holdings. If we do not, we also recover a significant and positive coefficient estimate in the disclosing firms, suggesting that the highly levered firms in Chemmanur et al. (2013) also tend to be cash-rich firms, which may be sharing their surplus with their workers through higher wages.
3.1. Optimization problem

We consider an infinitely lived firm in discrete time. Each period has a breakfast-lunch-dinner structure. At the start of each period, the firm’s risk-neutral manager decides to default on the firm’s outstanding debt. Next, if he decides not to default, he chooses new factor demands and how to finance these purchases, with the goal of maximizing the present value of after-tax cash flows to shareholders. These decisions are made with an eye toward their implications for the wage rate and interest rates that will prevail under different scenarios. Finally, after the quantities of factors and financing have been chosen, a risk-neutral lender determines the interest rate on debt and the firm bargains with the workers over wages. Our timing assumptions imply that at the beginning of each period, the firm chooses the levels of capital, \( k' \), and employment, \( n' \), that will be used in production at the beginning of next period, indicated by a prime. We assume that the compensation of all factors must be determined when hired.

Current output, \( y \), is given by a standard Cobb-Douglas production function: \( y = z k^\alpha n^\beta \), in which \( z \) is an idiosyncratic productivity draw that follows an AR(1) process in logs:

\[
\ln(z') = \rho_z \ln(z) + \varepsilon'.
\]  

(1)

Here, \( \rho_z \) is the autocorrelation coefficient, and \( \varepsilon' \) is an i.i.d., random variable with a normal distribution. It has a mean of 0 and a standard deviation of \( \sigma_z \).

The outflow of resources from the firm equals the sum of factor payments and the expenses of factor adjustment. Factor payments include the cost of investment and the wage bill, \( W(k', n', b', z) \), whose arguments preview its endogenous determination via the outcome of a bargaining game.

First, we consider investment, which is defined by the usual capital stock accounting identity:

\[
i \equiv k' - (1 - \delta) k,
\]

in which \( \delta \) is the constant rate of capital depreciation. We normalize the price of the capital good to 1, so the cost of purchasing \( i \) units of capital is just \( i \), if \( i \geq 0 \). If the firm sells (used) equipment, we assume it cannot recover the full purchase price. This assumption may reflect a lemons problem, that is, buyers require a discount because the quality of used equipment is uncertain (House and
Machinery might also be highly customized to a firm’s operations, so it has limited value on the secondary market. Accordingly, in the case of a sale, the firm earns $-c_k i$ if $i < 0$, with $c_k \in (0, 1)$. Therefore, the cost of investment is given by:

$$R(i) \equiv i \cdot 1_{[i \geq 0]} + c_k i \cdot 1_{[i < 0]}.$$  (2)

This friction serves two purposes in the model. First, it induces realistic investment inaction. Second, it is well-known that dynamic models with Cobb-Douglas technologies cannot produce the small investment variances typically observed in microeconomic data, so some sort of friction is necessary for the model to match the variance of investment.

Next, the firm bears the cost of adjusting labor by $\Delta n \equiv n' - n$ units, denoted by $C(\Delta n)$. We allow $C(\Delta n)$ to take a simple proportional form,

$$C(\Delta n) \equiv c_n \Delta n \cdot 1_{[\Delta n > 0]},$$  (3)

with $c_n$ representing the per-capita cost of hiring. For simplicity, we omit firing costs. Either type of cost induces the firm to hoard labor, thus allowing for a nontrivial wage bargaining problem. In addition, aside from premiums related to unemployment insurance, firing costs in the United States are arguably less salient.\(^6\)

To finance its factor demands, the firm can issue a one-period discount bond, on which it can default. Let $b'$ be the face value of debt, and let the interest rate on debt be $\tilde{r}(k', n', b', z)$, so debt proceeds are $b'/ (1 + \tilde{r}(k', n', b', z))$. As we outline below, this interest rate is determined endogenously from the lender’s zero-profit condition and is therefore a function of the model’s state variables. If instead the firm opts to save, which means $b' < 0$, it has access to a safe asset that pays a constant, exogenously given rate of return, $\bar{r}$. Thus, the interest rate on debt can be expressed as:

$$r(k', n', b', z) = \begin{cases} 
\tilde{r}(k', n', b', z) & \text{if } b > 0 \\
\bar{r} & \text{if } b \leq 0 
\end{cases}$$  (4)

The firm can also distribute excess funds to shareholders or raise funds from shareholders in the

\(^6\)Recent estimates of hiring and firing costs, spanning several methods, can be found in Anderson (1993), Barron, Berger, and Black (1997), Cooper et al. (2007), and Silva and Toledo (2009).
equity market. Distributions are the difference between the inflow and outflow of resources to the firm. Cash inflows include current production, while outflows include factor payments, adjustment frictions, and debt repayment. Net debt issuance, $b'/\left(1 + r(k', n', b', z)\right)$, minus net debt repayment, $b$, can be either an inflow or an outflow.

Putting these pieces together, the distribution before fees is:

$$D = zk^\alpha n^\beta - b + \frac{b'}{1 + r(k', n', b', z)} - W(k', n', b', z) - R(i) - C(\Delta n). \quad (5)$$

Negative distributions are interpreted as equity issuance and subject to underwriting fees. If $D < 0$, the firm incurs a fee of the form, $\Lambda^{-}(D) \equiv \lambda_1 |D|$. Hence, the real after-fee distributions are:

$$\hat{D} \equiv D - \Lambda^{-}(D)1_{[D<0]}.$$

The cost of issuing equity is especially important in the analysis. Without costly equity issuance, the firm never has a reason to issue possibly costly debt, nor does it have an incentive to hoard cash, so the capital structure decision becomes degenerate. Costly equity issuance thus breaks the Modigliani-Miller indeterminacy. To avoid the cost of equity financing, the firm issues debt to fill relatively modest funding gaps (differences between its factor demands and its internal funds). It turns to equity financing as a last resort, in response to a rising interest rate on debt.

Let $r_F$ be the rate at which the firm discounts its cash flows, and let $\rho \equiv \left(1 + r_F\right)^{-1}$. We assume that $r_F > \bar{r}$. This assumption is a simple way of capturing the tax benefit of debt. Essentially, both this assumption and a standard tax benefit render the firm impatient relative to the interest rate it pays on its debt. This impatience is the key force that induces the firm to hold debt on its balance sheet. Interestingly, as shown in Li, Whited, and Wu (2016), the wedge between $r_F$ and $r$ does not have to be large to rationalize the demand for debt we observe in the data.

The firm’s optimization problem can now be characterized recursively by the Bellman equation,

$$\Pi(k, n, b, z) = \max_{k', n', b', z'} \left\{ \hat{D} + \rho \int \Pi(k', n', b', z') \, dG(z' | z) \right\}, \quad (7)$$

where $G$ is the distribution of next-period productivity, conditional on current $z$, implied by (1).

This problem is solved by taking into account the cost of debt finance, $r(k', n', b', z)$, and the wage
bargain, \( W(k', n', b', z) \), as well as the evolution of internal funds. Thus, the firm’s choices of \( b' \), \( k' \), and \( n' \) influence both \( r(k', n', b', z) \) and \( W(k', n', b', z) \).

Before turning to the loan and wage contracting problems, it is worth highlighting why labor, which has been relatively neglected in studies of financing frictions, is subject to a financing constraint in this setting. The first reason is a matter of timing. Labor must be paid this period, but the revenue it generates is not realized until next period. If debt is defaultable, the risk of default reduces the expected marginal value of labor and thus influences labor demand. This timing convention is a straightforward way to build in absolute priority rules, under which labor must be paid before the lender in the case of bankruptcy. Second, labor is treated as a quasi-fixed factor. Accordingly, the costs of adjusting labor might induce the firm to sustain a level of employment over and above what is warranted—and what can be financed—by current profitability. This behavior can spur the firm to take on some default risk in order to borrow its way through (temporarily) bad times. Third, worker bargaining power implies a clear link between labor demand and debt finance. In particular, we show below that the marginal wage is declining in debt, so the choice of debt finance affects labor demand. In the absence of these three features, financing frictions do not bind on labor under decreasing returns (Ejarque 2002) because the firm earns a surplus from its employment of labor, so it can finance the (statically) optimal choice using realized sales.

### 3.2. Loan contract

We assume the firm can sign a one-period loan contract with a perfectly competitive financial intermediary. In the event that the firm is unable to repay, the lender can seize a fraction, \( 1 - \xi \), of the firm’s fixed assets, that is, its resalable capital. The share \( \xi \in (0, 1) \) can be thought of as a (deadweight) cost of processing the bankruptcy. This contract is inspired by the debt contract that emerges in the seminal costly state verification model in Townsend (1979) and later adapted by Bernanke and Gertler (1989).⁷

What triggers a default? Hennessy and Whited (2007) assume that lenders can extend credit as long as the firm has positive present (market) value. In that case, bondholders can at least obtain

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⁷We depart from Townsend (1979) in that the productivity shocks, \( z \), are persistent. Hence, even if the lender does not observe \( z \), the lender could infer \( z \) from current revenue and use this knowledge to forecast future \( z' \). In this setup, a noncontingent debt contract that is independent of \( z' \) is not necessarily optimal. Instead of attempting to solve for the optimal contract, we assume \( z \) is common knowledge but assert that state-contingent contracts are infeasible. This approach follows, among others, Cooley and Quadrini (2001) and Hennessy and Whited (2007).
shares of the firm as part of a bankruptcy settlement. However, firms do retain some control over the pace of bankruptcy proceedings, and they can use this control to induce creditors to waive their rights to new shares, at least partially, in exchange for accelerating the settlement (Franks and Torous 1989). As a technical matter, moreover, suppressing negotiation over new shares simplifies the interest-rate contracting problem.

In light of these considerations, we assume that repayments in the form of shares are suppressed altogether in bankruptcy. In other words, the firm’s future market value is not collateralizable. Accordingly, and following Gilchrist, Sim, and Zakrajsek (2013), a firm’s access to credit is mediated by a net worth covenant, which restrains the firm’s ability to sell new debt based on its current physical assets and liabilities.

Net worth has two components. The first is the firm’s internal funds:

\[ a(k, n, b, z) \equiv zk^\alpha n^\beta - b. \] (8)

The second is the fraction of the capital stock that can be seized by lenders in default: \( c^k (1 - \delta) k' \).

