Do Non-Compete Agreements Help or Hurt Workers? Evidence from the NLSY97

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Abstract

While non-compete agreements are prevalent, the incentives driving their use and their causal effects on workers remain poorly understood. We develop a model with asymmetric information to show that non-compete agreements shift the nature of allocative inefficiency—reducing inefficient quits but increasing inefficient retention—while mitigating the canonical hold-up problem. The model predicts that non-compete agreements are more likely to be used in industries with high returns on industry-specific investments, and that signers have longer job tenures, higher wages, and receive more firm-provided investment than similar workers without such agreements. Using panel data from the NLSY97 and a difference-in-differences research design, we estimate the causal impact of signing a non-compete agreement. Within one year, we find that non-compete agreements raise job tenures by 6% and wages by 9%, consistent with a compensating wage differential. In the longer run, this initial gain is eroded, as non-compete agreements reduce annual wage growth by 1%. While the theory links non-competes to firm investment, we find no evidence of increased investment in formal training, suggesting investments prompted by the agreement are likely informal.

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[§]We are grateful to Sandra Black, Bentley MacLeod, Suresh Naidu, and Bernard Salanié for their guidance. We thank Odeya Leikin for excellent research assistance and Evan Starr for thoughtful comments. Gopal acknowledges funding from the Social Sciences and Humanities Research Council of Canada Grant Number 430-2024-00035.

1 Introduction

The assumption that labor markets are perfectly competitive has been increasingly questioned in recent decades (e.g. Card 2022). One factor that can limit competition is the prevalence of non-compete agreements, contractual provisions that restrict workers from joining competing firms after leaving their current employer. The impact of non-compete agreements on labor markets remains contentious. Proponents argue that non-compete agreements increase worker retention and encourage firms to invest in industry-specific training, potentially benefiting workers through higher wages in the long run. Critics argue that non-compete agreements create mobility frictions, reducing workers' bargaining power and preventing them from transitioning to firms where they would be more productive.[1]

Despite their widespread use — 15% of U.S. workers were bound by non-compete agreements in 2017 — there is limited causal evidence on the effects of signing a non-compete agreement on long-run individual labor market outcomes. Most empirical studies focus on the effects of non-compete regulation rather than the direct worker-level effects of signing a non-compete agreement (e.g. Johnson, Lavetti, and Lipsitz 2023; Lipsitz and Starr 2022; Jeffers 2023; Kini, Williams, and Yin 2021). More limited research leveraging micro-data on the usage of non-compete agreements has focused on their effects on particular subpopulations such as physicians (Lavetti, Simon, and White 2020), or on the descriptive relationships between signing the agreement and various worker characteristics (Shi 2023; Starr, Prescott, and Bishara 2021). While these studies provide valuable insights into how regulation of non-compete agreements affects labor markets and the types of workers who sign non-compete agreements, they do not address the fundamental question of whether signing a non-compete helps or harms workers, and for which types of workers. Understanding these worker-level effects is crucial. Do non-compete agreements promote long-term gains, such as skill formation and higher earnings? Or do they primarily restrict mobility and suppress wages?

Theoretical research has provided important insights into how non-compete agreements affect investment incentives and allocative efficiency, but significant gaps remain. Prior models have explored how non-compete agreements encourage firms to invest in general training (e.g. Meccheri 2009; Posner, Triantis, and Triantis 2004; Shy and Stenbacka 2023) and influence the efficient matching between workers and firms (e.g. Shi 2023; Gottfries and Jarosch 2023). However, these theories do not fully explain why workers would voluntarily agree to sign non-compete agreements, despite their restrictive nature. If non-compete agreements are detrimental to workers, as critics

[1] Critics also argue that non-compete agreements deter business formation by making it difficult for startups to hire skilled workers (e.g., Aghion and Bolton 1987, Jeffers 2023). Additionally, some firms impose non-compete agreements on workers after they have already accepted job offers or without their full awareness, which may allow firms to retain workers at lower wages (Starr, Prescott, and Bishara 2021).

suggest, why do they remain so common? A complete framework must incorporate both firm and worker incentives, explicitly modeling the conditions under which signing a non-compete agreement is in the interest of both parties.

Our model connects with literature highlighting how contracts affect both investment incentives and labor market matching. The first strand of literature examines how contracts influence employer investment incentives, particularly when investments are general (e.g., Acemoglu and Pischke 1999; MacLeod and Malcomson 1993). The second focuses on how contracts shape labor market matching efficiency and mobility (e.g., Shi 2023; Gottfries and Jarosch 2023; Pakes and Nitzan 1983). By combining these two perspectives in a single theoretical framework, we formalize the trade-offs arising from using a non-compete agreement in the employment relationship. We show that non-compete agreements reduce inefficient quits, increase inefficient retention (job lock), and encourage firms to provide industry-specific investments.[2] Our model predicts that non-compete agreements tend to be most prevalent in industries where firms make substantial investments in industry-specific human capital. At the individual level, the model generates testable predictions that (i) workers who sign non-compete agreements should have longer job tenures, higher wages, and greater employer-sponsored training, but (ii) mobility restrictions may prevent workers from accessing higher-paying external opportunities within the industry.

A key assumption in our model is that workers have private information about their outside options, which prevents contract renegotiation (e.g. Hashimoto 1981; Hart and Moore 1988).[3] Prior work has shown that, in theory, firms could release workers from non-compete agreements in exchange for buyout payments (e.g. Shi 2023; Posner, Triantis, and Triantis 2004), restoring the efficient matching between workers and firms in a Coasean world (Coase 1960). Unlike Shi (2023), who focuses on how non-compete agreements can generate excessive rent extraction via buyouts, we focus on a distinct inefficiency: the outright prevention of efficient matches when workers cannot be released from binding non-compete agreements. At the same time, our model shows that non-compete agreements mitigate the hold-up problem by encouraging firms to invest in industry-specific skills. As a modelling extension, we also relax the asymmetric information assumption and allow the worker and firm to renegotiate the original contract. We show that when firms hold all the bargaining power, a contract with a non-compete agreement implements the social planner's solution. However, even with renegotiation, investment and allocative inefficiencies arise when termination fees are constrained to be common legal remedies such as training repayment fees or

[2]Other contract theory models have examined the interplay between investment incentives and matching efficiency in various contexts (e.g. Hellmann and Thiele 2017; MacLeod and Malcomson 1993), but none have explicitly analyzed this trade-off in the specific setting of non-compete agreements.

[3]To further elaborate, in our model, the firm cannot verify the terms of the worker's outside offer since it is private information to the worker. As such, the worker cannot command a higher wage by claiming to have a superior outside offer because the firm will assume such claims are inflated.

expectation damages.

Our theoretical framework provide a lens to understand why non-compete agreements are used and function differently across different segments of the labor market. For low-wage workers, whom we model as having lower returns on firm-provided investments and higher discount factors (e.g. Heckman, Lochner, and Todd 2006; Zeldes 1989; Lawrance 1991; Shah, Mullainathan, and Shafir 2012), non-compete agreements do little to encourage firm investment; instead, low-wage workers may sign the agreement for a minimal compensating wage differential and their primary function is to increase firm profits by reducing costly turnover. In contrast, for skilled professionals, where industry-specific human capital is paramount (e.g. Parent 2000), our model predicts a more productive role for non-competes. By mitigating the hold-up problem, they incentivize firms to invest in valuable industry-specific skills, which can translate into faster wage growth. Finally, for top executives, where investments often involve highly sensitive information (e.g. Kini, Williams, and Yin 2021), our model's extension with renegotiation is most applicable. In this setting, where lawyers can tailor buyout payments to demand conditions, non-compete agreements can implement the social planner's outcome by achieving efficient investments and matching between workers and firms. Our analysis caution against a blanket ban on the enforcement of non-competition agreements, as recently proposed by the US Federal Trade Commission. Instead, our framework support prohibiting such agreements only for low-wage workers, where they may fail to induce substantial firm investment.

