# Hiring with a Quantity-Skill Tradeoff*

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**Abstract**

When firms expand their workforce rapidly, do they maintain their educational requirements? Using Longitudinal Employer-Household Dynamics (LEHD) data from 2005–2015, we document a strong inverse relationship between a firm's hiring rate and the average educational attainment of its hires. We find that a doubling of the hiring rate results in a roughly five percentage point reduction in the share of hires with a college degree. We develop a search and matching model with worker heterogeneity and decreasing returns to scale to explain this quantity-skill tradeoff. The model demonstrates that the tradeoff is driven by the high marginal productivity of labor facing growing firms, which compels them to relax educational selectivity to meet recruiting targets.

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# 1 Introduction

How do firm-level constraints on hiring affect the human capital composition of the workforce? A large literature in labor economics explores how search frictions and hiring costs influence the scale of the firm, yet we know far less about how these constraints alter the specific types of workers a firm recruits during periods of rapid growth. While aggregate "upskilling" and "downskilling" have been documented over the business cycle (Modestino et al., 2016, 2020), it remains an open question whether these shifts are a byproduct of macro-conditions or an intrinsic feature of the firm's own life cycle and expansion process. Understanding this relationship is critical for evaluating how idiosyncratic shocks to firm productivity transmit to worker sorting and, ultimately, to the aggregate skill distribution.

In this paper, we document a systematic "quantity-skill tradeoff" at the micro-level: as firms increase their hiring intensity, the average educational attainment of their new hires falls. Following Katz and Murphy (1992) and numerous others, we link observed educational attainment with latent labor skill, using college degree completion as our empirical proxy and using the terms "skill" and "education" interchangeably. We address the central question of composition by first establishing a set of novel empirical facts using linked employer-employee data from the Longitudinal Employer-Household Dynamics (LEHD) infrastructure files. We then propose a search and matching model with worker heterogeneity and decreasing returns to scale that endogenizes this tradeoff.

We document a robust and persistent empirical relationship: a doubling of the hiring rate results in a roughly five percentage point reduction in the share of hires with a college degree. While a significant portion of this aggregate doubling rule is driven by sorting across different firm types, our results remain statistically significant when accounting for firm-level heterogeneity. Including firm fixed effects reveals a within-firm semi-elasticity of approximately minus one percentage point, indicating that individual firms systematically lower their educational standards as they transition into higher-growth regimes. To address concerns that these correlations might be driven by idiosyncratic firm-level shocks, we implement an instrumental variables strategy. We instrument for firm-level hiring using industry-level separation rates, calculated as a leave-out mean that excludes all firms within the same state. This approach isolates hiring needs driven by external sectoral churn—such as workers being poached by competitors—rather than a firm's internal productivity shocks. An instrumental variables estimation strategy motivated by firm needs for replacement hiring due to industry-level effects (separation rates) confirms the presence of a robust quantity-skill tradeoff, with magnitudes that are even larger than our baseline within-firm estimates. The magnitude and persistence of this relationship across both cross-sectional and longitu-

dinal specifications suggest that a firm's position relative to its steady-state size is a primary determinant of its skill demand, providing an explanation for why fast-growing firms appear to "downskill" even in the absence of aggregate economic shocks.

Our findings contribute to a growing literature on how firms adjust their labor composition along differential margins. The classic quasi-fixity insight of Oi (1962) implies that workforce adjustment occurs disproportionately through lower-skill labor. More recently, evidence suggests that formal skill requirements are not static but instead rise and fall with aggregate labor market slack (Modestino et al., 2016, 2020; Hershbein and Kahn, 2018). Micro-level evidence further indicates that firms apply endogenous skill thresholds within occupations, determining whether workers access high-skill roles or are displaced to lower-skill positions (Huckfeldt, 2022). We extend this line of work by providing a firm-level mechanism for these shifts in hiring cutoffs: as firms expand and face high marginal productivity of labor, they optimally relax selectivity to meet quantity targets, shifting their hiring to lower-skilled workers. As firms mature and hiring pressure falls, their selectivity naturally rises, generating systematic variation in workforce composition over the firm lifecycle.

This dynamic perspective complements a long-standing literature following Katz and Murphy (1992) that analyzes skill demand and firm composition as largely equilibrium allocations. Recent advancements in this framework highlight how these allocations are shaped by the labor supply margin (Patel, 2025), skill-biased technological change (Lindner et al., 2022) and market structure (Deb et al., 2024). While these models often focus on steady-state sorting, our contribution highlights the dynamic process of how firms arrive at those allocations. By showing that hiring intensity itself shifts acceptance thresholds, we provide a microfoundation for cross-firm differences in skill shares that operates through hiring flows in the presence of labor market frictions.

An additional contribution of this paper is the development of a quantitative framework that endogenizes firm-level hiring decisions within a multi-worker search environment. While the standard search and matching literature often focuses on single-worker firms for tractability, a growing body of work has begun to explore the complex dynamics of larger organizations. Our framework is related to a growing body of work studying firm dynamics in environments with multi-worker production and search frictions, including Kaas and Kircher (2015) and Schaal (2017).

Technically, our model is most closely related to the framework developed by Bilal et al. (2022), which studies how firm dynamics generate wage dispersion across employers. We extend this framework in a critical dimension: we explicitly incorporate worker heterogeneity to study the endogenous labor demand composition across the firm lifecycle. While previous multi-worker models have analyzed firm growth and productivity, they have largely

abstracted away from the specific educational composition of the inflow. By modeling the tradeoff between scale and selectivity, we provide a microfoundation for the "upskilling" and "downskilling" phenomena documented by Oi (1962) and Modestino et al. (2016, 2020). Our paper is complementary to Gulyas (2025), who studies how firm expansion reshapes the skill composition of the overall workforce through both hiring and separations. We focus instead on the firm's marginal recruiting decision: conditional on hiring, how does hiring intensity affect the educational composition of new hires? We also provide direct evidence that corroborates the quantitative frameworks developed by Sedláček (2014), Carrillo-Tudela et al. (2023), and Gulyas (2025) that propose hiring standards as a mechanism for differential matching efficiency across firms and markets. In our paper, we tie firm growth as a main driver of endogenous changes in skill-demand and firms' skill-composition, which drives selectivity even if meeting technology is fixed.

We argue that this tradeoff is driven by the fact that new entrants start small relative to their optimal size. Because of the concavity of the production function, the marginal product of labor (MPL) for these entrants is high. This creates an intense pressure to expand, leading firms to prioritize the quantity of hires over educational selectivity. Additional analysis of these relationships for particular firm size and age groups provides direct evidence for this mechanism, validating the "quasi-fixity" concept of Oi (1962) at the micro-level: high-skill employment is more stable, while the rapid margins of adjustment are concentrated in lower-skill hiring during periods of high MPL. As firms mature and approach their steady-state size, the MPL declines, allowing them to raise the skill floor for new hires.

Our modeling framework fills a distinct gap in the literature by characterizing the behavior of firms that must manage a stock of heterogeneous workers. Despite the importance of multi-worker firms to the aggregate economy, they remain relatively rare in search-theoretic models due to the computational complexity of tracking the intertemporal value of the firm over a multi-dimensional state space. We simplify this problem by introducing a match-specific "taste shock" parameter. This innovation allows us to model the firm's hiring decision as a continuous selectivity threshold, effectively simplifying the complex intertemporal decisions involved in worker-by-worker recruitment into a tractable flow problem while maintaining the essential dynamics of decreasing returns and poaching.

Furthermore, this micro-level mechanism has significant implications for the long-run trends in labor market dynamism. A robust literature has documented a secular decline in job-to-job mobility, reallocation, and firm entry rates in the United States (Hyatt and Spletzer, 2013; Davis and Haltiwanger, 2014; Decker et al., 2014; Molloy et al., 2016). Our results suggest that this decline in dynamism—and the corresponding reduction in the rate of firm entry—may have direct consequences for the relative employment rates of different

education groups. If fewer firms are entering the market or expanding at high rates, fewer firms are operating at the steep part of the MPL curve where they are structurally constrained to lower their educational requirements.

In this context, lower firm entry leads to a market dominated by mature, slow-growing firms with lower hiring rates. Such firms are less constrained by the volume requirements of rapid expansion and can therefore afford to be more selective, hiring predominantly from the high-skilled labor force. This shift in the aggregate distribution of hiring intensity provides an explanation for the widening employment gap between workers with and without college degrees: a less dynamic economy is one where the "hiring ladder" for lower-educated workers is effectively truncated, as the high-intensity hiring engines that once absorbed them have become increasingly scarce.

The remainder of the paper is organized as follows. Section 2 describes the LEHD infrastructure and the construction of our firm-level hiring and education measures. Section 3 presents the core empirical results, including the log-linear relationship between worker composition and the hiring rate, as well as heterogeneity by firm age and size. Section 4 develops a multi-worker search model and presents numerical calibration and simulation results. Section 5 concludes.

# 2 Data and Variable Construction

## 2.1 Data Sources

The empirical analysis in this paper utilizes the Longitudinal Employer-Household Dynamics (LEHD) infrastructure files from the U.S. Census Bureau. The LEHD program integrates administrative records from state unemployment insurance (UI) systems with Census Bureau surveys and other administrative data, as detailed in Abowd et al. (2009).[1] This linked employer-employee framework allows us to observe the near-universe of private-sector employment in the United States, providing the scale necessary to analyze workforce composition across the entire distribution of firm growth. Specifically, we utilize the internal Census Bureau LEHD Snapshot, which contains the longitudinal histories of employer-employee matches and firm-level characteristics (U.S. Census Bureau, 2024). It also includes information on employer industry and location (geography). It also contains annual measures of firm age and size as described in Haltiwanger et al. (2014).

A critical feature of the LEHD infrastructure is its reliance on a voluntary partnership between state labor market information agencies and the U.S. Census Bureau. Because

[1] We provide only an outline of our data here, for additional details, see Appendix A.1.

different LEHD state partners have provided data for different time periods, the available longitudinal depth varies significantly across jurisdictions. While some states provide records reaching back to the early 1990s, others joined the partnership much later. To ensure our results are nationally representative and not driven by the shifting geographic composition of reporting states, we restrict our primary analysis to the period from 2005 to 2015. This window represents the years in which the LEHD contains complete, continuous data from all fifty states plus the District of Columbia. By focusing on this consistent set of states, our primary sample covers a diverse set of economic conditions (including the 2007–2009 recession) while maintaining a consistent geographic scope. It is important to note that while the set of reporting states is constant, the underlying microdata is an unbalanced panel of firms; we do not restrict our analysis to continually-lived firms, which allows the sample to reflect the full impact of firm entry and exit during this period.

## 2.2 Firm Definitions

A primary challenge in using administrative data is the distinction between legal entities and economic firms. In our sample, firm identifiers are assigned following the methodology detailed in Haltiwanger et al. (2014). We aggregate federal Employer Identification Numbers (EINs) to the firm level, often referred to as the "alpha" level in Census Bureau terminology, to ensure that we capture the activities of multi-establishment parent companies as single decision-making units.

Following Cao et al. (2026a,b), in instances where a firm-level identifier is unavailable, we utilize the EIN as the proxy for the firm identifier. This approach ensures maximum coverage of the employer universe while maintaining longitudinal consistency for both large enterprises and the recent surge of small, single-unit startups.

## 2.3 The Hiring Rate

Our primary measure of firm growth is the annual hiring rate. Because the underlying administrative records consist primarily of quarterly earnings totals, we apply the foundational definitions of employment and hiring established by Abowd et al. (2009). Individual hires are identified using quarterly longitudinal links—identifying a new hire when an employer-employee match transitions from zero earnings to positive earnings.