Default is triggered when net worth reaches a minimum threshold, below which the recovery rates are anticipated to be unacceptably low. We assume this minimum is zero, as no intermediary would lend to a negative net worth firm. Thus, noting from (8) that \( a(k, n, b, z) \) is increasing in \( z \), one can define a threshold level of productivity, \( \hat{z} \), such that the firm that has chosen the triple \((b', k', n')\) defaults at the beginning of the next period if \( z' < \hat{z} \):

\[ 0 \equiv \hat{z}k'^\alpha n'^\beta - b' + c^k (1 - \delta) k'. \] (9)

Two features of (9) are of note. First, the right side of (9) represents the resources that the firm could raise in order to repay its debt just prior to bankruptcy. Hence, its capital is valued at the second-hand price \( c^k \). Second, the wage bill is absent from (9) because labor is paid in full, even if the firm subsequently defaults. This timing is in accordance with absolute priority rules.

With this default condition, we turn to the determination of the contractual interest rate, \( r \), which is determined by an expected zero profit condition that must hold under free entry. We construct this condition as follows. The payoff to the lender in the event of default is revenue plus a share, \( 1 - \xi \), of the depreciated capital stock, where \( \xi \in (0, 1) \). The interpretation of the parameter \( \xi \) is worth
discussion. The share, $1 - \xi$, is less than one for two reasons. First, it is hard to imagine that a firm could sell capital in default for a price greater than the price for used capital it receives in solvency, so $1 - \xi$ should be less than $c^k$. Second, to the extent that $1 - \xi < c^k$, the difference, $c^k - (1 - \xi)$, can be interpreted as a deadweight default cost, as in Bernanke and Gertler (1989). In our estimation below, we impose the condition $1 - \xi < c^k$, but this constraint does not bind. Alternatively, motivated by the literature on limited commitment, the quantity $1 - \xi$ can be interpreted as the fraction of the capital stock that can be surrendered as collateral.

The payoff outside of default is simply the interest payment. Thus, under free entry and risk-neutrality, the face value of debt discounted at the risky rate $r(k', n', b', z)$ must equal the expected payoff discounted at the risk-free rate. Therefore, $r(k', n', b', z)$ satisfies:

$$\frac{1}{1 + \bar{r}} \left[ \int_0^\hat{z} \left( z' k'^\alpha n'^\beta + (1 - \xi) (1 - \delta) k' \right) dG (z' | z) + (1 - G (\hat{z} | z)) b' \right] = \frac{b'}{1 + r(k', n', b', z)}.$$  \hspace{1in} (10)

For a given $(b', k', n', z)$, equations (9) and (10) pin down the loan contract, which can be summarized by $r(k', n', b', z)$. The effect of each argument on the contract is intuitive. For any $(k', n', z)$, $r(k', n', b', z)$ is increasing in $b'$, reflecting the rising default risk. As illustrated in Figure 1, this interest rate schedule shifts down if either $k'$, $n'$, or $z$ rises, in part because each portends greater future output that can be sold to repay the lender. In addition, a higher $k'$ means a larger asset base that can be surrendered in default. Hence, each of these variables reduces the riskiness of the loan.

3.3. Wage setting

We introduce endogenous wage setting for two reasons. First, the dynamics of firm-level employment suggest the presence of certain labor adjustment costs, which in turn imply the existence of rents to ongoing firm-worker matches. These rents have to be divided, and the sharing rule from the bargaining protocol in Stole and Zwiebel (1996) provides a tractable way to do so.\(^8\) Second, there is evidence that highly indebted firms, which face a relatively high risk of default, can negotiate lower wages (see Benmelech et al. (2012) and the references therein). This evidence suggests that firms can use the wage bargain to relax their financing constraints. As such, wage setting is an important

\(^8\)Recently, Brügemann, Gautier, and Menzio (2015) have formalized a static game (which they refer to as a “Rolodex” game) that yields the simple surplus sharing rule in Stole and Zwiebel (1996). We do not attempt to extend this bargaining game to a dynamic setting and instead use this result to motivate our use of a sharing rule.
element of the firm’s problem.

The outcome of the wage bargain can be understood heuristically by appealing to the notion of stability in Stole and Zwiebel (1996). Consider a firm that has just completed its desired labor adjustment and has a workforce of size $n$. Under the protocol, any one worker can request a pairwise bargaining session with the firm, and vice versa. If a wage is agreed upon, the two divide the marginal surplus implied by their joint production, with the worker receiving a constant share, $\psi$. Note that the marginal surplus is calculated by taking as given the participation of the remaining workers. This calculation reflects the assumption that individual workers are unable to coordinate their decisions to stay or quit. If a wage is not agreed upon, the worker exits and enjoys a flow payoff from non-employment—reflecting, for instance, the flow value of leisure—equal to $\mu$. The marginal contribution of the remaining workers is affected by his departure because there are decreasing returns to scale. Accordingly, the remaining workers will request a bargaining session to revise their agreements. This process continues until a stable outcome is reached in which neither firm nor any worker wishes to reopen the contract.

As detailed in Appendix B, we can solve for the outcome of this protocol in (nearly) closed form under certain circumstances. In particular, if the firm pays positive dividends, then we have:

**Proposition 1** The wage bargain is characterized by a differential equation for the wage bill, $W(k', n', b', z)$:

\[
(1 - \psi) \frac{W(k', n', b', z)}{n'} + \psi \frac{\partial W(k', n', b', z)}{\partial n'} = \psi \rho \mathbb{E} \left[ \frac{\partial a(k', n', b', z')}{\partial n'} \right] + (1 - \psi) \mu, \tag{11}
\]

where

\[
\mathbb{E} \left[ \frac{\partial a(k', n', b', z')}{\partial n} \right] = \int_{\hat{z}}^{z} \frac{\partial a(k', n', b', z')}{\partial n'} dG(z' \mid z)
\]

is the expected marginal effect of labor on next period’s internal funds, $a(k', n', b', z')$, implied by (8).

The lower limit of integration here is the default threshold, $\hat{z}$, because the worker’s contribution in the default regime is zero, with all assets being seized by the lender.\(^9\)

The economics of (11) are straightforward. The left-hand side consists of two parts. The first is the wage rate, $\frac{W(k', n', b', z)}{n'}$, paid to the new hire. The second component, $\frac{\partial W(k', n', b', z)}{\partial n'}$, reflects the marginal effect of a new hire on the (pre-existing) wage bill of his co-workers. The second term

\(^9\)In Appendix B, we show that the case of strictly negative dividends is nearly identical. The case of zero dividends arises because of the kink in cost of equity issuance, which induces a region of productivity values over which a zero dividend is optimal. However, in quantitative terms, this region is tiny and is rarely, if ever, observed in our simulations.
enters because of decreasing returns, which implies the marginal product is declining in $n$. Hence, the hiring of a worker forces a downward revision to the pre-existing wage rate. Putting these two components together, the weighted average of $\frac{\partial W(k',n',b',z)}{\partial n'}$ and $\frac{W(k',n',b',z)}{n'}$ on the left-hand side can be thought of as the marginal wage. The right-hand side states that the worker’s compensation reflects a weighted average of his outside option, $\mu$, and his contribution to the firm’s cash flow, as measured by $\mathbb{E} \left[ \frac{\partial a(k',n',b',z')}{\partial n'} \right]$. This form is clearly reminiscent of the standard Nash bargain.

Equation (11) simplifies if the firm chooses not to borrow. Indeed, it is straightforward to confirm that if the firm chooses to save, then (11) collapses to the familiar wage bargain in Stole and Zwiebel (1996), where the wage bill is, roughly speaking, a weighted sum of a worker’s productivity and his outside option. This simplification happens because the probability of default is zero if the firm chooses to hold cash, so the interest rate is independent of the firm’s factor demands. The solution to the wage bargain in this special case resembles that presented in Elsby and Michaels (2013) and Acemoglu and Hawkins (2014), except that a worker’s productivity in our setting with capital is also conditioned on $k$.

However, if the firm borrows, then the effect of $n'$ on expected internal funds is mediated by the financing friction. Fortunately, characterizing $\mathbb{E} \left[ \frac{\partial a(k',n',b',z')}{\partial n'} \right]$ is straightforward because our timing assumptions for debt imply that the interest rate does not appear in the expression for $a(k',n',b',z')$ in (8). Making use of equation (8), it follows that $\mathbb{E} \left[ \frac{\partial a(k',n',b',z')}{\partial n'} \right] = Z(k',n',b',z) \beta k^\alpha n'^{\beta - 1}$, where

$$Z(k',n',b',z) \equiv \int \hat{z}(k',n',b',z) z'dG(z' | z)$$

denotes the expected value of $z'$ (that a firm can appropriate) after accounting for the risk of default. Substituting for $\mathbb{E} \left[ \frac{\partial a(k',n',b',z')}{\partial n'} \right]$ in (11), the solution to the wage bargain is the following:

**Corollary 1** The solution to (11) is the wage bill,

$$W(k',n',b',z) = \rho n' - \bar{\psi} \int_0^{n'} Z(k',\nu,b',z) \beta k^\alpha \nu^{\beta - 1 + \bar{\psi}} d\nu + (1 - \bar{\psi}) \mu n', \quad (12)$$

where $\bar{\psi} \equiv (1 - \psi)/\psi$.

The solution in (12) conveys three pieces of intuition. First, the integral has a natural economic interpretation, which can be seen by considering what happens if a worker leaves a firm of size $n'$. 

This one exit increases the expected marginal product of the other \( n' - 1 \) workers, enabling them to bargain for higher wages. However, at this point any of the remaining \( n' - 1 \) workers are also free to leave, and an exit would increase the marginal products of the other \( n' - 2 \) workers, and so on. Thus, a worker’s departure would set off a chain of renegotiations. The implications for the wage are twofold. First, for a given default threshold, a smaller workforce implies a higher marginal product, which ratchets up the wage at each node of this chain. As a result, a worker is able to “hold up” the firm to demand a portion of all of these infra-margins of production. Second, a smaller workforce implies less future output, which raises the probability of default. As \( \nu \) falls at each node of this chain, \( \hat{z} \) rises, and \( Z (k', \nu, b', z) \) falls. These two forces determine the infra-margins of production, and the integral of these infra-margins is what is shown in (12). The other component of (12) is the outside option. The worker obtains a weighted sum of these two elements.

Second, note that, in (12), the default threshold that enters into \( Z \) is evaluated at \( \nu \) inside the integral. This feature of the solution captures an important force at play in the model. Specifically, if the firm finds itself with \( \nu \) workers after quits occur, its revenue is depleted and its probability of default is higher. Thus, even if the firm’s planned level employment, \( n' \), is large enough to enable it to raise risk-free debt, the added debt can still drive down the wage because the wage takes into account the off-equilibrium plays, that is, threats by the workers to quit. Hence, the wage can react negatively to higher leverage, even if the level of leverage does not imply a notable risk premium. This property of the model can be seen by comparing Figures 1 and 2 and noting that the wage turns down in advance of the point where the risk premium emerges.

