Labor shortage, Hiring and Stock Returns

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Abstract

In this paper, I find labor hiring constraint matters for stock return, and is essential to explain the negative hiring-return relation, both in the cross section and in time series. To proxy for labor hiring constraint, I construct a firm-year level measure of labor shortage using textual analysis of firms' SEC fillings. Via portfolio sorting and predictive regression, I show that labor shortage predicts low stock return, and the negative relationship between firm's hiring rate and its future return is only significant for firms that discuss labor shortage in their filings. These patterns are consistent with predictions from a neoclassical framework with hiring adjustment cost. In addition, I document relations between labor shortage and firms' policy and operation dynamics. Firms of high growth are more likely to discuss labor shortage. Once they do, their current hiring and future investment rate drop, leverage and book to market ratio increase. These findings are robust to small firm bias, and alternative interpretations of labor shortage measure.

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1 Introduction

Most firms list employees as their top concerns (Graham, 2022), which is hard to explain if labor market is frictionless. By friction, I mean the source of convex hiring cost that increases with hiring rate. Such conceptualisation of friction is common in contexts such as financial constraint (Farre-Mensa and Ljungqvist, 2016)[1]. Firms without hiring constraint should not be concerned with labor shortage. Therefore, labor shortage indicates hiring constraint. According to Q theory, firm's market value should reflect its rent from employed labor (Merz and Yashiv, 2007)[2]. Market prices in such rent by acknowledging that hiring constraint makes it costly for firms to adjust human capital. Hiring decision thus becomes forward-looking: firms incur high cost of adjusting human capital to reach high hiring, if and only if it can be compensated by high enough valuation, which is obtained from low discount rate, implying a negative relationship between hiring and future return (Belo, Donangelo, Lin, and Luo, 2023). A direct test of the effect of hiring constraint on the relation between hiring and firm value necessitates a good empirical measure of such constraint, which has been difficult given limited labor related accounting information at firm level.

This paper intends to fill the gap. In particular, I propose a text based measure of such hiring friction, through the lens of labor shortage. The idea is simple: similar to measuring financial constraint using firm's SEC filings (Hoberg and Maksimovic, 2015), one should also be able to identify firms who are concerned with labor constraint, henceforth labor shortage, from the same text. I show that compared to non labor-shortage firms, return is on average 4% annual percentage points lower for the labor-shortage ones, and the hiring spread is 11% annual percentage points higher, defined as the return from low-minus-high-hiring zero-cost portfolio. Figure 1 demonstrates the main result from two-way portfolio sorting based on hiring rate and labor shortage state. It shows that the hiring spread $(L - H)$ documented

[1] See Appendix for a graphic illustration of hiring friction in Figure A.1.

[2] "*Labor explicitly enters the picture (firm's value) whenever there are frictions in the labor market*"

by Belo, Lin, and Bazdresch (2014) mainly comes from firms that mention labor shortage, likely of more binding labor constraint. Conversely, Figure 2 shows that when forming a zero-cost portfolio by longing the non labor shortage firms, and shorting the labor shortage firms, the strategy $(N - S)$ yields economically significant positive returns only for the high hiring subsample. Both difference in spread can be attributed to the rather low return of high-hiring and labor-shortage portfolios, which from a risk-based perspective indicates that these firms are of lower systematic risk to aggregate shock. I rationalise these observations via a characteristic based model based on Q theory.

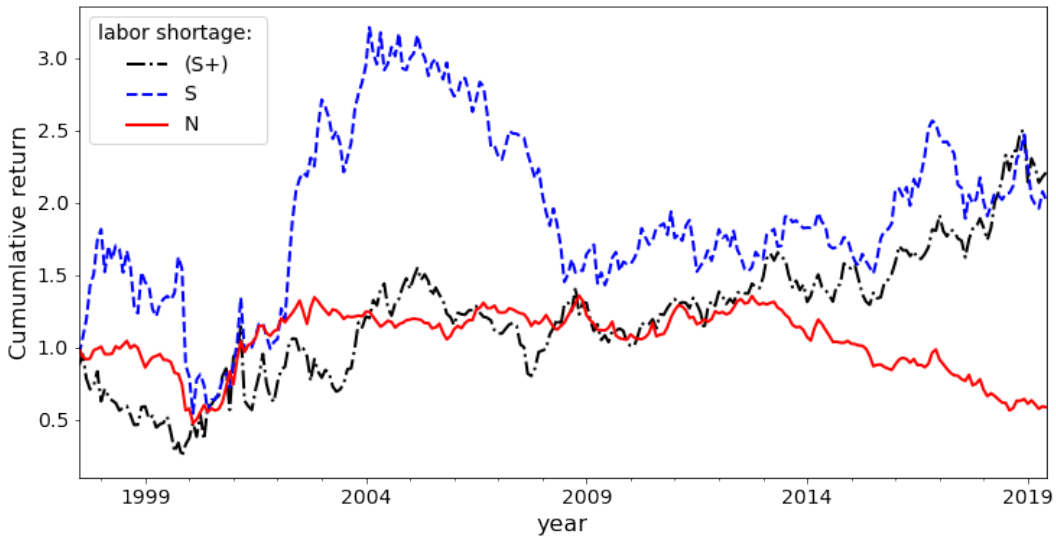


Figure 1: Hiring spread (L-H)

Note: This figure demonstrates the graphical results from two-way sorting by firm's hiring rate and labor shortage mentioning status. Each line represents the cumulative return from a zero-cost portfolio formed by buying low hiring firms and shorting high hiring firms, also denoted as labor shortage spread (L-H). The red solid line is the L-H spread formed on the non-labor shortage subsample, whereas the blue dashed line is formed on the labor shortage subsample. The black dot line represents the subsample where firms discuss labor shortage the most.

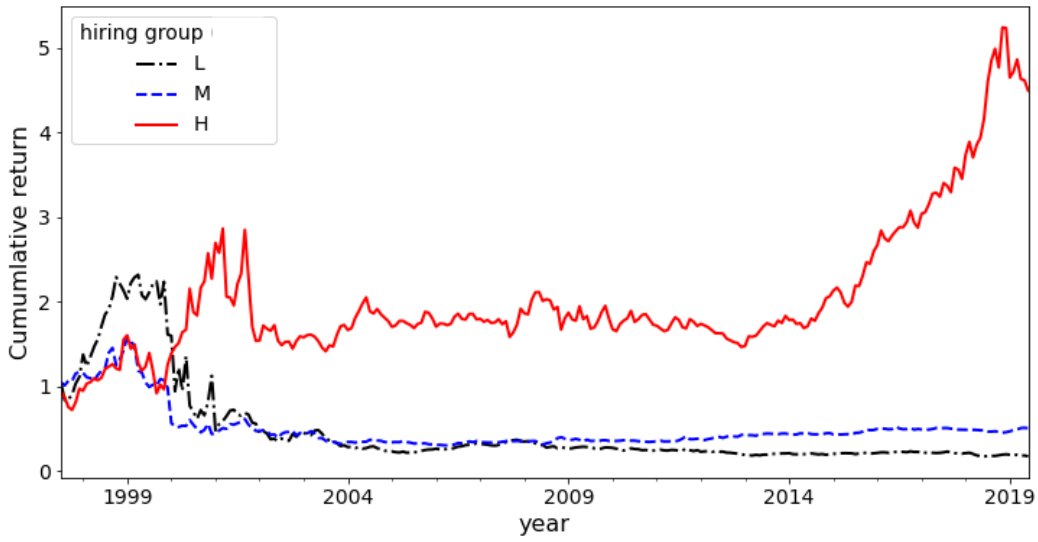


Figure 2: Labor shortage spread (N-S)

Note: This figure demonstrates the graphical results from two-way sorting by firm's hiring rate and labor shortage mentioning status. Each line represents the cumulative return from a zero-cost portfolio formed by buying non labor shortage firms and shorting labor shortage firms, also denoted as labor shortage spread (N-S). The red solid line is the N-S spread formed on the high hiring subsample, whereas the black dot line is formed on the low hiring subsample, and the blue dashed line is formed on the middle hiring subsample.

This paper relates closely to Belo et al. (2014), as they first document a negative hiring-return cross-sectional relation, and explain it using an investment-based model with costly hiring adjustment cost. However, there is no cross-section variation in firms' hiring constraint in their model. Based on a simple neoclassical framework, I explore novel theoretical implication by allowing hiring adjustment cost differ across firms. Two main implications emerge. First, all else equal, labor market friction (hiring constraint) corresponds to lower return. Second, hiring constraint is necessary for the negative hiring-return pattern to exist, and as hiring constraint increase, the pattern also gets stronger.

The paper makes it possible to test theory predictions by providing a firm-year level mea-

sure of labor shortage that proxies labor hiring constraint. To measure such constraint, I propose a simple and explicit two-step construction of firm-year labor shortage measure based on firms' SEC filings from 1997-2018: 10-K, 10-Q, and 8-K. Specifically, I first search through all these filings for the key word "shortage"; then within each sentence that contains "shortage", I check whether it mentions any word related to "labor" according to a synonym list. This way, I know whether a firm in a given year mentions shortage or not. And if so, whether it is labor related. I show the constructed measure is informative about the business cycle and industry characteristics at aggregate level. Over time, the aggregate fluctuation of labor shortage is pro-cyclical, negatively related to unemployment rate. Cross-sectionally, much of the labor shortage happens in industries such as manufacturing, service, mining and construction, classified according to SIC1 sectors.

Using the labor shortage measure, I find that higher hiring growth firms are more likely to mention labor shortage, but not necessarily for other type of shortages, which suggests an unique association between hiring and labor specific shortage. This makes sense because labor hiring constraint can be endogenously affected by the hiring rate. In addition, labor shortage mentioning firms in general tend to have higher return on asset, lower book to market ratio, leverage and bigger size. Despite that large and growth firms are known to have lower returns, later I show that these characteristics cannot explain why high hiring firms earn low returns when they mention labor shortage.

I compare a variety of corporate variables between firms that mention labor shortage in their SEC filings and firms that do not. The findings largely align with intuitions. For example, for firms that mention labor shortage, their past hiring rate are higher than the rest on average, yet their hiring rate drops below that of non labor shortage mentioning firms concurrently, as they mention labor shortage. labor shortage firms also experience decline of investment rate, firm size, and book to market ratio, increase of leverage. All together these evidence

supports the view that labor shortage mentioning is not cheap talk, and is informative of firm's future corporate policy.

These findings regarding labor shortage, hiring and stock return, along with firm operation outcomes, are consistent with the neoclassical theory of human capital investment (Belo et al., 2014). However, I also note the following limitation. The objective is to empirically document the essential role labor shortage plays in contributing to the negative hiring-return relationship. Because I report associations and not direct causal relationships, my findings should be viewed as suggestive. Further research, especially natural experiments or instrumental variable tests, should be fruitful for establishing causality.

This paper is organised as follows. In Section 2, I review relevant work. In Section 3, I set up a simple Q theory model to elaborate the theoretical foundation of labor shortage. In Section 4, I describe my sample of firms and empirical construction of labor shortage. In Section 5, I conduct portfolio sorting and predictive regression to show labor shortage is necessary for a negative hiring-return relationship. In Section 6, I show aggregate hiring predicts lower future return especially when labor market is tight. In Section 7, I present conclusions.

2 Literature

First, the paper is directly related to papers that extract information from corporate related text regarding certain constraint or risk, that are normally hard to directly infer from structured data. For example, a variety of papers intend to infer the extent to which firms are facing trouble financing their investment, known as financing constraint. Lamont, Polk, and Saaá-Requejo (2001) manually read through a subsample of firm SEC filings, and categorise them by the extent to which they are concerned with financing. Hoberg and Maksimovic (2015) look for expressions regarding delaying investment, equity and debt issuance in the management discussion and analysis session of 10-K filling, and assign financing constraint scores to the entire sample based on cosine similarity. Buehlmaier and Whited (2018) take a naive Bayesian approach to evaluate firm's financing constraintedness as a function of word appearance in the 10-K[3]. My paper proposes a simple and explicit two-step procedure to extract useful labor shortage information from firm's SEC filings.

Second, despite the rising application of textual analysis of corporate filings, few focuses on production related measure of constraintedness, which are mostly based on another commonly used source of text, earnings call[4]. Ersahin, Giannetti, and Huang (2023) use conference call to measure supply chain risk and uncertainty from quarterly conference call, and find implications in supplier composition and vertical integration[5]. Darmouni and Sutherland (2023) use equipment transaction level data to study the effect of capital supply on firms. The closest paper to mine is Harford, He, and Qiu (2023), who use conference calls to construct firm level labor shortage. Different from their focus on corporate decisions, I mostly analyse asset pricing patterns through a neoclassical framework of Q theory. Since

[3]Examples of using 10-K to obtain information includes product market competition Hoberg and Phillips (2016), product life cycle Hoberg and Maksimovic (2022), etc.

[4] For example, Hassan, Hollander, Van Lent, and Tahoun (2019) use it to construct firm level political risk, and find that firms exposed to political risk retrench hiring and investment and actively lobby and donate to politicians.

[5]Recent works using non textual analyses to study supply chain shortages include Acharya, Crosignani, Eisert, and Eufinger (2023) and Franzoni, Giannetti, and Tubaldi (2023).

existing data source[6] of labor shortage only provide measures at state and industry level, my firm level text-based measure of labor shortage contributes to the nuance of measurement.

Next, the paper builds on asset pricing literature where certain forms of labor market friction are important in explaining return patterns. For example, Belo et al. (2014) document the negative hiring-return relationship, and interpret it as differential of risk associated to the existence of labor market friction. The intuition is, because of adjustment cost of labor, high hiring firms are those that incur high adjustment cost. Aggregate shocks that lower such cost will benefit the most therefore serves as a hedge. Tuzel and Zhang (2017) finds that wage pro-cyclicality as expense also hedges firms' value. Petrosky-Nadeau, Zhang, and Kuehn (2018) shows that searching friction in labor market can give rise to rare disasters. Regardless of which specific friction these papers motivate, there must be some inefficiency in the labor market that leads to the labor-return connection. Therefore, the labor shortage as a proxy of labor hiring constraint can be used to test models that rely on such friction at firm level. My paper provides the first empirical findings that document both the relation between labor shortage and return, and more importantly how labor shortage strengthens the negative relation between labor hiring and return.

Lastly, the paper is related to labor and firm growth literature. Le Barbanchon, Ronchi, and Sauvagnat (2022) uses French private sector firm level micro-data to show that hiring difficulties can have negative effect on firm growth, and such effect is stronger for firms in expanding and hard-to-substitute sectors. Bai, Fairhurst, and Serfling (2020) uses state-level employment protection law variation to show that stronger protection decreases firm's investment and sale's growth, explained by increased investment irreversibility, which is a form of adjustment cost.

[6]For the US data, one can refer to America Works Data; for German data, one can refer to IAB Labour Shortage Index

3 Theoretical motivation

Before entering into empirics, it helps clarify the question by laying out the basic idea of Q theory, and most importantly, explaining how the following empirical tests are related to the theory. Much of the introduction borrows knowledge from Campbell (2017)[7] and Zhang (2017). In the context of human capital investment, at the core of Q theory, it concerns the optimal hiring decision[8] of a given firm. A value-maximising firm will keep hiring until its marginal benefit equal to marginal cost. Productivity is typically an important element that goes into the marginal benefit, whereas on the marginal cost side, it usually concerns production related real cost, which is also referred to as hiring adjustment cost. The theory thus establish a connection between optimal hiring and the level of labor market friction.

Once the optimal hiring is obtained, one can always define hiring return, which is next period output plus continuation value (stochastic), divided by today's total cost of hiring. The key message is that, expected investment return should be negatively related to the rate of hiring, because holding expected output fixed, the higher the expected return, the lower the present value the firm's human capital stock is, therefore the firm has less desire to hire. Finally, to tie hiring return to stock market return, additional assumptions are needed, for example constant returns to scale in both production and adjustment costs (Hayashi, 1982).

To sum up, the neoclassical Q theory of human capital investment allows stock return to be negatively related to hiring rate, under the presence of hiring adjustment cost as key friction embedded in the production process. The rest of this chapter conveys the same intuition in formal expressions.

[7] Chapter 7, pg 207-215.
[8] A particular form of investment where capital is human.