To test our theories, we assess the causal impact of signing a non-compete agreement on various labor market outcomes using data from the National Longitudinal Survey of Youth (NLSY97) and a difference-in-differences research design. The NLSY97 is a nationally representative longitudinal survey that tracks a cohort of individuals who were teenagers in 1997. By 2017, when the survey first includes a question on non-compete status, the sample is between the ages of 32 and 38 — an ideal period for studying labor market outcomes as respondents are in their prime working years. Of the 5,236 individuals who reported their non-compete status in the 2017 questionnaire, approximately 15% responded affirmatively to having a non-compete agreement in their contract and more than 90% are "Very Confident" in the accuracy of the response.[4] The NLSY97 includes a wide range of outcome variables, allowing us to assess the effects of non-compete agreements on key variables featured in the theoretical model — wages, job mobility, and training — but also on broader aspects of job quality, such as job tasks, job satisfaction, and working hours. The dataset also provides detailed worker characteristics, enabling us to examine heterogeneity across several

[4]NLSY97 respondents appear confident in reporting their non-compete status, which contrasts with findings from Cowgill, Freiberg, and Starr (2024). In a field experiment with job applicants for full-time positions at a large U.S. financial services company, they document that many workers fail to notice or recall non-compete clauses in their contracts, particularly when the clause is not made salient at the time of signing. Their results suggest that some workers unknowingly accept non-compete agreements.

dimensions, including race, income, gender, education, and cognitive ability.

An advantage of the NLSY97 is that it allows us to track individual workers over time and across jobs, enabling the use of panel data research methods to estimate the causal impact of signing a non-compete agreement on career trajectories. Unlike prior research using this dataset which has primarily examined non-compete usage in cross-section (Rothstein and Starr 2022), we follow workers across survey waves. Using the panel component of the NLSY97 is critical for several reasons. First, it allows us to use individual fixed effects to account for time-invariant unobserved heterogeneity across workers who do and do not sign non-compete agreements, improving causal identification. Second, it enables us to examine how non-compete agreements affect wage growth, rather than cross-sectional wage differences. Third, it allows us to track the effects of signing a non-compete agreement even if a worker later changes jobs, ensuring that we capture the longer-run impacts of the agreement on labor market outcomes.

Estimating the causal effects of signing a non-compete agreement is challenging because workers who sign these agreements differ systematically from those who do not. Signing a non-compete agreement is often coincident with job mobility, which itself is linked to wage increases (i.e. Topel and Ward 1992). Furthermore, in the cross-section, we observe that non-compete signers have characteristics that are associated with higher wages, which complements findings from prior research (i.e. Starr, Prescott, and Bishara 2021). To overcome these challenges, we leverage the fact that different individuals sign non-compete agreements at different points in time and compare their individual labor market outcomes to a control group of workers who never sign a non-compete agreement during the sample period but start jobs in the same year. This approach ensures that we are comparing the trajectories of new job holders (in a given year) with and without a non-compete agreement rather than workers with fundamentally different labor market experiences. We construct our dataset using NLSY97 data from 2013 to 2021, defining a cohort as a group of individuals who start a new job in a given year. In a given cohort, treated workers are those who begin a job with a non-compete agreement in that year, while control workers are those who start a job in the same year but never sign a non-compete agreement over the entire sample period.[5] This setup ensures that for each "experiment," we are comparing newly hired workers with and without non-compete agreements, reducing concerns about selection bias.

[5]Since the NLSY97 only begins tracking non-compete status in 2017, we assume that if an individual reports signing a non-compete agreement in 2017, they had it from the beginning of their job tenure. This assumption allows us to estimate the longer-term effects of signing a non-compete agreement, even though the dataset does not capture non-compete agreements from the job's start date. As a sensitivity check, we re-estimate our results using only the 2017, 2019, and 2021 cohorts—workers who started new jobs in those survey waves. For these workers, we directly observe their non-compete agreement status at the time of hiring, eliminating the need for any assumptions about when the agreement was signed. The results from this restricted sample closely align with our main findings, reinforcing the validity of our long-term estimates. If an individual signs multiple non-compete agreements over the sample period, the individual is only included in the treated cohort corresponding to the earliest recorded use of the agreement.

Following prior work on treatment effects with staggered adoption, we estimate the parameters of a stacked difference-in-differences model, aggregating across cohorts to estimate the average treatment effect of signing a non-compete agreement (Cengiz et al. 2019; Johnson, Lavetti, and Lipsitz 2023; Gormley and Matsa 2011). By stacking these cohorts together, we construct a series of clean difference-in-differences comparisons, avoiding the issues that arise in standard two-way fixed effects models with staggered treatment timing (Goodman-Bacon 2021; Callaway and Sant'Anna 2021; Sun and Abraham 2021). We are confident in the validity of our causal estimates, as our event-study design reveals no pre-trends for wages, job mobility, or other key outcomes. This finding indicates that workers who go on to sign non-compete agreements are not experiencing systematically different trends before signing. To address the primary identification challenge of selection bias, we also use "not-yet-treated" workers as a control group, showing our results are robust when comparing individuals who sign an agreement in a given year to those who will sign one in the future. Finally, our conclusions are robust to including a rich set of controls, such as firm size, industry, and occupation, to account for alternative explanations like the possibility that non-compete signers systematically sort into higher-productivity firms.

Our primary empirical finding is that signing a non-compete agreement leads to a statistically significant and immediate increase in wages. Our stacked event-study estimates indicate that signing a non-compete agreement raises wages by 9.4% within one year, a magnitude comparable to the returns to an additional year of education (e.g. Card 1999). This wage premium persists for at least six years, though we observe that it declines by approximately 1% per year, consistent with non-compete agreements lowering wage growth over time.[6] Notably, the estimated causal wage effect from the quasi-experimental research design (9.4%) is similar in magnitude to the cross-sectional wage premium with controls (8%), suggesting that our cross-sectional wage results are not likely subject to substantial omitted variable bias. We also observe that non-compete agreements lower job mobility, as predicted by our theoretical model. On average, non-compete agreements increase job tenure by 0.3 years (approximately 6% of the average tenure in the 2017 cross-section). Despite theoretical predictions that non-compete agreements encourage firm-provided training, we find no significant effects on formal measures of employer-provided training. Similarly, we find no significant effects on job satisfaction, working hours, or the nature of job tasks.

We find significant heterogeneity in the effects of non-compete agreements across various dimensions, including education, income, and race. For higher-wage, college-educated, and White workers, signing a non-compete is associated with a large and persistent wage premium, reaching as high as 12.4% for those with above-median wages. For these groups, the agreement induces an upward-sloping wage-experience profile. This dynamic aligns with a key prediction of our model:

[6] The fact that career earnings remain higher for non-compete signers but that the wage gap narrows over time aligns with the descriptive statistics reported in Shi (2023).