Third, equations (9) and (12) help reveal the effect of financing constraints on the wage bargain. Suppose a firm has already agreed to a loan contract such that it is highly leveraged, that is, \( b' \) is large. From (9), this situation implies a higher probability of default, so \( \hat{z} \) is higher and \( Z \) is lower for any \( (k', \nu, z) \). As a result, the expected contribution of a worker to the firm’s cash flow, as captured by the integral in (12), is diminished. This bargaining outcome translates in (12) to a lower wage, as illustrated in Figure 2. The negative relation between debt and wages seen here is reminiscent of the result in Perotti and Spier (1993), who show that outstanding leverage can affect the renegotiation of senior claims. However, our model is more specific to the case of wage setting, as their model does not allow any separation between quantities and prices embodied in the senior claim in their model, and their senior claim does not necessarily represent payments to a factor of production. Our result
is also reminiscent of the debt-overhang result in Hennessy (2004), except that we show that this familiar mechanism extends to wage setting, in addition to investment. Our result lies in contrast to the result in Berk, Stanton, and Zeckner (2010), in whose model highly levered firms pay risk-averse workers more to compensate for the risk of unemployment that accompanies firm default. However, given our robust empirical finding of a negative within-firm correlation between labor earnings and leverage, we conjecture that our debt overhang mechanism is empirically dominant.

Of course, wage bargaining is not the only mechanism that implies a negative association between average labor earnings and leverage. An alternative theory might be that firms under financial distress shed their high-wage workers first. However, we view this scenario as unlikely. Post-war recessions are typically times when firms face heightened financial distress (Bhamra, Kuehn, and Streubulaev 2010). At the same time, the evidence in Solon, Barsky, and Parker (1994) indicates that higher-wage workers increase their share of hours worked in recessions.

In sum, we note that the interest rate and wage setting in our model have the virtue of being tractable. Because the wage bill does not enter the default condition, we can solve (9)-(10) for \( r \) and \( \hat{z} \) for any given tuple \((b', k', n', z)\). Then, with \( \hat{z} \) in hand, we can solve (12) for the wage bargain.

### 3.4. Optimal policies

To obtain intuition for the model, we examine the model’s first order conditions. All of the following analysis assumes a non-zero dividend, which, as noted above, is nearly always observed in our simulations. First, we consider optimal investment policy. Conditioning on nonzero investment, substituting (5) and (6) into (7), and differentiating with respect to \( k' \) gives the optimal policy:

\[
\left(1_{[k'>k]} + c^k1_{[k'<k]} + \frac{b'}{(1 + r(k', n', b', z))^2} \frac{\partial r(k', n', b', z)}{\partial k'} - \frac{\partial W(k', n', b', z)}{\partial k'} \right) (1 + \lambda 1_{[D<0]}) = \rho \int \frac{\partial \Pi(k', n', b', z')}{\partial k'} dz'.
\]

The right-hand side of (13) represents the marginal benefit of an extra unit of capital, while the left-hand side represents the marginal cost. The first two terms in parentheses refer to the purchase and sale prices of capital, respectively. The third term is negative, as a higher choice of \( k' \) increases next period’s net worth and thus lowers the interest rate the firm is charged for its debt. The fourth term in parentheses captures the effect of capital on the wage bill. Higher capital raises wages for
two reasons. First, it increases the marginal product conditional on survival, and second, it increases the expected surplus from the firm-worker match by lowering the default probability. Equation (12) then implies that the wage should rise. Finally, in those states of the world in which the firm chooses to raise external equity, the marginal cost of capital is naturally higher by an amount $1 + \lambda$.

Next, we look at the first-order condition for optimal employment, which is given by:

$$\left(c_n 1_{n'>n} + \frac{b'}{(1 + r(k', n', b', z))^2} \frac{\partial r(k', n', b', z)}{\partial n'} - \frac{\partial W(k', n', b', z)}{\partial n'} \right) (1 + \lambda 1_{[D<0]}) = \rho \int \frac{\partial \Pi (k', n', b', z')}{\partial n'} dG (z' | z).$$

(Natural, (14) bears a great resemblance to (13), as both are conditions for optimal factor demand. Further, the effects of $n'$ and $k'$ on $r(k', n', b', z)$ are both negative. Although labor cannot serve as collateral, an increase in $n'$ nonetheless serves to increase the firm’s internal funds and thus lowers borrowing costs. In contrast, the effect of an increase in $n'$ on the wage bill is more muted than the effect of an increase in $k'$, although still positive. This difference arises because a higher $n'$ implies a lower wage rate via decreasing returns. Another important difference is in the interpretation of the term $\partial W(\cdot)/\partial n'$. Although an increase in $n$ reduces the wage rate, the wage bill is nonetheless increasing in $n$, following (12).

Finally, we examine optimal debt policy in the following first-order condition:

$$\left(\frac{1}{1 + r(k', n', b', z)} - \frac{b'}{(1 + r(k', n', b', z))^2} \frac{\partial r(k', n', b', z)}{\partial b'} - \frac{\partial W(k', n', b', z)}{\partial b'} \right) (1 + \lambda 1_{[D<0]}) = \rho \int \frac{\partial \Pi (k', n', b', z')}{\partial b'} dG (z' | z).$$

(15)

In the absence of default risk, the second and third terms in (15) equal zero, and in this model the optimal policy is to borrow an infinite amount because of the high impatience implied by the assumption that $\rho < (1 + \bar{r})^{-1}$. Naturally, as can be seen in the second term of (15), the presence of default risk limits this behavior because $\partial r(\cdot)/\partial b' > 0$. Finally, (12) implies that the term $\partial W(\cdot)/\partial b' < 0$, so the downward pressure on the wage bill from an extra dollar of debt gives the firm an incentive to increase leverage.

We add texture to the preceding analysis by plotting the policy functions for the model in Figure 3. The policy functions map the state variables $(z, k, n, b)$ into optimal policies $(n', k', b')$. Because
this function is multidimensional, we visualize it using level curves. We plot optimal investment \((i/k)\), employment growth \((n'/n - 1)\), the wage bill, \(W(k', n', b', z)\), distributions \((D/k)\), and leverage \((b'/k')\) as a function of the productivity shock, \(z\), holding capital, labor, and debt \((k, n, b)\), at their median levels in the model simulation. All of these policy functions are evaluated at the parameter estimates discussed below.

We emphasize several important features of Figure 3. First, the resale discount on capital induces an investment inaction region for low realizations of \(z\), and the hiring cost induces a similar, but smaller, hiring inaction region for intermediate realizations of \(z\). Second, leverage increases monotonically with \(z\). Intuitively, as factor productivity rises, investing in a storage technology, such as cash (negative debt), becomes less appealing, and thus the firm wishes to fund both factor demands with external debt finance. Third, distributions to shareholders rise monotonically with \(z\) because decreasing returns implies a diminishing incentive to plough profits back into factor accumulation. Finally, the total wage bill, \(W\), is increasing in \(z\).

To conclude this section, we comment on the association between current debt, \(b\), and the optimal policies in (13)–(15). In states in which the firm chooses a positive dividend, one sees in (13)–(15) that, conditional on the dividend, there is no direct link between initial debt and optimal policies. In contrast, if the dividend is zero, then \(b'\) must “fill in the gap” between the firm’s internal funds and its factor payments. This mechanism implies a direct, positive link between \(b'\) and \(b\). However, if zero-dividend states occur rarely, the sense in which initial net worth directly constrains optimal policies appears limited.

However, these observations do not imply that initial debt is unimportant to the firm’s problem. Initial debt depletes the firm’s internal funds and, therefore, affects the likelihood that negative dividend states occur, even if optimal policy conditional on \(D < 0\) is independent of \(b\). Because the firm finances factor demands at the margin with equity when \(D < 0\), the high cost of external equity serves to depress capital and labor demands. This fall in factor demand implies an unconditional, negative association between \(b\) and factor demand. More importantly, the prospect of negative dividends in the future, and the associated costs of debt and equity finance, influence today’s optimal policies even if current dividends are positive. This information about the future is impounded in the forward values in (13)–(15), which reflect the payoffs if the firm were to make choices that increased the probability of future negative-dividend states.
4. Estimation

We estimate the model parameters using a simulated minimum distance estimator. This procedure identifies values of the structural parameters that generate outcomes within the model that most closely fit their empirical counterparts. In what follows, we first review the mechanics of the model solution, simulation, and estimation. Next, we review the sample moments used in estimation and relate the intuition behind why these moments help identify the structural parameters. We then summarize our results.

4.1. Model solution, estimation, and identification

We solve the model via value function iteration. The grid and transition matrix for the productivity shock, $z$, are formed using the method in Tauchen and Hussey (1991). Grids for capital and labor are formed to span the range of optimal choices in the simulation. The upper end of the grid for debt is equal to the upper end of the grid for capital, while the lower end is half of the upper end, but opposite in sign.

The mechanics of the estimation are straightforward. For a given set of parameters, we solve the model and use the solution to generate simulated data, which is ten times the size of our merged LDE-Compustat dataset (Michaelides and Ng 2000). Next, we calculate a set of moments or functions of moments (detailed below). Based on the distance between model-generated moments and their empirical counterparts, the values of the structural parameters are updated. To gauge this distance, we use the clustered covariance matrix of the empirical moments. We use the genetic differential evolution algorithm to update the parameters and search for a better fit.

A number of parameters in our model can be easily pinned down based on information outside of our merged panel. Thus, these parameters are not part of our minimum distance estimation. We set the risk-free rate, $\bar{r}$, to 2.5% on an annualized basis, consistent with the average 3-month Treasury bill rate over our sample period. We then set $r_F$ to be 20% higher than $\bar{r}$, in line with an effective corporate tax rate of 20%. Next, we estimate $\lambda_1$ using a regression of issuance fees on issuance proceeds, where we scale both of these variables by total firm assets. The slope of the regression is then an estimate of $\lambda_1$. With these auxiliary parameters taken care of, we have 10 structural parameters to be estimated: $\{\alpha, \beta, \delta, \rho_z, \sigma_z, c_k, c_n, \xi, \psi, \mu\}$.
4.2. Identification

While the estimation process is straightforward, the identification of the model parameters requires explanation. We start with an intuitive discussion, and after we report our estimation results, we present analysis that supports the intuition. Although all of the model parameters affect all of the moments we use in our estimation, the dependence of some parameters on a particular set of moments is sufficiently pronounced that we can provide intuition for how these moments inform and identify our parameters. For example, $\rho_z$ and $\sigma_z$ are easily identified by including in the list of moments the standard deviation and serial correlation of sales. We estimate this autoregression using the technique in Han and Phillips (2010), which allows for firm-specific intercepts and time trends.

The rate of depreciation, $\delta$, is identified by including the mean investment rate. In the absence of stochastic productivity or investment adjustment frictions, the firm simply invests to replace depreciated capital. Although productivity innovations and the partial reversibility that we model both cause the firm to deviate from its frictionless investment policy, average investment still depends strongly on the depreciation rate.