3.1 Model setup

Consider a canonical two-period stochastic partial equilibrium model focusing on the production side of economy, a simplified version from Zhang (2017). Given that the paper focus on labor hiring, I characterise firms as pure human capital based productive units, but the main mechanism works through for physical investment as well. The defining feature of this neoclassical economics is firms maximise their market value of equity taken as given an exogenous stochastic discount factor M_{t+1}. There are two dates, t and $t+1$, firms produce a single commodity to be consumed or invested, the price of which is normalised to 1. Firm i starts with productive human capital, K_{it}, operates in both dates, and exits at the end of date $t+1$ with a liquidation value of zero. The rate of human capital depreciation is set to be 100% for simplicity. Firms differ in human capital, K_{it}, and profitability, X_{it}, both of which are known at the beginning of date t. The operating profits are given by $\Pi_{it} = X_{it}K_{it}$. Firm i's profitability at date $t+1$, X_{it+1}, is stochastic, and is subject to aggregate shocks affecting all firms simultaneously, and firm-specific shocks affecting only firm i. Let I_{it} be the among of labor hired for date t, then $K_{it+1} = I_{it}$. Hiring entails quadratic adjustment costs, $(a/2)\left(I_{it}/K_{it}\right)^2 K_{it}$, in which $a > 0$ is a constant parameter.

Generally speaking, hiring adjustment cost form the model is a catch-all term summarising the convex cost in installing new human capital. A firm facing such cost will find it increasing costly to hire as they increase hiring rate. This may arise from searching friction, or increasing expense in training the workers and getting them ready to work. The paper is agnostic about the exact micro foundation of giving rising to hiring adjustment cost. Instead, it takes the concept as a starting point of the test. Following the literature, I refer to I_{it}/K_{it} as hiring rate thereafter.

Firm i uses its operating profits at date t to pay hiring cost I_{it} and adjustment costs $(a/2)\left(I_{it}/K_{it}\right)^2 K_{it}$. Therefore, its free cash flow at date t, D_{it}, can be expressed as $X_{it}K_{it} -$

$I_{it} - (a/2)\left(I_{it}/K_{it}\right)^2 K_{it}$. If D_{it} is positive, the firm distributes it back to the household. A negative D_{it} means external equity raised by the firm from the household. At date $t+1$, firm i uses capital, K_{it+1}, to obtain operating profits, which are in turn distributed as dividends, $D_{it+1} \equiv X_{it+1}K_{it+1}$. With only two dates, firm i does not invest in date $t+1, I_{it+1} = 0$, and the ex-dividend equity value, P_{it+1}, is zero. Taking the household's stochastic discount factor, M_{t+1}, as given, firm i chooses I_{it} to maximise the cum-dividend equity value at the beginning of date t:

$$P_{it} + D_{it} = \max_{\{I_{it}\}} \left[X_{it}K_{it} - I_{it} - \frac{a}{2}\left(\frac{I_{it}}{K_{it}}\right)^2 K_{it} + E_t\left[M_{t+1}X_{it+1}K_{it+1}\right] \right]$$

The first order condition of investment says that:

$$1 + a\frac{I_{it}}{K_{it}} = E_t\left[M_{t+1}X_{it+1}\right]$$

The left-hand side is the marginal cost of hiring: unit cost of human capital and marginal adjustment cost; and the right-hand side is the marginal benefit of hiring, or more popularly referred to as marginal Q: expected discounted present value of date $t+1$'s operating profit per unit of human capital. Firm i hires until marginal cost equal to marginal benefit. Next, I show what stock return has to do with this condition.

By definition, stock return of firm i from date t to date $t+1$ can be expressed as:

$$r^S_{it+1} \equiv \frac{P_{it+1} + D_{it+1}}{P_{it}} = \frac{X_{it+1}K_{it+1}}{E_t\left[M_{t+1}X_{it+1}K_{it+1}\right]} = \frac{X_{it+1}}{E_t\left[M_{t+1}X_{it+1}\right]} = \frac{X_{it+1}}{1 + a\left(I_{it}/K_{it}\right)} \qquad (1)$$

Here the second equality uses the fact that this is a two-period model where $P_{it+1} = 0$, $D_{it+1} \equiv X_{it+1}K_{it+1}$, and ex-dividend price of firm i at date t is its expected discounted present value of date $t+1$'s operating profit: $P_{it} = E_t\left[M_{t+1}X_{it+1}K_{it+1}\right]$, The third equality uses the fact that human capital depreciates fully such that at date $t+1$ capital is actually

determined at date t: $K_{it+1} = I_{it}$, therefore K_{it+1} can be taken out of the expectation operator and gets cancelled out. The last equality substitutes the denominator by the first order condition of hiring obtained from above.

3.2 Model interpretation

The interpretation of this equation is, holding profitability X_{it+1} fixed, hiring rate I_{it}/K_{it} is negatively related to stock return r^S_{it+1}, which holds if one takes expectation on both sides. In the asset pricing terminology, it is equivalent so say if one constructs a characteristic-based portfolio that longs low hiring and shorts high investment firms, it will on average generate positive return, which was documented documented and explained explicitly in Belo et al. (2014) and Belo et al. (2023). As for physical investment, such investment spread has also been well documented, as early as in Titman, Wei, and Xie (2004) [9]. Given more consistent findings in follow-up studies, "investment factor" has been officially coined and become part of those main stream multi-factor models, such as Hou, Xue, and Zhang (2015), Fama and French (2015).

Despite ample empirical evidence of hiring and investment spread, no consensus has yet been reached on its explanation[10]. Regarding the debate between behavioural and neoclassical explanation, this paper intends to provide further supporting evidence of the neoclassical Q theory, by testing its additional prediction related to adjustment cost. To convey the full intuition, the paper allows previously constant convex adjustment cost parameter a from Equation 1 to be firm and time varying, such that the relationship between return and hiring:

$$r^S_{it+1} = \frac{X_{it+1}}{1 + a_{it}\left(I_{it}/K_{it}\right)} \tag{2}$$

[9] By constructing five capital investment (CI) portfolios, they find the spread between lowest and highest is 0.168% per month.

[10] For instance, Titman et al. (2004) argues that over investment explains the pattern.

For the moment if a_{it} is fixed, then one obtains predictions between hiring and stock return:

Hypothesis 1. *The faster the firm hires (higher I_{it}/K_{it}), i.e., as the firm incurs higher marginal cost of hiring, the lower is the stock return such that the marginal benefit is large enough to compensate the cost, holding profitability and hiring constraint fixed.*

The paper is not the first to propose and test this prediction. For example, Belo et al. (2014) find consistent empirical evidence and explain it using a dynamic model with hiring adjustment cost. The main deviation of my paper from Belo et al. (2014) is that I allow a_it to be firm specific, and examine the following two novel predictions from the model.

Specifically, as both the hiring constraint and hiring rate show up as a product in the denominator of Equation 2, one can also examine how stock return moves as a_{it} varies, the prediction of which can be formulated as follows:

Hypothesis 2. *The larger is labor adjustment cost a_{it}, i.e., as hiring constraint gets more severe, the lower must the stock return be such that firm sticks with the same level of hiring rate, holding profitability fixed.*

The intuition is, as firm becomes increasingly hiring constrained, its hiring adjustment cost also increases. Should the firm not down scale its hiring, the rate of return must be lower to allow room for higher marginal benefit of hiring.

In addition, Equation 2 also gives predictions on how a_{it} moderates the relationship between stock return and hiring rate. First, imagine an extreme case where $a_{it} = 0$, stock return becomes irrelevant to hiring rate, $r^S_{it+1} = X_{it+1}$. When Q theory was first formulated by Tobin (1969), it is actually implicitly assumed that there is no adjustment cost, meaning

$a_{it} = 0$. That's why sometimes people say that optimally firm hires (invests) until marginal $Q = 1$[11]. The bottom line is, without adjustment cost, the relationship between stock return and hiring disappears.

More formally, one can check whether as a_{it} becomes larger, i.e., as new labor is more costly to put into use, stock return is more negatively correlated to hiring rate. In model, it is equivalent to ask, whether the first order derivative of r^S_{it+1} with respect to I_{it}/K_{it}, is more negative as a_{it} increases. That is, whether the derivative of $\frac{\partial r^S_{it+1}}{\partial\left(\frac{I_{it}}{K_{it}}\right)}$ with respect to a_{it}, or the cross-second order derivative $\frac{\partial^2 r^S_{it+1}}{\partial\left(\frac{I_{it}}{K_{it}}\right)\partial a_{it}}$, is negative. Starting from Equation 2, one can show that it can be expressed as follows:

$$\frac{\partial^2 r^S_{it+1}}{\partial\left(\frac{I_{it}}{K_{it}}\right)\partial a_{it}} = X_{it+1}\frac{a_{it}\frac{I_{it}}{K_{it}} - 1}{(a_{it}\frac{I_{it}}{K_{it}} + 1)^3}$$

This derivative is negative if and only if $a_{it}\frac{I_{it}}{K_{it}} < 1$, which under ordinary parameterisation will be the case. For example in Belo et al. (2014) a takes value 1.2, and we know that hiring rate on average is about 0.15, so their product is well below 1. This idea can be summarised in the following hypothesis:

Hypothesis 3. *Without hiring constraint (hiring adjustment cost), stock return and hiring rate will not be related. Within reasonable parameter range, as hiring constraint gets more severe, return will be more negatively related to hiring rate.*

Therefore, it takes a good measure of labor hiring constraint to make this hypothesis testable. The next section describe the construction of the measure, and summarise its properties.

[11] Because once $a = 0$, the left-hand side of the first order condition $1 + a\frac{I_{it}}{K_{it}} = E_t\left[M_{t+1}X_{it+1}\right]$ becomes 1, which is also the value of marginal Q.

4 Sample construction

The paper implicitly assumes that as firm's hiring constraint worsens, it is more likely to discuss labor shortage[12] . Therefore, the first and central task of empiric work is to properly capture firm's experience of shortage. As one can imagine, there can be a variety of type of shortage associated to the production of the firm, being it labor, capital, raw material etc. However, just like financial constraint being implicit, such general input constraint measures are rarely established. Among all alternative approaches, textual data provide an opportunity to distinguish shortage firms from their peers. There are several advantages associated with using SEC filing. First, it can timely reflect firm's shortage state at least on annual base. Second, the methodology of identifying shortage is simple and comprehensible, mitigating concern of black box that are commonly seen on natural language processing. Third, the indicator is at firm-year level, enough to test for implications of economic impact and asset price.

In Figure A.2 of Appendix A, I provide a motivating example of Patterson, an oil drilling company who discussed the impediment caused by labor shortage on its operation in its 10-K. In the text, it explains that a rising demand of domestic drilling activity causes labor shortage of its drilling rigs, resulting in wage rise and delay of its core business. Through out the rest of the paper, I define labor shortage firms to be firms that explicitly mention labor related shortage in their SEC filings for a given time. Caveats regarding this definition will be discussed later.

4.1 Constructing shortage indicator from SEC filing

I use WRDS SEC Analytics Suite[13] to identify firms that experience shortage. Given the uncertain occurrence of shortage and potential significant impact of shortage, I confine my

[12]This interpretation is in close parallel with Lamont et al. (2001), which writes: "By 'financially constrained,' we mean that, broadly, the firm is not able to fund all the projects it wants to. This might be due to credit constraints or inability to borrow, inability to issue equity, dependency on bank loans, illiquidity of assets, or similar phenomena."

[13]https://wrds-www.wharton.upenn.edu/pages/get-data/wrds-sec-analytics-suite/

search to 10-K, 10-Q and 8-K within the entire EDGAR database of filing from 1999-2022[14] . SEC regulation S-K adds credence to these filings, where firms are expected to talk about shortage when they face it[15]. The choice of filing type universe is largely driven by ample observations in filings beyond 10-K. For example, pandemic related shortage shoot up in quite a few firms' 10-Q entering 2020. Indeed, Figure 3 confirms that each of the filing source consists of a non-trivial amount of labor shortage observations in the sample, with around 50% from 10-K, 40% 10-Q and 10% from 8-K. It is easy to verify that main results are robust to the choice of filing types. Following Fama and French (1993), I require each firm to have at least two years of data in Compustat before it is included in the sample. The data for the three Fama–French factors (small-minus-big [SMB], high-minus-low [HML], and market [MKT]) are from Kenneth French's Web page.

[14]One concern regarding including Covid period is that results may be driven by Covid dominated shock, I started this project without including Covid sample and the results are qualitative similar.

[15]Firms are obliged to "describe any known trends or uncertainties or any significant economic changes that have had or that are reasonably likely materially affected income from continuing operations...such as known or future increases in costs of labor or materials or price increases or inventory adjustments"

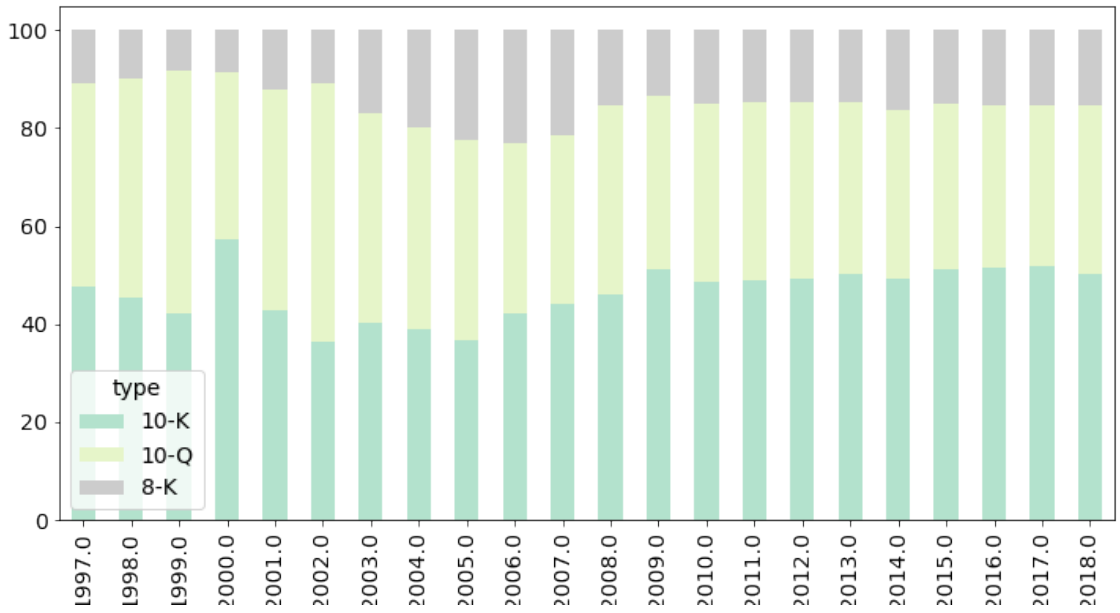


Figure 3: Composition of labor shortage mentioning across SEC filing types

Note: this figure shows the composition of labor shortage mentioning occurrence across SEC filing types over time.

Specifically, I proceed in the following steps [16] . Step one, I search for key word "shortage" from the entire filling universe, which generates a sentence-firm-filing level sample, total of 294747 records (see Figure A.3 in Appendix A as an example of the outcome structure). Since the merging index is CIK for SEC filings with COMPUSTAT, I drop observations where CIK or fiscal year end is missing. Then I combine sentences of the same file of a given firm together. This way I keep 243103 records from 118548 filing-year, and total of 59689 firms-year. Step two, I filter the text records by labor related words. To do so, I refer to Google word2vec pretrained model to form a list of words: "labor", "person", "wage",

[16]Two-step textual search has been widely applied in the past decade to draw informative insights in finance studies. In general, it begins with looking for sentences that contain words from a designated list, then it asks whether the neighbouring words contain expressions in search. To provide a concrete example, Hoberg and Moon (2019) adopts a two-step procedure to measure firm's offshoring activity. In particular, they find paragraphs that contains country names, then they check whether the neighbouring words are within a list of words that indicate offshoring activities. My approach to measuring labor shortage inherits its advantage of being explicit and concise.

"work", "hiring", "skill", "employ", "staff", "welfare", "union", "pension". See Figure A.1 for an example of labor related word reference. I could have done it the same way to construct a list of words closely related to "shortage" in the first step, but it turns out to be less of a need. The first reason is that search for only "shortage" keeps the method simple and explicit. Second, there is little gain from searching for extra words based on the occurrence of shortage mentioning in the sample. As a reference, also see Figure A.1 for list of words related to "shortage". Alternatively, one can construct a list of unigrams and bigrams using GPT based LLMs. The results are robust.