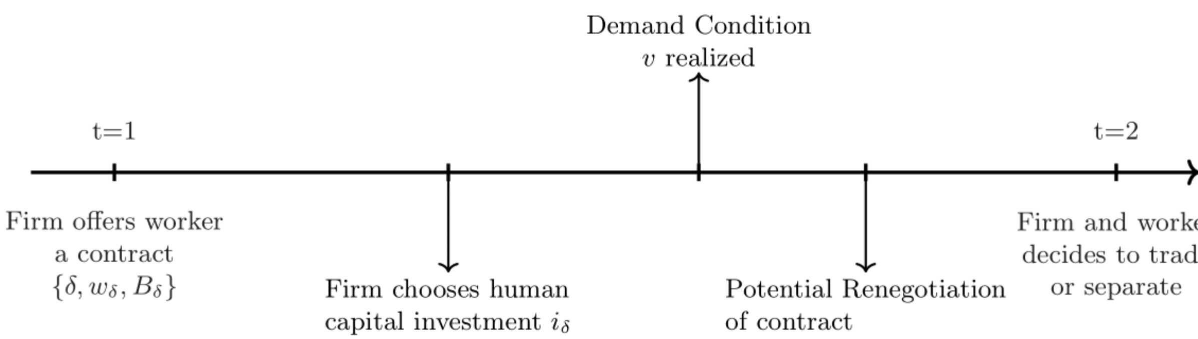
non-competes can encourage firm-provided investment and raise wage growth. In stark contrast, a markedly different dynamic emerges for lower-wage, non-college-educated, and minority workers. For these groups, an initial wage premium – 7.3% for Black and Hispanic workers – is followed by significantly flatter wage growth over time. This pattern suggests the initial premium functions as a one-time compensating differential for accepting restricted job mobility. This outcome is consistent with our model's predictions that for workers with higher discount rates and lower returns on investment, the primary effect of a non-compete is to create profitable job lock for the firm and not to foster skill formation.

The paper proceeds as follows. Section 2 lays out the theoretical framework. Section 3 discusses data sources and Section 4 examines the effect of signing a non-compete agreement on various labor market outcomes. Section 5 concludes.

2 Theoretical Framework

2.1 The Model

Figure 1: Timeline of the Model



We study a two-period model featuring a risk-neutral firm F and a risk-neutral worker W. The worker discounts future compensation by $\beta \leq 1$, while the firm values current and future profits equally. At the beginning of period 1, the firm and worker agree to a contract consisting of a non-compete clause $\delta \in \{0,1\}$, a fixed wage w_δ, and an up-front transfer B_δ from the firm to the worker. Production in the initial period is normalized to zero and we allow the worker to earn initial period wages below marginal product, or $B_\delta < 0$. The non-compete clause restricts the worker, upon separation in period 2, from joining firms in the same industry as F. We initially assume that the contract is rigid: the wage and the non-compete clause cannot be renegotiated in period 2 because of the worker's asymmetric information on his outside option. This assumption prevents the firm from tailoring the employment contract to realized conditions and thus results in inefficient turnover.

Because investment is non-contractible (e.g. Grossman and Hart 1986), once the contract is signed the firm chooses $i_\delta \geq 0$ to maximize its expected profits, incurring a cost of $\frac{1}{2}i_\delta^2$. An additional unit of investment raises the worker's productivity within the firm by r while raising the worker's productivity at industry competitors by ρ. A non-compete agreement prevents the worker from moving to industry competitors; as a result, additional investment by the firm does not raise the worker's outside option when $\delta = 1$.

We assume that the firm and worker know the values of r and ρ ex-ante and understand the probability distribution of future outside offers v, but do not observe the realization of v when making the contract or choosing investment. In particular, $v \sim \text{Exponential}(\lambda)$ is drawn at the beginning of period 2 and is privately observed by the worker. We interpret v as the demand for the worker from competing firms, which is private information to the worker, as in Hashimoto (1981). If unrestricted by a non-compete, the worker's outside option is $v + \rho i_0$; if bound by a non-compete, her option remains v. The worker then decides whether to stay at the firm and receive wage w_δ, or to leave and accept the outside offer. Simultaneously, the firm decides whether to retain or fire the worker. If the firm fires the worker, the firm can hire an untrained worker whose marginal product is zero; as a result, the firm will retain the incumbent worker so long as final period wages are less than or equal to marginal product, or $w_\delta \leq r i_\delta$. We remain agnostic about labor market conditions at the time of contracting. The worker has a reservation utility of μ^0 in the initial period that is commonly known to all parties, and will only accept the contract so long as expected utility exceeds this value. Symmetrically, the firm will only offer a contract if its expected profit is non-negative, which in turn requires the total joint surplus of the relationship to be at least as large as the worker's reservation utility. Throughout our analysis, we assume this condition holds, as no mutually beneficial contract could be formed otherwise.[7] Since the firm acts first, it will choose a contract so that the worker's participation constraint binds.

We allow both r and ρ to vary freely. When $\rho = 0$, investment is purely firm-specific; when $\rho = r$, it is fully transferable across firms in the industry. In practice, different sectors exhibit different returns to training, and the external value of a worker's training may vary substantially. Importantly, when $\rho > 0$, the firm's investment benefits not only the firm itself but also the worker by improving his outside option, so the investment is *industry-specific* in nature. This type of investment is common in relational settings and has been analyzed in, for example, Parent (2000). We focus on cases where $r > \rho$, meaning the internal return on investment exceeds the external

[7] Although the model features a single firm, it can represent a perfectly competitive labor market. In that context, μ^0 should be interpreted as the endogenous utility level determined by perfect competition, which forces firms to offer contracts that yield zero expected profit.

return. However, the model can also handle situations in which a firm's investment increases the worker's productivity more for third parties than for the incumbent firm, as in Pakes and Nitzan (1983).

Although the firm has the option to fire the worker in period 2, this option is never exercised in equilibrium.[8] To see why, observe that if wages are above marginal product in the final period, the firm must earn profits in the first period for the relationship to be profitable. However, anticipating that a firing will occur, the firm will make no investments. The worker is well aware of the firm's incentives and thus would be unwilling to earn below marginal product in the first period for investment that never occurs, so the relationship will not materialize in the first place. We denote this feature as the firm's "viability constraint", which rules out wage-tenure profiles where wages can exceed marginal product, as in the implicit insurance contracts explored in Harris and Holmstrom (1982).

In standard hold-up models, firms underinvest because they anticipate having to share the additional surplus with workers through a higher wage (i.e. Becker 1962; Acemoglu and Pischke 1999). Here, instead, the firm underinvests without a non-compete agreement due to two reasons. First, the firm does not internalize the benefits to the worker when she leaves for a competitor. Second, the firm's investment raises the worker's outside option and thus the probability of a quit. As a result, the firm captures only a fraction of the marginal social returns to investment and invests sub-optimally.

Non-compete agreements mitigate this distortion by decoupling investment from the worker's outside option. When $\delta = 1$, the worker's outside option is fixed at v, so increased investment does not raise the probability the worker quits. Furthermore, for any given wage, a worker is less likely to quit with a non-compete than without a non-compete. Both of these forces raise the firm's incentives to invest in industry-specific skills. However, non-compete agreements also induce inefficient stays or "job lock." When $v + \rho i_1 > r i_1$ and $w_1 > v$, separation to an industry competitor is socially efficient but the worker is contractually barred from doing so. In these instances, the firm's private returns from investment exceed social returns. As a result, if investment is highly specific (large $r - \rho$), a non-compete agreement may lead to over-investment relative to the socially optimal level.