Our specific hiring rate is an annualized version of the quarterly flow measures, following the methodology used by Hyatt et al. (2021). Our hiring concept represents the total volume of recruitment over a four-quarter span. The annual hiring volume is the sum of these

quarterly inflows, normalized by average employment across the same four quarters.[2]

As noted previously, while net employment growth is bounded by the symmetric growth rate formula of Davis et al. (1996), this hiring rate $h_{j,year}$ is not bounded above. This is particularly relevant for startups and high-churn firms where the total number of individuals cycling through the firm over a year can significantly exceed the average headcount. By annualizing the data in this manner, we smooth idiosyncratic quarterly volatility and provide a more robust measure of a firm's position on its lifecycle-driven marginal product of labor (MPL) curve.

## 2.4 Measuring Educational Composition

To measure workforce composition, we leverage the person-level educational attainment data available within the LEHD infrastructure. A distinctive feature of our empirical strategy is that we do not use any imputed values for education. Instead, we rely exclusively on observed educational attainment for the subset of workers who can be matched to the Census 2000 Long Form or the American Community Survey (ACS). Because educational attainment is a relatively stable characteristic for the adult population, we utilize the education level reported by the individual in these surveys, regardless of whether the survey was conducted in the same year as the hiring event.

While this approach means we do not observe the education level for every worker at a given firm, the Census and ACS are both large-scale, random samples of the U.S. population. Consequently, the observed subset of workers at a firm provides a representative estimate of that firm's overall hiring composition. This sampling framework is particularly robust when aggregated across the deciles of the hiring rate, as the law of large numbers ensures that the mean college share within each decile is a statistically representative measure of the latent skill intensity.

This "college share" serves as our empirical proxy for high-skilled labor, following the literature that begins with Katz and Murphy (1992). By focusing on the flow of new hires rather than the stock of existing employees, we capture the firm's marginal hiring decision. This is a critical distinction in our framework: while the stock of human capital may change slowly due to tenure and training, the composition of the inflow is immediately sensitive to the firm's current recruitment standards and its location on the MPL curve. We calculate this share as the number of matched college-educated hires in the year divided by the total number of matched hires in the year, ensuring the composition estimate is consistent with the sampling frame of the underlying Census data.

[2]Additional details on the construction of the hiring rate are provided in Appendix A.2.

### 2.5 Sample Selection

To ensure the stability of our annual measures, we restrict our primary analysis to firms that report positive employment in all four quarters of the focal year. However, for firms that enter mid-year (e.g., new startups), we calculate the annual hiring rate and composition based on the available active quarters, with the denominator adjusted to reflect the average employment over the period of operation. This ensures that high-intensity hiring associated with the earliest stages of a firm's lifecycle, a key driver of our quantity-skill tradeoff, is captured in our estimates.

Finally, for our primary outcome variable—the share of hires with a college degree—to be defined for a given firm-year, we impose the requirement that the firm must have hired at least one worker whose educational attainment is observed in either the Census 2000 Long Form or the ACS. Crucially, this observation of educational attainment may occur at any point in the worker's longitudinal history within the Census records, not necessarily within the same calendar year as the hire. This restriction ensures that our measure of educational composition is based on actual observed data, while the aggregation into hiring rate deciles addresses potential sampling noise at the individual firm level.

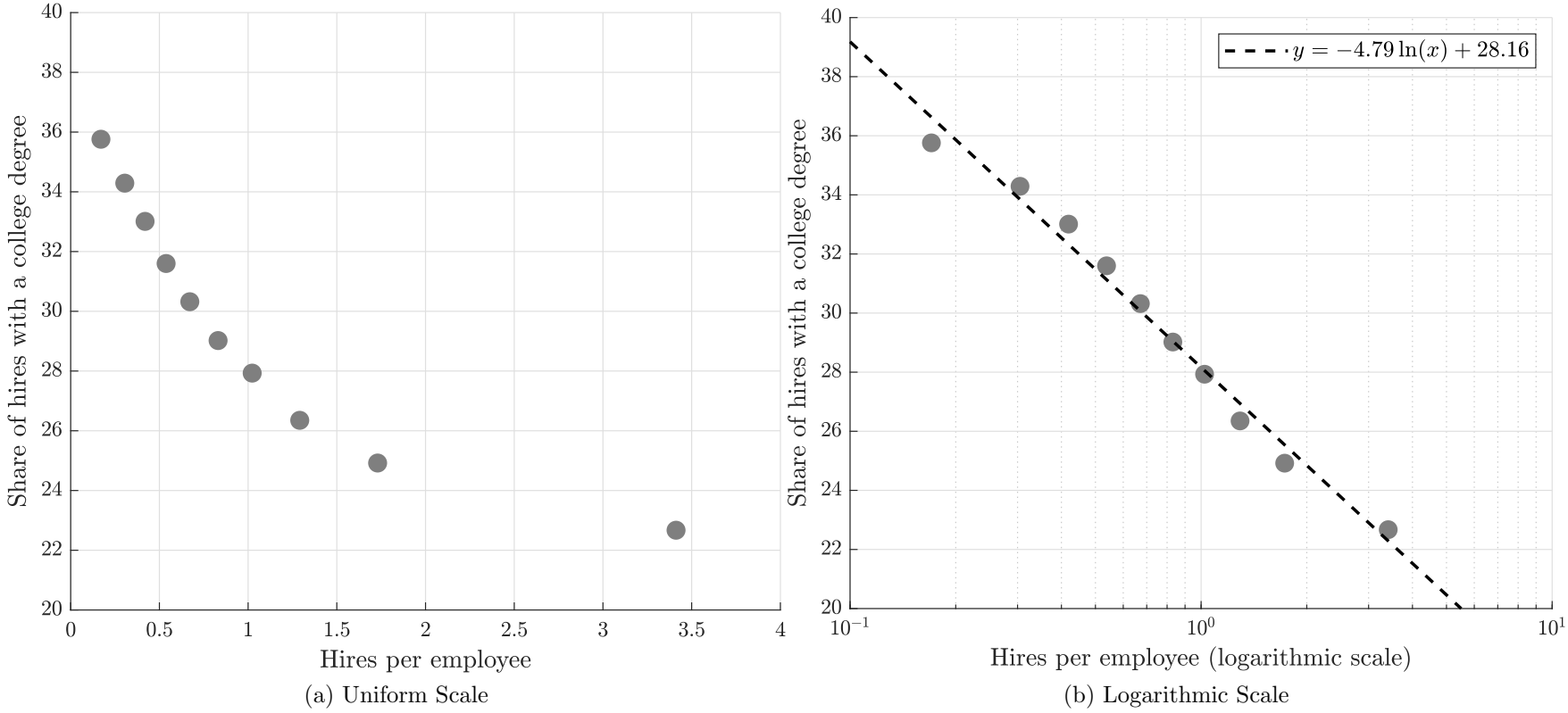
## 3 Empirical Findings

In this section, we present the core empirical regularities governing the relationship between firm growth and workforce composition. Using the LEHD infrastructure files, we document a persistent "quantity-skill tradeoff" that characterizes the hiring behavior of firms across the U.S. economy. This relationship provides the empirical foundation for the model developed in Section 4.

### 3.1 The Quantity-Skill Tradeoff

We begin by documenting a novel and stark empirical regularity: the inverse relationship between a firm's hiring intensity and the educational attainment of its new hires. Figure 1(a) presents the mean college-educated share of hires across ten deciles of the annual hiring rate. The horizontal axis measures hiring intensity as the total number of hires made over the course of a calendar year divided by the firm's average employment. This ratio represents the gross inflow of new workers relative to firm size, capturing both expansion-driven hiring and replacement hiring due to churn.

The horizontal axis captures a vast heterogeneity in recruitment intensity, ranging from firms engaged in minimal replacement hiring to those whose annual hiring volume is several




(a) Uniform Scale

(b) Logarithmic Scale

Figure 1: Average educational attainment for ten deciles of the hiring rate

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.

times the size of their existing workforce. As shown in Figure 1(a), there is a monotonic and significant decline in skill composition as this intensity increases. Firms in the lowest decile of hiring intensity—which are typically mature, stable organizations engaged primarily in low-volume replacement hiring—maintain a college-educated hire share of 35.8%. As we move across the distribution, the hiring rate increases steadily. Notably, in the sixth decile, the hires per employee ratio is approximately equal to one, implying the firm makes exactly one hire for every existing employee over the course of the year. Because the sixth decile is the first to reach this parity, it follows that more than half of all firms in our sample operate with an annual hiring rate of less than one.

In contrast, firms in the highest decile, representing those expanding at the most rapid rates, see the college-educated share fall to 22.7%. This represents a total 13.1 percentage point decline across the hiring distribution. The importance of this finding is twofold. First, it demonstrates that educational selectivity is not a static firm characteristic determined solely by industry or technology; rather, it is a dynamic choice that responds to growth imperatives. Second, it suggests that the primary entry points for workers without a college degree are concentrated in high-intensity hiring regimes. In this sense, the "skill floor" for entry is significantly lower at firms that are under high pressure to expand.

To better understand the functional form of this relationship, Figure 1(b) plots the same data on a logarithmic scale. This transformation reveals a strong log-linear relationship, which we estimate as $y = -4.79 \ln(x) + 28.16$. The intercept term of 28.16 is reached near the sixth decile, at which $x \approx 1$, and at this parity the regression predicts a college-educated hire share of approximately 28.2% (noting that $\ln(1) = 0$). The slope coefficient of -4.79 quantifies the severity of the tradeoff: for every doubling of the annual hiring rate, the share of hires with a college degree falls by approximately five percentage points. This semi-elasticity suggests that the "hiring penalty" on skill is substantial; as firms move from modest growth to rapid expansion, the necessity of meeting high recruitment targets compels them to relax their educational requirements.

Table 1 presents the results of regressing the college share of hires on the log hiring rate. Column (1) shows the unconditional tradeoff, where a 1% increase in the hiring rate is associated with a 4.66 percentage point decline in the college share. In Column (2), we control for firm age and size; while older firms tend to hire fewer college-educated workers and larger firms hire fewer, the primary coefficient on the hiring rate remains stable at -5.08.

The relationship between the regression estimates in Columns (1) and (2) and the graphical evidence in Section 3.1 is direct. The slope of the regression line in Figure 1(b) is approximately equal to the estimate reported in Column (1) of Table 1 (-4.79 and -4.66, respectively). This similarity arises because Figure 1(b) is effectively a discretized visual-

Table 1: Regression of College Share on Hiring Rates

| Dependent Variable: | College Share (pp) | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Log(Hiring Rate) | -4.664*** | -5.048*** | -1.007*** | -1.041*** |
| | (0.016) | (0.017) | (0.018) | (0.018) |
| Firm Age | | -0.136*** | | -0.028* |
| | | (0.001) | | (0.015) |
| Log(Firm Size) | | 0.448*** | | -0.340*** |
| | | (0.013) | | (0.021) |
| Fixed Effects | No | No | Yes | Yes |
| R-squared | 0.010 | 0.012 | 0.567 | 0.567 |

*Notes:* Robust standard errors clustered at the firm level are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable is the college share of hires multiplied by 100. Fixed effects allow a parameter estimate for every firm, as well as every year (not reported). Firm size is increased by one prior to taking logarithms.

ization of the bivariate regression; while the plot bins the data into deciles for clarity and to limit disclosure, the underlying linear fit captures the same unconditional quantity-skill tradeoff as an OLS estimate on the microdata without age and size controls.