Ideally I hope that each mentioning of the word "shortage" be a perfect reflection of the state of the firm experiencing shortage at that time. Mis-classification can happen in several ways. For example, there are texts where shortage is only mentioned in a generally soft way, containing little information. If this is the case, I shall expect to find the labor shortage indicator being excessively persistent, which is not supported by the Markov transitioning matrix in Table 1. Other mis-classification includes discussing shortage as not likely to happen in the future, instead of what they are actually concerned about. To address this concern, I subjectively restrict the sample to not have a list of words that are negative or in hypothetical tone[17]. In many cases, these two situations tend to happen in the same time, in some corresponding cautionary discussion part of the reports. Lastly, it is likely that firms strategically mention labor shortage in their SEC filings, perhaps to blame it for their weak performance. Such case may be possible in reality, if this is true, I shall expect general shortage mentioning work as good as labor shortage. Yet later I will show that my main results can not be obtained if labor shortage is replaced by non-labor shortage.

In order to merge SEC filing with COMPUSTAT, I use fiscal year and CIK to match. This way, shortage information with be incorporated in public filing 6-30 months before forming

[17]For example, one may not want to count the following sentence as labor shortage: "We do not expect to have labor shortage..."

	no mention	mention only 1	multiple mention	exit
no mention	86.01	3.04	1.15	9.79
mention only 1	36.03	41.48	13.88	8.61
multiple mention	12.14	13.19	65.56	9.11

Table 1: Markov transitioning matrix

the portfolios. This will help distinguish long term story from any short term effect such as post earning announcement drift. There is a small portion of firms that file more than one type of documents in at one time, I combine the text together and set fiscal year the minimum of all. In the meantime, I count total mentioning of labor related "shortage" for each fiscal year-CIK observation.

Apart from using textual analysis to measure labor shortage at firm level such as Harford et al. (2023), there are of course other alternative way of constructing a labor shortage measure. For example, Tuzel and Zhang (2017) form a coarser group level measure of local labor market constraint. Li (2011) relies mainly on reduced-form regression on accounting variables to obtain a measure of financial constraintedness. Hennessy and Whited (2007) represents a structural way of estimation. Other than these survey based measure may also be of use. My paper intends to supplement the space of potential measure on labor shortage, not necessarily claiming that it subsumes others.

4.2 Stock and firm data

Monthly stock returns are from the Center for Research in Security Prices (CRSP), and accounting information is from the CRSP/Compustat Merged Annual Industrial Files. The sample is from July 1997 to June 2022 and includes firms with common shares (shrcd = 10 and 11) and firms traded on the New York Stock Exchange, the American Stock Exchange, and NASDAQ (exchcd = 1, 2, and 3). I omit firms whose primary standard industrial classification is between 4900 and 4999 (regulated firms) or between 6000 and 6999 (financial

firms) Following Belo et al. (2014), I require a firm to have a December fiscal year end to align the accounting data across firm. Latter I show relaxing such choice does not drive away the results. Following Fama and French (1993), I require each firm to have at least two years of data in Compustat before it is included in the sample. The data for the three Fama–French factors (small-minus-big [SMB], high-minus-low [HML], and market) are from Kenneth French's Web page.

4.3 Summary statistics

I first present time series trend and cross-sectional industry composition of labor shortage, then I show the summary statistics of hiring rate and other key accounting variables. In particular, I compute the median of accounting variables conditional on labor shortage state. Lastly, I perform an event study analysis to show how labor shortage firms differ from non labor shortage ones on key accounting variables before and after mentioning labor shortage.

In Table 2, I show the summary statistics from SEC filings aggregated to year level. In the case of extracting shortage from 10-K, on average 15% of firms have mentioned shortage in their 10-K, and about one third of them are labor related, which is about 400 firms in an average year, or 5% of all listed firms. This ratio lies in a reasonable range if compared with previous literature that study financial constraint.

In Figure 4, I plot shortage and labor shortage ratios over years. shortage ratio is defined to be the number of all shortage mentioning firms in a given year divided by the total amount of firms of that year. Labor shortage ratio is construct similarly with the numerator being the number of labor-specific shortage mentioning firms. Several features are worth mentioning. First, even though the ratios are relatively flat in large part of the sample, it does not mean that at firm level this status is nearly time invariant, on the contrary, firms switch in and out frequently (see Table 1). Therefore, if only aggregate level statistics are available,

	Total firms	Shortage firms	Labor Shortage firms	Shortage ratio	Labor Shortage ratio	Labor Shortage among Shortage
year	23	23	23	23	23	23
mean	8006	1213	415	0.15	0.05	0.33
std	909	348	180	0.05	0.02	0.05
min	6247	595	168	0.09	0.03	0.27
25%	7302	1104	334	0.12	0.04	0.3
50%	8146	1243	420	0.15	0.05	0.32
75%	8759	1311	444	0.16	0.06	0.36
max	9356	2091	930	0.28	0.13	0.44

Table 2: Summary Statistics of SEC filings

one is likely to miss important firm level dynamics. Second, the sharp increase of all three measures towards the end of the sample corresponds to post-Covid time of supply shortage, especially for labor as it accounts for more than half of all variety of shortage mentioning, as indicated by the red line. This gives rise to the third feature of the data, that is labor shortage seems to be more cyclical than overall shortage mentioning, which is supported by the rise of multiple mentioning of labor shortage during boom time (see the rising black line from Figure A.4). This may be because there exists more friction in labor market, limiting the ability for firm to smooth its hiring. Note that nonlabor related shortage here can be related to inventory, working capital, raw material, equipment, etc.

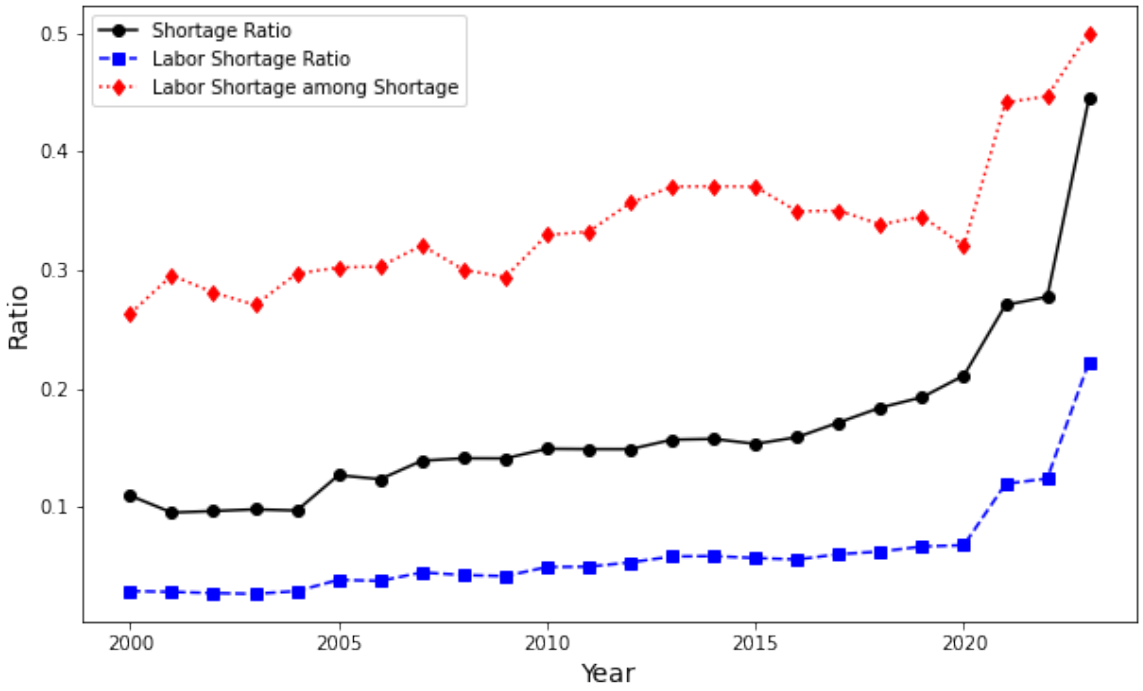


Figure 4: Time series of aggregate labor shortage change and unemployment rate

Note: the black solid line represents annual general shortage firms as a percentage of total 10-K reporting firms; the blue dashed line represents annual labor shortage firms as a percentage of total 10-K reporting firms; the red doted line represents annual labor shortage firms as a percentage of general shortage firms.

In Figure 5, I plot the percentage change of labor shortage mentioning over the sample period, as well as unemployment rate in the US. The main message is that the aggregate measure of labor shortage is pro-cyclical. It decreases during crises and negatively correlates with unemployment rate data obtained from FRED[18]. This aligns with the intuition that labor shortage usually happens at boom.

[18]https://fred.stlouisfed.org/series/UNRATE

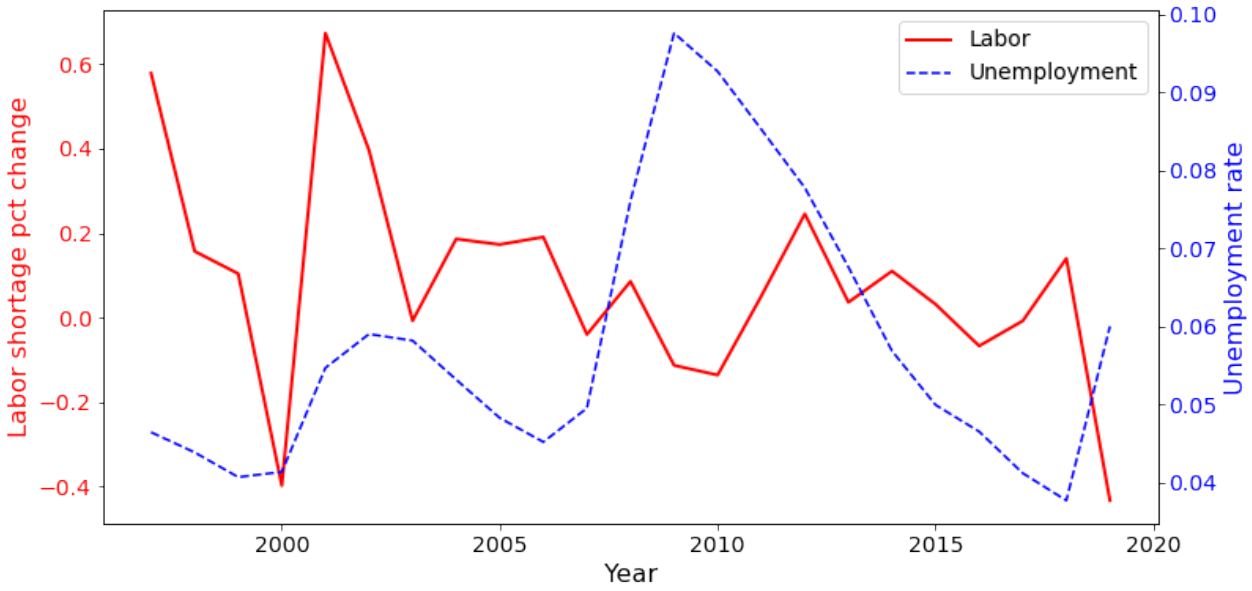


Figure 5: Time series of aggregate labor shortage change and unemployment rate

Note: the red solid line represents annual aggregate labor shortage percentage change, defined as the difference of total mentioning between current year and last year, divided by last year's total mentioning. The blue dashed is annualized US unemployment data.

Apart from patterns from times series, it is also important to check how such measure distributes cross-sectionally. Figure 6 plots comparison across SIC1 industry at both absolute and relative level. In terms of absolute mentioning of labor shortage, manufacturing industry witnesses the most of such mentioning, both for overall shortage and labor shortage. Yet if compared from a relative perspective, such large portion of absolute occurrence can be partially explained by the large based of manufacturing firms. In fact, if viewed from the portion of labor related shortage among all shortage in manufacturing industry, the ratio is the lowest among SCI1 industries. Meaning, when manufacturing firms mention shortage, it is less likely to be labor related shortage. Among all these industries, construction industry is mostly prone to shortage and especially labor shortage, at relative level: over half of construction firms have mentioned shortage in their SEC filings, and 80% of those mentioning are

labor related. This is largely aligned with our common knowledge on labor intensity industry.

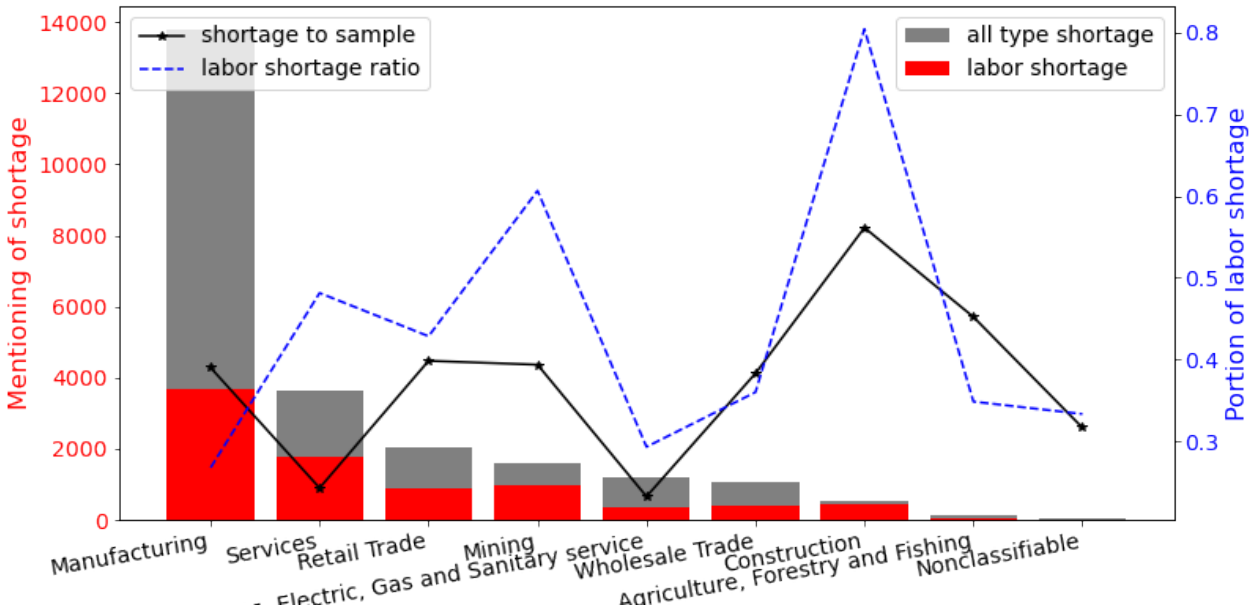


Figure 6: Labor shortage mentioning across SIC1 industries

Note: the bar chart corresponds to left axis, grey level counts total shortage mentioning for a given industry, whereas red level counts only total labor shortage mentioning. The line chart corresponds to right axis. The blue dashed line is the ratio of labor shortage to all shortage, i.e. the red bar divided by the grey bar. The black stared line is the ratio of all shortage mentioning firms to all firms in the given industry.

Next, I compute summary statistics unconditional on labor shortage state, following the name convention of Belo et al. (2014), which is presented in Table 3. In their study, "hn" hiring rate is the key variable, as is highlighted in green in the table. It is defined to be $hn_t = h_t/[0.5 \times (n_{t-1} + n_t])$, in which the number of employees (n_t) is given by Compustat data item EMP, and net hiring (h_t) is given by the change in the number of employees from year $t-1$ to year t ($h_t = n_t - n_{t-1}$). By construction, this measure of labor hiring is symmetric around zero and bounded between ± 200 percent. The investment rate is given by $ik_t = i_t/[0.5 \times (k_{t-1} + k_t])$, in which the physical capital stock k_t is given by data item

PPENT (net property plant and equipment), and physical capital investment (i_t) is given by Compustat data item CAPX (capital expenditures) minus SPPE (sales of property, plant, and equipment). Missing values of SPPE are set to zero.

Summary Statistics

				Percentile			Correlations					
	mean	std	ac1	10%	50%	90%	hn	ik	roa	bm	lev	size
hn	0.05	0.17	-0.04	-0.18	0.03	0.32	1.00	0.27	0.18	-0.10	-0.13	0.17
ik	0.27	0.14	0.18	0.06	0.20	0.60	0.27	1.00	0.16	-0.07	-0.14	0.13
roa	-0.02	0.09	0.18	-0.25	0.03	0.12	0.18	0.16	1.00	-0.16	-0.33	0.30
bm	0.96	0.58	0.25	0.14	0.53	2.23	-0.10	-0.07	-0.16	1.00	0.59	-0.60
lev	0.37	0.12	0.34	0.07	0.32	0.77	-0.13	-0.14	-0.33	0.59	1.00	-0.65
size	6.10	0.68	0.38	3.26	6.12	8.93	0.17	0.13	0.30	-0.60	-0.65	1.00
labor	0.13	0.23	0.14	0.00	0.00	1.00	-0.00	0.03	-0.01	-0.00	0.02	0.09

Table 3: Summary Statistics

Note: this table reports the mean, standard deviation (S.D.), autocorrelation (AC1), the 10th, median and 90th percentiles, and the pairwise correlation of the following variables: hn: hiring rate; ik: physical capital investment rate; roa: return on assets; beme: book to market equity ratio; lev: book debt to market value of the firm; size: log of firm market value; labor: indicator of labor shortage mentioning.