[8] According to 2017 NLSY97 data, approximately 5% of workers were fired, making this feature of the model relatively realistic.

2.2 Benchmark Outcomes

2.2.1 The Social Planner's Allocation

To establish an efficiency benchmark, we first characterize the allocation chosen by a social planner who controls both the investment and separation decisions to maximize total social surplus. The planner's problem unfolds in two stages. First, the planner chooses an investment level $i \geq 0$ at a social cost of $\frac{1}{2}i^2$. Second, after the outside option $v \sim \text{Exponential}(\lambda)$ is realized, the planner dictates whether the worker stays with the firm or separates. The planner makes this ex-post decision by comparing the total surplus generated in each state. If the worker stays, the surplus is ri. If the worker separates, the surplus is $v + \rho i$.

It is therefore socially efficient for the worker to stay if and only if the surplus from staying exceeds the surplus from separating. We assume $r > \rho$, meaning investment is more productive inside the firm.[9] The efficient separation rule is to continue the match whenever

$$ri \geq v + \rho i \quad \iff \quad v \leq (r - \rho)i. \tag{1}$$

Letting $\Delta := r - \rho$ denote the productivity gap, the planner retains the match if $v \leq \Delta i$.

Anticipating this efficient separation rule, the planner chooses the investment level i ex-ante to maximize the expected total surplus:

$$\mathscr{S}(i) = \int_0^{\Delta i} (ri)\lambda e^{-\lambda v} dv + \int_{\Delta i}^{\infty} (v + \rho i)\lambda e^{-\lambda v} dv - \frac{1}{2}i^2.$$

Using the properties of the exponential distribution, this simplifies to:

$$\mathscr{S}(i) = -\frac{1}{2}i^2 + ri + \frac{e^{-\lambda \Delta i}}{\lambda}.$$

The socially optimal level of investment, $i^\star$, is therefore implicitly defined by the first-order condition $\mathscr{S}'(i^\star) = 0$:

$$\underbrace{r - \Delta e^{-\lambda\,\Delta\, i^\star}}_{=\text{SMB}(i^\star)} \;=\; i^\star. \tag{2}$$

Appendix A.1 shows the existence and uniqueness of the investment level as well as the comparative statics of optimal investments and quit probabilities with respect to the parameters of the model.

[9] When $\rho \geq r$, it is straightforward to show that the planner always separates ex-post and sets $i^\star = \rho$.

2.2.2 Allocative Inefficiency with Fixed Investments and Wages

To isolate the allocative inefficiencies arising from contractual rigidity, we analyze a simplified case where investments and wages are fixed parameters. In this setting, the only actions consist of the parties making separation decisions in period 2. We compare the ex-post separation decisions under contracts with and without a non-compete agreement. The comparison between private and efficient decision rules is illustrated in Figures 2 and 3.

First, we establish the socially efficient separation benchmark. An allocation is efficient if the worker is placed where they are most productive. Separation is therefore efficient if and only if the surplus from the worker moving to a competing firm exceeds the surplus from remaining at the incumbent firm. This condition is given by $v+\rho i > ri$, or equivalently, $v > (r-\rho)i$. When $r > \rho$, retention is efficient whenever $v \leq (r-\rho)i$. Conversely, when $\rho > r$, continuing the match is never efficient. Efficient stay is depicted by the hatched regions C and D in Figure 2 and A and B in Figure 3.

With a non-compete agreement ($\delta = 1$), the worker's outside option is simply v and will stay as long as $w \geq v$. This decision rule is represented by the shaded regions A, B and C in Figure 2. This arrangement creates two types of allocative inefficiency. First, it leads to inefficient stays ("job lock"), depicted by region A and B in Figure 2, where separation is efficient but does not occur. In region A, separation is efficient since $\rho > r$, but since $w > v$, the worker will stay in the job. Similarly, in region B, $v > (r-\rho)i$ but $w > v$ and it leads to inefficient stays. Second, inefficient quits can still occur with a non-compete agreement, and corresponds to the region below the dashed line and above the shaded area in region D of Figure 2 , where $(r-\rho)i > v > w$.

In the absence of a non-compete agreement ($\delta = 0$), the worker's outside option is $v+\rho i$, and their private decision rule is to separate if $v+\rho i > w$. This can lead to inefficient quits, depicted by region B in Figure 3, which occur when the worker leaves even though retention is socially optimal ($ri > v+\rho i > w$). However, this arrangement ensures all socially efficient separations are realized. Since the firm's participation constraint ensures $w \leq ri$, the condition for an efficient separation ($v+\rho i > ri$) necessarily implies the condition for a private separation ($v+\rho i > w$). Thus, no inefficient stays occur.

This analysis of the fixed investment and wage case reveals a fundamental trade-off. Contracts without non-compete agreements ensure all efficient separations occur but are susceptible to inefficient quits. Conversely, contracts with non-compete agreements reduce inefficient quits but introduce the possibility of inefficient stays (job-lock).