## 3.2 Within-Firm Variation

The baseline results in Section 3.1 establish a clear negative relationship between hiring intensity and the educational attainment of new hires across the broad distribution of firms. However, these unconditional correlations might be driven by persistent, unobserved heterogeneity across entities. For instance, certain industries may structurally require lower-skill workers while naturally maintaining higher turnover or hiring rates.[3] Alternatively, geographic location or local labor market conditions could simultaneously dictate both the available pool of college graduates and the typical hiring intensity of a firm.

To determine whether the quantity-skill tradeoff is a dynamic response to firm-level shocks rather than a reflection of static cross-sectional differences, we move to a fixed-effects

[3]As shown in Appendix Table B.1, the semi-elasticity of college share with respect to hiring varies by an order of magnitude across sectors—ranging from -0.74 in Leisure and Hospitality to -9.67 in Professional and Business Services. Because different industries operate with different long-run average hiring rates and educational requirements, a pooled OLS estimate risks conflating these structural sector-level differences with the functional tradeoff we seek to identify. By introducing entity fixed effects in Table 1, we effectively control for these persistent sectoral (and firm-specific) differences, ensuring the resulting coefficient captures the dynamic tradeoff within firms over time.

regression framework. By including entity-level fixed effects, we control for all time-invariant firm characteristics—such as industry, location, and technology.[4] This allows us to isolate the "within-firm" variation: when a specific firm hires more than its own historical average, does it simultaneously lower its educational requirements?

The results of this within-entity analysis are presented in Columns (3) and (4) Table 1. While the coefficient magnitude decreases from the pooled OLS estimate of -4.66 in Column (1) to a within-firm estimate of -1.01 in Column (3), the relationship remains highly statistically significant. This confirms that the quantity-skill tradeoff is a robust feature of firm-level hiring dynamics that persists even when controlling for firm-specific heterogeneity.

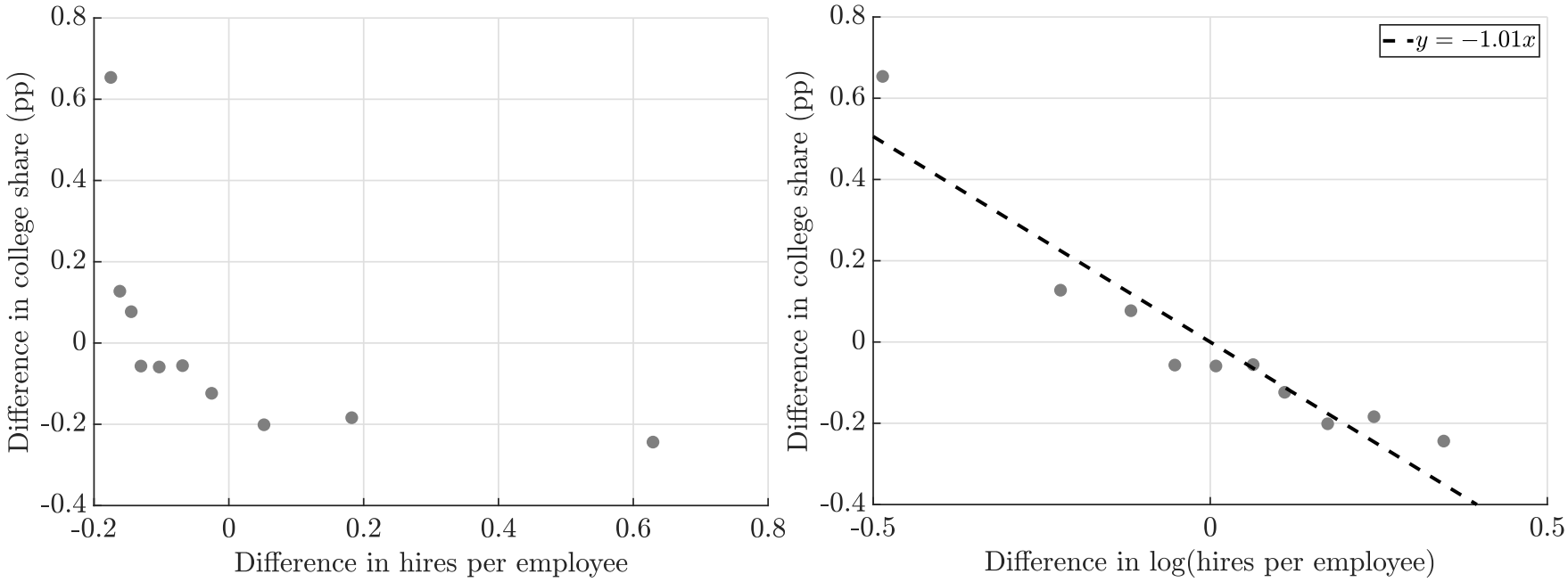
This within-firm relationship is visualized in Figure 2. By plotting the difference between each observation and its entity-level average, we remove the cross-sectional "level" effects. Figure 2b shows that the log-difference in hiring is negatively correlated with the difference in college share, with a regression line summarizing the relationship for these deciles that passes through the origin ($y = -1.01x$). The slope of this relationship is virtually identical to that which is reported in Column (3) of Table 1, which was run on the underlying microdata. This confirms that the quantity-skill tradeoff is a robust feature of firm-level hiring dynamics, persisting even when controlling for firm-specific heterogeneity.

## 3.3 Industry-Level Separation Rates

In this section, we expand our empirical analysis by introducing an instrumental variables (IV) strategy to further address potential endogeneity in the relationship between firm-level hiring and hire composition. While our previous fixed-effects specifications account for time-invariant firm characteristics, they may still be susceptible to time-varying idiosyncratic shocks that simultaneously affect both the scale and the selectivity of recruitment. To isolate exogenous variation in hiring intensity, we utilize industry-level separation rates as a Bartik-style instrument for firm-level hiring.

The motivation for this instrument rests on the premise that firms often face hiring pressures driven by factors outside their direct control. Specifically, we focus on separations driven by external labor market competition, such as the success of other sectors that may poach workers from a firm. To ensure the instrument is purged of local geographic shocks or the focal firm's own employment decisions, we calculate the leave-out-mean (LOM) separation rate at the 4-digit NAICS level, excluding all firms operating within the same dominant

[4]Because our dataset is restricted to firm-year observations from 2005–2015, the estimation of these fixed effects is subject to left and right censoring. Specifically, firms that entered the market before 2005 or remained active after 2015 have their historical or subsequent hiring behavior excluded from the calculation of the firm-level average.

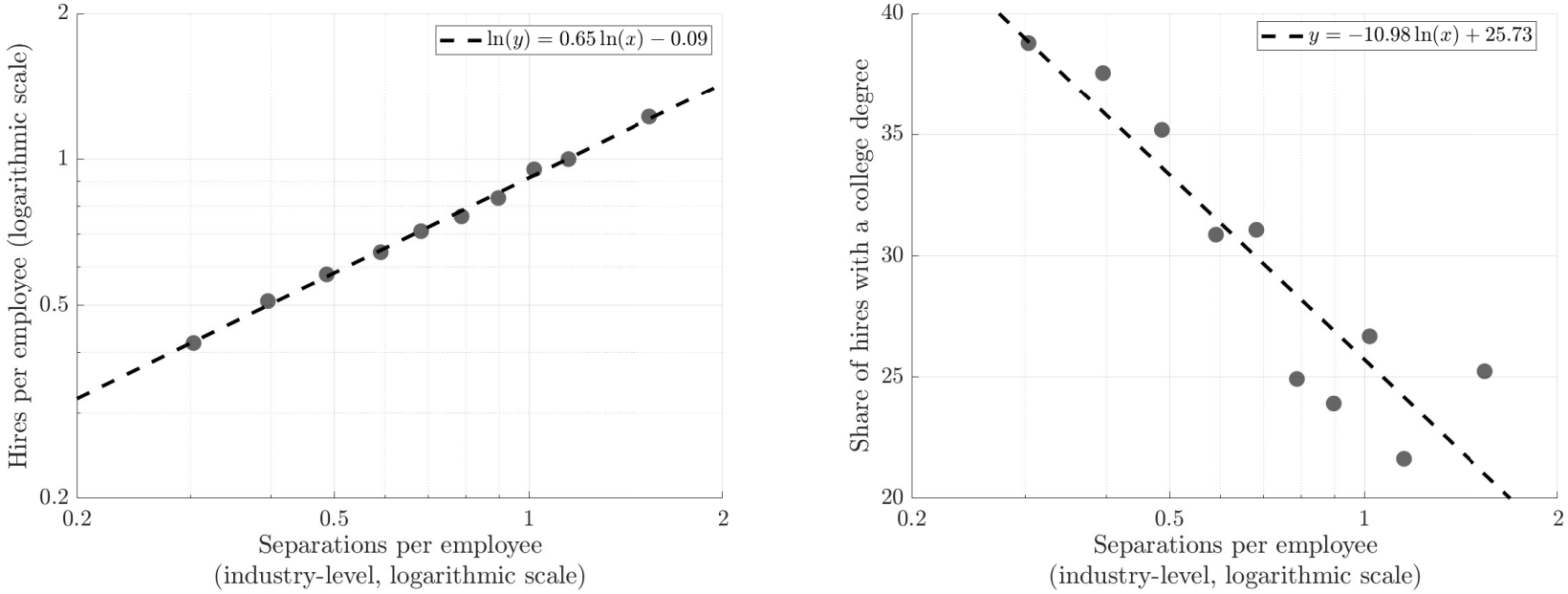



(a) Uniform Scale

(b) Logarithmic Scale

Figure 2: Average educational attainment for ten deciles of the hiring rate (difference from firm-level average)

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.




(a) First Stage (b) Reduced Form

Figure 3: Hiring rate and share of hires with a college degree for ten deciles of the industry-level separation rate

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows industry-level total separations in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. Industry is defined at the 4-digit NAICS level. A firm's industry-level separation rate leaves out the dominant state in which firm operates, including that firm. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.

state as the focal firm. This construction ensures that the instrument captures broad industrial trends in labor market churn rather than firm-specific or local-market conditions.

Figure 3 visualizes the strength and direction of this identification strategy. Panel (a) presents the first-stage relationship, showing a clear positive correlation between firm-level hiring and the industry-level instrument. The fitted line, $y = 0.65\ln(x) - 0.09$, confirms that firms significantly increase recruitment to backfill positions when their broader industry experiences high turnover. Panel (b) displays the reduced-form relationship between the instrument and the college share of hires. Consistent with our quantity-skill tradeoff hypothesis, as industry-level separation pressure pushes firms into higher-intensity hiring regimes, the educational attainment of their hires falls, following the negative relationship $y = -10.98 + 25.73$.

Table 2 provides the formal regression estimates for this IV framework. Panel A confirms a highly robust first stage across all specifications; in our preferred model with firm and year fixed effects (Column 4), the LOM separation rate remains a potent predictor of firm hiring with a first-stage $F$-statistic of 2,162. The 2SLS results in Panel B indicate that the quantity-skill tradeoff remains statistically significant when identified through these industry-level shocks. In the most restrictive specification (Column 4), the coefficient of -5.416 suggests that a doubling of the instrumented hiring rate results in an approximately 5.4 percentage point decline in the college-educated share of hires. These IV estimates are notably larger in magnitude than our within-firm OLS estimates, suggesting that the tradeoff is a fundamental structural feature of the recruitment process, particularly when firms are compelled to scale rapidly due to external labor market pressures.

## 3.4 Taking Stock

The empirical evidence presented in this section establishes a robust inverse relationship between the quantity of workers a firm hires and the average skill level of those hires. Across the broad distribution of the U.S. economy, the baseline OLS estimates suggest a semi-elasticity of approximately $-5.0$: a firm operating at a hiring rate twice that of a peer typically hires a cohort with a college share five percentage points lower.