Consistent with the sign in Belo et al. (2014), the hiring rate is naturally related to other firm characteristics. For example, hiring is negatively correlated with book-to-market ratio, and positively correlated with investment rate. Such fact is consistent with neoclassical model, where book-to-market ratio is usually a decreasing function of investment. I later show that after controlling for book-to-market ratio, significant hiring spread still exists for labor shortage firms. Finally, firms with high hiring rates tend to be more profitable and less levered. Last but not least, the last row of Table 3 is "labor", the main variable of interest in this paper, which is a dummy equal to 1 if the firm of the year mentions labor shortage.

Based on the univariate correlation table, larger firms seem to be mentioning labor shortage more often. I will provide more explicit analysis on its relation with other variable in the following paragraphs.

Median of Accounting Variables by groups

	hn	ik	roa	beme	lev	size	ratio%
all sample	0.034	0.203	0.019	0.582	0.364	12.669	100.000
shortage	0.034	0.201	0.024	0.520	0.314	13.172	27.345
nonlabor1	0.029	0.190	0.025	0.545	0.335	12.999	2.086
nonlabor+	0.037	0.208	0.024	0.511	0.298	13.305	15.507
nonlabor	0.031	0.199	0.025	0.524	0.306	13.112	17.593
labor1	0.035	0.204	0.024	0.527	0.332	13.145	5.347
labor+	0.047	0.213	0.021	0.493	0.328	13.386	4.405
labor	0.040	0.208	0.022	0.512	0.330	13.267	9.752

Table 4: Median of Accounting Variables by groups

Note: this table reports the time-series averages of portfolio-level characteristics of different one-way classified on shortage mentioning state. All sample includes all firms; shortage includes only shortage mentioning firms; nonlabor is consisted of firms mentioning shortages other than labor; nonlabor1 is consisted of firms mention non labor related shortages only once in the year; nonlabor+ is consisted of firms mention non labor related shortages more than once in the year; similar for labor portfolios. The portfolio-level characteristics are computed as the median value of each characteristic across all firms in the portfolio in July of any given year. hn: hiring rate; ik: physical capital investment rate; roa: return on assets; beme: book to market equity ratio; lev: book debt to market value of the firm; size: log of firm market value; labor: indicator of labor shortage mentioning.

Every year, one can form portfolios based on firms' (labor) shortage mentioning status. In Table 4, I compare median characteristics of these portfolios. The results are robust when mean instead of median is reported. The upper part compares full sample market portfo-

lio with portfolio consist of generic shortage mentioning firms; the middle part compares three portfolios based on shortage mentioning firms that are not labor related; the lower part compares three portfolios that are just about labor shortage. The most important message from it is the first column, where it shows that: 1. compared to the overall sample (fist row), labor shortage portfolios (last row) on average have higher hiring rate, especially for multiple mentioning case (second last row). 2. such monotonic relationship between shortage and hiring is unique for labor related shortage (lower part) and does not sustain for nonlabor related shortage mention (middle part). About 9.8% firm-year observations are labor shortage ones. It is reasonable to see that high hiring firms are more likely to mention labor shortage, and the fact that these firms do not necessarily increase chance of discussing other type of shortage alleviates the concern that firms may strategically blame or discuss shortage so that management is not to be blamed for upcoming weak performance.

4.4 Explain labor shortage

To better understand the relationship between firm-level labor shortage and the firm's accounting variables, I run Logit regression of the binary measure of labor shortage on contemporary hiring rate, investment rate, return on asset, book-to-market ratio, leverage and log of size.

Table 5 studies how contemporary firm conditions are related to their labor shortage status. For better interpretation, I compute the percentage change in odds of being labor shortage for a unit change in each variable, reported in column (%), as well that for a standard deviation change in each variable, reported in column (**%StdX**). In the following text, I focus on interpreting the last column. Consistent with evidence from Table 4, the first row shows that firm's hiring rate is an important factor explaining its labor shortage status. When the hiring rate increase by one standard deviation (17%), the odds of the firm to become labor

Variable	Coefficient (b)	%	%StdX
hn	0.40***	49.8	9.0
ik	-0.03	-2.8	-0.9
roa	0.50***	65.5	10.8
bm	-0.06	-5.7	-4.1
lev	0.98***	167.6	24.6
size	0.06***	6.3	13.7
constant	-3.04***		

Table 5: Logit Regression Results

Note: this table reports results from running logistic regression to explain the binary variable of labor shortage that takes value 1 if the firm mentions labor shortage in that year. All sample includes all firms; hn: hiring rate; ik: physical capital investment rate; roa: return on assets; beme: book to market equity ratio; lev: book debt to market value of the firm; size: log of firm market value.

shortage is 9% higher. Such relationship is absent from the second row, where investment rate is neither statistical nor economical significant, suggesting that firm's labor condition is not just a byproduct from its physical investment, instead, high hiring demand can make firm with tight hiring constraint more binding.

In addition, higher return on asset (one standard deviation being 10%) corresponds to 11% increase in the odds of labor shortage, this hints that firms may experience labor shortage while it is facing strong demand. Moreover, 10% higher leverage ratio is related to 25% percent increase in labor shortage, this can either be because financial constraint is inter-related to the tightness of firm's labor condition, or simply explained by high growth firm demanding both more capital and labor. Lastly, as a firm becomes bigger, its odds of being labor shortage is also higher, suggesting that labor shortage is not likely a small firm only thing. In Table A.2 I report robustness check with SIC industry identification code used as fixed effect, the coefficient and magnitude for hiring rate remain significant. This shows that variation in labor shortage is not likely to be mainly due to industry effect.

4.5 Firm dynamics

Finally, I investigate the dynamic of firm characteristics before and after mentioning labor shortage. To do so, I regress accounting variables of interests on the dummy variable "labor-shortage", including firm and year fixed effect, standard errors are clustered at industry level. I include lead and lag of labor shortage dummy for ± 2 years. In Figure 7, I show that after the mentioning of labor shortage, firm hiring (row 1, column 1), investment (row 1, column 2) and size (row 2, column 2) drop significantly, whereas book-to-market (row 2, column 1) and leverage (row 3, column 1) increase significantly. These evidence suggests that: 1. labor shortage state does not seem to be randomly assigned, it is closely related to firm operation and corporate policy, they are on average large and expanding firms, in other words, it's endogenously related to firm's state; 2. more binding labor supply constraint is related to firm's slow down of expansion.

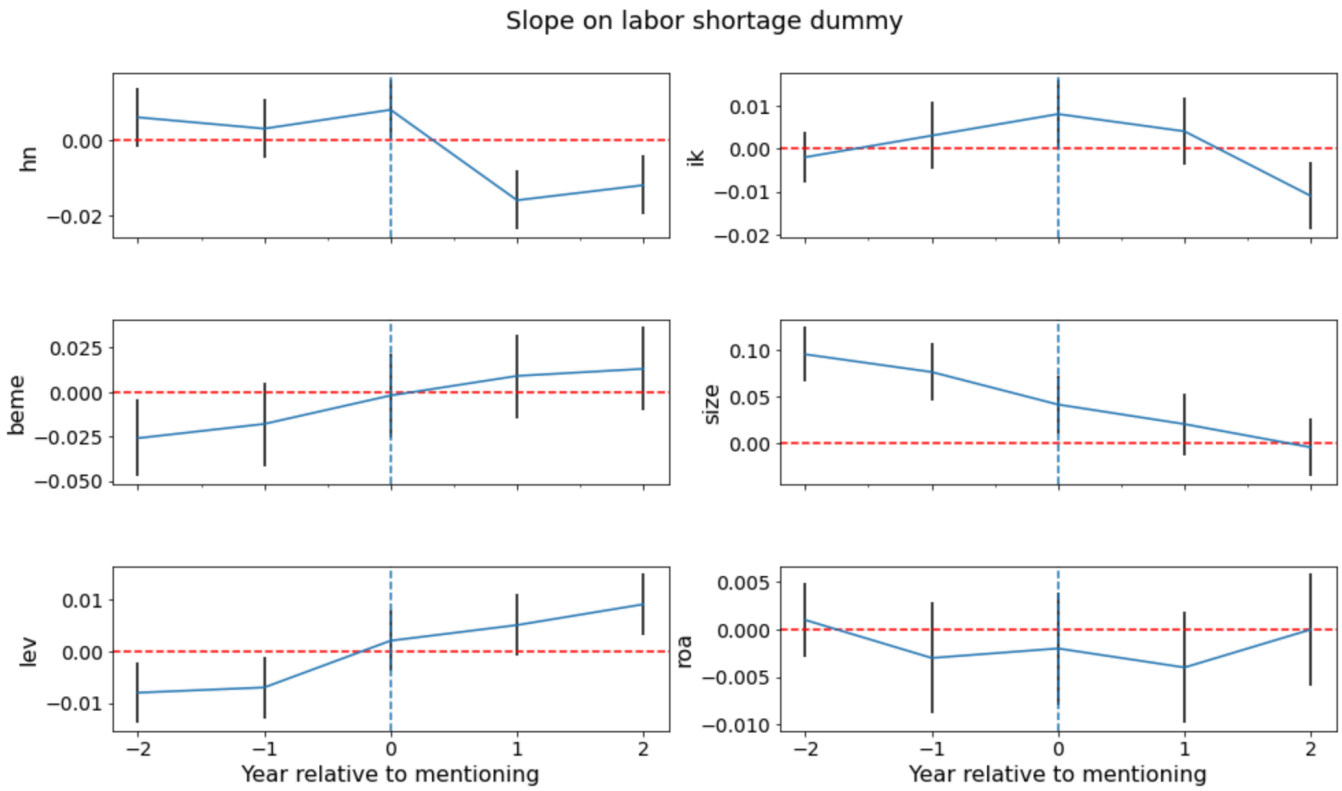


Figure 7: Time series of labor shortage ratios

Note: This figure displays the result from six regressions of the following structure:

$$Y_{i,t} = \sum_{s=-2}^{2} \beta_s labor shortage_{i,t} * \mathbb{1}[yrtomention = s]_{i,t} + \alpha_i + \gamma_t + e_{i,t}$$

where $Y_{i,t}$ is one of the six firm characteristics formed in previous tables. β_s captures the average level difference of labor shortage mention firms and the rest, before and after mentioning ($\pm$ 2 years). α_i and γ_t are firm and time fixed effect. Black line represents the 95% confidence interval.

5 Labor shortage and stock returns

The aforementioned features imply that labor shortage is closely related to firm's operation, therefore can potentially affect asset price. This section focuses on testing the theory based hypotheses regarding the relation between labor shortage and stock return, using both portfolio sorting and predictive regression methods.

5.1 Does hiring predict lower return? Test of Hypothesis 1

Following the theoretical guidance formulated in Section 3, I start by testing Hypothesis 1, which entails investigating the link between hiring and future stock returns in the cross section. Specifically, I first perform one-way portfolio sorting on hiring rate, as is in Belo et al. (2014). To define the hiring rate breakpoints used to allocate firms into portfolios, I follow Fama and French (2008) and compute the deciles of the hiring rate cross-sectional distribution of all but micro cap firms in NYSE-AMEX, NASDAQ. The micro cap firms are defined as firms with a market capitalisation that is lower than the bottom 20th percentile of the market capitalisation cross-sectional distribution of NYSE firms. Every year, Ten portfolios are constructed based on the threshold. Firms with the lowest hiring rate are classified into L portfolio, and firms with the highest hiring rate are classified into H portfolios. The quantity of major economic interests is the average return of a long-short portfolio that longs L and shorts H, denoted as $L - H$.

Table 6 presents the results from one-way sorting on hiring rate. The highlighted column suggests that there is a strong negative hiring-return relation in the sample. As Hypothesis 1 implies, it takes certain level of labor hiring constraint on average among all firms such that one is able to observe the hiring spread. Quantitatively, $L - H$ (long low hiring short high hiring) portfolio yields a significant 16.6% equal-weighted annualised excess return and 7.2% (not statistically significant) value-weighted excess return. These results align well with the

magnitude of Belo et al. (2014), if not larger.

Panel A: Returns

	Low	2	3	4	5	6	7	8	9	High	L-H	MAE
	Equal-Weighted Portfolios											
r^S	16.50	14.23	12.31	13.32	10.99	11.92	10.63	11.37	2.91	-0.08	16.58	
$[t]$	2.75	3.15	2.63	3.29	2.59	2.84	2.33	2.22	0.49	-0.01	4.64	
α	6.10	5.07	3.78	4.86	2.30	3.15	1.10	1.19	-7.88	-12.15	18.24	4.76
$[t]$	1.41	1.95	1.19	2.24	0.96	1.40	0.45	0.39	-1.97	-3.04	5.13	
α^{FF}	5.66	4.22	2.79	4.01	1.72	2.90	0.93	1.44	-7.21	-11.26	16.92	4.21
$[t]$	1.61	2.28	1.03	2.55	0.93	1.81	0.54	0.63	-2.21	-3.59	5.01	
	Value-Weighted Portfolios											
r^S	11.21	9.58	7.24	8.67	6.02	8.31	7.03	7.62	5.40	4.05	7.16	
$[t]$	2.19	2.82	1.92	2.71	1.80	2.55	1.77	1.70	1.13	0.73	1.33	
α	3.47	2.53	1.03	1.97	-0.75	1.34	-1.52	-1.57	-3.08	-7.00	10.46	2.43
$[t]$	0.84	1.36	0.36	1.14	-0.39	0.82	-0.77	-0.63	-0.93	-2.16	1.98	
α^{FF}	2.48	2.09	0.12	1.49	-0.73	1.05	-1.33	-0.91	-2.03	-5.20	7.67	1.74
$[t]$	0.61	1.16	0.04	0.91	-0.39	0.67	-0.69	-0.38	-0.65	-1.95	1.66	
	Panel B: Accounting Variables											
hn	-0.20	-0.06	-0.01	0.01	0.04	0.07	0.11	0.19	0.28	0.57	-0.77	
ik	0.15	0.17	0.17	0.19	0.21	0.25	0.27	0.33	0.40	0.46	-0.31	
roa	-0.06	0.02	0.03	0.04	0.04	0.04	0.04	0.03	0.02	-0.01	-0.05	
lev	0.35	0.37	0.33	0.33	0.30	0.28	0.26	0.22	0.19	0.19	0.16	
beme	0.68	0.59	0.57	0.53	0.49	0.47	0.46	0.43	0.35	0.37	0.31	
size	11.63	12.56	12.73	13.24	13.23	13.07	12.94	13.01	12.94	12.69	-1.06	

Table 6: One way sorting portfolio on hiring rate

This table reports the average equal- and value-weighted portfolio excess stock returns and abnormal returns of 10 portfolios one-way sorted on hiring rate. 1 is the lowest hiring rate portfolio. The term r^S is the average annualized $(\times 1,200)$ portfolio excess stock return; $[t]$ are heteroscedasticity consistent t-statistics. α and α^{FF} are portfolio average abnormal returns, obtained as the intercept from monthly CAPM or Fama and French (1993) regressions, MAE is the mean absolute pricing errors (average of absolute values of α or α^{FF}). $L-H$ stands for the low-minus-high hiring portfolio. Panel B keeps track of the mean of the median of accounting variables of the portfolio over time series.

5.2 Does labor shortage predict lower return? Test of Hypothesis 2

Next, I test Hypothesis 2, which entails investigating the link between labor shortage and future stock returns in the cross section. To do so, I construct three portfolios orderly classified on the firm's current labor shortage mentioning state, and compare these portfolios' post-formation average stock returns. Specifically, at the end of June of year t, I sort the universe of common stocks into three portfolios based on the firm's hiring rate at the end of year $t-1$. Once the portfolios are formed, their returns are tracked from July of year t to June of year $t+1$, the average of which are computed. The procedure is repeated at the end of June each year. I report both average equal- and value-weighted portfolio returns across all firms to mitigate concerns over small firm bias, leaving a more comprehensive picture of the link between labor shortage and stock returns in the overall economy.