Figure 2: Separation Decisions with a Non-Compete Agreement

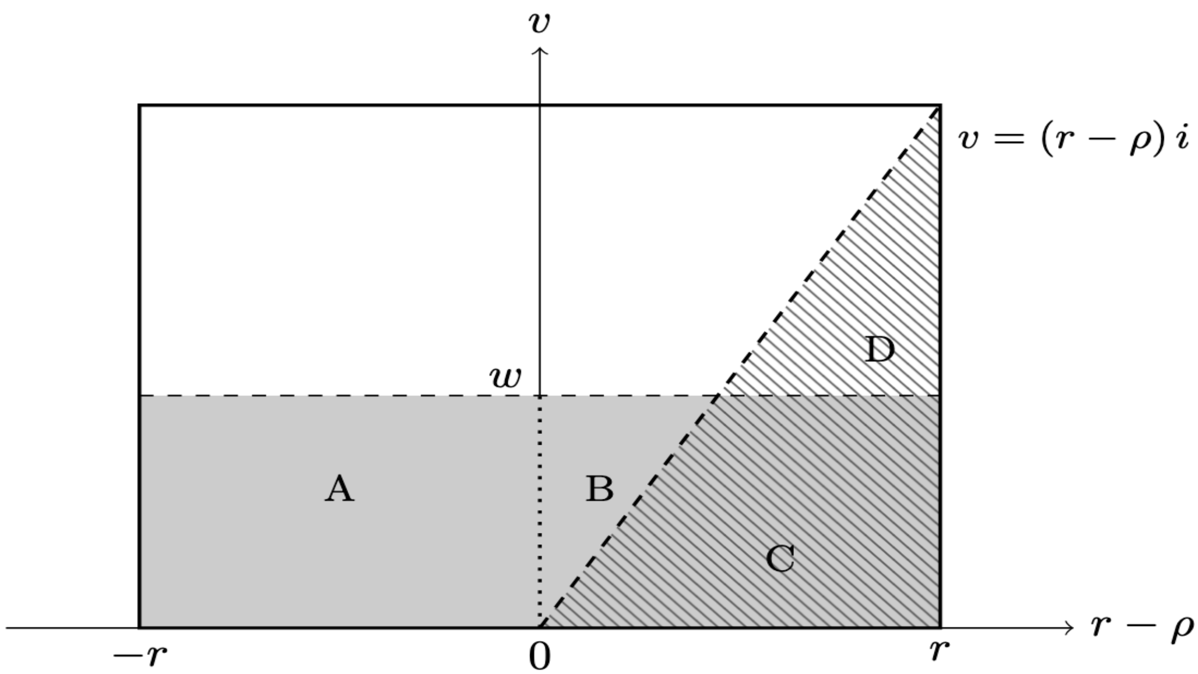
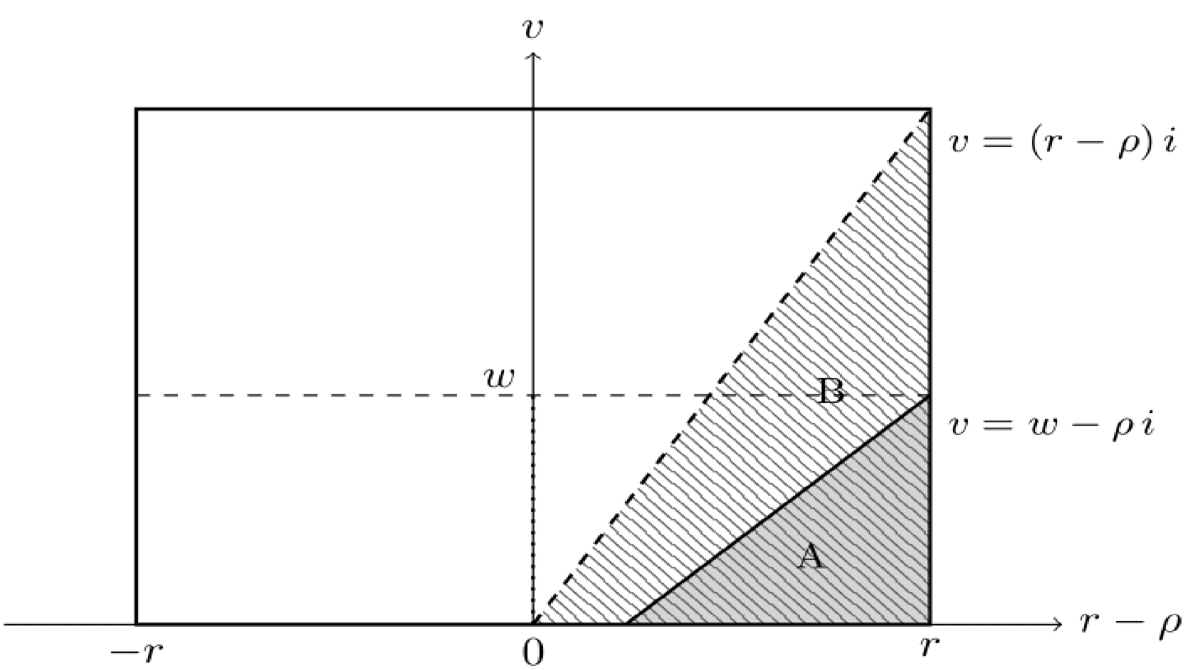


Figure 3: Separation Decisions without a Non-Compete Agreement



2.2.3 Spot-Market Equilibrium: Inefficient Separations and Under-investment

To understand the surplus generated by contractual commitment, we first analyze a spot-market benchmark without wage commitment. The game proceeds in two stages. First, the firm chooses an investment level $i_s \geq 0$ at cost $\frac{1}{2}i_s^2$. Second, after the worker's outside option $v \sim \text{Exp}(\lambda)$ is realized, the firm makes a take-it-or-leave-it wage offer w_s. The worker accepts if $w_s \geq v + \rho i_s$. In equilibrium, the firm chooses its investment i_s^* anticipating its own subsequent optimal wage-setting. We then compare this equilibrium to the social planner's benchmark, which is characterized by the efficient separation threshold $v_{\text{eff}}(i) = (r-\rho)i$ and the optimal investment level i^* that satisfies $\text{SMB}(i^*) = i^*$.

Proposition 1 (Spot Market Inefficiency)**.** *The spot-market equilibrium is inefficient in two dimensions:*

(i) **Inefficient Separations:** *For any given level of investment $i_s > 0$, the market generates an inefficiently high rate of separations. The spot market separation threshold is strictly lower than the efficient threshold.*

(ii) **Under-investment:** *The equilibrium investment level i_s^* is strictly lower than the socially optimal level i^*.*

Proof. (i) Let the private separation threshold be $v_T^s(i_s) = w_s^*(i_s) - \rho i_s$, where $w_s^*(i_s)$ is the equilibrium wage. For the firm to find it profitable to retain the worker, the wage it offers must be less than the worker's output, $w_s^*(i_s) < r i_s$. Substituting this profitability constraint into the definition of the threshold directly yields the result:

$$v_T^s(i_s) = w_s^*(i_s) - \rho i_s < r i_s - \rho i_s = (r-\rho)i_s = v_{\text{eff}}(i_s).$$

Since the private threshold below which a worker stays is strictly lower than the socially efficient threshold, the market generates inefficient quits.

(ii) To prove under-investment, we compare the firm's Private Marginal Benefit of investment (PMB_s) with the Social Marginal Benefit (SMB). The firm chooses i_s^* such that $\text{PMB}_s(i_s^*) = i_s^*$, while the planner chooses i^* such that $\text{SMB}(i^*) = i^*$. We show that $\text{PMB}_s(i) < \text{SMB}(i)$ for all $i > 0$, which implies $i_s^* < i^*$.

The Social Marginal Benefit from the planner's first-order condition is:

$$\text{SMB}(i) = r - (r-\rho)e^{-\lambda(r-\rho)i}$$

The Private Marginal Benefit is the marginal increase in the firm's expected second-period profit from an additional unit of investment. The firm's expected profit for a given i and w is $E[\Pi_s] =$

$(ri - w)(1 - e^{-\lambda(w - \rho i)})$. The PMB is the total derivative of this profit with respect to i, evaluated at the firm's optimal wage $w_s^*(i)$. By the Envelope Theorem, this simplifies to the partial derivative with respect to i:

$$\begin{aligned}
\text{PMB}_s(i) &= \frac{d}{di} E[\Pi_s(i, w_s^*(i))] = \left. \frac{\partial E[\Pi_s]}{\partial i} \right|_{w = w_s^*(i)} \\
&= r\left(1 - e^{-\lambda(w_s^* - \rho i)}\right) - \lambda \rho (ri - w_s^*) e^{-\lambda(w_s^* - \rho i)}.
\end{aligned}$$

The firm's marginal benefit is strictly lower than the social marginal benefit due to two problems:

1. **The Rent-Sharing Effect:** The second term in the PMB, $-\lambda \rho (ri - w_s^*) e^{-\lambda(w_s^* - \rho i)}$, is strictly negative. When the firm invests, it also increases the value of the worker's outside option by ρi. This makes the worker more expensive to retain, forcing the firm to share more of the investment returns. This leakage of surplus to the worker directly reduces the firm's incentive to invest.

2. **The Inefficient Separation Effect:** The firm anticipates the outcome from part (i)—that it will fail to retain the worker in states where retention is socially valuable. This lower probability of retention further depresses the firm's expected return on investment compared to the planner's.