The importance of this finding is twofold. First, as shown in the previous subsections and detailed in Appendix B, this tradeoff is not confined to specific sectors or types of firms. Whether examining startups or established conglomerates, or comparing high-growth service sectors to manufacturing, the downward-sloping relationship between hiring intensity and educational attainment remains a fundamental feature of the data. Even after controlling for persistent firm-level heterogeneity, which reduces the semi-elasticity to $-1.01$, the

Table 2: IV Regression of College Share on Hiring Rates

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Panel A: First Stage | | | | |
| Dependent Variable: | Log(Hiring Rate) | | | |
| LOM Separations | 0.652*** | 0.550*** | 0.072*** | 0.074*** |
| | (0.001) | (0.001) | (0.002) | (0.002) |
| Firm Age | | -0.014*** | | 0.027*** |
| | | (0.000) | | (0.000) |
| Log(Firm Size) | | -0.110*** | | -0.186*** |
| | | (0.000) | | (0.000) |
| R-squared | 0.144 | 0.227 | 0.734 | 0.740 |
| Panel B: Two-Stage Least Squares | | | | |
| Dependent Variable: | College Share (pp) | | | |
| Log(Hiring Rate) | -15.620*** | -19.040*** | -5.568*** | -5.416*** |
| | (0.050) | (0.063) | (1.075) | (1.048) |
| Firm Age | | -0.391*** | | 0.090*** |
| | | (0.002) | | (0.032) |
| Log(Firm Size) | | -1.325*** | | -1.154*** |
| | | (0.015) | | (0.196) |
| First-stage F-stat | 687,600 | 493,200 | 2,002 | 2,162 |
| Fixed Effects | No | No | Yes | Yes |

*Notes:* Robust standard errors clustered at the firm level are reported in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The dependent variable in Panel B is the college share of hires multiplied by 100. The instrument in Panel A is the leave-out mean of separations in the firm's industry. Fixed effects in columns (3) and (4) allow a parameter estimate for every firm and every year. Firm size is increased by one prior to taking logarithms. The leave-out-mean (LOM) separation rate is calcualted at the 4-digit industry level, and excludes all firms in the dominant state in which it operates. Following the Census Bureau's rounding requirements for disclosed data, all results have been rounded to four signiciant digits, including the first-stage F-statistic testing the exclusion of the LOM separation rate instrument.

relationship remains highly statistically significant. This suggests that while sorting across firm types is an important component of the aggregate tradeoff, a robust behavioral response remains: individual firms systematically relax their educational requirements when they transition into higher-growth regimes. In our most restrictive specification with firm and year fixed effects, we find that a doubling of the instrumented hiring rate results in a 5.4 percentage point decline in the college-educated share of hires. These results confirm that

the quantity-skill tradeoff is a robust feature of firm-level hiring dynamics, persisting even when identification is driven by external sectoral shocks.

Second, this relationship implies that the primary entry points for workers without a college degree are concentrated in high-intensity hiring regimes. In these regimes, the "skill floor" for entry is significantly lower because the opportunity cost of waiting for a high-skilled match—in terms of forgone growth—is prohibitively high. These high-pressure firms effectively serve as the economy's "hiring engines" for non-college labor.

This micro-level behavior has important implications for the macroeconomy, particularly in the context of declining labor market dynamism. As the density of high-growth start-tups and rapidly expanding incumbents decreases, the aggregate distribution of hiring shifts toward more mature, low-intensity firms. Because these firms operate in a regime of high selectivity, their dominance effectively raises the aggregate skill floor. This transition mechanically reduces the availability of positions for which a college degree is not a prerequisite, potentially explaining a portion of the widening employment gap between education groups.

The persistence of this within-firm tradeoff provides the empirical motivation for the model developed in the next section. To explain why a firm would optimally choose to lower the quality of its workforce as it grows, we require a framework that endogenizes the recruitment decision. In Section 4, we show how the high marginal productivity of labor facing growing firms compels them to lower their hiring thresholds, formally linking the quantity-skill tradeoff to the firm's dynamic expansion problem.

# 4 A Firm Hiring Model with a Quantity-Skill Tradeoff

To rationalize the empirical quantity-skill tradeoff, we develop a dynamic model of firm hiring with heterogeneous labor, decreasing returns to scale, and search frictions. Firms choose recruiting intensity separately by worker type and, upon meeting a worker, decide whether to form or continue the match. The key mechanism is that firms with a high marginal value of employment recruit more aggressively and accept weaker matches. As firms expand and marginal products decline, they become more selective and tilt hiring toward higher-skill labor.

## 4.1 Environment

Time is continuous. The economy consists of a continuum of risk-neutral workers and a measure of firms. Workers are of two skill types, $j \in \{H, L\}$, where $H$ denotes high-skill

labor and $L$ low-skill labor. A firm's workforce is

$$n = (n_H, n_L) \in \mathbb{Z}_+^2,$$

where $n_H$ and $n_L$ are the numbers of high- and low-skill workers employed by the firm.

Firms are subject to aggregate and idiosyncratic productivity shocks. Let

$$A_t \in \{\ell, h\}, \qquad I_t \in \{\ell, h\},$$

denote the aggregate and idiosyncratic states. The firm's productivity state is

$$s = (A, I) \in \mathcal{S} = \{(\ell, \ell), (\ell, h), (h, \ell), (h, h)\},$$

with associated productivity level $z_s > 0$. The state $s$ evolves as a continuous-time Markov process.

## 4.2 Production

A firm in state $(s, n_H, n_L)$ produces

$$y_s(n_H, n_L) = z_s\Big(a_H n_H^{\xi} + a_L n_L^{\xi}\Big)^{\gamma/\xi}, \qquad \gamma \in (0, 1), \tag{1}$$

where $a_H > a_L > 0$ captures the productivity advantage of high-skill workers. The parameter $\gamma < 1$ generates decreasing returns to scale, while $\xi$ governs substitutability across worker types.

We present the model in CES form for generality. In the quantitative parameterization, we specialize to the linear case

$$y_s(n_H, n_L) = z_s(a_H n_H + a_L n_L)^{\gamma}, \tag{2}$$

which treats worker types as perfect substitutes in efficiency units while preserving decreasing returns.

Decreasing returns are central to the model: as the firm grows, the marginal value of additional labor falls. This declining marginal value drives both vacancy creation and hiring standards.

## 4.3 Recruiting and match formation

Search is random. Firms recruit workers by matching in separate skill-specific submarkets. They choose recruiting effort as a vacancy rate separately for each worker type. Let $v_j(n, s) \geq 0$ denote recruiting intensity directed toward type $j$ in state $(n, s)$. In aggregate state $A$, a unit of recruiting effort aimed at type $j$ generates meetings at rate $\eta_j(A)$.

Workers have outside option $U > 0$. When a firm meets a worker of type $j$, the match draws an idiosyncratic taste component $\varepsilon_j$, capturing non-wage fit such as amenities, commute quality, or match-specific compatibility. We assume

$$\varepsilon_j = -Y_j, \qquad Y_j \sim \text{Exponential}(1/\sigma),$$

so that $\varepsilon_j \leq 0$ and $\sigma > 0$ governs the dispersion of match quality.

This reduced-form worker side is summarized by the outside option $U$ and the match-specific shock $\varepsilon_j$; there is no explicit wage-posting or bargaining stage.

Let $V_s(n) = V_s(n_H, n_L)$ denote firm value in state $(s, n)$. Define the marginal value of adding or removing a worker of type $j$ as

$$\Delta^+_{j,s}(n) = V_s(n + \mathbf{e}_j) - V_s(n), \qquad \Delta^-_{j,s}(n) = V_s(n) - V_s(n - \mathbf{e}_j),$$

where $\mathbf{e}_H = (1, 0)$ and $\mathbf{e}_L = (0, 1)$.

A contacted worker of type $j$ is hired if match formation yields nonnegative surplus relative to the worker's outside option:

$$\Delta^+_{j,s}(n) + \varepsilon_j \geq U.$$

Hence the acceptance probability is

$$p_{j,s}(n) = \begin{cases} 0, & \Delta^+_{j,s}(n) \leq U, \\ 1 - \exp\left(-\dfrac{\Delta^+_{j,s}(n) - U}{\sigma}\right), & \Delta^+_{j,s}(n) > U. \end{cases} \tag{3}$$

The expected surplus from a meeting with a type-$j$ worker is

$$\mathcal{G}_{j,s}(n) = \begin{cases} 0, & \Delta^+_{j,s}(n) \leq U, \\ x - \sigma\left(1 - e^{-x/\sigma}\right), & x \equiv \Delta^+_{j,s}(n) - U > 0. \end{cases} \tag{4}$$

These expressions make selectivity endogenous. When the marginal value of employment is high, firms accept a larger share of contacts and derive more surplus from recruiting. As the firm expands or productivity falls, $\Delta^+_{j,s}(n)$ declines, reducing both acceptance rates and recruiting incentives.

## 4.4 Vacancy creation

Recruiting is costly. The firm's flow payoff from vacancy creation is

$$(n_H + n_L + 1) \sum_{j \in \{H,L\}} \left[ \eta_j(A)\, v_j(n,s)\, \mathcal{G}_{j,s}(n) - \kappa_j v_j(n,s)^2 \right]. \tag{5}$$

The term $(n_H + n_L + 1)$ allows recruiting capacity to scale with firm size while permitting even very small firms to hire.

For each worker type $j$, the firm solves

$$\max_{v_j \geq 0} \; \eta_j(A)\, v_j\, \mathcal{G}_{j,s}(n) - \kappa_j v_j^2,$$

which implies an optimal vacancy rate of

$$v_j^*(n,s) = \begin{cases} \dfrac{\eta_j(A)\, \mathcal{G}_{j,s}(n)}{2\kappa_j}, & \mathcal{G}_{j,s}(n) > 0, \\ 0, & \text{otherwise.} \end{cases} \tag{6}$$

The resulting hiring rate for type $j$ is

$$r^+_{j,s}(n) = (n_H + n_L + 1)\, \eta_j(A)\, v_j^*(n,s)\, p_{j,s}(n). \tag{7}$$

Thus firms adjust hiring along two margins: recruiting intensity by type and acceptance rates conditional on contact. Changes in hiring composition arise from these margins rather than from a wage-posting tradeoff.

## 4.5 Separations

Matches end for two reasons. First, each match is subject to an exogenous separation hazard $\delta > 0$. Second, firms receive opportunities to renegotiate or restructure employment at rate $\psi > 0$. At such opportunities, a type-$j$ worker is retained if

$$\Delta^-_{j,s}(n) \geq U.$$

Otherwise the match is terminated. Endogenous separations therefore arise when the continuation value of the match falls below the worker's outside option.

This firing friction prevents firms from instantaneously adjusting employment at all times, while allowing them to shed low-value matches as conditions evolve. In addition, firms exit at rate $\lambda > 0$, destroying all existing matches.

## 4.6 Firm problem

Let $q_s = \sum_{s' \neq s} Q^z_{ss'}$ denote the total transition rate out of productivity state $s$. The firm's value function satisfies

$$\begin{aligned}(\rho + \lambda + q_s)V_s(n_H, n_L) = y_s(n_H, n_L) &+ \delta n_H\big(U - \Delta^-_{H,s}(n)\big) + \delta n_L\big(U - \Delta^-_{L,s}(n)\big) \\ &+ \lambda(n_H + n_L)U + \psi n_H\big(U - \Delta^-_{H,s}(n)\big)_+ + \psi n_L\big(U - \Delta^-_{L,s}(n)\big)_+ \\ &+ (n_H + n_L + 1)\sum_{j\in\{H,L\}}\big[\eta_j(A)\, v_j(n,s)\, \mathcal{G}_{j,s}(n) - \kappa_j v_j(n,s)^2\big] \\ &+ \sum_{s' \neq s} Q^z_{ss'} V_{s'}(n_H, n_L), \end{aligned} \tag{8}$$

where $(x)_+ \equiv \max\{x, 0\}$.