Table 7 reports the result from previous portfolio sorting. I denote non labor shortage firms as N, firms with only one time mentioning as S, and firms with multiple times mentioning as $S+$. The economic object of interests is the average return from long-short portfolio made out of $(S+) - N$, that is to long the multiple mentioning $S+$ and to short the non labor shortage N. This long-short portfolio's return is highlighted in the left half of Panel A from the Table 7. Consistent with Hypothesis 2, labor shortage portfolio indeed on average makes lower return than the non labor shortage portfolio. Such relationship is robust if one use both S and $S+$ to construct the long leg of the portfolio, and is robust for both weighting methods. For example, when value-weighted, labor shortage portfolio makes over 4% less annually than the non labor shortage portfolio, which is significant at 90% confidence level. The fact that one finds stronger pattern in value weighted portfolio sorting, suggests that the result is robust to small firm bias, therefore conveys economics significance.

Admittedly, the one-way sorting comes with a few caveats. First, it does not control for other

characteristics that can potentially determine return, therefore, there is no guarantee to all else equal. Second, the result is marginally statistical significant. I argue that these two concerns can be two sides of the same coin. Because the omitted variable can go both way in affecting return. For example, in Panel B of Table 7, leverage is larger for labor shortage firms, which can potentially make it harder for the return of $(S+) - N$ to be significantly negative[19]. Later in the predictive regression, I mitigate this concern by adding controls to the regression.

In addition, one may wonder whether firms with shortage in production in general deliver lower return, or it is unique to hiring constraint. To mitigate the concern of false positive, I redo the one-way sorting analysis, this time on the state of shortage mentioning other than labor, as a placebo test. Meaning, if a firm discusses shortage other than labor, be it inventory, raw material or working capital, then the firm is categorised as S or $S+$ if mentioning multiple times. The rest firms go into N portfolio. In the right half of Panel A from the Table 7, I show that neither the weighting scheme deliver consistent sign on such zero-cost portfolio return, which are far from significant.This evidence conveys an important reminder that by simply pooling together multiple types of shortage, the economic meaning gets blurred, making it hard to obtain any clear shortage-return pattern, let along holding all else equal.

To sum up, I test Hypothesis 2 through one-way portfolio sorting on labor shortage, and find that labor shortage predicts lower future return in the cross section. In addition, the distinct comparison between labor shortage and the rest type of shortage suggests that the measure of labor shortage is uniquely informative of labor hiring constraint. In the next subsection, I test Hypothesis 3 by checking whether the hiring spread is larger for labor shortage firms, compared to non labor shortage firms.

[19]Several papers in asset pricing explicitly discuss the issue with sorting conditioning on key confounders to better examine the mechanism, see for instance Li (2011) and Kilic, Yang, and Zhang (2022)

Panel A: Returns

	N	S	S+	(S+)-N	MAE	N	S	S+	(S+)-N	MAE
	Labor Shortage					Nonlabor Shortage				
Equal-Weighted Portfolios										
r^S	11.17	7.50	11.05	-0.12		10.91	9.70	12.09	1.18	
$[t]$	2.42	1.37	1.93	-0.05		2.38	1.96	2.28	0.79	
α	1.95	-2.93	0.62	-1.33	1.83	1.84	-0.05	1.51	-0.33	1.13
$[t]$	0.80	-0.91	0.17	-0.62		0.75	-0.02	0.54	-0.24	
α^{FF}	1.59	-3.38	-0.09	-1.68	1.69	1.51	-0.79	1.13	-0.38	1.14
$[t]$	1.01	-1.52	-0.03	-0.80		0.94	-0.42	0.55	-0.28	
Value-Weighted Portfolios										
r^S	7.70	3.15	3.47	-4.23		7.80	5.76	9.45	1.64	
$[t]$	2.49	0.68	0.73	-1.31		2.55	1.61	2.18	0.62	
α	0.65	-5.87	-4.78	-5.43	3.77	0.88	-1.98	0.77	-0.11	1.21
$[t]$	0.98	-2.21	-1.49	-1.68		1.13	-1.45	0.34	-0.04	
α^{FF}	0.68	-6.08	-4.80	-5.47	3.85	0.84	-2.01	1.40	0.56	1.42
$[t]$	1.06	-2.31	-1.58	-1.83		1.12	-1.46	0.65	0.23	
Panel B: Accounting Variables										
hn	0.05	0.06	0.07	0.02		0.05	0.05	0.04	-0.01	
ik	0.23	0.25	0.26	0.03		0.23	0.22	0.23	0.00	
roa	0.02	0.02	0.01	-0.01		0.02	0.03	0.02	0.00	
beme	0.49	0.49	0.49	0.00		0.49	0.49	0.48	-0.01	
lev	0.28	0.30	0.33	0.05		0.28	0.29	0.26	-0.02	
size	12.66	12.86	13.03	0.37		12.59	13.06	13.01	0.42	

Table 7: One way sorting portfolio on shortage

This table reports the average equal- and value-weighted portfolio returns based on labor shortage and nonlabor shortage state. Here, nonlabor shortage represents shortage type other than labor. The term r^S is the average annualised $(\times 1, 200)$ portfolio excess stock return; $[t]$ are heteroscedasticity consistent t-statistics. α and α^{FF} are portfolio average abnormal returns, obtained as the intercept from monthly CAPM or Fama and French (1993) regressions, MAE is the mean absolute pricing errors (average of absolute values of α or α^{FF}). N is the portfolio of firms do not mention labor shortage of the year, S of firms mentioning labor shortage only once of the year, and $S+$ as multiple labor shortage mentioning portfolio. Panel B keeps track of the mean of the median of accounting variables of the portfolio over time series.

5.3 Does labor shortage strengthen the negative relation of hiring-return? Test of Hypothesis 3

Section 5.1 has documented that the negative relation between hiring rate and return persists in the full sample. This subsection, instead, concerns if labor shortage as a moderator strengthens such negative relation. To do so, I move onto the two-way portfolio sorting test. Specifically, in each year, six portfolios are formed based their hiring rate and labor shortage state independently. For hiring rate, firms are classified into low hiring L, median hiring M and high hiring H subgroups. For labor shortage state, firms are classified into labor shortage S and non labor shortage N subgroups. Together a firm will fall into one of the $2 \times 3 = 6$ portfolios among the two dimensions of classification. I compute the average return of these portfolios and display the result in Table 8.

The economic quantity of interests is the average return of $L - H$ across two labor shortage subgroups S and N, which are the highlighted rows in Table 8. Focusing on value-weighted, it shows that the $L - H$ spread is 9.7% for labor shortage group S. In comparison, such spread goes below zero to -1.15% for the non labor shortage group N. Further investigation at each leg of the $L - H$ portfolio for labor shortage group S reveals that the high excess return can be mainly explained by the rather low return of the HS leg, that is the high-hiring and labor shortage portfolio. This is exactly the prediction from Equation 2: holding all else equal, the product of high hiring and high adjustment cost implies a high marginal cost of hiring in the denominator, corresponding to a low return.

Symmetrically, one can examine the labor shortage $S - N$ spread across different hiring rate subgroups. According to Equation 2, the labor shortage spread should be wider for the high hiring subgroup H, which is also confirmed in the data. Quantitatively, the highlighted row shows that the labor shortage $S - N$ spread is only significantly negative for high hiring subgroup H (-10.6% excess return with $t = -2.37$), yet that for low hiring subgroup L is

0.3% and not significant.

Lastly, the middle and lower part of Table 8 report risk adjusted returns from CAPM and Fama-French three factor model. The results are consistent with findings from excess return, suggesting that such spread contains independent risk beyond market, size and value. This is important because it rules out the concern that confounding characteristics such as large size and growth can potentially explain the rather low return from the HS leg. In addition, in all hypotheses, one implicit but important assumption is that all else especially profitability should be held equal. Although it is hard to verify directly, but there is preliminary evidence from Figure 7, which suggests that return on asset does not have significant differential changes between labor shortage firms and non labor shortage firms (see the last subplot). In unreported robustness check, I vary the breakpoint of hiring rate, as well as conduct two way sorting based on size or value and labor shortage, and I find the main results still hold.

After offering evidence of negative relation between labor shortage and return, and the relative stable negative relation between hiring rate and return, I move on to two-way sorting test, which is robust to extreme values. I display the result in Table 8. Focusing on value-weighted, it shows that the $L - H$ spread is 9.7% for labor shortage group, but goes below zero to -1.15% for no labor shortage group. When investigating each leg of the zero-cost portfolio, I find that the high hiring and labor shortage portfolio's rather low return drives the difference. From a risk perspective, it says that high hiring firms are only less risky when their labor supply constraint is more binding, which is exactly aligned with the idea that it takes labor market friction to obtain the negative hiring-return relationship. Conversely, the $S - N$ spread is only significantly negative for high hiring group (-10.6% excess return with $t = -2.37$), yet that for low hiring is 0.3% and not significant. The result from CAPM and Fama-French three factor models looks similar, suggesting that such spread contains independent risk beyond size and value, this is important in that it rules out the concern on confounding characteristics such as large size and growth. In unreported robustness check, I vary the breakpoint of hiring rate, as well as conduct two way sorting based on size or value and labor shortage, and I find the main results still hold.

Hiring and Labor Shortage Portfolios

	Equal-Weighted				Value-Weighted			
	N	S	S-N	[t]	N	S	S-N	[t]
	Excess Return r^e							
L	15.08	10.95	-4.14	-1.79	7.51	7.83	0.31	0.07
M	12.35	11.72	-0.63	-0.4	7.18	5.95	-1.23	-0.39
H	4.06	3.92	-0.14	-0.05	8.66	-1.87	-10.53	-2.37
L-H	11.03	7.02			-1.15	9.70		
[t]	4.25	1.83			-0.33	1.55		
	CAPM α							
MAE	3.61				1.13			
L	6.27	1.12	-5.15	-2.25	1.15	-0.69	-1.84	-0.42
M	4.43	2.64	-1.79	-1.2	1.01	-1.66	-2.67	-0.85
H	-5.90	-6.9	-1.0	-0.4	0.15	-10.9	-11.05	-2.47
L-H	12.17	8.02			1.00	10.21		
[t]	4.75	2.08			0.30	1.61		
	Fama-French α^F							
MAE	2.61				1.25			
L	5.08	-0.35	-5.43	-2.4	0.81	-1.21	-2.01	-0.47
M	3.54	1.48	-2.07	-1.46	1.00	-1.99	-2.99	-1.01
H	-6.09	-7.47	-1.38	-0.56	1.03	-10.54	-11.57	-2.59
L-H	11.17	7.12			-0.22	9.33		
[t]	4.93	1.92			-0.09	1.49		

Table 8: Two way sorting portfolio on hiring and labor shortage

This table reports the average equal- and value-weighted portfolio excess stock returns and abnormal returns of portfolios two-way sorted on hiring rate and labor shortage. Specifically, S represents labor shortage, N represents not mentioning labor shortage portfolio. Independently I sort hiring into three groups, with breakpoint at 20% and 80% of NYSE non-micro cap. L is the low hiring rate portfolio, M as middle and H as the high. The term r^S is the average annualized $(\times 1,200)$ portfolio excess stock return; $[t]$ are heteroscedasticity consistent t-statistics. α and α^{FF} are portfolio average abnormal returns, obtained as the intercept from monthly CAPM or Fama and French (1993) regressions, MAE is the mean absolute pricing errors (average of absolute values of α or α^{FF}). $L-H$ stands for the low-minus-high hiring portfolio. $S-N$ stands for the labor shortage-minus-not shortage portfolio. Panel B keeps track of the mean of the median of accounting variables of the portfolio over time series.

5.4 Evidence from predictive regression

Previous portfolio sorting analyses are known to be robust to outliners, whereas the downside of which is their limited space to control for other objects of interests. Therefore, I supplement the above portfolio sorting with predictive regression including an interaction term between hiring and labor shortage. Estimation is achieved following the classical procedure of the first-stage of Fama-Macbeth regression. Specifically, I treat each year as an independent cross-section, the coefficients of which are the average from all the cross-section estimates, which are reported in Table 9.

The main economic quantities of interests are the two level effects of hiring rate and labor shortage, as well as the heterogenous effect from the interaction term. First, in terms of labor shortage, its level effect remains a significant predictor of stock returns in the cross section as is highlighted in the table, even after controlling for size, and hiring rate, across all specification. Quantitatively, when firm mentions labor shortage, its next year's return decrease by 3% on average, which is consistent with results of labor shortage based one-way portfolio sorting, as is shown in Table 7. This result also provides supporting evidence for Hypothesis 2. Second, in terms of hiring rate, it seems to be insignificant in predicting return in the cross section on average, as is indicated by the first row of Table 9. At the first glance, the result does not directly support Hypothesis 1. Nevertheless, hiring can only be negatively correlated with stock return if there is large enough hiring constraint, as suggested by Hypothesis 3. Quantitatively, column 4 of Table 9 shades light on the relative strengthening of the negative relation as hiring constraint gets more sever. In particular, the coefficient on the interaction term is four times larger than the level effect of hiring rate. Despite the lack of significance of the negative coefficient on the interaction term between hiring rate and labor shortage state (-4% with $t = -0.84$). This may be explained by extreme values and insufficient sample size. In unreported results, I show that the results are robust to adding controls.

Firm-Level Stock Return Predictability Regression

	Fama-Macbeth				
	1	2	3	4	5
hn_{t-1}	-0.02		-0.02	-0.01	-0.01
$[t]$	-0.78		-0.78	-0.62	-0.42
labor1_{t-1}		-0.03	-0.03	-0.03	-0.04
$[t]$		-2.02	-2.16	-2.22	-2.00
micro_{t-1}				0.03	0.03
$[t]$				0.88	0.88
hnxlabor1_{t-1}					-0.04
$[t]$					-0.84
$\text{microxlabor1}_{t-1}$					0.02
$[t]$					0.55

Table 9: Firm-level stock return predictability regression

This table reports the coefficient of the following specification. Each month, stock return is regressed on the latest right hand side variables. Then I take the average of the estimate from the cross section as the final estimates reported in the table. *micro* here is a dummy variable of firm size being below the NYSE 20% breakpoint. The coefficent of interest are b and e.

$$r_{it}^{s} = a + b \times HN_{it-1} + c \times labor_{it-1} + d \times \text{ Micro }_{it-1} + e \times labor \times HN_{it-1} + f \times \text{ Micro } \times labor_{it-1} + e_{it}$$

5.5 Economic interpretation

Findings above are largely consistent with predictions from the neoclassical hiring model with heterogenous hiring adjustment cost. This two-period model is convenient in relating firm hiring to return. In fact, one can take a step further to rationalise this feature in a dynamic framework, where expected return is determined by the product of price of risk and risk loading. First of all, from a risk interpretation, high-hiring firms with labor hiring constraint should be a good hedge to certain aggregate variation to make such low average

return. In particular, in Belo et al. (2014), they show that with hiring adjustment, firms incur high adjustment cost when they intend to make high hiring. These firms thus benefit the most from shocks that lowers aggregate hiring adjustment cost. Assuming that low aggregate hiring adjustment cost corresponds to the bad state of the world (imagine more commodity can be directed to production, lowering aggregate consumption), then aggregate adjustment cost shock comes with positive price of risk. As high hiring firms' value increases during low aggregate hiring adjustment cost, their risk loading on the shock is negative, making them a good hedge.

The paper builds upon their intuition and provides the first empirical evidence to show that when hiring adjustment cost differs across firms, an extended version of the theory can still explain the observed correlation between labor shortage and return, as well as labor shortage's effect on the correlation on hiring and return.

6 Aggregate Evidence

This section complements the earlier cross-sectional analysis by examining whether labor demand conditions at the aggregate level help forecast the equity risk premium, or if they are more closely related to future profitability. In the essence, Q theory suggests that hiring be a forward-looking decision based on discount rate and/or cash flow, the degree of which is an empirical question.

6.1 Hiring and Risk Premium

As in Kothari and O'Doherty (2023), I use the job openings-to-employment ratio (JOE) as a proxy for aggregate labor demand and assess its predictive power for future excess returns on the aggregate stock market. While job openings are not a direct measure of labor market tightness, the finding that higher labor demand today is associated with lower future returns

suggests that hiring conditions may be systematically linked to time variation in expected returns. This pattern is consistent with the idea that hiring frictions—such as adjustment costs or wage pressures—may affect firms' discount rates through their impact on marginal costs.