Next, the factor demand distributions speak to several different parameters. The cost of firming/hiring, for instance, attenuates the dispersion in employment growth, making this moment especially informative about this adjustment cost. Similarly, the lower $c^k$, the greater the inaction range for optimal investment and the lower the standard deviation of investment. In addition, the covariance of factor demand adjustments, namely employment growth and investment, discipline the model’s implications for the elasticities of factor demands to productivity, $z$. Intuitively, because both factors respond to shifts in $z$, their covariance encodes information about the factor demand elasticities and thus informs the choices of $\alpha$ and $\beta$.

Our external financing moments include average leverage, which we measure as long-term debt plus debt in current liabilities less cash-equivalent assets, all divided by total assets. This netting off of liquid assets is a common approach in the literature to identifying a notion of debt that maps most cleanly to that in the model, where $b$ represents the firm’s net financial position. Viewed through the lens of our model, this moment reflects several salient parameters. For example, high leverage is deterred by the size of the bankruptcy cost, $\xi$, which implies a lower repayment in default, thus amplifying risk premia and reducing demand for debt. In addition, the demand for net debt is
dampened by the precautionary savings motive, which is increasing in the extent of idiosyncratic risk, \( \sigma_z \). In addition to mean leverage, we also include the variance and serial correlation of leverage as moments. As we show later, these moments help to discipline key mechanisms in the model relevant to the counterfactual analyses we do. Thus, they are valuable overidentifying moments to include.

We include two additional moments to identify the production function parameters: \( \alpha \) and \( \beta \). First, note that despite the presence of bargaining, \( \beta \) remains a key influence on labor’s share. Accordingly, we use average operating income as a fraction of the wage bill to inform the choice of \( \beta \), where operating income is defined in the model as \( zk^\alpha n^\beta - W(\cdot) \). This ratio is inversely related to labor’s share and thus to the parameter \( \beta \).\(^{10}\) The next moment is a measure of the average profit rate, defined as the mean of operating income, divided by assets. This moment is naturally decreasing in \( \alpha \). Intuitively, a higher \( \alpha \) triggers an expansion in the capital stock relative to the profit flow.

Several moments help identify the bargaining parameter, \( \psi \). For example, as workers have more bargaining power, the mean ratio of operating income to wages falls. More novel is our identification of \( \psi \) via the mean and standard deviation of shareholder distributions per unit of capital, which are also particularly sensitive to bargaining power. For instance, as \( \psi \) increases, the wage bill rises in response to a positive productivity shock, which leaves a smaller residual to be paid to shareholders. Lastly, in models with a constant wage, distributions inherit much of their variability from the productivity shock, \( z \). However, in our model, bargaining implies that the wage bill covaries positively with sales, so the variance of distributions declines as \( \psi \) increases. In addition, both the mean and variance of leverage rise with \( \psi \), as in this case, the firm has a strong incentive to use leverage to keep the bargained wage lower.

Finally, we turn to the identification of the outside option, \( \mu \). This parameter is critical in models of surplus sharing (e.g., Hagedorn and Manovskii 2008), and yet there is no consensus on its value in that literature. We suggest a new way to identify this outside option. In our model, the mean market-to-book ratio is particularly sensitive to \( \mu \). As the outside option rises, the wage bill also rises, leaving less for shareholders. Thus, the surplus to holding and using capital inside the firm falls relative to its replacement value. In other words, the market-to-book ratio declines.

\(^{10}\)We do not use a direct measure of labor’s share, as the value-added concept of output in our model differs from sales in Compustat data. Operating income in Compustat, in contrast, nets off intermediate input purchases from revenue.
4.3. Baseline results

We now summarize our baseline results in Table 8. In Panel A, we report the actual data moments and the model simulated moments. Because of our large sample size, five of the fourteen moment pairs are significantly different from one another, but few are economically different, and several of these pairs match up nicely. Actual and simulated mean leverage are nearly identical, as are the means of investment and distributions and the standard deviations of employment growth, investment, and leverage. We only see one instance in which the simulated and actual moments differ by a factor of two or more. In particular, the model markedly misses the standard deviation of the change in log sales. Overall, however, we believe the fit of the model is remarkably good. Accordingly, it is a useful laboratory for counterfactual policy experiments. We emphasize in particular the model’s ability to replicate the joint distributions of debt and factor demands. To make a prediction regarding the real effects of default risk, a model should be, at a minimum, consistent with the size and variance of (net) debt.

Next, we turn to the parameter estimates. In many cases, these seem comparable to related estimates in the literature. For instance, the estimate of the standard deviation of the driving process, \( z \), is in line with the estimate in Hennessy and Whited (2007). In contrast, the estimate of the serial correlation of \( z \) is somewhat lower than many comparable estimates in the finance literature but comparable to the results from Cooper et al. (2007). Next, we turn to the default cost parameter, \( \xi \). At a level of 50%, it is much larger than the 10% figure from Hennessy and Whited (2007) or the 10%–20% estimates from Andrade and Kaplan (1998). Nonetheless, this parameter can be understood in the context of our default threshold, which is essentially a net worth covenant. Thus, one interpretation of \( 1 - \xi \) is the fraction of the capital stock that can be surrendered to the lender in default as collateral. Given this interpretation, our estimate of this parameter is in line with the estimates of the collateral parameter in Li et al. (2016). Next, at 69%, our estimate of the resale price of capital is nearly identical to the 66% resale price from Bloom (2009). Although our estimate of the linear hiring cost, at 4.6%, is somewhat higher than the 2% figure from Bloom (2009), the latter is measured as a fraction of the wage bill, while our cost is measured as a fraction of the number of workers hired.

We now return to the question of the identification of the model by computing the sensitivity of
the parameters to the moments, using the scaled metric from Gentzkow and Shapiro (2015). This measure runs from -1 to 1, with numbers near either end signifying that a parameter is sharply identified by a moment. This measure incorporates two factors essential to parameter identification. The first is the intuitive, “partial-derivative” relation between a parameter and a moment. The second operates through the weight matrix, with imprecisely estimated moments having a smaller effect on any given parameter. Thus, a high sensitivity requires not only that a moment respond to a parameter but that the moment be well estimated. The results are in Table 9. Each row corresponds to one of the moments, while each column corresponds to a parameter. To reduce clutter, we present sensitivities only if they are greater than 0.3 in absolute value. One can, in a heuristic sense, regard the model as “identified” as long as there are as many moments with non-empty cells in Table 9 as there are parameters. This condition is satisfied.

We find many results that conform to the intuition presented in Section 4.2. For example, the sensitivity of the depreciation rate, $\delta$, to the mean rate of investment is over 0.9, and the sensitivity of the serial correlation of $\ln(z)$, $\rho_z$, to the serial correlation of sales is over 0.8. Similarly, the estimate of default costs, $\xi$, is strongly inversely related to the mean of leverage, and the bargaining power parameter, $\psi$, is negatively related to the mean and standard deviation of distributions. Finally, we note that these sensitivities represent only local responses of moments to parameters, as they are based on numerical derivatives, which are taken over tiny ranges of the parameter. As such, some moments appear uninformative when, in fact, they provide considerable identifying information. The most prominent example is the covariance between investment and employment growth. The sensitivities from Gentzkow and Shapiro (2015) are small, but the effect of $\beta$ on this moment is strong over a wide range for $\beta$.

5. Implications

We can now assess the estimated model’s ability to engage our own descriptive results, as well as other recent reduced-form evidence on financing constraints. First, examine the sensitivity of average labor earnings and employment to beginning-of-period leverage that we observe in our data. These results are of interest in part because they constitute an out-of-sample test of the model, as neither of these features of the data was used in the estimation of the model. Finally this exercise is of
interest because it constitutes an estimate of the model’s policy functions. Bazdresch et al. (2016) note that because all dynamic models have policy functions, the empirical fit of the policy function is a uniform metric for understanding the performance of the model.

Recall that in our data, we find that log average labor earnings decrease by 0.14 in response to a one percentage point increase in leverage but that the corresponding sensitivity for employment is, at a quarterly frequency essentially zero. In our model, we find a negligible sensitivity for employment and a comparable sensitivity of -0.178 for average labor earnings.

As we have emphasized throughout, the negative sensitivity of labor earnings to leverage occurs through the effect of financial frictions on the wage bargain. The low sensitivity of employment to leverage is an artifact of factor adjustment frictions, both to capital and labor. If we remove these frictions, we do find a negative coefficient on lagged leverage in our simulated data. However, we find little effect from varying each factor adjustment friction individually. The intuition is as follows. Because choosing high debt today raises the probabilities of equity issuance or default tomorrow, the expected future marginal product of labor falls. In the absence of factor adjustment frictions, this fall in the expected marginal product leads to lower employment. Capital adjustment frictions play a particularly important role in undoing this employment response because the firm chooses to retain workers when the capital stock is more persistent. This mechanism highlights the value of having a model with both capital and labor adjustment frictions.

Next, we use the model to quantify the economic forces behind the negative relation between labor earnings and leverage. To this end, we conduct several comparative statics exercises, which are in Figure 4. We present average leverage, as well as the sensitivities of employment and average labor earnings to leverage, as functions of the two model parameters that are most important for these quantities: labor bargaining power, $\psi$, and the deadweight cost of default, $\xi$. We calculate the sensitivities exactly as in Table 4, except that we omit fixed effects, as there is no cross-sectional firm heterogeneity in our simulated data. We construct each panel by setting all model parameters equal to their values from our estimation. Next, one at a time, we change a model parameter, solve the model, and recalculate the statistic, which we plot against the value of the parameter.

We first examine the effects of bargaining power, $\psi$. Intuitively, we find that average leverage increases with $\psi$. This result reinforces the intuition in equations (9) and (12). A firm that faces workers with high bargaining power finds it optimal to lever up. The benefit of the ensuing lower
wage bill dominates the cost of a higher default probability. Not surprisingly, this high leverage translates into a high sensitivity of wages to leverage. If leverage is negative, it has no effect on the bargained wage, as the probability of default is zero. It is only when leverage is high enough to affect default probabilities that wages and leverage interact. Finally, the sensitivity of employment to leverage is largely unaffected by worker bargaining power.

Next, we examine the effects of deadweight default costs, $\xi$. Here, we find the reassuring result that leverage is lower when $\xi$ is higher, as a large financial friction deters raising debt. Again, we find that higher leverage is accompanied by a higher sensitivity of wages to leverage, and again, we find a near zero sensitivity of employment to leverage over the entire range of $\xi$.