Current firm value is the sum of current production, the continuation consequences of separations and exit, net recruiting surplus, and expected capital gains or losses from productivity transitions.

## 4.7 Economic mechanism

The model generates a quantity-skill tradeoff through the interaction of decreasing returns, type-specific recruiting, and endogenous match selection. When a firm is small or highly productive, the marginal value of labor is high. The firm then recruits aggressively and accepts weaker matches, raising hiring rates but lowering average match quality.

As the firm grows, diminishing returns reduce the marginal value of additional workers. Recruiting intensity falls, hiring thresholds tighten, and low-skill hiring contracts earlier than high-skill hiring because high-skill workers contribute more to production. In sufficiently weak states, the firm may also end low-value matches when renegotiation opportunities arise. As a result, rapidly expanding firms hire more workers but are less selective, whereas larger or lower-growth firms hire more slowly and become more skill intensive.

## 4.8 Numerical Simulation

The current calibration abstracts from aggregate business-cycle variation: meeting rates and productivity levels are set equal across aggregate states, and transition rates are symmetric. This reduces the effective parameter count from 25 to 19 distinct values. Table 3 reports all parameters, grouped by role and by whether they are set externally or chosen to match data moments.

Table 3: Model parameters (no business-cycle variation)

| Symbol | Description | Value | Status |
|---|---|---|---|
| *Preferences & discounting* | | | |
| $\rho$ | Discount rate | 0.05 | External |
| $U$ | Worker outside-option value | 0.23 | Internal |
| $\sigma$ | Taste-shock dispersion | 0.42 | Internal |
| *Production* | | | |
| $\gamma$ | Decreasing returns | 0.85 | External |
| $\xi$ | CES elasticity | 1.0 | External |
| $a_H$ | High-type weight | 1.90 | Internal |
| $a_L$ | Low-type weight | 1.15 | Internal |
| $z_\ell$ | Productivity, $I{=}\ell$ | 0.175 | Internal |
| $z_h$ | Productivity, $I{=}h$ | 0.30 | Internal |
| *Turnover* | | | |
| $\alpha$ | Renegotiation rate | 4.0 | External |
| $\lambda$ | Firm death rate | 0.055 | Internal |
| $\delta$ | Exogenous separation rate | 0.035 | Internal |
| *Search & matching* | | | |
| $\eta_H$ | Meeting rate, $H$-type | 0.10 | Internal |
| $\eta_L$ | Meeting rate, $L$-type | 0.24 | Internal |
| $\kappa$ | Vacancy cost scale | 0.65 | Internal |
| $\omega$ | Matching function scale | 0.35 | Internal |
| $\zeta$ | Matching function elasticity | 0.50 | Internal |
| *Shock transitions (symmetric)* | | | |
| $q^A$ | Aggregate switching rate | 0.50 | Internal |
| $q^I$ | Idiosyncratic switching rate | 0.50 | Internal |

We simulate our model to illustrate our main mechanism influencing firms' composition of hires. We choose plausible parameters to recreate the empirical moments documented in Section 3.

We set the discount rate to 5% annually, consistent with the real return used in standard DMP calibrations (Shimer (2005); Hall and Milgrom (2008). We currently set the CES elasticity parameter $\xi$ so types are perfect substitutes. The annual renegotiation rate $\alpha$ is set to 4 (i.e. one renegotiation per quarter on average) to be consistent with a high frequency

of renegotiation opportunities or low firing frictions. We set the decreasing returns parameter $\gamma$ in our production function to 0.85, consistent with the literature (Hopenhayn (1992)). The remaining parameters are estimated by simulated method of moments in our calibration. We target the decile-bin means of the growth rate and skill-share of hires distribution. We also target the average firm size.

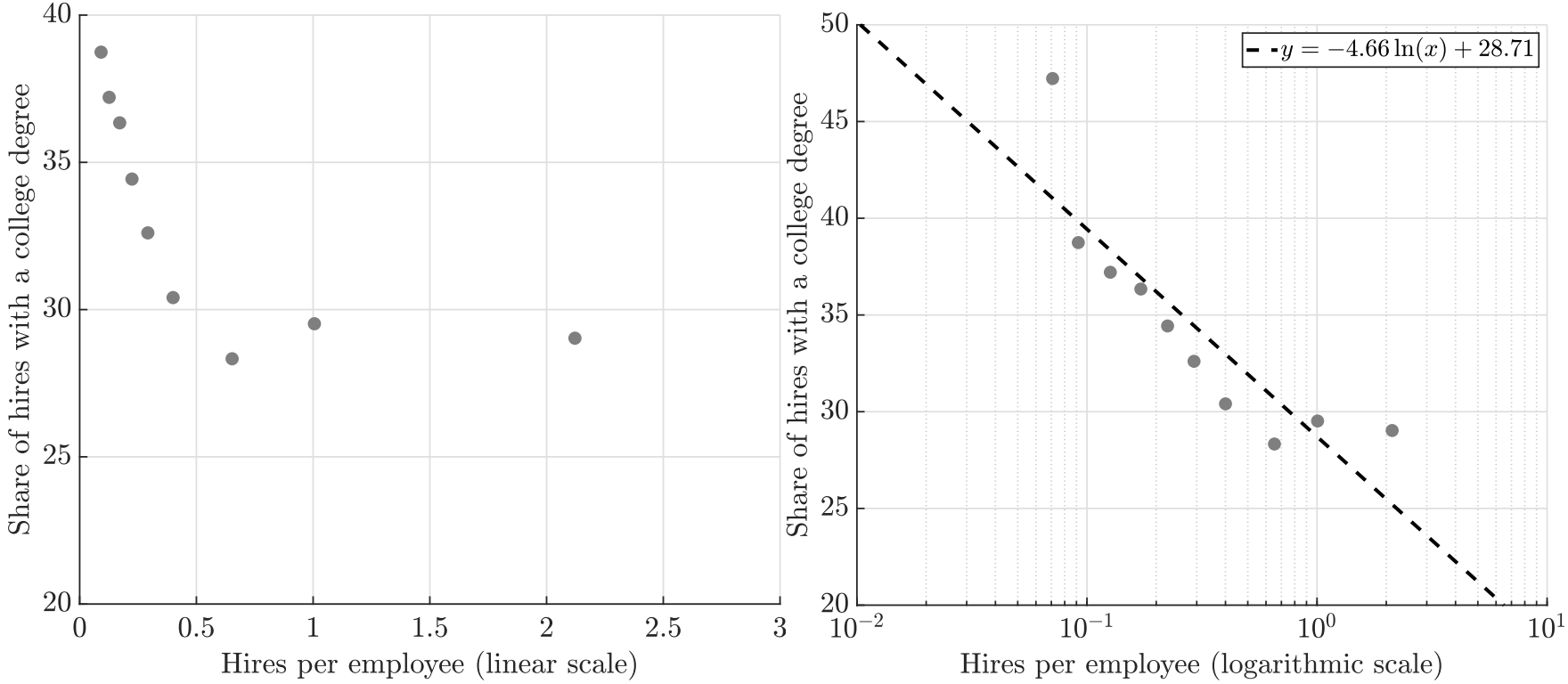
Figure 4 displays the hiring selectivity patterns produced by the numerical simulation, which closely replicate the functional forms observed in the empirical data. In Figure 4(a), the relationship between the hiring rate and the college share of hires is presented on a uniform scale. The model generates a sharp initial decline in selectivity as the hiring rate increases from zero, followed by a pronounced convex curvature as the marginal productivity of labor stabilizes at higher employment levels. This non-linear decay visually parallels the raw patterns shown in Figure 1. When the relationship is viewed on a logarithmic scale in Figure 4(b), the simulation yields the appropriate log-linearity required to match our empirical specification. A linear regression fit to the simulated data points produces the relationship $y = -4.66 \ln(x) + 28.71$. This simulated semi-elasticity of $-4.66$ is very close to the OLS estimate. The alignment between Figure 4 and Figure 1 confirms that the theoretical mechanism—where high-MPL firms lower hiring thresholds to satisfy quantity targets—is quantitatively capable of generating the specific quantity-skill tradeoff observed in the administrative records.

### 4.9 Next Steps

We plan to extend the model along several dimensions to improve its quantitative realism and to make it more amenable to policy analysis. First, we will incorporate richer business cycle dynamics, allowing changing productivity to change the growth distribution, and therefore the hiring distribution, of firms. Second, we will endogenize firm entry rates. This will allow us to use our model to study how policies that affect business dynamism differentially impact high- and low-skilled workers.

## 5 Conclusion

This paper documents a robust quantity-skill tradeoff in U.S. firm-level hiring: a doubling of a firm's hiring rate is associated with an approximately five percentage point reduction in the college share of new hires. While much of this relationship reflects the composition of firms—smaller, younger, and high-growth entities naturally operate in high-intensity hiring regimes—our longitudinal analysis reveals a substantial within-firm component. Even




(a) Uniform Scale

(b) Logarithmic Scale

Figure 4: Model Simulation: Skill Composition vs. Hiring Rate

after absorbing persistent firm-level heterogeneity through fixed effects, the within-firm semi-elasticity is approximately minus one percentage point, demonstrating that individual firms systematically relax their educational standards as they scale up.

The model interprets this tradeoff as an optimal response to lifecycle constraints. Firms far from their steady-state scale face a high marginal product of labor that raises the opportunity cost of continued search, leading them to lower selectivity thresholds—differentially across skill types—to capture the immediate gains of expansion. As firms mature and approach their optimal size, the pressure to scale subsides and they return to high-selectivity regimes. High-intensity hiring thus serves as a crucial entry point for workers without college degrees, who would otherwise be screened out by the higher standards of mature, stable firms.

These dynamics carry direct implications for labor market inclusion. As the density of high-growth startups has diminished over recent decades, the aggregate distribution of hiring has shifted toward mature, low-intensity organizations that operate with higher selectivity. Our results imply that this shift is not skill-neutral: by reducing the prevalence of high-intensity hiring margins, the secular decline in dynamism has effectively raised the economy's skill floor, contributing to widening employment gaps between education groups. If the primary mechanism for absorbing non-college labor is concentrated in the economy's "hiring engines," then a less dynamic economy is inherently a less inclusive one—suggesting that policies aimed at broadening labor market access must account for the role of firm growth.

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# A Data Appendix

## A.1 Data Sources and Sample Construction

The primary dataset used in this paper is constructed by linking several components of the Longitudinal Employer-Household Dynamics (LEHD) infrastructure files. We analyze the LEHD snapshot, which allows for the integration of firm-level characteristics with individual-level longitudinal employment histories (U.S. Census Bureau, 2024).

Specifically, our sample construction relies on the following four core files:

1. **Employer Characteristics File (ECF):** The ECF is the primary source for firm-level longitudinal identifiers and attributes. We use this file to obtain industry classifications (NAICS) and to construct our measures of firm age and size.