Both forces unambiguously push the firm's private incentive to invest below the social incentive. Thus, for any level of investment i, we have $\text{PMB}_s(i) < \text{SMB}(i)$. Consequently, the spot market generates inefficiently low retention and investments. ■

2.3 Subgame Perfect Equilibrium with a Non-Compete Agreement

2.3.1 Equilibrium Characterization

The equilibrium is solved via backward induction. Before analyzing the firm's choices, we first define the worker's expected utility. In the Production Stage, the worker stays if $v \leq w_1$ and quits if $v > w_1$. The worker's ex-ante expected future utility, $E[U_W(w_1)]$, calculated before the outside option v is realized, is therefore:

$$\begin{aligned}
E[U_W(w_1)] &= \int_0^{w_1} w_1 \lambda e^{-\lambda v} dv + \int_{w_1}^{\infty} v \lambda e^{-\lambda v} dv \\
&= w_1(1 - e^{-\lambda w_1}) + e^{-\lambda w_1}(w_1 + 1/\lambda) \\
&= w_1 + \frac{1}{\lambda} e^{-\lambda w_1}.
\end{aligned}$$

The worker's participation constraint, checked in Stage 1, is $B_1 + \beta E[U_W(w_1)] \geq \mu^0$.

In Stage 2, for a given wage w_1, the firm chooses investment i_1 to maximize its expected profit, anticipating the worker's separation decision:

$$\max_{i_1 \geq 0} \quad \underbrace{(ri_1 - w_1)}_{\text{Profit if stay}} \underbrace{\Pr(v \leq w_1)}_{(1-e^{-\lambda w_1})} - \frac{1}{2} i_1^2$$

The first-order condition yields the firm's optimal investment response function:

$$i_1(w_1) = r(1 - e^{-\lambda w_1}). \tag{3}$$

This expression reflects the expected private marginal return to investment, which equals the probability the worker stays $(1 - e^{-\lambda w_1})$ multiplied by marginal product r of investment. In Stage 1, the firm chooses (w_1, B_1) to maximize its profit. Since the bonus B_1 can be used to transfer utility ex-ante, this problem is equivalent to choosing w_1 to maximize the private joint surplus of the match, Σ_1, subject to the constraint that the firm will not fire the worker ($w_1 \leq ri_1$). The joint surplus is the sum of the firm's profit (before the bonus) and the worker's discounted expected utility:

$$\Sigma_1(w_1) = \left[(ri_1(w_1) - w_1)(1 - e^{-\lambda w_1}) - \frac{1}{2} i_1(w_1)^2 \right] + \beta E[U_W(w_1)].$$

Substituting in the expression for $E[U_W(w_1)]$, maximizing Σ_1 with respect to w_1, and applying the Envelope Theorem yields the following key relationship.

Proposition 2 (Optimal Contract Structure)**.** *The optimal wage w_1 and the corresponding investment level $i_1(w_1)$ are related by the equation:*

$$w_1 = ri_1(w_1) + \frac{(\beta - 1)(e^{\lambda w_1} - 1)}{\lambda}. \tag{4}$$

For any worker patience $\beta \leq 1$, this contract ensures the equilibrium wage satisfies the firm's viability constraint, $w_1 \leq ri_1(w_1)$, so the firm does not fire the worker.

In Appendix Section A.2, we provide the necessary and sufficient conditions for a non-zero wage. All further analysis assumes $\lambda r^2 > 2$, which provides a sufficient condition. This wage structure creates a back-loaded compensation profile, where workers receive lower compensation early in the job in exchange for higher wages in the future. The steepness of this intertemporal trade-off is governed by the worker's patience β. A more patient worker is more willing to trade present for future earnings, accepting lower initial compensation (B_1) in exchange for a higher future wage (w_1). When $\beta = 1$, the worker earns exactly marginal product in the final period; to satisfy the firm's participation constraint, it must be the case that the worker earns below marginal product in the initial period, leading to an upward sloping wage-tenure profile.

2.3.2 Comparison with the Social Optimum

The structure of the private contract deviates from the social optimum because the firm's objective function ignores the external productivity parameter ρ. We formally compare the investment levels for the case where the worker is perfectly patient ($\beta = 1$).

Proposition 3 (Private vs. Social Investment)**.** *When $\beta = 1$, private investment with a non-compete, i_1, is compared to the social optimum, i^*, as follows:*

- *A sufficient condition for under-investment ($i_1 < i^*$) is $1 - \lambda r i^* > 0$.*
- *A sufficient condition for over-investment ($i_1 > i^*$) is $1 - \lambda \Delta i^* < 0$, where $\Delta = r - \rho$.*

Proof. Let the optimal investments be the roots of the first-order conditions (FOCs) defined as Marginal Benefit - Marginal Cost.

- For the social planner: $F_P(i) \equiv \left(r - \Delta e^{-\lambda \Delta i}\right) - i = 0$
- For the firm: $F_F(i) \equiv \left(r - re^{-\lambda r i}\right) - i = 0$

The firm chooses i_1 such that $F_F(i_1) = 0$. By the second-order condition for a maximum, the derivative of the firm's FOC must be negative at the optimum, so $\partial F_F / \partial i < 0$. This means $F_F(i)$ is a decreasing function of investment i. Because $F_F(i)$ is decreasing, we can determine the sign of the investment distortion by evaluating the sign of $F_F(i^*)$. If $F_F(i^*) < 0$, then $i_1 < i^*$ (under-investment). If $F_F(i^*) > 0$, then $i_1 > i^*$ (over-investment).

We evaluate the firm's FOC at the social optimum i^*:

$$F_F(i^*) = r - re^{-\lambda r i^*} - i^*$$

From the planner's FOC, we know $F_P(i^*) = 0$, which can be rearranged to get $r - i^* = \Delta e^{-\lambda \Delta i^*}$. Substituting this into the expression for $F_F(i^*)$ yields:

$$F_F(i^*) = (r - i^*) - re^{-\lambda r i^*} = \Delta e^{-\lambda \Delta i^*} - re^{-\lambda r i^*}$$

The sign of this expression is given by the sign of $f(\Delta) - f(r)$, where we define the auxiliary function $f(K) = Ke^{-\lambda K i^*}$. The derivative, $f'(K) = e^{-\lambda K i^*}(1 - \lambda K i^*)$, determines if $f(K)$ is increasing or decreasing over the interval $[\Delta, r]$.

A sufficient condition for **under-investment** ($i_1 < i^*$) is $F_F(i^*) < 0$, which requires $f(\Delta) < f(r)$. Since $\Delta < r$, this holds if $f(K)$ is increasing on the interval $[\Delta, r]$. This requires $f'(K) > 0$, for which a sufficient condition is $1 - \lambda r i^* > 0$.

A sufficient condition for **over-investment** ($i_1 > i^*$) is $F_F(i^*) > 0$, which requires $f(\Delta) > f(r)$. Since $\Delta < r$, this holds if $f(K)$ is decreasing on the interval $[\Delta, r]$. This requires $f'(K) < 0$, for which a sufficient condition is $1 - \lambda \Delta i^* < 0$. ■

With a high distribution of outside offers (low λ), a non-compete agreement may still yield under-powered investment incentives, as quits (to non-industry competitors) are frequent. When quit risk is minimal and when investments are highly specific (high λ, Δ), a non-compete agreement may result in over-investment relative to socially optimal.