Our second counterfactual exercise is motivated not by our own results but by evidence of financing constraints from the 2008-2009 financial crisis. Chodorow-Reich (2014) considers the experiences of firms whose intermediaries suffered the largest declines in lending capacity. For instance, banks that happened to be more heavily invested in mortgage-related securities saw their net worth decline significantly. This deterioration, in turn, reduced their capacity to make risky loans. Chodorow-Reich (2014) finds that firms that had a history of borrowing from these intermediaries reduce employment more than comparable firms that had long-standing ties to “healthier” lenders.

We implement this idea by augmenting the model to include a shock to the risk-free rate, which follows a two-state Markov process. The shock is either zero or 50 basis points. This spread is consistent with the evidence in Chodorow-Reich (2014) regarding the interest rates paid by firms with relatively unhealthy lenders. Our intent is to model an unanticipated shock that is expected to last, so we calibrate the Markov transition matrix so that the shock switches states once every 500 periods. We then compare employment, capital, and wages in the high-cost versus low-cost states.

The model implies a 4.3% decline in labor demand, which nearly replicates the 5.5% drop in employment documented in Chodorow-Reich (2014). Although Chodorow-Reich does not report results for other outcomes, we also note that the model yields a decline in labor earnings of 5.1%, but, perhaps surprisingly, an uptick in capital of nearly 1%.

Which forces in the model contribute to these findings? As a qualitative matter, the decline in labor demand is not obvious. Although an interest rate increase constitutes a negative cash-flow shock, a 50 basis point rise is not large. Nonetheless, a rise in funding costs can depress labor demand. Recall from (14) that higher employment can mitigate default risk because firms can use the extra
revenue to repay debt. When the cost of funds rises, firms de-lever and the value of labor as a means to guard against default declines.

Clearly, this reasoning does not carry over exactly to capital demand because capital can serve as collateral for debt, independent of capital’s use in production. Thus, after a rise in the risk-free rate, the firm has an incentive to lower overall borrowing costs by employing more capital relative to labor and thus pushing the default threshold out. This collateral effect can counter the negative effect on capital demand that would otherwise occur after a rise in the risk-free rate.\textsuperscript{11}

Finally, we examine the role of two key model parameters in shaping the quantitative effect of a higher cost of funds. The results from this counterfactual experiment are in Figure 5, which shows how movements in employment, labor earnings, and capital depend on bargaining power, $\psi$, and default costs, $\xi$. Interestingly, we find that the drops in employment and labor earnings are largest when labor has a great deal of bargaining power. Intuitively, high borrowing costs reduce factor demand by more when the firm is already more highly leveraged, as in the case of higher worker bargaining power. We find a similar result, with similar intuition for low default costs.

6. Conclusion

We bring new data and a new model to the underexplored questions of whether, how, and why financing frictions affect labor demand and wage setting. Our dataset is unique in that it covers a broad sample of firms, while combining information on labor earnings and employment with information on investment and financing. With these data, we establish that average labor earnings covary negatively with leverage both in the cross-section and within firms. We find a much less robust negative relation between employment and leverage.

We explore these facts in the context of a dynamic model of factor demand with financial frictions. This task is challenging, as labor demand interacts in important ways with the demand for other quasi-fixed factors, in particular, capital. The effect of financing constraints on one factor clearly spills over to the other, via their interaction in production. Moreover, in contrast to the case of capital, it is unrealistic to assume that firms are price takers in the labor market, so the consideration of wage setting is important. Our model therefore incorporates realistic adjustment frictions, financial

\textsuperscript{11}The absence of a contraction in capital highlights a challenge to the model. One could overturn this result if a larger share of firms relied on external credit to finance their marginal factor demands. However, this condition is inconsistent with the stylized fact in the data that most firms fund internally.
frictions, and wage bargaining.

When we estimate the model’s parameters, we find that the model can match several relevant features of the data and can thus serve as a useful laboratory for analyzing the mechanisms underlying our reduced-form empirical analysis. We find that leverage has a quantitatively important effect on the wage bargain, as leverage increases the probability of default. Thus, the expected surplus to be shared between the firm and workers falls, as does the wage. We also find that our model can also replicate the sensitivity of factor demand to exogenous movements in interest rates found in Chodorow-Reich (2014).

We view our research as providing a microeconomic foundation for aggregate equilibrium analysis. An understanding of financing constraints in aggregate equilibrium is vital to our interpretation of aggregate capital and labor market dynamics. For example, Buera, Fattal Jaef, and Shin (2015) examine the implications of collateral constraints on unemployment in an equilibrium model. Our results on the interaction between wage setting and financial frictions have the potential to inform this type of analysis because in our model financial frictions directly affect wage flexibility. As such, our research can also be useful for analyzing the employment effects of any government policies that affect credit markets.
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Quadrini, Vincenzo, and Qi Sun, 2014, Credit and hiring, Manuscript, USC.


Table 1: Sample Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Disclosing firms</th>
<th>Non-disclosing firms</th>
<th>Merged panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>468</td>
<td>9,309</td>
<td>577</td>
</tr>
</tbody>
</table>

Means:

<table>
<thead>
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<th></th>
<th>Disclosing firms</th>
<th>Non-disclosing firms</th>
<th>Merged panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets (billion $)</td>
<td>7.18</td>
<td>2.22</td>
<td>4.25</td>
</tr>
<tr>
<td>Sales (billion $)</td>
<td>5.12</td>
<td>1.60</td>
<td>1.01</td>
</tr>
<tr>
<td>Employment</td>
<td>20,337</td>
<td>5,616</td>
<td>8,001</td>
</tr>
</tbody>
</table>

Industry makeup (%):

<table>
<thead>
<tr>
<th></th>
<th>Disclosing firms</th>
<th>Non-disclosing firms</th>
<th>Merged panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durable mfg.</td>
<td>14.3</td>
<td>29.0</td>
<td>36.8</td>
</tr>
<tr>
<td>Non-durable mfg.</td>
<td>18.7</td>
<td>22.6</td>
<td>21.8</td>
</tr>
<tr>
<td>Transportation</td>
<td>34.4</td>
<td>13.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Trade (wholesale &amp; retail)</td>
<td>11.4</td>
<td>9.6</td>
<td>18.9</td>
</tr>
<tr>
<td>Services</td>
<td>21.2</td>
<td>25.5</td>
<td>15.2</td>
</tr>
</tbody>
</table>

Calculations in the first two columns are based on samples of firms in Compustat, and in the third column, on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012. With respect to Compustat, we distinguish between firms that disclose Total Staff Expenses (item XLR) and those that do not. We classify a firm as disclosing if it reports staff expenses in each year.

Table 2: Employment in Compustat and the merged panel

<table>
<thead>
<tr>
<th></th>
<th>Employment in merged panel</th>
<th>Employment in Compustat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment in merged panel</td>
<td>0.875 (0.026)</td>
<td>0.935 (0.020)</td>
</tr>
<tr>
<td></td>
<td>0.513 (0.076)</td>
<td>0.680 (0.064)</td>
</tr>
<tr>
<td>Constant</td>
<td>1.61 (0.208)</td>
<td>0.947 (0.158)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.820</td>
<td>0.900</td>
</tr>
<tr>
<td>No. of obs.</td>
<td>2,960</td>
<td>2,105</td>
</tr>
<tr>
<td>Sample</td>
<td>Full</td>
<td>Domestic</td>
</tr>
<tr>
<td>Fixed Effects</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Calculations are based on samples of firms in Compustat, as well as on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012. This table reports the linear projection of log Compustat employment on log employment in our merged panel. In all cases, standard errors are clustered at the firm level.
Table 3: Average Labor Earnings by Size and Leverage

<table>
<thead>
<tr>
<th>Panel A: Log earnings by terciles of leverage (middle normalized =0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom tercile</td>
</tr>
<tr>
<td>0.089</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel B: Log earnings by terciles of size (assets)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottom tercile</td>
</tr>
<tr>
<td>0.065</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Panel C: Log earnings by size and leverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assets &lt; median</td>
</tr>
<tr>
<td>Leverage &lt; median</td>
</tr>
<tr>
<td>Leverage &gt; median</td>
</tr>
</tbody>
</table>

Calculations are based on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012. This table shows average labor earnings according to size and leverage, where we define size as book assets. In each panel, one category is normalized to zero, and average labor earnings in the other categories are expressed as a log difference relative to the normalized category.
### Table 4: Dynamics of Labor Earnings in Merged Panel

<table>
<thead>
<tr>
<th>Dependent variable: Labor earnings</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag capital</td>
<td>0.105</td>
<td>0.102</td>
<td>0.106</td>
<td>0.105</td>
<td>0.105</td>
<td>0.063</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.016)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.014)</td>
<td>(0.012)</td>
<td>(0.022)</td>
</tr>
<tr>
<td>Lag employment</td>
<td>−0.105</td>
<td>−0.063</td>
<td>−0.104</td>
<td>−0.105</td>
<td>−0.105</td>
<td>−0.086</td>
<td>−0.111</td>
</tr>
<tr>
<td></td>
<td>(0.050)</td>
<td>(0.082)</td>
<td>(0.050)</td>
<td>(0.050)</td>
<td>(0.050)</td>
<td>(0.051)</td>
<td>(0.054)</td>
</tr>
<tr>
<td>Lag leverage</td>
<td>−0.138</td>
<td>−0.149</td>
<td>−0.203</td>
<td>−0.215</td>
<td>−0.054</td>
<td>−0.121</td>
<td>−0.103</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
<td>(0.043)</td>
<td>(0.054)</td>
<td>(0.068)</td>
<td>(0.054)</td>
<td>(0.032)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Sales</td>
<td>0.051</td>
<td>0.039</td>
<td>0.051</td>
<td>0.050</td>
<td>0.059</td>
<td>0.025</td>
<td>0.056</td>
</tr>
<tr>
<td></td>
<td>(0.018)</td>
<td>(0.025)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.017)</td>
<td>(0.018)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>Lag leverage × 1(goods sector)</td>
<td>0.090</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.059)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag leverage × 1(size &lt; median)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.122</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.075)</td>
</tr>
<tr>
<td>Lag leverage × Sales</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>−0.021</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.012)</td>
</tr>
<tr>
<td>R²</td>
<td>0.0929</td>
<td>0.0693</td>
<td>0.0935</td>
<td>0.0943</td>
<td>0.0941</td>
<td>0.151</td>
<td>0.166</td>
</tr>
<tr>
<td>Obs.</td>
<td>13306</td>
<td>9566</td>
<td>13306</td>
<td>13306</td>
<td>13306</td>
<td>13306</td>
<td>3041</td>
</tr>
<tr>
<td>Sample</td>
<td>Full</td>
<td>Domestic</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Time effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Calculations are based on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012. Estimation is done with OLS. The dependent variable is log average labor earnings. The independent variables are once-lagged log capital, once-lagged log employment, once-lagged leverage (net debt divided by assets), and log sales. Column (1) uses the full quarterly merged panel sales. Column (2) restricts the sample to domestically oriented firms. Columns (3)–(5) add regressors. The indicator 1(goods sector) equals 1 if the firm is classified in a goods-producing industry and zero otherwise. The indicator 1(size < median) equals 1 if the firm’s average assets over our sample is less than the median. Dummy variables for each quarter are added in Column (6). Column (7) uses annual data, that is, end-of-fiscal-year observations. All regressions use firm fixed effects, and, if time effects are omitted, seasonal dummies are included. Standard errors in all cases are clustered at the firm level.
Table 5: Subsample Dynamics of Labor Earnings in Merged Panel