Data Construction. The predictor variable is the job openings-to-employment ratio (JOE), constructed at monthly frequency from 1951 to 2021. For the pre-2001 period, it uses the composite help-wanted index developed by Barnichon (2010), which combines the Conference Board's Help Wanted Index (1951–1994) and the Help Wanted Online Index (1995–2000). Post-2000, it uses total nonfarm job openings from the BLS Job Openings and Labor Turnover Survey (JOLTS). In both periods, vacancy counts are normalized by the civilian employment level (FRED series CE16OV). I standardize the resulting JOE series to have zero mean and unit variance.

Monthly market returns and risk-free rates are obtained from the Fama-French data library. To construct the equity premium over an h-month horizon, I compound the monthly market return and the monthly risk-free rate separately and take the difference:

$$\text{Premium}_{t,t+h} = \left(\prod_{\tau=1}^{h}(1+\text{MKT}_{t+\tau})\right) - \left(\prod_{\tau=1}^{h}(1+\text{RF}_{t+\tau})\right)$$

Empirical Specification. For each forecast horizon $h = 1, 2, \ldots, 36$, I estimate the predictive regression:

$$\text{Premium}_{t,t+h} = \alpha_h + \beta_h \cdot \text{JOE}_t + \varepsilon_{t+h}$$

I lag JOE by one month to ensure that it is observable at the time of forecasting. Newey-West standard errors are used with lag length $h-1$ to account for serial correlation in the overlapping return horizons.

Results. Figure 8 plots the estimated slope coefficients $\hat{\beta}_h$ and 95% confidence intervals across horizons from 1 to 36 months. The coefficients are negative and statistically significant

across all horizons, including at the 1-month forecast window. Moreover, the magnitude of the coefficients increases with the forecast horizon, indicating stronger predictive power over longer periods. At the 36-month horizon, a one-standard-deviation increase in JOE is associated with a cumulative decline in the market risk premium of approximately 12%. These results suggest that periods of strong labor demand are robustly associated with lower subsequent expected returns on the aggregate stock market.

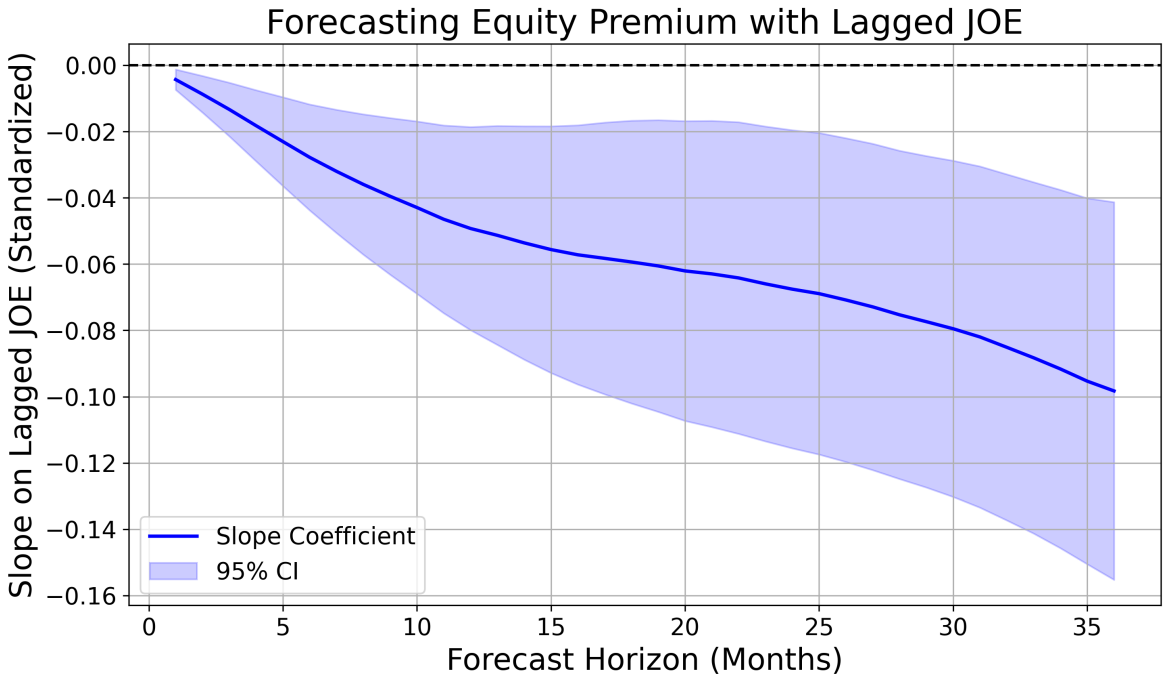


Figure 8: Forecasting coefficients of future equity premium on lagged JOE

Note: this figure plots slope coefficients and 95% confidence intervals from predictive regressions of the h-month ahead market risk premium on the lagged standardized job openings-to-employment ratio (JOE). The regressions are estimated separately for each forecast horizon $h = 1, 2, \ldots, 36$, using Newey-West standard errors with lag length $h - 1$. The dependent variable is the compounded excess return over h months.

6.2 Hiring and Profitability

To complement the evidence on expected returns, I next examine whether aggregate hiring conditions predict future corporate profitability. If hiring reflects underlying business

optimism or investment plans, then high labor demand today may signal stronger future earnings performance.

Following standard practice, I construct a quarterly measure of aggregate profitability as corporate profits after tax (CP) divided by the beginning-of-quarter book value of nonfinancial corporate assets (TAB). Specifically:

$$\text{Profitability Rate}_t = \frac{\text{CP}_t}{\text{TAB}_{t-1}},$$

where both CP and TAB are obtained from the FRED database (series IDs: CP and TABSNNCB, respectively). Profits are reported at seasonally adjusted annual rates in billions of dollars, while TAB is the book value of total assets reported at the end of each quarter.

To align the predictor and outcome frequencies, I aggregate the monthly JOE series into quarterly values by taking their average within each quarter. I then estimate the predictive regression:

$$\text{Profitability}_{t+k} = \alpha_k + \beta_k \cdot \text{JOE}_t + \varepsilon_{t+k},$$

where k ranges from 1 to 8 quarters (i.e., up to a two-year horizon). The JOE variable is standardized and lagged to ensure ex-ante observability. Standard errors are Newey-West adjusted for serial correlation with lag length $k-1$.

Figure 9 plots the estimated slope coefficients $\hat{\beta}_k$ and associated 95% confidence intervals from predictive regressions of future aggregate profitability on lagged JOE. The results indicate that JOE is a statistically significant predictor of future profitability starting from the third forecast quarter. The coefficients are negative across all horizons and become statistically significant at the 5% level for horizons $k = 3$ through $k = 6$. At its peak effect, a one-standard-deviation increase in JOE is associated with a 0.32 percentage point decline

in the profitability rate over a five-quarter horizon ($\hat{\beta}_5 = -0.0032$, $p < 0.01$). This negative association suggests that elevated labor demand may signal rising cost pressures or diminishing marginal returns to hiring and investment, consistent with theories of hiring frictions. These findings reinforce the notion that hiring conditions affect not only expected returns (via discount rates), but also expected cash flows.

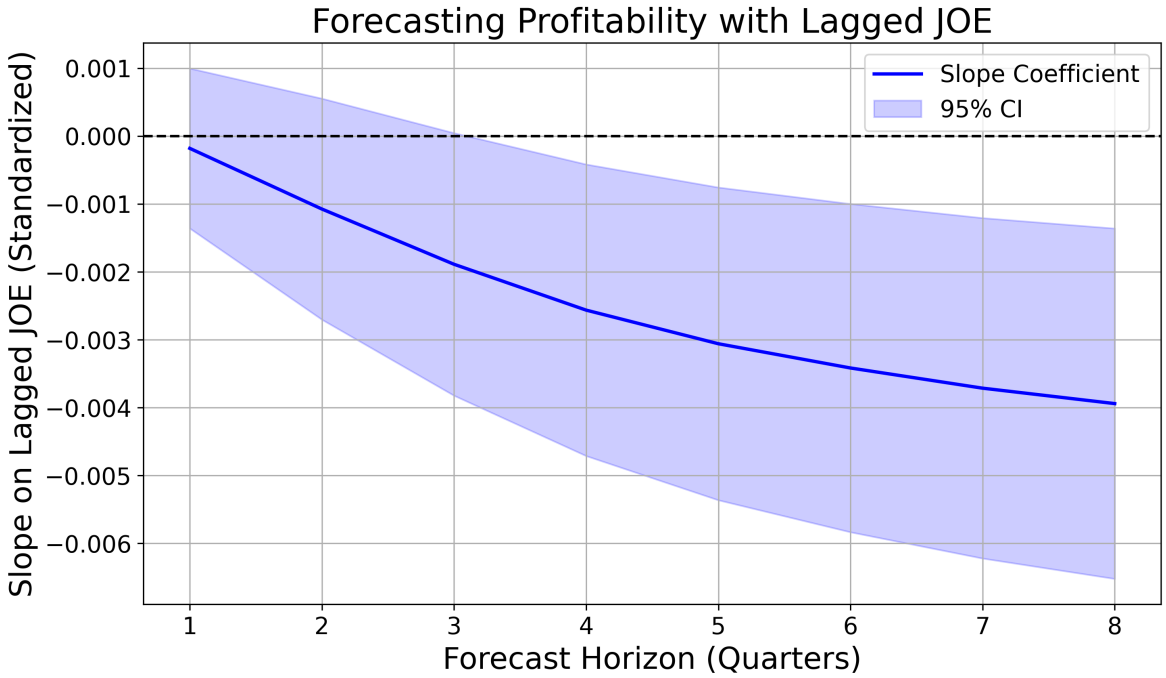


Figure 9: Forecasting coefficients of future profitability on lagged JOE

Note: this figure plots slope coefficients and 95% confidence intervals from predictive regressions of future aggregate profitability (CP over lagged TAB) on lagged standardized JOE. The regressions are estimated separately for each forecast horizon $k = 1, 2, \ldots, 8$, using Newey-West standard errors with lag length $k - 1$.

Taken together, the results in this section demonstrate that aggregate labor demand conditions, as proxied by the job openings-to-employment ratio (JOE), predict variation in stock returns and profitability in ways consistent with the discount rate channel of hiring. Specifically, high labor demand today forecasts lower future equity risk premia, but is not associated with higher future profitability. This pattern echoes the findings of Belo et al. (2023), who

show that fluctuations in aggregate hiring are primarily driven by changes in discount rates and short-term expected cash flows, with negligible contribution from long-term cash flow variation. Our evidence reinforces the interpretation that hiring is a forward-looking decision shaped by time-varying risk, rather than a simple response to improved profitability prospects. These aggregate patterns complement our earlier firm-level analysis and underscore the macro-finance implications of labor market frictions.

6.3 Time Varying Relationship between Hiring and Risk Premium

This section explores the relationship between labor market tightness-proxied by the vacancy rate (JOE)-and expected equity market returns. We construct forward-looking returns and estimate rolling predictive regressions to assess how JOE correlates with and forecasts future market conditions.

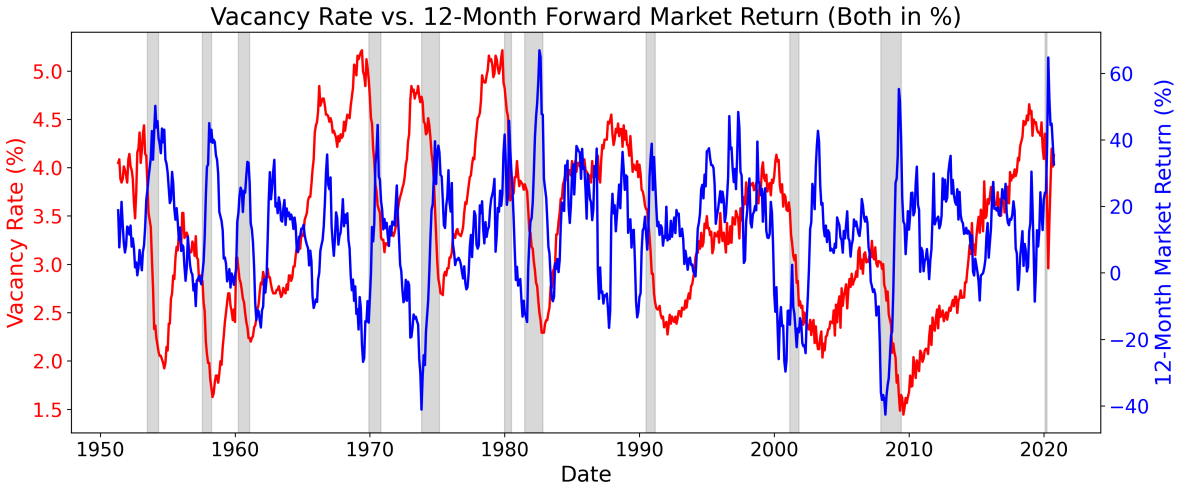


Figure 10: Vacancy Rate and 12-Month Forward Market Return

Note: this figure plots the vacancy rate (JOE) and the 12-month ahead cumulative market return over time. Both series are expressed in percent and smoothed using monthly frequency. The vacancy rate is plotted on the left axis in red, and the forward market return is plotted on the right axis in blue.

Figure 10 displays the time series of the vacancy rate (JOE) and the 12-month forward market return. The overall correlation between the two series is modestly positive, at approximately

0.20. However, this average masks substantial variation across time. In particular, a more nuanced relationship emerges when conditioning on the state of the labor market. Periods of historically tight labor markets-when the vacancy rate reaches local peaks-are often followed by pronounced declines in market returns.

For example, in the late 1960s, the vacancy rate peaked prior to the onset of the 1970 recession, with a noticeable subsequent drop in forward returns. A similar pattern is observed in the late 1990s, where a sustained rise in labor market tightness precedes the collapse of the dot-com bubble. Likewise, in the years immediately preceding the COVID-19 recession, the vacancy rate stood at post-crisis highs, followed by a sharp drawdown in equity markets. These episodes are consistent with the notion that tight labor markets may coincide with rising marginal costs, diminished slack, and depress future equity returns.

Figure 11 provides more formal evidence based on rolling 60-month predictive regressions of future market returns on lagged JOE. The figure displays estimated slope coefficients for four forecast horizons: one-month ahead, and cumulative returns over 1–3, 1–6, and 1–12 months. While the 1-month and 1–3 month betas tend to hover near zero, the coefficients become more substantially negative for the 1–6 and especially the 1–12 month horizons. These longer-horizon betas exhibit marked declines during periods of elevated vacancy rates, such as the late 1960s, early 1980s, and late 2010s. The 95% confidence intervals for the 1–12 month beta (shaded area) indicate that these negative values are statistically significant in several of these episodes, particularly during tight labor market conditions. These patterns highlight the state-dependent predictive power of JOE for future equity returns.

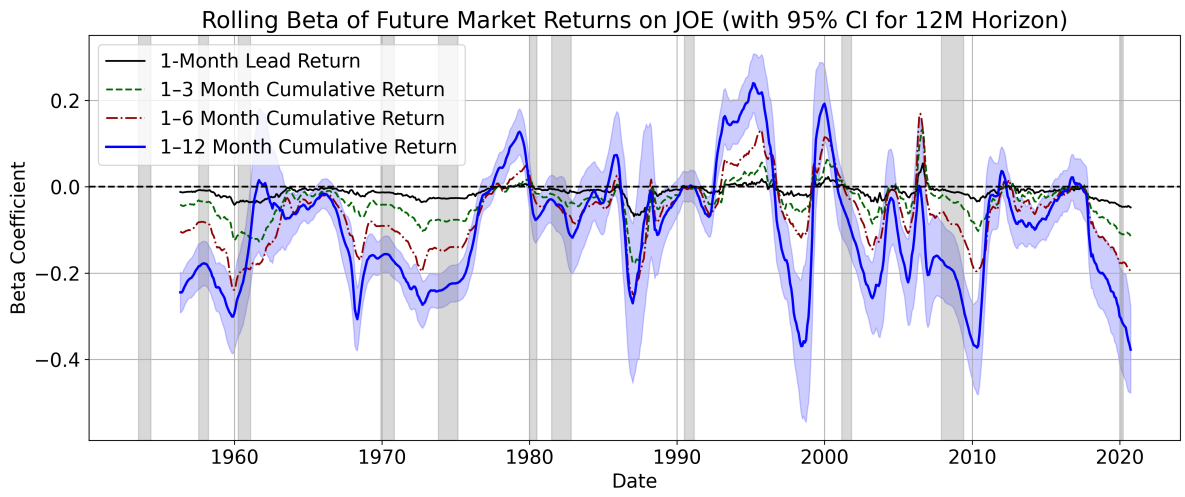


Figure 11: Rolling Beta of Future Market Returns on JOE

Note: this figure plots the rolling 60-month beta coefficients from regressions of future market returns on the job openings-to-employment ratio (JOE). The solid blue line shows the 1-12 month ahead cumulative market return, along with its 95% confidence interval (shaded area). The black, green, and red lines show the betas for the 1-month, 1-3 month, and 1-6 month horizons, respectively. Shaded gray areas represent NBER recessions.