2.3.3 Comparative Statics of the Non-Compete Equilibrium

The parameters of the model influence the equilibrium wage, which in turn affects the worker's quit decision, the firm's investment level, and the total surplus generated by the match. The following proposition summarizes these relationships.

Proposition 4 (Comparative Statics of Equilibrium Outcomes)**.** *In the equilibrium with a non-compete agreement, the effects of the model parameters on the equilibrium wage (w_1), bonus (B_1), quit probability ($q_1 = e^{-\lambda w_1}$), investment (i_1), and maximized joint surplus (Σ_1^*) are as follows:*

(i) An increase in r raises the wage, lowers the bonus, lowers the quit probability, increases investment, and increases the joint surplus.

(ii) A change in the skill-generality parameter, ρ, has no effect on any equilibrium outcome.

(iii) An increase in worker patience, β, raises the wage, lowers the bonus, lowers the quit probability, increases investment, and increases the joint surplus.

(iv) The effect of the quit rate parameter, λ, depends on worker patience.

- *If $\beta = 1$, an increase in λ raises the wage, lowers the quit probability, and increases investment, but decreases the joint surplus.*
- *If $\beta < 1$, the effects of an increase in λ on all equilibrium variables are ambiguous.*

Proof. The proof proceeds by establishing the comparative static for the wage, w_1, and then deriving the effects on B_1, q_1, i_1, and Σ_1^* as logical consequences. The wage response, $\frac{dw_1}{dx}$, is found by applying the Implicit Function Theorem to the wage FOC, $G(w_1, \mathbf{p}) \equiv d\Sigma_1/dw_1 = 0$. The sign is given by $\text{Sign}(\frac{dw_1}{dx}) = \text{Sign}(G_x)$, where $G_x \equiv \partial^2\Sigma_1/\partial w_1 \partial x$.

(i) Effect of Productivity r.

- **Wage:** The cross-partial with respect to r is $G_r = 2\lambda i_1 e^{-\lambda w_1}$. Since $i_1 > 0$, $G_r > 0$, which implies $\frac{dw_1}{dr} > 0$.
- **Bonus:** $\frac{dB_1}{dr} = -\beta(1-e^{-\lambda w_1})\frac{dw_1}{dr} < 0$ since $\frac{dw_1}{dr} > 0$.
- **Quit Probability:** $\frac{dq_1}{dr} = -\lambda e^{-\lambda w_1}\frac{dw_1}{dr}$. Since $\frac{dw_1}{dr} > 0$, we have $\frac{dq_1}{dr} < 0$.
- **Investment:** By the product rule, $\frac{di_1}{dr} = \frac{d}{dr}[r(1-q_1)] = (1-q_1) - r\frac{dq_1}{dr}$. Since $q_1 < 1$ and $\frac{dq_1}{dr} < 0$, both terms are positive, thus $\frac{di_1}{dr} > 0$.
- **Surplus:** By the Envelope Theorem, $\frac{d\Sigma_1^*}{dr} = \frac{\partial \Sigma_1}{\partial r} = i_1(1-e^{-\lambda w_1}) > 0$.

(ii) Effect of skill-generality ρ. The parameter ρ does not appear in the joint surplus function Σ_1 or its first-order conditions under a non-compete. Thus, all derivatives with respect to ρ are zero.

(iii) Effect of Worker Patience β.

- **Wage:** The cross-partial is $G_\beta = \frac{d}{dw_1}\left(\frac{\partial \Sigma_1}{\partial \beta}\right) = \frac{d}{dw_1}(E[U_W(w_1)]) = 1 - e^{-\lambda w_1} > 0$. Thus, $\frac{dw_1}{d\beta} > 0$.
- **Bonus:** $\frac{dB_1}{d\beta} = \frac{\partial B_1}{\partial \beta} + \frac{dB_1}{dw_1}\cdot\frac{dw_1}{d\beta} = -(w_1 + \frac{1}{\lambda}e^{-\lambda w_1}) - (1-e^{-\lambda w_1})\beta\frac{dw_1}{d\beta} < 0$.
- **Quit Probability:** $\frac{dq_1}{d\beta} = -\lambda e^{-\lambda w_1}\frac{dw_1}{d\beta} < 0$.
- **Investment:** $\frac{di_1}{d\beta} = -r\frac{dq_1}{d\beta} > 0$.
- **Surplus:** By the Envelope Theorem, $\frac{d\Sigma_1^*}{d\beta} = \frac{\partial \Sigma_1}{\partial \beta} = E[U_W(w_1)] > 0$.

(iv) Effect of Quit Rate Parameter λ. The effects depend on the value of β.

- **Wage:** The sign depends on the cross-partial $G_\lambda \equiv \partial^2\Sigma_1/\partial w_1 \partial\lambda$. Using the property of mixed partials, we find:

$$
\begin{aligned}
G_\lambda = \frac{d}{dw_1}\left(\frac{\partial \Sigma_1}{\partial \lambda}\right) &= \frac{d}{dw_1}\left[(ri_1 - w_1)w_1 e^{-\lambda w_1} - \frac{\beta}{\lambda^2}e^{-\lambda w_1}(1+\lambda w_1)\right] \\
&= \frac{\beta-1}{\lambda}\left(1 - e^{-\lambda w_1} + \lambda w_1 e^{-\lambda w_1}\right) + \beta w_1 e^{-\lambda w_1}.
\end{aligned}
$$

  If $\beta = 1$, the first term is zero, leaving $G_\lambda = w_1 e^{-\lambda w_1} > 0$. Thus, $\frac{dw_1}{d\lambda} > 0$. If $\beta < 1$, the first term is negative while the second is positive, making the sign of G_λ ambiguous. Thus, the sign of $\frac{dw_1}{d\lambda}$ is ambiguous.

- **Quit Probability:** The total derivative is $\frac{dq_1}{d\lambda} = -w_1 e^{-\lambda w_1} - \lambda e^{-\lambda w_1} \frac{dw_1}{d\lambda}$. If $\beta = 1$, $\frac{dw_1}{d\lambda} > 0$, so both terms are negative, implying $\frac{dq_1}{d\lambda} < 0$. If $\beta < 1$, the sign is ambiguous because the sign of $\frac{dw_1}{d\lambda}$ is ambiguous.

- **Investment:** The derivative is $\frac{di_1}{d\lambda} = -r\frac{dq_1}{d\lambda}$. If $\beta = 1$, $\frac{dq_1}{d\lambda} < 0$, implying $\frac{di_1}{d\lambda} > 0$. If $\beta < 1$, the sign is ambiguous.

- **Surplus:** By the Envelope Theorem, $\frac{d\Sigma_1^*}{d\lambda} = (ri_1 - w_1)w_1 e^{-\lambda w_1} - \frac{\beta}{\lambda^2} e^{-\lambda w_1}(1 + \lambda w_1)$. If $\beta = 1$, the first term is zero (since $w_1 = ri_1$), leaving a strictly negative result. If $\beta < 1$, the first term is positive and the second is negative, so the sign is ambiguous.

■

An increase in the worker's internal productivity (r) or patience (β) raises the potential value of the employment relationship. The firm responds strategically by offering a more back-loaded contract with a higher future wage. The higher wage reduces worker turnover, which in turn makes a higher level of firm investment profitable. Notably, the parameter ρ is irrelevant to the equilibrium, as raising investments does not increase the worker's outside option.