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag capital</td>
<td>0.108</td>
<td>0.201</td>
<td>0.104</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
<td>(0.119)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Lag employment</td>
<td>−0.156</td>
<td>0.257</td>
<td>−0.122</td>
</tr>
<tr>
<td></td>
<td>(0.038)</td>
<td>(0.117)</td>
<td>(0.040)</td>
</tr>
<tr>
<td>Lag leverage</td>
<td>−0.079</td>
<td>0.012</td>
<td>−0.133</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.211)</td>
<td>(0.035)</td>
</tr>
<tr>
<td>Sales</td>
<td>0.107</td>
<td>−0.013</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>(0.057)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.154</td>
<td>0.441</td>
<td>0.095</td>
</tr>
<tr>
<td>Obs</td>
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<td>36</td>
<td>10845</td>
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<td>Sample</td>
<td>Investment Grade</td>
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</tr>
<tr>
<td>Time Effects</td>
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<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Frequency</td>
<td>Qtly.</td>
<td>Qtly.</td>
<td>Qtly.</td>
</tr>
</tbody>
</table>

Calculations are based on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012. Estimation is done with OLS. The dependent variable is log average labor earnings. The independent variables are once-lagged log capital, once-lagged log employment, once-lagged leverage (net debt divided by assets), and log sales. Column (1) uses the firms from the quarterly merged panel with an investment grade credit rating. Column (2) restricts the sample to firms with a below investment grade (junk) credit rating. Column (3) restricts the sample to firms with with no public credit rating. All regressions use firm fixed effects. Standard errors in all cases are clustered at the firm level.
<table>
<thead>
<tr>
<th></th>
<th>Merged panel</th>
<th>Compustat, 2006-12</th>
<th>Compustat, 1970-12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lag capital</td>
<td>0.097</td>
<td>−0.003</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>(0.022)</td>
<td>(0.036)</td>
<td>(0.016)</td>
</tr>
<tr>
<td>Lag employment</td>
<td>−0.111</td>
<td>0.033</td>
<td>−0.109</td>
</tr>
<tr>
<td></td>
<td>(0.054)</td>
<td>(0.048)</td>
<td>(0.024)</td>
</tr>
<tr>
<td>Lag leverage</td>
<td>−0.103</td>
<td>−0.019</td>
<td>0.015</td>
</tr>
<tr>
<td></td>
<td>(0.037)</td>
<td>(0.073)</td>
<td>(0.030)</td>
</tr>
<tr>
<td>Sales</td>
<td>0.056</td>
<td>0.022</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.031)</td>
<td>(0.023)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.166</td>
<td>0.082</td>
<td>0.667</td>
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<td>15986</td>
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<tr>
<td>Year effects</td>
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<td>YES</td>
<td>YES</td>
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</tbody>
</table>

Calculations are based on samples of firms in Compustat, as well as on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012, except in the third column, in which we extend it back to 1970. This table presents regression results using annual data. The first column, “Merged panel” uses end-of-fiscal-year observations from our quarterly panel. This is the same result show in Column (7) of Table 7. The other two columns here show results using two different sample periods of Compustat data on “total staff expenses” (XLR).
Table 7: Dynamics of Employment in Merged Panel

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
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<tr>
<td>Lag capital</td>
<td>−0.001</td>
<td>0.001</td>
<td>−0.001</td>
<td>−0.001</td>
<td>−0.001</td>
<td>0.007</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.007)</td>
<td>(0.037)</td>
</tr>
<tr>
<td>Lag employment</td>
<td>0.819</td>
<td>0.834</td>
<td>0.818</td>
<td>0.819</td>
<td>0.819</td>
<td>0.819</td>
<td>0.463</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.034)</td>
<td>(0.029)</td>
<td>(0.029)</td>
<td>(0.029)</td>
<td>(0.029)</td>
<td>(0.050)</td>
</tr>
<tr>
<td>Lag leverage</td>
<td>−0.002</td>
<td>0.001</td>
<td>0.044</td>
<td>0.0005</td>
<td>−0.019</td>
<td>0.001</td>
<td>−0.080</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.018)</td>
<td>(0.034)</td>
<td>(0.026)</td>
<td>(0.026)</td>
<td>(0.016)</td>
<td>(0.045)</td>
</tr>
<tr>
<td>Sales</td>
<td>0.113</td>
<td>0.111</td>
<td>0.113</td>
<td>0.113</td>
<td>0.112</td>
<td>0.112</td>
<td>0.248</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.020)</td>
<td>(0.016)</td>
<td>(0.016)</td>
<td>(0.015)</td>
<td>(0.017)</td>
<td>(0.053)</td>
</tr>
<tr>
<td>Lag leverage × 1(goods sector)</td>
<td></td>
<td>−0.063</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.037)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag leverage × 1(size &lt; median)</td>
<td></td>
<td>−0.004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.034)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lag leverage × Sales</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.004</td>
<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>(0.005)</td>
<td></td>
</tr>
<tr>
<td>R²</td>
<td>0.754</td>
<td>0.775</td>
<td>0.755</td>
<td>0.755</td>
<td>0.755</td>
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<td>0.37</td>
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<td>Obs.</td>
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<td>9566</td>
<td>13306</td>
<td>13306</td>
<td>13306</td>
<td>13306</td>
<td>3041</td>
</tr>
<tr>
<td>Sample</td>
<td>Full</td>
<td>Domestic</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
<td>Full</td>
</tr>
<tr>
<td>Time effects</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Calculations are based on our merged panel, which integrates into Compustat labor earnings and employment data from the Bureau of Labor Statistics’ Quarterly Census of Employment and Wages. The sample period is first quarter 2006 to fourth quarter 2012. Estimation is done with OLS. The dependent variable is log employment. The independent variables are once-lagged log capital, once-lagged log employment, once-lagged leverage (net debt divided by assets), and log sales. Column (1) uses the full quarterly merged panel sales. Column (2) restricts the sample to domestically oriented firms. Columns (3)–(5) add regressors. The indicator 1(goods sector) equals 1 if the firm is classified in a goods-producing industry and zero otherwise. The indicator 1(size < median) equals 1 if the firm’s average assets over our sample is less than the median. Dummy variables for each quarter are added in Column (6). Column (7) uses annual data, that is, end-of-fiscal-year observations. All regressions use firm fixed effects, and, if time effects are omitted, seasonal dummies are included. Standard errors in all cases are clustered at the firm level.
Table 8: Simulated Minimum Distance Estimation

Panel A. Moments

<table>
<thead>
<tr>
<th>Actual Moments</th>
<th>Simulated Moments</th>
<th>T-statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean investment</td>
<td>0.024</td>
<td>0.024</td>
</tr>
<tr>
<td>Mean net debt</td>
<td>0.079</td>
<td>0.083</td>
</tr>
<tr>
<td>Mean operating income</td>
<td>0.035</td>
<td>0.031</td>
</tr>
<tr>
<td>Mean distributions</td>
<td>0.011</td>
<td>0.011</td>
</tr>
<tr>
<td>Mean income/wages</td>
<td>0.908</td>
<td>1.026</td>
</tr>
<tr>
<td>Mean market-to-book ratio</td>
<td>1.730</td>
<td>1.685</td>
</tr>
<tr>
<td>Std. dev. investment</td>
<td>0.017</td>
<td>0.020</td>
</tr>
<tr>
<td>Std. dev. employment growth</td>
<td>0.060</td>
<td>0.061</td>
</tr>
<tr>
<td>Std. dev. leverage</td>
<td>0.102</td>
<td>0.103</td>
</tr>
<tr>
<td>Std. dev. of operating income</td>
<td>0.019</td>
<td>0.017</td>
</tr>
<tr>
<td>Std. dev. of distributions</td>
<td>0.013</td>
<td>0.009</td>
</tr>
<tr>
<td>Cov. of investment and employment growth (×100)</td>
<td>0.010</td>
<td>0.015</td>
</tr>
<tr>
<td>Std. dev. change in log sales</td>
<td>0.165</td>
<td>0.072</td>
</tr>
<tr>
<td>Serial correlation of log sales</td>
<td>0.601</td>
<td>0.793</td>
</tr>
<tr>
<td>Serial correlation of leverage</td>
<td>0.786</td>
<td>0.794</td>
</tr>
</tbody>
</table>

Panel B. Parameters

<table>
<thead>
<tr>
<th>$\lambda_1$</th>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$\rho_z$</th>
<th>$\sigma_z$</th>
<th>$\delta$</th>
<th>$c^k$</th>
<th>$c_n$</th>
<th>$\xi$</th>
<th>$\psi$</th>
<th>$\mu$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0446</td>
<td>0.370</td>
<td>0.527</td>
<td>0.469</td>
<td>0.155</td>
<td>0.089</td>
<td>0.691</td>
<td>0.046</td>
<td>0.507</td>
<td>0.192</td>
<td>1.007</td>
</tr>
<tr>
<td>(0.0018)</td>
<td>(0.021)</td>
<td>(0.028)</td>
<td>(0.092)</td>
<td>(0.051)</td>
<td>(0.023)</td>
<td>(0.152)</td>
<td>(0.059)</td>
<td>(0.120)</td>
<td>(0.019)</td>
<td>(0.430)</td>
</tr>
</tbody>
</table>

Calculations are based on our merged panel of the LDE with Compustat. The estimation is done with simulated minimum distance, which chooses structural model parameters by matching the moments (or functions of moments) from a simulated panel of firms to the corresponding moments from the data. Panel A reports the simulated and actual moments and the clustered $t$-statistics for the differences between the corresponding moments. Panel B reports the estimated structural parameters, with clustered standard errors in parentheses. $\alpha$ and $\beta$ are the returns to scale with respect to capital and labor, respectively; $\delta$ is the capital depreciation rate; $\rho_z$ is the persistence of productivity; $\sigma_z$ is the standard deviation of the innovation to productivity; $\xi$ is the bankruptcy cost (as a share of a firm’s capital stock); $\lambda_1$ is the linear cost of equity issuance; $c^k$ is the resale price of capital outside bankruptcy, and $c_n$ is the per capita hiring cost. $\psi$ is the bargaining power parameter, and $\mu$ is the outside option. $\lambda_1$ is estimated via linear regressions of issuance fees on issuance proceeds.
Table 9: Local Sensitivity of parameters to moments