These results highlight a state-dependent relationship between labor market hiring and future equity returns, where the state is labor market tightness. The negative association between JOE and subsequent returns strengthens during periods of exceptionally tight labor markets, suggesting that high hiring activity in such states signals lower expected equity premia, consistent with Q theory.

6.4 Beta Dynamics and Long–Term Labor Market Tightness

The previous analysis establishes two main findings. First, higher hiring activity—as measured by the job openings–to–employment ratio (JOE)—is associated with lower subsequent market returns. Second, the strength of this negative association is not constant over time. In this subsection, I examine whether variation in the predictive power of JOE reflects changes in labor market tightness. Specifically, I test whether the relationship between hiring and

future equity returns strengthens during periods of persistently tight labor markets.

Figure 12 presents evidence on this point by plotting the rolling 12-month beta of future market returns on lagged JOE alongside a 60-month smoothed vacancy rate. The beta series is shown in blue and plotted on the left axis, while the long–term vacancy rate is in red on the right axis. The figure reveals a strong inverse relationship: during periods when the labor market is persistently tight, the rolling beta becomes more negative. This suggests that elevated job openings are more strongly associated with lower expected returns precisely when labor demand is high and slack is limited.

To formally test this relationship, I regress the rolling 12-month beta on the 60-month smoothed vacancy rate. The results indicate a statistically significant negative relationship: a one percentage point increase in the long–term vacancy rate is associated with a 3.06 percentage point decline in the beta coefficient ($t = -4.17$). In other words, the tighter the labor market, the more strongly hiring activity forecasts lower future returns.

These results reinforce the interpretation that the return implications of hiring are state–dependent. The predictive power of JOE strengthens precisely when the labor market is already tight—a pattern consistent with the logic of Q theory, in which marginal hiring becomes more costly and informative about declining risk premia when slack is scarce.

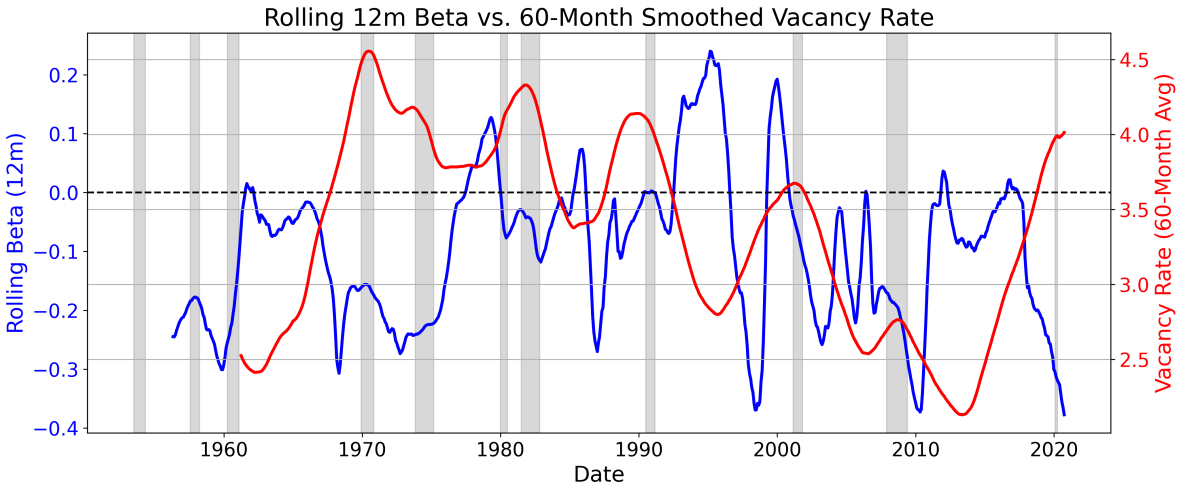


Figure 12: Rolling 12-Month Beta vs. Long–Term Smoothed Vacancy Rate

Note: this figure plots the 60-month rolling beta of 12-month cumulative market returns on lagged JOE (blue line, left axis), alongside the 60-month smoothed vacancy rate (red line, right axis). The rolling beta measures the strength of the predictive relationship between hiring and future returns in a moving window of 60 months. The dashed black line indicates a zero beta. Gray shaded areas correspond to NBER recession periods.

6.5 Time-Varying Labor Adjustment Cost via Structural Estimation

This section develops and estimates a structural model of hiring under adjustment costs, with a key feature: the marginal cost of hiring is allowed to vary with the state of the labor market. This approach enables me to directly test whether labor adjustment costs are higher in tight labor markets and whether this variation helps explain fluctuations in expected equity returns.

6.5.1 Model Setup

I consider a frictional labor market with a continuum of identical firms operating under perfect competition. Each firm hires a homogeneous labor input and takes all prices as

given. Firms maximize their value by choosing optimal labor input L_t, subject to wage payments and hiring frictions. Output is produced according to a Cobb-Douglas production function:

$$Y_t = A_t L_t^{\alpha}, \tag{3}$$

where A_t is aggregate productivity and α is the output elasticity of labor. Firms pay a real wage W_t per worker and face a real hiring cost.

The key innovation lies in the specification of the adjustment cost. Let H_t denote the number of new hires, and define the hiring rate per worker as $h_t = H_t/L_t$. Let h_t^{60} denote the 60-month backward-looking average of the hiring rate, capturing long-run labor market tightness. The total adjustment cost per worker is assumed to take the form:

$$\text{AdjCost}(h_t) = c_{H2} \cdot h_{t+1}^{60} \cdot h_{t+1} + \frac{1}{2} c_{H3} \cdot h_{t+1}^{60} \cdot h_{t+1}^2, \tag{4}$$

where c_{H2} and c_{H3} are parameters governing the convexity and state-dependence of the adjustment cost. In particular, the interaction term $c_{H3} \cdot h_{t+1}^{60} \cdot h_{t+1}^2$ implies that marginal hiring costs increase more sharply when hiring activity is sustained at high levels, capturing persistent labor market tightness.

Firms choose L_{t+1} to maximize their expected present discounted value of profits:

$$\max_{L_{t+1}} \mathbb{E}_t \sum_{s=0}^{\infty} M_{t,t+s} \left[A_{t+s} L_{t+s}^{\alpha} - W_{t+s} L_{t+s} - L_{t+s} \cdot \text{AdjCost}\left(h_{t+s}\right) \right], \tag{5}$$

where $M_{t,t+s}$ is the stochastic discount factor.

The model features the following main variables. A_t denotes total factor productivity, L_t is labor employed at time t, and H_t is the number of new hires. The hiring rate per worker is $h_t = H_t/L_t$, and its 60-month moving average is h_t^{60}. Firms pay real wage W_t and discount future profits using the stochastic discount factor $M_{t,t+s}$. The elasticity of output with respect to labor is α, and labor attrition occurs at rate δ. The function $\text{AdjCost}(h_t)$ captures per-worker hiring frictions, governed by two parameters: c_{H2} for baseline convexity and c_{H3} for state-dependence. The marginal value of labor is denoted q_t^L, and its empirical proxy is labeled MC_t.

6.5.2 First Order Condition and Euler Equation

Using the envelope condition and applying dynamic programming, I derive the Euler equation for optimal hiring:

$$q_t^L = \mathbb{E}_t \left\{ M_{t,t+1} \left[\alpha A_{t+1} - W_{t+1} + c_{H2} h_{t+1}^{60} h_{t+1} + \frac{1}{2} c_{H3} h_{t+1}^{60} h_{t+1}^2 + (1-\delta) q_{t+1}^L \right] \right\} \tag{6}$$

where $q_t^L = (c_{H2} + c_{H3} h_t^{60})\, h_t$ represents the marginal cost of hiring one additional worker today.

6.5.3 Estimation and Moment Conditions

I estimate the model using a two-step Generalized Method of Moments (GMM). The key moment condition is based on the residual from the Euler equation:

$$\epsilon_t(\theta) = \left(c_{H2} + c_{H3} h_t^{60}\right) h_t - \mathbb{E}t \left\{ M_{t,t+1} \left[\alpha A_{t+1} - W_{t+1} + \text{AdjCost}_{t+1} + (1-\delta) q_{t+1}^L \right] \right\} \tag{7}$$

Lagged values of h_t are used as instruments to construct moment conditions.

The estimation proceeds in two stages. First, I minimize the quadratic form of average

moments using the identity matrix. Then, I compute a Newey-West adjusted optimal weighting matrix based on residuals. In the second stage, I re-estimate parameters using this efficient weighting matrix, enforcing the constraint that the marginal cost of hiring $\partial q_t^L/\partial h_t = c_{H2} + c_{H3} h_t^{60} \geq 0$ for all t. Multi-start optimization is applied to ensure robustness.

Estimation results suggest that labor adjustment costs are both economically significant and time-varying. The parameter c_{H2} is estimated to be positive and statistically significant, indicating a baseline convex cost of adjusting labor. More importantly, c_{H3} is estimated to be nonzero and large in magnitude, with statistical significance at conventional levels.

To interpret these coefficients, I construct the marginal cost of labor adjustment:

$$MC_t = \left(c_{H2} + c_{H3} h_t^{60}\right) h_t, \tag{8}$$

where h_t^{60} is the 60-month rolling average of H/L.

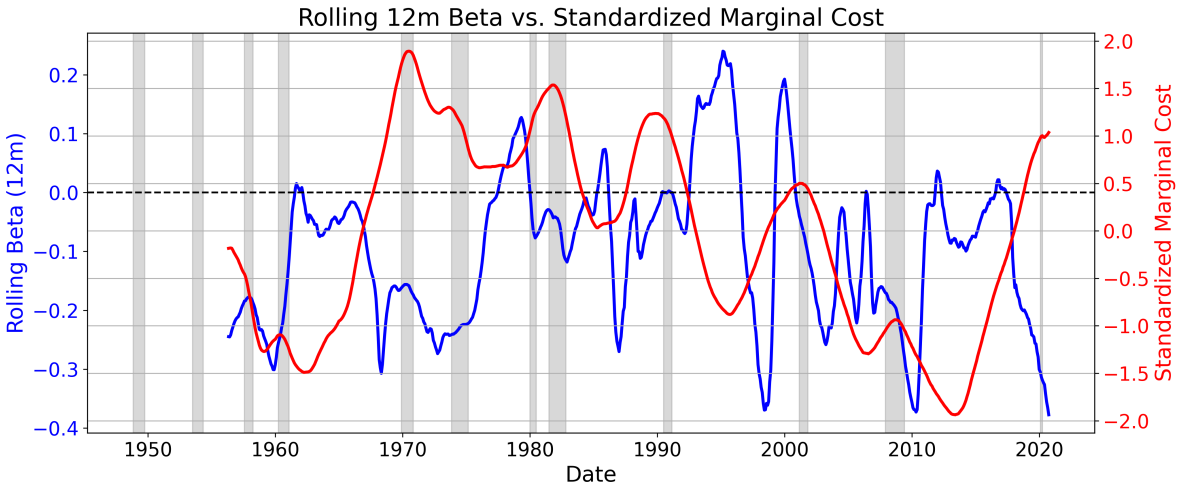


Figure 13: Marginal Labor Adjustment Cost over Time

Note: This figure plots the time series of marginal labor adjustment costs implied by the structural GMM estimation. The series is calculated using the estimated parameters and a 60-month smoothed hiring rate. The shaded gray regions indicate NBER recessions.

The marginal cost exhibits considerable variation across time, increasing substantially during tight labor market periods such as the late 1960s, early 2000s, and late 2010s. These results support the hypothesis that labor adjustment costs are state-dependent, rising when labor market slack is scarce.

Furthermore, I regress the 12-month forward market return beta on the standardized marginal cost of hiring and find a negative and statistically significant relationship. The estimated coefficient on standardized marginal cost is -0.0098 with a t-statistic of -2.16 and a p-value of 0.031. This implies that a one standard deviation increase in marginal labor adjustment costs is associated with a 1 percentage point decline in the 12-month beta coefficient. Although the R^2 of the regression is modest (0.006), the statistical significance supports the notion that higher labor adjustment costs predict lower risk premia over a one-year horizon. This suggests that higher marginal labor costs—which proxy for reduced hiring flexibility—are associated with lower expected risk premia. The structural estimates reinforce the time-varying predictive power of hiring for asset returns, consistent with the Q-theoretic interpretation developed earlier.

7 Conclusion

To conclude, this paper provides supporting evidence for Q-theory in explaining the hiring-return relation, using labor shortage as a proxy for hiring constraints. In the theoretical section, I derive two testable asset pricing hypotheses from a neoclassical framework, showing that hiring constraints are a necessary condition for hiring to predict returns. In the empirical section, I construct a firm-year level measure of labor shortage using textual analysis of firms' SEC filings, and document its key characteristics across time and firm types. I then test the theoretical predictions, finding that labor shortage significantly predicts lower future stock returns and strengthens the hiring spread-the return differential between low-

and high-hiring firms. These results suggest that labor market frictions play a central role in linking hiring behavior to asset prices.

Building on this, I estimate a structural model of labor adjustment cost at the aggregate level, allowing marginal costs to vary with labor market tightness. The GMM estimates reveal significant convex and state-dependent hiring frictions. In particular, I find that marginal hiring costs increase with indicator for labor market tightness, and this time-varying component negatively predicts the 12-month forward market beta. These aggregate results reinforce the cross-sectional evidence, and together, they support the interpretation that hiring-return relations are shaped by labor market constraints whose intensity varies over time-consistent with the logic of Q-theory.

References

Acharya, Viral V, Matteo Crosignani, Tim Eisert, and Christian Eufinger, 2023, How do supply shocks to inflation generalize? evidence from the pandemic era in europe, Technical report, National Bureau of Economic Research.

Bai, John, Douglas Fairhurst, and Matthew Serfling, 2020, Employment protection, investment, and firm growth, *The Review of Financial Studies* 33, 644–688.

Barnichon, Regis, 2010, Building a composite help-wanted index, *Economics Letters* 109, 175–178.

Belo, Frederico, Andres Donangelo, Xiaoji Lin, and Ding Luo, 2023, What Drives Firms' Hiring Decisions? An Asset Pricing Perspective, *The Review of Financial Studies* 36, 3825–3860.

Belo, Frederico, Xiaoji Lin, and Santiago Bazdresch, 2014, Labor hiring, investment, and stock return predictability in the cross section, *Journal of Political Economy* 122, 129–177.

Buehlmaier, Matthias MM, and Toni M Whited, 2018, Are financial constraints priced? evidence from textual analysis, *The Review of Financial Studies* 31, 2693–2728.

Campbell, John Y, 2017, *Financial decisions and markets: a course in asset pricing* (Princeton University Press).

Darmouni, Olivier, and Andrew Sutherland, 2023, Investment when new capital is hard to find, *MIT Sloan Research Paper* Available at SSRN: `https://ssrn.com/abstract=4342687` or `http://dx.doi.org/10.2139/ssrn.4342687`.

Ersahin, Nuri, Mariassunta Giannetti, and Ruidi Huang, 2023, Supply chain risk: Changes in supplier composition and vertical integration, Technical report, National Bureau of Economic Research.

Fama, Eugene F, and Kenneth R French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of financial economics* 33, 3–56.

Fama, Eugene F, and Kenneth R French, 2008, Dissecting anomalies, *The Journal of Finance* 63, 1653–1678.

Fama, Eugene F, and Kenneth R French, 2015, A five-factor asset pricing model, *Journal of financial economics* 116, 1–22.

Farre-Mensa, Joan, and Alexander Ljungqvist, 2016, Do measures of financial constraints measure financial constraints?, *The review of financial studies* 29, 271–308.

Franzoni, Francesco A, Mariassunta Giannetti, and Roberto Tubaldi, 2023, Supply chain shortages, large firms' market power, and inflation, *Large Firms' Market Power, and Inflation (September 27, 2023)* .

Graham, John R, 2022, Presidential address: Corporate finance and reality, *The Journal of Finance* 77, 1975–2049.

Harford, Jarrad, Qiyang He, and Buhui Qiu, 2023, Firm-level labor-shortage exposure, *Available at SSRN 4410126* .