    - *Firm Identifier and Aggregation:* The ECF provides the State Employer Identification Number (SEIN), which we use as our primary firm identifier to group all establishments belonging to the same entity within a state. Because a consistent firm identifier is critical for our longitudinal analysis, we follow the methodology of Cao et al. (2026b) and supplement the SEIN with the Federal Employer Identification Number (EIN) in cases where the primary firm identifier is missing.
    - *Firm Age:* We follow the methodology of Haltiwanger et al. (2014), in which a firm's age is determined by the age of its oldest establishment. Specifically, age is calculated as the number of quarters since the firm's first positive employment observation in the LEHD. For our descriptive analysis, we follow the categories used in the publication of the LEHD Quarterly Workforce Indicators (QWI), grouping firms into five cohorts: 0–1 years, 2–3 years, 4–5 years, 6–10 years, and 11+ years.
    - *Firm Size:* Firm size is defined as the total number of employees who work for the firm, calculated as the average employment across the four quarters of the calendar year. Consistent with the QWI, we group firms into size categories of 1–19, 20–49, 50–249, 250–499, and 500+ employees.
    - *Industry Classification:* We obtain industry information at the establishment level from the ECF. To assign a single industry to a firm that may operate establishments in multiple sectors, we use an employment-weighted modal industry. For the descriptive heterogeneity analysis in Appendix B, firms are classified into supersectors based on this modal assignment.

2. **Quarterly Workforce Indicators (QWI)** While the QWI is widely known as a public-use aggregated data product, we utilize the underlying establishment-level microdata to construct our measures of firm dynamics. The QWI microdata includes longitudinal records of employment, hires, and separations for every establishment in the LEHD universe. We aggregate these establishment-level flows to the firm level using the State Employer Identification Number (SEIN). This allows us to calculate the total annual hires and the average annual employment denominator needed for the hiring rate. By using the microdata that feeds the QWI, we ensure that our measures of hiring intensity are consistent with the Census Bureau's official definitions of labor market flows, providing a precise metric of how rapidly a firm's workforce is turning over or expanding in a given year.

3. **Job History File (JHF):** The JHF provides the longitudinal links between workers and firms and is the primary tool for identifying hiring events. Crucially, the hire concept in the JHF is adjusted for successor-predecessor events. In raw administrative data, an employer identifier (SEIN) change—often due to a merger, acquisition, or internal reorganization—can spuriously induce an apparent separation and subsequent hire for the entire workforce. The JHF utilizes worker-flow patterns to identify these administrative transitions, allowing us to exclude spurious hires and focus on true recruitment. This file serves as the vital link between the firm's expansion intensity and the individual worker's attributes; by correctly dating a hire to a specific firm and quarter, we can accurately merge in the worker's educational attainment from the Individual Characteristics File (ICF).

4. **Individual Characteristics File (ICF):** The ICF provides person-level demographic attributes, most notably educational attainment. These data are sourced from the 2000 Census Long Form and the American Community Survey (ACS). Crucially, our analysis relies exclusively on *observed* educational attainment. While the LEHD infrastructure includes imputed education values for individuals without a direct Census or ACS match to maintain aggregate representativeness, we exclude these imputations from our calculations. By restricting our sample to workers with explicitly reported credentials, we ensure that the observed changes in the college share of hires reflect actual shifts in firm-level selectivity rather than artifacts of the imputation algorithm. As a result, firms in our research sample are required to have at least one hired worker with an observed (non-imputed) education record in a given year.

These files are linked using a common set of protected identification keys (PIKs) for individuals, as well as LEHD employer identifiers (State Employer Identification Numbers,

or SEINs). By integrating these records, we can observe the human capital composition of the hiring flow for specific firms at precise points in their growth cycle.

As described in the main text, our primary sample is restricted to the 2005–2015 period to ensure continuous data coverage from all fifty states and the District of Columbia (Abowd et al., 2009). The final research sample consists of an unbalanced panel of firms that meet the minimum requirement of having at least one hired worker with an observed education record in the ICF.

## A.2 Labor Market Measures

We now provide formal definitions of the employment, hire, and separation concepts used throughout this paper. Our definitions follow the framework established in Abowd et al. (2009), adapted to relate quarterly earnings observations to annual hiring intensity.

### A.2.1 Employment Concepts

Let $w_{ijt}$ denote the earnings of individual $i$ from employer $j$ in quarter $t$. An employment relationship, or job, is defined by the presence of positive earnings ($w_{ijt} > 0$). To identify individuals with a stable attachment to an employer, we define beginning- and end-of-quarter employment based on presence in consecutive periods.

An individual is counted as employed at the beginning of quarter $t$ if they had positive earnings at the same employer in the preceding quarter:

$$b_{ijt} = \begin{cases} 1, & \text{if } w_{ijt-1} > 0 \text{ and } w_{ijt} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

Likewise, an individual is counted as employed at the end of quarter $t$ if they have positive earnings at the employer in the subsequent quarter:

$$e_{ijt} = \begin{cases} 1, & \text{if } w_{ijt} > 0 \text{ and } w_{ijt+1} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

### A.2.2 Hires and Separations

A hire is identified in quarter $t$ when an individual begins a new earnings stream at employer $j$. Formally:

$$h_{ijt} = \begin{cases} 1, & \text{if } w_{ijt-1} = 0 \text{ and } w_{ijt} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

Similarly, an individual separates from an employer in quarter $t$ if it is the last quarter they are observed at that employer:

$$s_{ijt} = \begin{cases} 1, & \text{if } w_{ijt+1} = 0 \text{ and } w_{ijt} > 0 \\ 0, & \text{otherwise.} \end{cases}$$

### A.2.3 Annual Aggregation and Rates

The annual measures used in Section 3.1 are aggregated from these quarterly indicators. Total annual hires for employer $j$ in year $T$ is the sum of quarterly hires: $H_{jT} = \sum_{t \in T} \sum_i h_{ijt}$.

Following Hyatt et al. (2021), the denominator for our rates is the average of beginning-of-year and end-of-year employment. Let $B_{jT}$ be the employment at the beginning of the first quarter of year $T$, and $E_{jT}$ be the employment at the end of the fourth quarter of year $T$. The hiring rate $HR_{jT}$ is defined as:

$$HR_{jT} = \frac{H_{jT}}{(B_{jT} + E_{jT})/2}$$

This denominator ensures that the hiring rate is symmetric and bounded, providing a stable measure of hiring intensity even for rapidly expanding or contracting firms.

# B Supplementary Tables and Figures

This appendix provides additional descriptive evidence on how the quantity-skill tradeoff varies across observable firm characteristics. To quantify these relationships, we estimate the semi-elasticity of the college share with respect to the hiring rate using the same binned regression approach described in Section 3.1. Specifically, we regress the mean college share of hires (in percentage points) on the log of the mean hiring rate across ten deciles within each specific subgroup.

As a baseline, Table B1 reports the overall semi-elasticity of $-4.79$, which implies that

Table B1: Semi-Elasticity of the Share of Hires with a College Degree to the Hiring Rate

| Firm Group | Semi-Elasticity | Std. Error | $R^2$ |
|---|---|---|---|
| Overall | -4.79*** | (0.22) | 0.98 |
| *Firm Age* | | | |
| Age 0 – 1 | -4.61*** | (0.41) | 0.94 |
| Age 2 – 3 | -5.30*** | (0.35) | 0.97 |
| Age 4 – 5 | -5.90*** | (0.36) | 0.97 |
| Age 6 – 10 | -6.14*** | (0.32) | 0.98 |
| Age 11+ | -4.75*** | (0.40) | 0.95 |
| *Firm Size* | | | |
| Size 1 – 19 | -3.90*** | (0.24) | 0.97 |
| Size 20 – 49 | -5.42*** | (0.28) | 0.98 |
| Size 50 – 249 | -6.45*** | (0.53) | 0.95 |
| Size 250 – 499 | -9.08*** | (1.24) | 0.87 |
| Size 500+ | -10.58*** | (1.41) | 0.87 |
| *Firm Growth* | | | |
| Separations more than 20% above hires | -4.65*** | (0.15) | 0.99 |
| Separations 5% to 20% above hires | -6.51*** | (0.45) | 0.96 |
| Separations within 5% of hires | -3.99*** | (0.31) | 0.95 |
| Separations 5% to 20% below hires | -7.06*** | (0.45) | 0.97 |
| Separations more than 20% below hires | -4.91*** | (0.29) | 0.97 |

*Notes:* Estimates represent the coefficient from a log-linear regression of the college-educated hire share on the annual hiring rate for ten deciles of the hiring rate. Standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

a doubling of the hiring rate is associated with an approximately five percentage point reduction in the share of hires with a college degree. The following subsections explore how this relationship modulates across the dimensions of firm age, size, growth, and industry.

## B.1 Firm Age

The relationship between quantity and skill is highly consistent across the firm lifecycle. As shown in Table B1, the estimated semi-elasticities across five distinct age cohorts range narrowly from $-4.61$ for the youngest firms (Age 0–1) to a peak of $-6.14$ for mature firms (Age 6–10). Figure B1 illustrates that the downward-sloping, log-linear relationship holds within each group.

Table B1: Semi-Elasticity of the Share of Hires
with a College Degree to the Hiring Rate (continued)

| Firm Group | Semi-Elasticity | Std. Error | $R^2$ |
|---|---|---|---|
| *Industry* | | | |
| Natural Resources and Mining | -1.20*** | (0.29) | 0.69 |
| Construction | -2.39*** | (0.14) | 0.97 |
| Manufacturing | -1.58*** | (0.43) | 0.63 |
| Trade, Transportation, and Utilities | -2.00*** | (0.11) | 0.98 |
| Information | -3.65*** | (0.36) | 0.93 |
| Financial Activities | -4.54*** | (0.15) | 0.99 |
| Professional and Business Services | -9.67*** | (0.58) | 0.97 |
| Education and Health Services | -4.31*** | (0.56) | 0.88 |
| Leisure and Hospitality | -0.74* | (0.38) | 0.32 |
| Other Services (Except Public Administration) | -3.60*** | (0.45) | 0.89 |
| Public Administration | -3.26*** | (0.30) | 0.94 |
| *Time Interval* | | | |
| 2005-2007 | -4.63*** | (0.26) | 0.97 |
| 2008-2009 | -4.35*** | (0.19) | 0.99 |
| 2010-2012 | -4.60*** | (0.17) | 0.99 |
| 2013-2015 | -5.25*** | (0.28) | 0.98 |

*Notes:* Estimates represent the coefficient from a log-linear regression of the college-educated hire share on the annual hiring rate for ten deciles of the hiring rate. Standard errors are in parentheses. Significance levels: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

## B.2 Firm Size

The magnitude of the quantity-skill tradeoff scales with the size of the employer. While small firms (1–19 employees) exhibit a semi-elasticity of $-3.90$, this coefficient increases in magnitude to $-10.58$ for the largest firms with 500 or more employees. Figure B2 provides visual evidence for this trend, showing that as firms increase in scale, the reduction in hire quality required to achieve a higher quantity of hires becomes significantly steeper. This suggests that the coordination or search costs associated with scaling may be more acute for larger organizations.