<table>
<thead>
<tr>
<th>Moments</th>
<th>$\alpha$</th>
<th>$\beta$</th>
<th>$\rho_z$</th>
<th>$\sigma_z$</th>
<th>$\delta$</th>
<th>$c_k$</th>
<th>$c_n$</th>
<th>$\xi$</th>
<th>$\psi$</th>
<th>$\mu$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean investment</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean net debt</td>
<td></td>
<td>-0.831</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Mean operating income</td>
<td>-0.880</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Mean distributions</td>
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<td></td>
<td></td>
<td></td>
<td>-0.496</td>
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<td></td>
</tr>
<tr>
<td>Mean income/wages</td>
<td></td>
<td>-0.630</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean market-to-book ratio</td>
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<td>-0.477</td>
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<td>Std. dev. employment growth</td>
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<td>0.612</td>
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<td>-0.493</td>
<td>-0.458</td>
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<td>Std. dev. leverage</td>
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<td></td>
<td></td>
<td></td>
<td>-0.576</td>
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<td></td>
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<tr>
<td>Std. dev. of operating income</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Std. dev. of distributions</td>
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<tr>
<td>Cov. of investment and employment growth</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Std. dev. change in log sales</td>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Serial correlation of log sales</td>
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<td></td>
<td>0.533</td>
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</tr>
</tbody>
</table>

This table presents the sensitivities of parameters to moments from Gentzkow and Shapiro (2015), which is a number that ranges from negative one to one. Blank entries indicate a sensitivity of less than 0.3 in absolute value. $\alpha$ and $\beta$ are the returns to scale with respect to capital and labor, respectively; $\delta$ is the capital depreciation rate; $\rho_z$ is the persistence of productivity; $\sigma_z$ is the standard deviation of the innovation to productivity; $\xi$ is the bankruptcy cost (as a share of a firm’s capital stock); $c_n$ is the per capita hiring cost; $\psi$ is the bargaining power parameter; and $\mu$ is the outside option.
Figure 1 plots the contractual rate of interest in loan agreements for different values of capital and productivity. The debt levels that run along the horizontal axis are all normalized by the mean capital stock. In the baseline case, capital, labor, and productivity ($k, n, z$), are at their mean levels in the model simulation.
Figure 2 plots the wage bill as a function of net debt/capital. This figure is drawn for capital and labor, $(k, n)$, at their mean levels in the model simulation.
Figure 3 plots optimal investment ($i/k$), employment growth ($n'/n - 1$), labor earnings, $W(z,k',n',b')$, and leverage ($b'/k'$) as a function of the log productivity shock, $\ln(z)$, holding capital, labor, and debt ($k,n,b$), at their mean levels in the model simulation.
Figure 4: Sensitivity of Labor Earnings and Employment to Leverage

Figure 4 shows how the elasticity of employment and leverage each change with respect to two model parameters. Panel A shows the results for labor bargaining power, \( \psi \), and Panel B shows the results for the deadweight cost of default, \( \xi \).

A:

B:
Figure 5: Sensitivity of Counterfactuals to Model Parameters

Figure 5 shows the response of the logs of labor, labor earnings per worker, and capital to a 50 basis point increase in the cost of debt. Panel A plots these responses as a function labor bargaining power, $\psi$, and Panel B plots these responses as a function of the deadweight cost of default, $\xi$.

A:

B:
Appendix A

In this appendix, we provide some additional details regarding the construction of the merged panel. Ideally, we would execute this merge for all Compustat parent firms. However, because corporations in Compustat can have hundreds of establishments and because Infogroup charges by the establishment, this strategy is too costly. In light of this issue, we construct our sample in the following way.

First, we draw a random sample of 1,000 firms from Compustat. The universe from which the sample is drawn consists of firms that operated at some point in time since 2000. Some of these firms, however, have workforces based largely outside the U.S. This detail complicates our analysis because we observe the firm’s global balance sheet in Compustat but only its U.S. employment and wage bill in LDE. Hence, we discard firms whose workforces are substantially based overseas. To isolate these firms, we investigate firms with annual sales greater than $10 billion because they are the ones most likely to have a large international presence. We then discard those whose U.S. employment makes up less than three-quarters of their total workforce. This criterion eliminates roughly 200 firms.

Second, we deliver our list of parents to Infogroup and request that it pull records on each parent’s establishments. To this end, we make the identifying assumption that if two establishments within the same state are operated by the same parent, they use the same EIN. This assumption is useful because it implies that for each parent in a given year, we can conserve on costs by requesting information from Infogroup on one establishment per state per parent. We chose to ask for the name and address of the oldest establishment. Therefore, using our sample selection, the year-t cross-section from Infogroup records the names and addresses of the oldest-operating establishment of each parent in each state in which the parent is active in that year. Note that if we match the oldest establishment to a record in the LDE, then (under our identifying assumption) we can discover the unique EIN that the parent uses in the state. This procedure allows us to pinpoint the remaining establishments in the LDE operating under that parent in the state. Thus, even though the high cost of ReferenceUSA data can be constraining, we can still merge ReferenceUSA to the LDE.

Not surprisingly, we have identified some violations of this identifying assumption, in which different EINs are used within a single state. Because we under-count the parents’ establishments in these cases, we typically find that our estimate of the parent’s employment is substantially less than
the annual Compustat figure. We follow up in these scenarios by doing Internet searches to track down the names and addresses of additional establishments operated by the parent in each state. These searches produce (in the LDE) the EINs we are missing. We again “hard-code” an allowance for this type of situation into the matching code.

We have two annual cross-sections from Infogroup, one from 2006 and another from 2012. We match each to the LDE. The use of the 2006 cross section means that, if a firm operated in a state in 2006 but exited by 2012, we will still be able to identify the firm’s establishments in that state in the LDE data. However, if the firm enters and exits a state between 2007 and 2011, we will miss it and thus under-count employment for those years.

Infogroup retrieves comprehensive data for 771 of the 808 parents on our list. We, in turn, have been able to match 577 of these parents to the LDE, so our panel consists of these firms spanning the period 2006-2012.

*Merging ReferenceUSA to LDE*

As a first step, we standardize names and addresses. For instance, “Corporation,” “Corp.,” and “Corp” are all set to the latter value. The conventions for standardization follow practices at the Census Bureau.

Next, the character-matching algorithm identifies establishments in the LDE that inhabit the same state and exhibit a “similar” name to the corresponding establishment in ReferenceUSA. Our principal criterion for “similar” is that the first three-quarters of the characters in the ReferenceUSA and LDE names agree identically, although we relax this criterion if establishments match exactly on zip code. We stress agreement on the initial characters of each name because keypunch errors tend to increase as strings advance from left to right (Winkler 2006). If we fail to match several of a parent’s ReferenceUSA establishments, we manually examine how these establishments’ names are recorded in the LDE (by, for instance, looking up the name in LDE corresponding to the address in ReferenceUSA). One can usually identify a pattern to the discrepancy, in that the LDE consistently reports a variant of the ReferenceUSA name. We then make an allowance for these variations in the matching code.
Missing data in LDE

One remaining challenge is that a seven states—Florida, Massachusetts, Michigan, Mississippi, New Hampshire, New York, and Pennsylvania—do not make their micro data available through the BLS. Thus, in all, we have data for 43 states and territories, including Delaware and Nevada, where most U.S. corporations are incorporated. For this reason, we have been using both LDE and Compustat data to estimate employment and the wage bill. In particular, if we are missing states at random, then LDE provides a consistent estimate of the average wage rate and quarterly employment growth. We can combine this information with end-of-fiscal-year estimates of the level of employment in Compustat to estimate firm-wide wages and employment in each quarter. For example, labor’s share involves a comparison of the wage bill to the firm’s revenue. Because revenue is based on sales in all geographic segments, the wage bill must be comparable. Accordingly, we scale LDE employment so that its average coincides with the mean in Compustat. We then measure the total wage bill for the firm as the product of this scaled LDE series and average labor earnings in the LDE.

Changes in ownership

A second challenge has to do with changes in ownership. Suppose a parent divests several establishments between 2006 and 2012. If those establishments adopt new EINs, we will, appropriately, exclude them when aggregating across the parent’s EINs. However, we have noticed that if the establishments operated as a wholly owned subsidiary and if the entire subsidiary is divested, then the plants may retain their original EINs. This situation is especially likely if the subsidiary—and its establishments—never shared the same EIN as its original parent’s headquarters, and if it continues intact under the new parent. In these cases, we would (wrongly) continue to assign these establishments’ employment to the original parent, since they report the same EIN as in 2006. To address this concern, we try to identify likely changes in ownership based on “jumps” in Compustat’s data on assets. Using internet searches, we then determine if a change in ownership did occur and make an allowance for this in the matching code.
Data definitions

Our Compustat variables are defined as follows. Investment is given by \( (\text{CAPXY} - \text{SPPEY}) / \text{lag(PPENTQ)} \). Because CAPXY and SPPEY are reported cumulatively over the year, we first difference to obtain the actual quarterly expenditures. Net debt is defined as book assets minus book equity minus cash: \( \text{ATQ} - \text{SEQQ} + \text{TXDITCQ} + \text{PSTKQ} - \text{CHEQ} \). Leverage is book debt scaled by ATQ. Operating income is IOBDPQ.

In the LDE, monthly employment at the establishment is defined as employment in the pay period including the 12th of the month. We average monthly employment over each calendar quarter to create the quarterly panel. The monthly wage bill is total wages paid by the establishment during the month. We calculate the average wage by simply dividing the wage bill by employment and, again, take the quarterly average. For both the LDE and Compustat variables, we winsorize the top and bottom 2.5% of observations.

Appendix B

In this appendix, we derive equation (11) in Proposition 1.

Preliminaries

The wage bargain sets the wage rate to split the marginal match surplus between the firm and worker. Let \( J \) denote the firm’s surplus and \( W(k', n', b', z) \) the worker’s surplus. The wage then solves:

\[
W(k', n', b', z) = \psi \left( J(k', n', b', z) + W(k', n', b', z) \right),
\]

where \( \psi \in (0, 1) \) is the worker’s bargaining power. In what follows, we first assess \( J(k', n', b', z) \) and then turn to the worker’s problem.