Hassan, Tarek A, Stephan Hollander, Laurence Van Lent, and Ahmed Tahoun, 2019, Firm-level political risk: Measurement and effects, *The Quarterly Journal of Economics* 134, 2135–2202.

Hayashi, Fumio, 1982, Tobin's marginal q and average q: A neoclassical interpretation, *Econometrica: Journal of the Econometric Society* 213–224.

Hennessy, Christopher A, and Toni M Whited, 2007, How costly is external financing? evidence from a structural estimation, *The Journal of Finance* 62, 1705–1745.

Hoberg, Gerard, and Vojislav Maksimovic, 2015, Redefining financial constraints: A text-based analysis, *The Review of Financial Studies* 28, 1312–1352.

Hoberg, Gerard, and Vojislav Maksimovic, 2022, Product life cycles in corporate finance, *Review of Financial Studies Forthcoming* .

Hoberg, Gerard, and S Katie Moon, 2019, The offshoring return premium, *Management Science* 65, 2876–2899.

Hoberg, Gerard, and Gordon Phillips, 2016, Text-based network industries and endogenous product differentiation, *Journal of Political Economy* 124, 1423–1465.

Hou, Kewei, Chen Xue, and Lu Zhang, 2015, Digesting anomalies: An investment approach, *The Review of Financial Studies* 28, 650–705.

Kilic, Mete, Louis Yang, and Miao Ben Zhang, 2022, The cross-section of investment and profitability: Implications for asset pricing, *Journal of Financial Economics* 145, 706–724.

Kothari, Pratik, and Michael S O'Doherty, 2023, Job postings and aggregate stock returns, *Journal of Financial Markets* 64, 100804.

Lamont, Owen, Christopher Polk, and Jesús Saaá-Requejo, 2001, Financial constraints and stock returns, *The review of financial studies* 14, 529–554.

Le Barbanchon, Thomas, Maddalena Ronchi, and Julien Sauvagnat, 2022, Hiring difficulties and firms' growth.

Li, Dongmei, 2011, Financial constraints, r&d investment, and stock returns, *The Review of Financial Studies* 24, 2974–3007.

Merz, Monika, and Eran Yashiv, 2007, Labor and the market value of the firm, *American Economic Review* 97, 1419–1431.

Petrosky-Nadeau, Nicolas, Lu Zhang, and Lars-Alexander Kuehn, 2018, Endogenous disasters, *American Economic Review* 108, 2212–2245.

Titman, Sheridan, KC John Wei, and Feixue Xie, 2004, Capital investments and stock returns, *Journal of financial and Quantitative Analysis* 39, 677–700.

Tobin, James, 1969, A general equilibrium approach to monetary theory, *Journal of money, credit and banking* 1, 15–29.

Tuzel, Selale, and Miao Ben Zhang, 2017, Local risk, local factors, and asset prices, *The Journal of Finance* 72, 325–370.

Zhang, Lu, 2017, The investment capm, *European Financial Management* 23, 545–603.

A Appendix

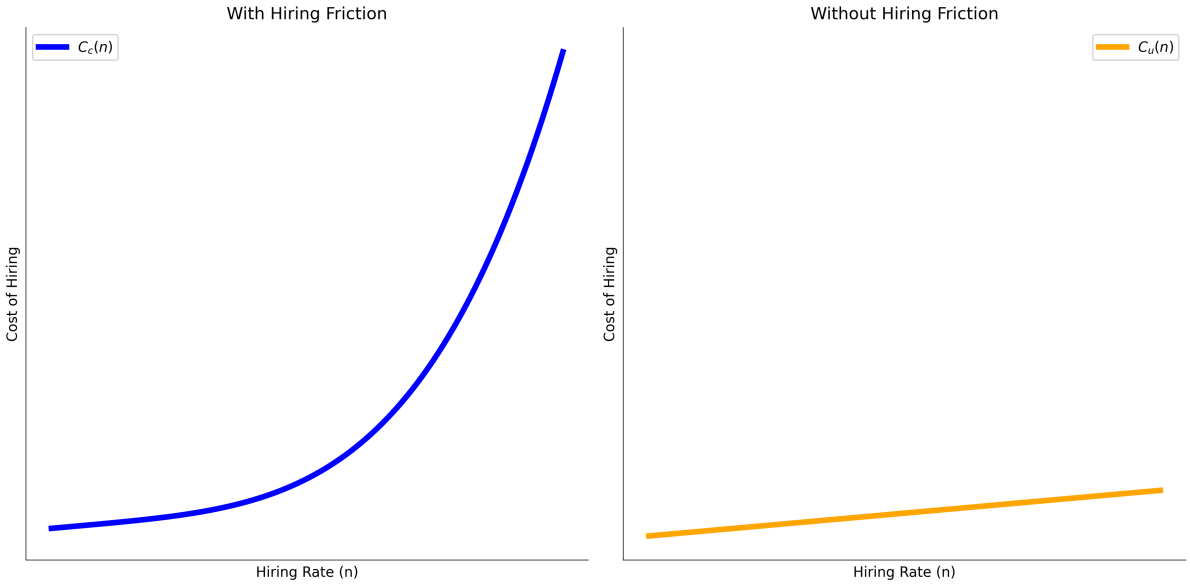


Figure A.1: Illustration of hiring friction

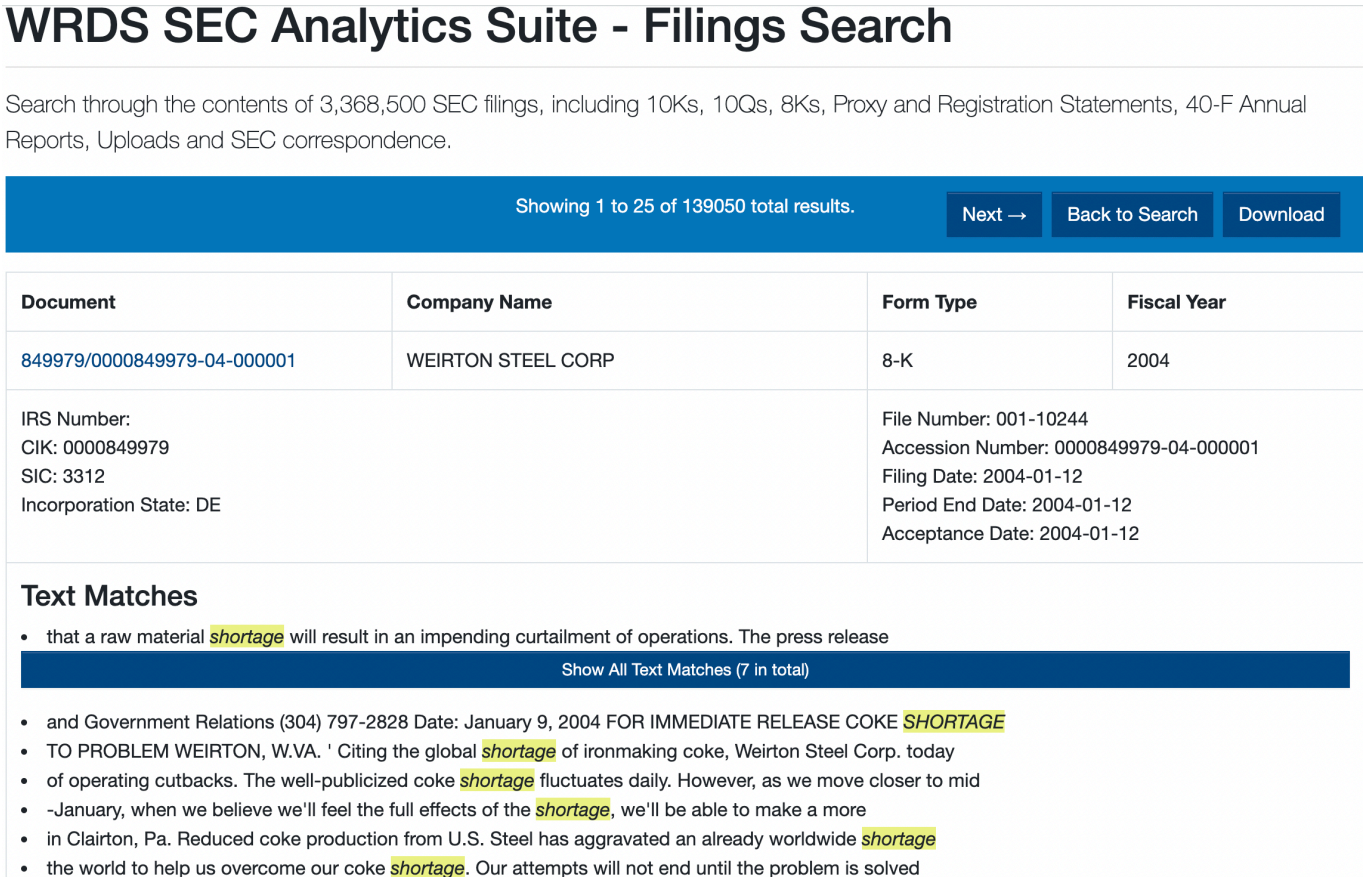
The figure shows the marginal cost of hiring curves of two hypothetical firms. The firm on the left faces hiring friction, whereas the firm right does not. Such characterisation relies on the difference of elasticity of supply of labor.

LABOR SHORTAGES ARE ADVERSELY AFFECTING PATTERSON'S DRILLING OPERATIONS.

The increase in domestic drilling demand from mid-1995 through the third quarter of 1997 and related increase in contract drilling activity caused a shortage of qualified drilling rig personnel in the industry. This increase adversely impaired our ability to attract and retain sufficient qualified personnel and to market and operate our drilling rigs. Further, the labor shortages resulted in wage increases, which impacted our operating margins. The return to higher demand levels in the contract drilling industry has reinstated the problems associated with labor shortages. Of particular concern to us is that these problems are more severe than those previously experienced by Patterson and were reinstated at a much lower rig utilization rate than experienced in the past. These labor shortages are adversely effecting Patterson's operations. They are impeding Patterson's ability to place additional drilling rigs into operation and are causing delays in the drilling of new wells for Patterson customers.

Figure A.2: Example of labor shortage in 10-K

This screenshot captures the exact wording where labor shortage is mentioned in Patterson's 10-K filing.



WRDS SEC Analytics Suite - Filings Search

Search through the contents of 3,368,500 SEC filings, including 10Ks, 10Qs, 8Ks, Proxy and Registration Statements, 40-F Annual Reports, Uploads and SEC correspondence.

Showing 1 to 25 of 139050 total results. Next → Back to Search Download

Document	Company Name	Form Type	Fiscal Year
849979/0000849979-04-000001	WEIRTON STEEL CORP	8-K	2004

IRS Number:
CIK: 0000849979
SIC: 3312
Incorporation State: DE

File Number: 001-10244
Accession Number: 0000849979-04-000001
Filing Date: 2004-01-12
Period End Date: 2004-01-12
Acceptance Date: 2004-01-12

Text Matches

- that a raw material *shortage* will result in an impending curtailment of operations. The press release

Show All Text Matches (7 in total)

- and Government Relations (304) 797-2828 Date: January 9, 2004 FOR IMMEDIATE RELEASE COKE *SHORTAGE*
- TO PROBLEM WEIRTON, W.VA. ' Citing the global *shortage* of ironmaking coke, Weirton Steel Corp. today
- of operating cutbacks. The well-publicized coke *shortage* fluctuates daily. However, as we move closer to mid
- -January, when we believe we'll feel the full effects of the *shortage*, we'll be able to make a more
- in Clairton, Pa. Reduced coke production from U.S. Steel has aggravated an already worldwide *shortage*
- the world to help us overcome our coke *shortage*. Our attempts will not end until the problem is solved

Figure A.3: Example of labor shortage in WRDs SEC Analytics Suite

This screenshot captures the output structure from searching "shortage". It provides information about the firm, filing type, state, and most importantly, it outputs all text matches within the document.

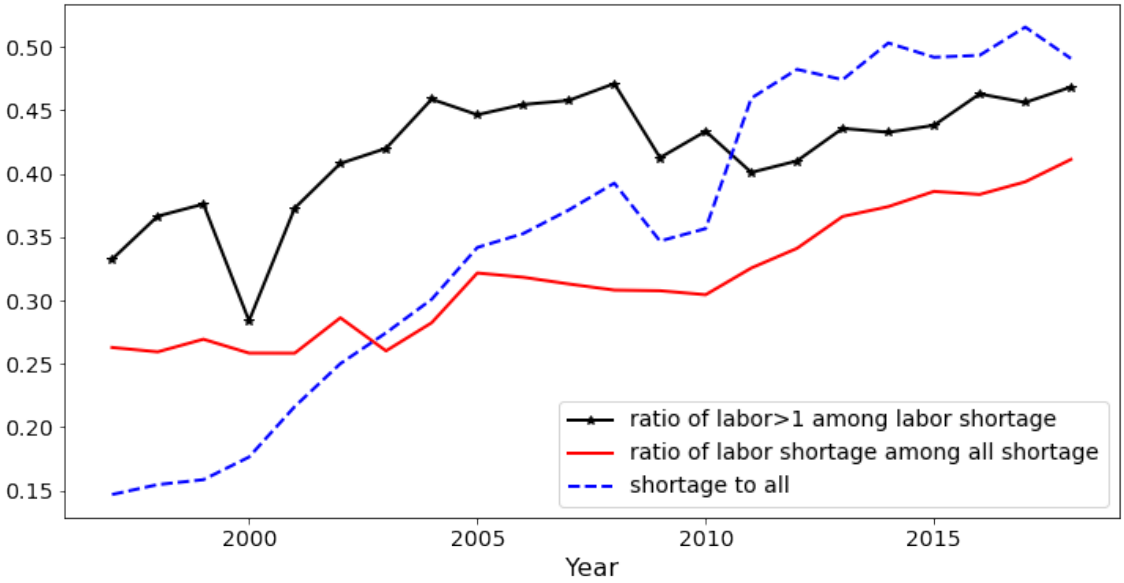


Figure A.4: Time series of labor shortage ratios

Note: the red solid line represents annual aggregate labor shortage ratio, defined as the ratio between labor shortage total mentioning and shortage total mentioning. The blue dashed line is annual aggregate shortage ratio, defined as the ratio between total firms mentioning shortage, and total firms in the year. The black stared line is the annual ratio between amount of firms mentioning labor shortage more than once in the year, and that of firms mentioning only one time.

	labor	labor score	shortage	shortage score
0	labour	0.84	shortages	0.94
1	employment	0.79	scarcity	0.78
2	reform	0.79	cope	0.76
3	unions	0.78	supply	0.76
4	employers	0.76	alleviate	0.75
5	wage	0.76	chronic	0.74
6	union	0.75	severe	0.74
7	policies	0.75	supplies	0.73
8	policy	0.74	affected	0.72
9	wages	0.74	scarce	0.71
10	government	0.74	problems	0.71
11	workers	0.74	suffer	0.71
12	jobs	0.72	food	0.71
13	economic	0.72	reduce	0.70
14	welfare	0.72	skyrocketing	0.70
15	reforms	0.72	ease	0.70
16	social	0.72	experiencing	0.70
17	industry	0.70	fuel	0.70
18	unemployment	0.70	costs	0.69
19	non	0.70	drought	0.69
20	civil	0.69	demand	0.69
21	sector	0.69	caused	0.69
22	spending	0.69	suffering	0.69
23	demand	0.69	acute	0.69
24	hiring	0.69	oversupply	0.69
25	current	0.69	increasing	0.69
26	economy	0.69	lack	0.68
27	pensions	0.69	influx	0.68
28	tax	0.69	pressures	0.68
29	poor	0.69	relieve	0.68

Table A.1: Word2vec words list

This table provides reference lists of the word "labor"(left) and "shortage"(right). The higher the score the more related the model thinks the word is related to the search word. Note that in my two-step procedure, I only use "shortage" to search for matched sentences, mainly to avoid confounding factors other than shortage. In the second step, I only use a selective set from labor list, again to reduce confounding meanings.

Variable	Coefficient (b)	%
hn	0.31***	36.6
ik	0.16**	17.3
roa	0.14	15.3
bm	-0.01	-1.1
lev	0.70***	101.4
size	0.11***	11.2

Table A.2: Logit Regression Results with Industry Fixed Effect

Note: this table reports results from running logistic regression to explain the binary variable of labor shortage that takes value 1 if the firm mentions labor shortage in that year. All sample includes all firms; hn: hiring rate; ik: physical capital investment rate; roa: return on assets; beme: book to market equity ratio; lev: book debt to market value of the firm; size: log of firm market value.