## B.3 Firm Growth

The tradeoff remains robust regardless of whether a firm is expanding or contracting. Table B1 partitions the data by separation categories to capture different growth regimes. The tradeoff is most pronounced for firms where separations are between 5% and 20% above hires,

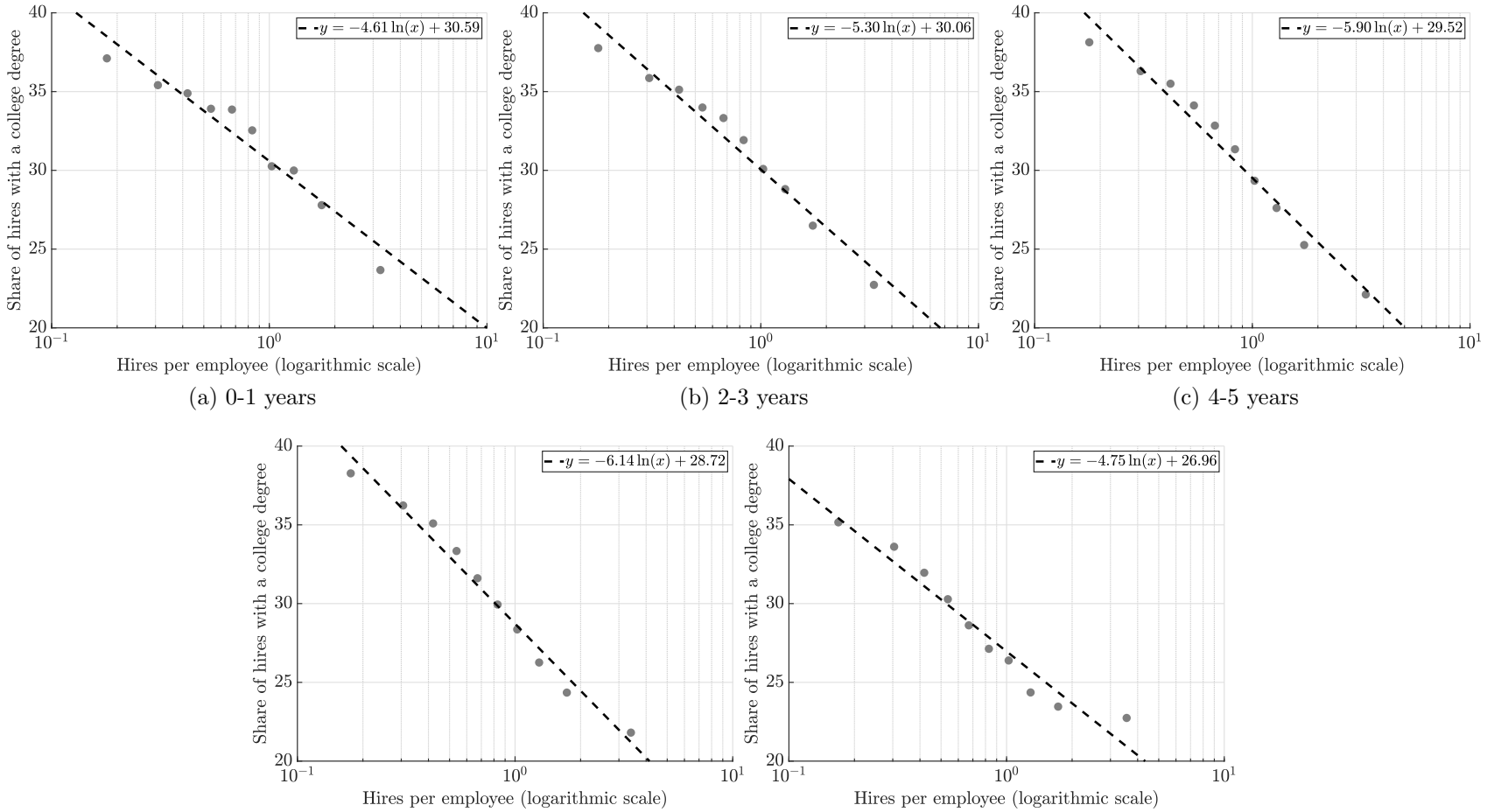
exhibiting a semi-elasticity of −6.51. However, even for firms with separations significantly below hires (rapidly growing), the elasticity remains stable near −5.00. Figure B3 shows that the inverse relationship between the hiring rate and educational composition is a pervasive feature across all varieties of firm growth dynamics.

## B.4 Industry

We examine variation across industry supersectors. While the quantity-skill tradeoff is negative in every sector, there is significant variation in its magnitude. In knowledge-intensive services, the tradeoff is most pronounced; *Professional and Business Services* exhibits the steepest slope at −9.67, followed by *Financial Activities* (−4.54). In contrast, physical production sectors such as *Manufacturing* (−1.58) and *Natural Resources and Mining* (−1.20) exhibit much shallower tradeoffs, possibly reflecting more standardized skill requirements. *Leisure and Hospitality* shows the smallest semi-elasticity at −0.74, consistent with a sector that maintains lower baseline educational requirements. These supersector-level relationships are visualized in Figure B4.

## B.5 Time Interval

Firms face a quantity-skill tradeoff in different economic conditions. Table B1 estimates the relationship separately by four year intervals: 2005-2007, 2008-2009, 2010-2012, and 2013-2015. The first time interval, 2005-2007, was an economic expansion in which the slope was −4.63. The years 2008-2009 correspond with a strong regression in which the relationship flattened slightly to −4.35. In the "jobless recovery" years 2010-2012 in which the unemployment rate was substantially elevated but gradually easing, this relationship had a slope of −4.60. During the expansion years of 2013-2015, the relationship had its steepest slope of −5.25. These relationships are also shown in Figure B5. Overall, this evdience indicates that the quantity-skill tradeoff is more severe during economic expansions. During the 2008-2009 recession, it was easier for expanding firms to hire skilled workers.

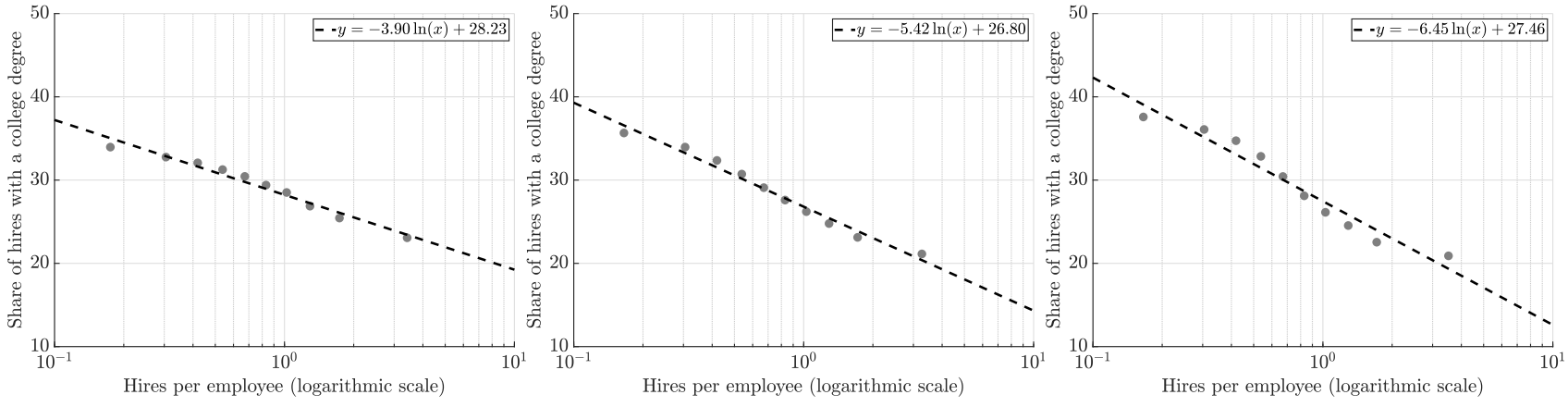



(a) 0-1 years (b) 2-3 years (c) 4-5 years

(d) 6-10 years (e) 11+ years

Figure B1: Educational attainment by firm age (logarithmic scale).

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.

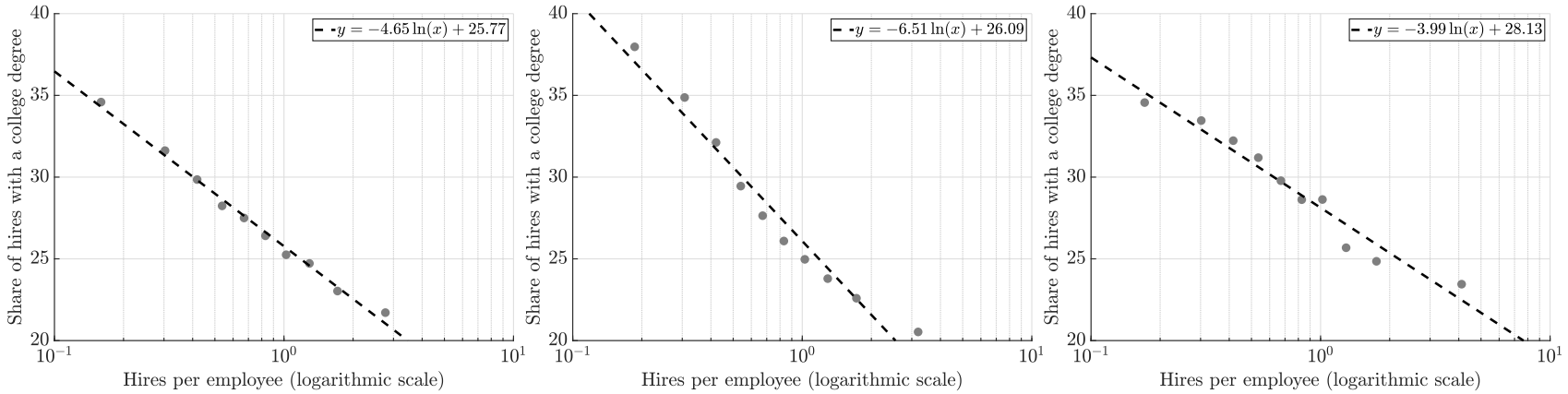



(a) 1-19 employees (b) 20-49 employees (c) 50-249 employees

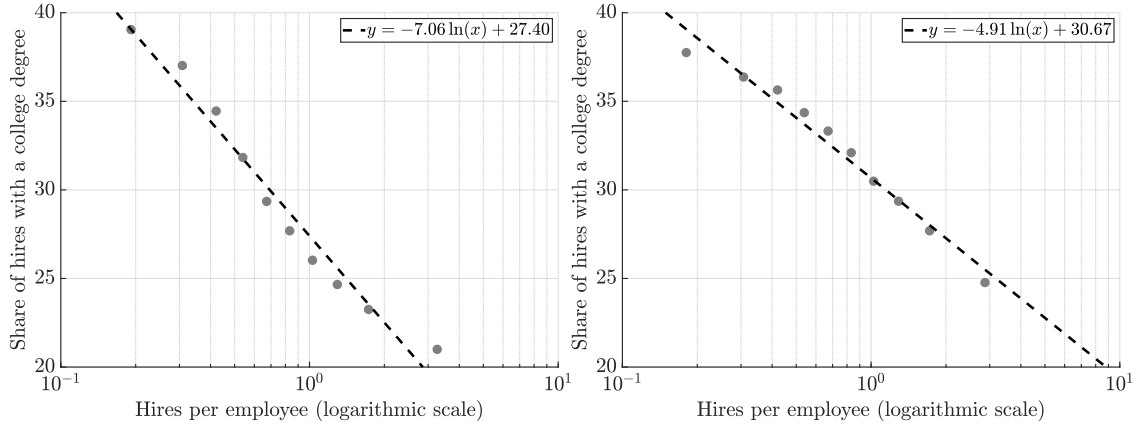
(d) 250-499 employees (e) 500+ employees

Figure B2: Educational attainment by firm age (logarithmic scale).

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.