Throughout, we make use of an approximation to facilitate the analysis. We assume that states of nature where dividends are exactly zero are sufficiently unlikely to be realized that they may be neglected. As noted in the main text, this is a good quantitative approximation because these states are rare unconditionally and, if one does occur, it is unlikely to be repeated soon. As a result, the
evaluation of the firm’s future marginal value of labor assumes that its choice of future debt, \( b' \), is not constrained to ensure dividends are zero. Therefore, the Envelope theorem will apply to future debt decisions, such that perturbations to this period’s labor will not alter future debt outcomes. This assumption preserves the tractability of the problem.

**The firm’s problem**

Because a vacant job yields zero return to the firm, the firm’s surplus is the marginal value of labor, which can be expressed as:

\[
\mathcal{J} (k', n', b', z) = -\frac{\partial W (k', n', b', z)}{\partial n'} + \rho \frac{\partial}{\partial n'} \mathbb{E} [\Pi (k', n', b', z')], \tag{17}
\]

in which the expectation is taken with respect to the conditional distribution function \( G(z' | z) \).

Note that the arguments of the wage bill, \( W (k', n', b', z) \), preview the solution below. The first term in (17) represents the effect of a new hire on the wage bill. Note that, for given \( b' \) and \( k' \), a perturbation to \( n' \) affects dividends solely via \( W (k', n', b', z) \). Such a perturbation does not imply a marginal adjustment cost, because these costs are sunk by the time the surplus is divided. The second term in (17) expresses the future marginal value of labor. To evaluate this term, we must explore the firm’s labor demand decision in greater detail.

Linear factor adjustment costs imply that the optimal employment policy can be decomposed into three regimes. For a low range of productivity realizations, the firm fires; for a high range of productivity draws, the firm hires; and for an intermediate range, the firm does not adjust employment. Non-adjustment is optimal in some states of nature because the marginal cost of adjusting is discretely higher than zero. Therefore, for small fluctuations in productivity, the marginal benefit of adjusting does not exceed marginal cost. In the absence of financial frictions, it can be shown that this structure of adjustment frictions implies an optimal employment policy of this form (see Elsby and Michaels 2013).

In case the firm fires, we conjecture that capital demand is non-increasing, that is, the firm
either opts not to undertake gross investment or chooses to disinvest. This policy is optimal under frictionless credit markets if the cost of adjusting capital is sufficiently large relative to the cost of adjusting labor (Dixit 1997; Eberly and Van Mieghem 1997). In the same spirit, we conjecture capital demand is non-decreasing if the firm hires, and that gross investment is zero if the firm chooses not to adjust employment. We then verify in our simulations that this policy obtains.

By Leibniz’s rule, this optimal labor demand policy implies that the marginal value of labor is:

$$
\frac{\partial}{\partial n'} \mathbb{E} \left[ \Pi \left( k', n', a', z' \right) \right] = \int \frac{\partial}{\partial n'} \Pi^f \left( k', n', b', z' \right) dG \left( z' \mid z \right) + \int \frac{\partial}{\partial n'} \Pi^0 \left( k', n', b', z' \right) dG \left( z' \mid z \right) + \int \frac{\partial}{\partial n'} \Pi^h \left( k', n', b', z' \right) dG \left( z' \mid z \right),
$$

where the subscript in a value function, such as $\Pi^f$, refers to the labor demand regime. For example, “$f$” is for firing. To evaluate this continuation value, we consider each of the three regimes in turn.

**Firing**

Consider a firm that is calculating the future marginal value of this period’s labor choice, $n'$, in the event that it will be firing in the subsequent period ($n'' < n'$). The value of the firm next period is given by:

$$
\Pi^f \left( k', n', b', z' \right) = \max_{b''} \left\{ \frac{a(k', n', b', z') + b''/(1 + r(\cdot)) - W(k'', n'', a'', z') - R(i')}{\rho} + \rho \int \Pi \left( k'', n'', a'', z'' \mid z' \right) dG \left( z'' \mid z' \right) \right\}. \quad (19)
$$

Note that, if the firm defaults at the beginning of the period, the firm’s output and fixed assets are transferred to the lender such that $a(k', n', b', z')$ is reset to zero. Hence, (19) holds but with $a(k', n', b', z') = 0$.

By the envelope theorem, a firm this period calculates the future marginal value of labor in this regime to be:

$$
\frac{\partial}{\partial n'} \Pi^f \left( k', n', b', z' \right) = \frac{\partial a(k', n', b', z')}{\partial n'}. \quad (20)
$$

This condition states that because the firm will re-optimize its labor demand next period ($n'' < n'$),
the only effect of the labor choice, \( n' \), on the firm’s future present value is channeled through labor’s marginal effect on via start-of-next period cash on hand. Clearly, if the firm defaults, then \( \partial a(k', n', b', z') / \partial n' = 0 \).

**Hiring**

A hiring firm’s present value as of next period is:

\[
\Pi^h \left( k', n', b', z' \right) = \max_{b''} \left\{ \left( a(k', n', b', z') + b'' / (1 + r(\cdot)) - W \left( k'', n'', a'', z' \right) - c^n \Delta n'' - R (i') \right) + \rho \int \Pi \left( k'', n'', a'', z'' \right) dG \left( z' \mid z'' \right) \right\}.
\]

Again, if the firm defaults in this state of nature, \( (21) \) obtains with \( a' = 0 \). By the envelope Theorem, the marginal value of labor is then:

\[
\frac{\partial}{\partial n'} \Pi^h \left( k', n', b', z' \right) = \left( \frac{\partial a(k', n', b', z')}{\partial n'} + c^n \right),
\]

with \( \partial a(k', n', b', z') / \partial n' = 0 \) in the case of default. As in the firing case, the choice of \( n' \) affects the firm’s future present value start-of-next period cash on hand. In this case, however, because of the hiring cost, we must account for this extra term.

**Inaction**

Next, consider a firm that does not adjust next period, that is, \( n'' = n' \). Given that, under our conjecture, \( \Delta k'' = 0 \), as well, the firm’s present value is:

\[
\Pi^0 \left( k', n', b', z' \right) = \max_{b''} \left\{ \left( a(k', n', b', z') + b'' / (1 + r(\cdot)) - W \left( k', n', b', z' \right) + \rho \int \Pi \left( k', n', b', z'' \right) dG \left( z'' \mid z' \right) \right) \right\}.
\]

By the envelope theorem (as applied to \( b'' \)), the firm this period calculates the future marginal value of this period’s labor to be:

\[
\frac{\partial}{\partial n'} \Pi^0 \left( k', n', b', z' \right) = \left( \frac{\partial a(k', n', b', z')}{\partial n'} - \frac{\partial W \left( k', n', b'', z' \right)}{\partial n'} \right) + \rho \frac{\partial}{\partial n'} \int \Pi \left( k', n', b'', z'' \right) dG \left( z'' \mid z' \right)
\]

\[
= \frac{\partial a(k', n', b', z')}{\partial n'} + J \left( k', n', b', z' \right).
\]
Summing up

Piecing together (20), (22), and (24) and combining with (17) yields:

\[
\mathcal{J} (k', n', b', z) = - \frac{\partial W (k', n', b', z)}{\partial n'} + \rho \left\{ \int_{\text{Non-default}} \frac{\partial a(k', n', b', z')}{\partial n'} dG (z' | z) \right\} \\
+ c^n \left( \int_{\text{Hiring}} dG (z' | z) + \int_{\text{Inaction}} \mathcal{J} (k', n', b'', z') dG (z' | z) \right).
\]

(25)

Note that, as anticipated by the discussion above, the partial effect of \( n' \) on net worth \( a(k', n', b', z') \), \( \partial a(k', n', b', z') / \partial n' \), is weighted by the probability of survival.

Surplus sharing

The firm and worker split the match surplus according to (16). The worker’s surplus is given by:

\[
W (k', n', b', z) = w (k', n', b', z) - \mu + \rho \int (1 - s') : W (k', n', b', z') dG (z' | z),
\]

(26)

where \( w (k', n', b', z) \equiv W (k', n', b', z) / n' \) is the wage per worker, \( \mu \) is the flow return to non-employment, and \( s' \) is the endogenous probability of separation from the firm next period. The surplus-sharing arrangement (16) sets \( W (k', b', n', z') = \frac{\psi}{1-\psi} \mathcal{J} (k', b', n', z) \). Because \( b' \) and \( n' \) are chosen optimally, the first-order conditions for a firing firm imply that it fires until the marginal value of a worker is zero. That is, differentiating (19) with respect to \( n' \) shows:

\[
\Delta n' < 0 : \mathcal{J} (k', n', b', z) = 0.
\]

(27)

By the same logic, a hiring firm expands employment until the marginal value of labor is just offset by the hiring cost, \( c^n \). Therefore,

\[
\Delta n' > 0 : \mathcal{J} (k', n', b', z) = c^n.
\]

(28)

If the firm does not adjust \( n \), then \( \mathcal{J} (k', n', b', z) = \mathcal{J} (k, n, b', z) \).
Combining these expressions, using the mapping from \( W(b', k', n', z') \) to \( J(b', k', n', z') \), and substituting into (26) yields:

\[
W(k', n', b', z) = \frac{W(k', n', b', z)}{n} - \mu \\
+ \rho \frac{\psi}{1 - \psi} \left\{ \int_{\text{Inaction}} J(b', k, n, z') \, dG(z' | z) + \int_{\text{Hiring}} c^ndG(z' | z) \right\}.
\] (29)

Next, we substitute (25) and (29) into the surplus-sharing rule (16). After canceling terms and noting that \( \frac{\partial W(k', n', b', z)}{\partial n'} = w(k', n', b', z) + \frac{\partial w(k', n', b', z)}{\partial n'} n' \), we have:

\[
(1 - \psi) \frac{W(k', n', b', z)}{n'} + \psi \frac{\partial W(k', n', b', z)}{\partial n'} = \psi \rho \int_{\text{Non-default}} \frac{\partial a'}{\partial n'} dG(z' | z) + (1 - \psi) \mu. \tag{30}
\]

Equivalently, we can recall that default is a single crossing condition, namely, the firm defaults if productivity, \( z' \), is less than a threshold, \( \hat{z}(k', n', b', z) \). Then (30) becomes:

\[
(1 - \psi) \frac{W(k', n', b', z)}{n'} + \psi \frac{\partial W(k', n', b', z)}{\partial n'} = \psi \rho \int_{\hat{z}(k', n', b', z)} \frac{\partial a'}{\partial n'} dG(z' | z) + (1 - \psi) \mu.
\]

This expression is the same as (11) in Proposition 1.

**Remark 1**

Our neglect of future zero-dividend states should not be taken to mean that the possibility of a zero-dividend state, conditional on a labor demand policy, is unimportant to the firm’s decision. Rather, the key observation is that the continuation values in the surplus-sharing rule reflect the firm’s optimal response to this possibility. In simulations of the model, this best response appears to reduce the probability that a zero-dividend state is realized to a virtually negligible level. As a result, our solution to the wage represents a very good approximation.