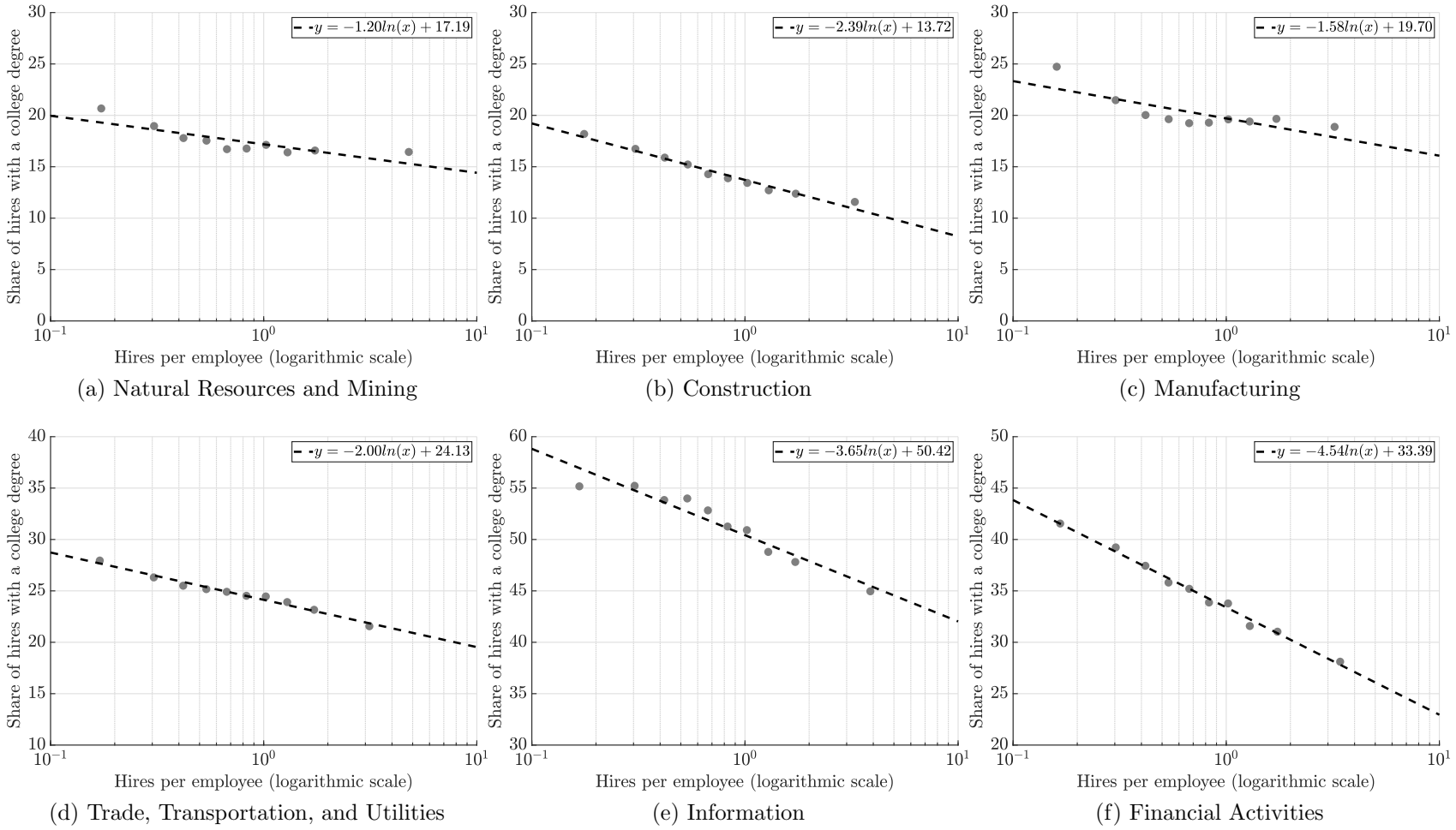

(a) Separations more than 20% above hires (b) Separations 5% to 20% above hires (c) Separations within 5% of hires




(d) Separations 5% to 20% below hires (e) Separations more than 20% below hires

Figure B3: Educational attainment by firm growth (logarithmic scale).

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.

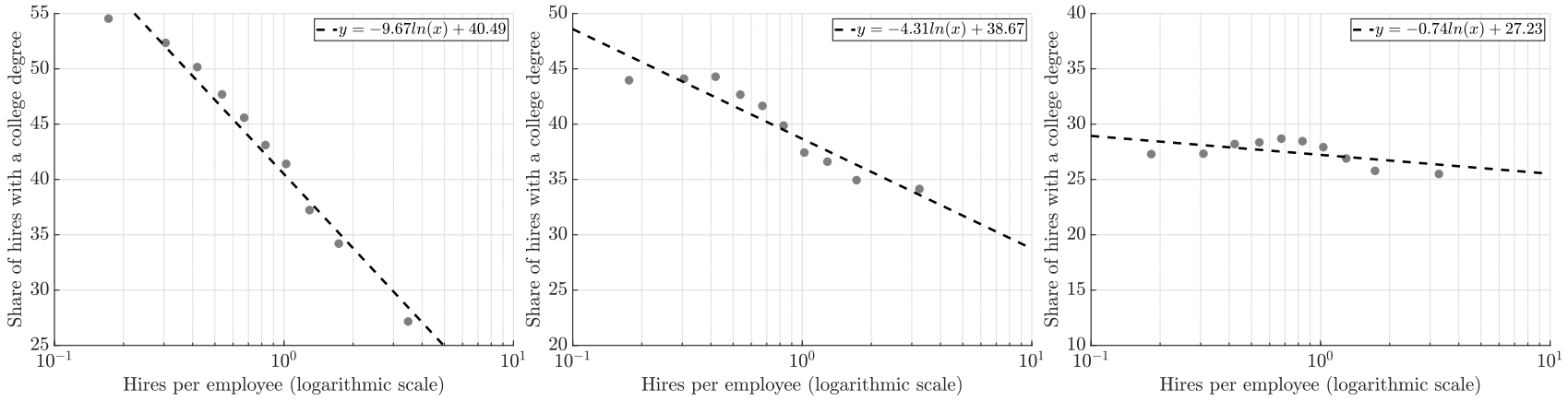



(a) Natural Resources and Mining (b) Construction (c) Manufacturing

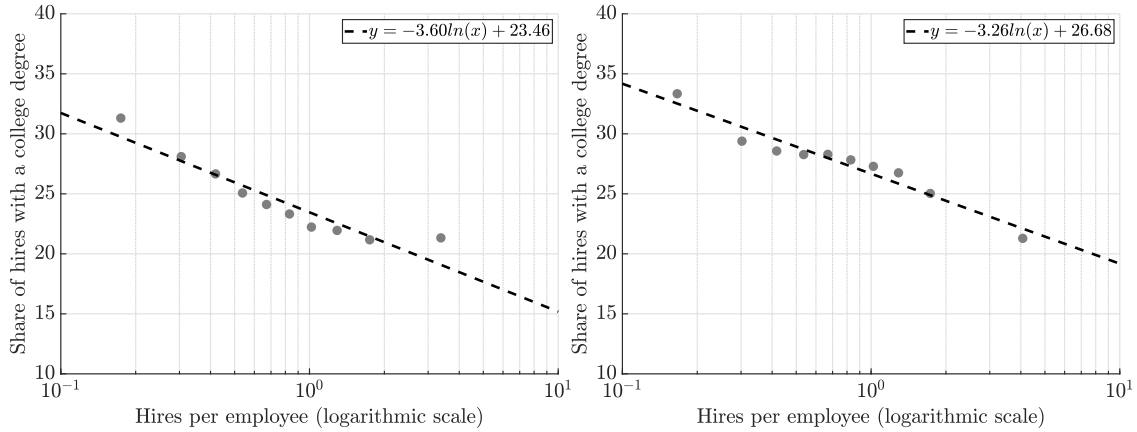
(d) Trade, Transportation, and Utilities (e) Information (f) Financial Activities

Figure B4: Educational attainment by industry (logarithmic scale).

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.



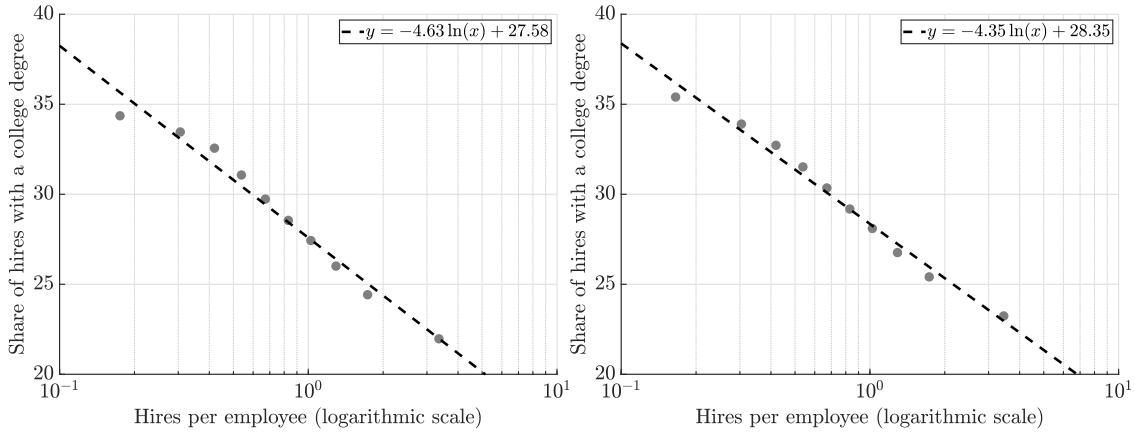

(g) Professional and Business Services (h) Education and Health Services (i) Leisure and Hospitality




(j) Other Services (Except Public Administration) (k) Public Administration

Figure B4: Educational attainment by industry (logarithmic scale, continued).

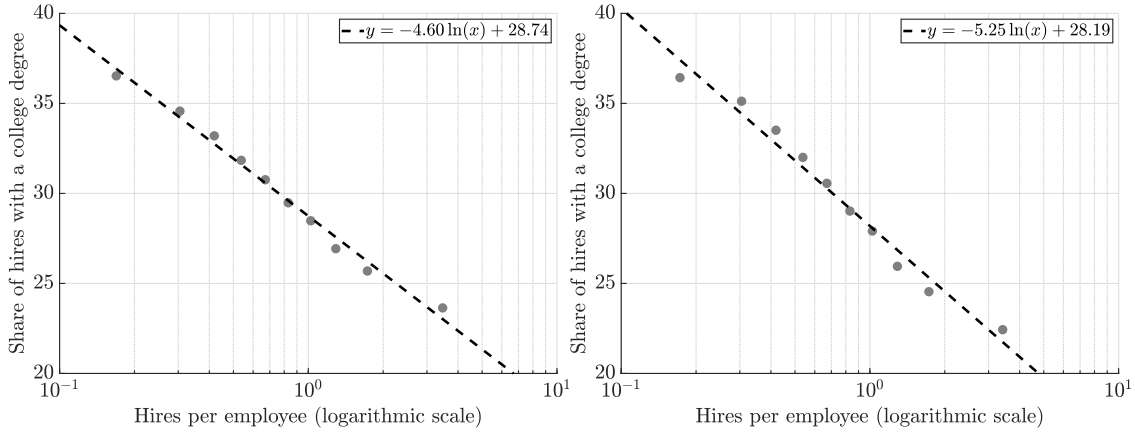
*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.




(a) 2005-2007




(b) 2008-2009




(c) 2010-2012




(d) 2013-2015

Figure B5: Educational attainment by time interval (logarithmic scale).

*Notes:* Deciles are calculated based on the quarterly hiring rate. Educational attainment is measured as the share of new hires with at least a four-year college degree. The horizontal axis shows total hires in a calendar year, relative to average annual employment, as obtained from the Longitudinal Employer-Household Dynamics Employer Characteristics File, 2005-2015. College degree attainment is obtained from the Census 2000 long form and the American Community Survey (ACS). Firms must have positive employment in each quarter of the year and at least one hired worker who reported their educational attainment to either the Census 2000 long form or the ACS.