2.4 Subgame Perfect Equilibrium Without a Non-Compete Agreement

2.4.1 Equilibrium Characterization

The equilibrium is characterized by the firm's optimal investment and wage choices. The firm chooses the wage w_0 to maximize the private joint surplus of the match, anticipating its own investment response in the subsequent stage. The joint surplus, Σ_0, is the sum of the firm's expected profit and the worker's discounted expected future utility:

$$\Sigma_0(w_0, i_0) = (ri_0 - w_0)(1 - e^{-\lambda T_0}) - \frac{1}{2}i_0^2 + \beta\left(w_0 + \frac{1}{\lambda}e^{-\lambda T_0}\right)$$

where $T_0 = w_0 - \rho i_0$ is the retention threshold for labor demand conditions v.

First-Order Condition for Investment. In Stage 2, the firm chooses i_0 to maximize its own expected profit, $E[\Pi_0] = (ri_0 - w_0)(1 - e^{-\lambda T_0}) - \frac{1}{2}i_0^2$, taking the wage w_0 as given. The first-order condition implicitly defines the firm's investment response function, $i_0(w_0)$:

$$H(i_0, w_0) \equiv \underbrace{r(1 - e^{-\lambda T_0})}_{\text{Marginal Product Effect}} - \underbrace{(ri_0 - w_0)\lambda\rho e^{-\lambda T_0}}_{\text{Hold-up Cost}} - \underbrace{i_0}_{\text{MC}} = 0 \tag{5}$$

This condition characterizes the firm's optimal investment choice in Stage 2, taking the wage w_0 as fixed. The first term, $r(1-e^{-\lambda T_0})$, is the expected marginal benefit of investment: the gain in the worker's productivity if the match persists multiplied by the probability the match persists. The second term, $(ri_0 - w_0)\lambda\rho e^{-\lambda T_0}$, captures the hold-up problem: by investing more, the firm raises the worker's outside option and thus the likelihood of a quit, making it more probable that the firm will lose its profit margin on the worker, $(ri_0 - w_0)$.

First-Order Condition for Wages. The firm chooses w_0 to maximize the joint surplus $\Sigma_0(w_0, i_0(w_0))$, subject to the viability constraint $w_0 \leq ri_0(w_0)$. The unconstrained optimum, which we denote w^*_{unc}, is the wage that solves the first-order condition $\frac{d\Sigma_0}{dw_0} = 0$. This total derivative is:

$$\frac{d\Sigma_0}{dw_0} = \frac{\partial \Sigma_0}{\partial w_0} + \frac{\partial \Sigma_0}{\partial i_0}\frac{di_0}{dw_0} = 0 \tag{6}$$

The partial derivatives are $\partial\Sigma_0/\partial w_0 = (\beta-1)(1-e^{-\lambda T_0}) + \lambda(ri_0 - w_0)e^{-\lambda T_0}$ and $\partial\Sigma_0/\partial i_0 = \beta\rho e^{-\lambda T_0}$. Substituting these into the above equation yields the wage FOC:

$$\lambda e^{-\lambda T_0}(ri_0 - w_0) + (\beta-1)(1-e^{-\lambda T_0}) + \beta\rho e^{-\lambda T_0}\frac{di_0}{dw_0} = 0 \tag{7}$$

This condition characterizes how the firm optimally sets the wage to maximize joint surplus, accounting for both direct and indirect effects.

- The first term, $\lambda e^{-\lambda T_0}(ri_0 - w_0)$, reflects the firm's gain from increasing retention: raising the wage increases the probability the worker stays, which is valuable when the worker's marginal product exceeds her wage.
- The second term, $(\beta-1)(1-e^{-\lambda T_0})$, captures the cost of transferring surplus to an impatient worker. If the worker is impatient ($\beta < 1$), then increasing the wage reduces joint surplus because the worker undervalues the extra compensation.
- The third term, $\beta\rho e^{-\lambda T_0}\frac{di_0}{dw_0}$, is the indirect benefit of higher wages through investment incentives: a higher wage reduces hold-up risk, encouraging more investment, which in turn raises the worker's future utility by improving her outside option.

Note that this unconstrained solution is only chosen if it is feasible. If w^*_{unc} violates the viability constraint (i.e., if $w^*_{unc} > ri_0(w^*_{unc})$), then the equilibrium wage will be a corner solution. In this case, the firm is constrained and will choose the highest possible wage that still satisfies viability. This is the wage w^*_0 that lies on the boundary of the feasible set, solving the fixed-point equation $w^*_0 = ri_0(w^*_0)$. We show the existence of this fixed point and the conditions under which it is positive in Appendix A.3.[10] As in the case with a non-compete, this optimal contract features a back-loaded compensation profile. The worker's patience, β, determines the steepness of this intertemporal trade-off. A more patient worker is more willing to trade lower initial compensation (B_0) for a higher future wage (w_0) that encourages greater firm investment. This dynamic is most apparent in the limit where the worker is perfectly patient ($\beta = 1$). In this case, the unconstrained solution would feature a wage above marginal product. As this is not profitable for the firm, the viability constraint binds, and the equilibrium is a corner solution where the worker receives exactly product in the final period.[11] To ensure the firm participates ex-ante, wages are below marginal product in the initial period, again leading to an upward sloping wage-tenure profile.

2.4.2 The Hold-Up Problem: Under-investment

Proposition 5 (Under-investment without a Non-Compete)**.** *In the equilibrium without a non-compete agreement, the firm's investment level, i_0^*, is strictly less than the socially optimal level, i^*.*

Proof. The proof proceeds by establishing an upper bound for the equilibrium investment and showing this bound is below the social optimum. Let the social planner's marginal benefit be $\mathrm{SMB}(i) = r - \Delta e^{-\lambda \Delta i}$, where $\Delta = r - \rho$. The social optimum i^* solves $\mathrm{SMB}(i^*) = i^*$, as previously shown in Equation 2.

1. The Benchmark Case ($w_0 = ri_0$). Consider the boundary case where the firm earns zero profits ex-post. Let the investment at this boundary be i_{bench}. Substituting $w_0 = ri_0$ into the investment FOC yields $i_{\text{bench}} = r(1 - e^{-\lambda \Delta i_{\text{bench}}})$. The firm's private marginal benefit in this case is $\mathrm{PMB}_{\text{bench}}(i) = r(1 - e^{-\lambda \Delta i})$. The difference between the social and private marginal benefit is $\mathrm{SMB}(i) - \mathrm{PMB}_{\text{bench}}(i) = \rho e^{-\lambda \Delta i} > 0$. Since the social marginal benefit is strictly greater than the firm's private marginal benefit for all i, the socially optimal investment level must be strictly greater than the firm's choice, i.e., $i^* > i_{\text{bench}}$.

2. The General Case ($w_0 < ri_0$). In any equilibrium where the firm earns positive profits ex-post, $w_0 < ri_0$. The firm's investment reaction function is strictly increasing in the wage ($\frac{di_0}{dw_0} > 0$). Therefore, any equilibrium investment $i_0^*(w_0^*)$ must be less than the investment level at the boundary benchmark: $i_0^*(w_0^*) < i_0(ri_0) = i_{\text{bench}}$. Combining these two results ($i_0^* \leq i_{\text{bench}}$ and $i_{\text{bench}} < i^*$),

[10] Throughout our analysis, we assume parameter values satisfy both $\lambda r(r-\rho) > 1$ and $\lambda r^2 > 2$. As shown in the Appendix, the first condition ensures a positive wage and investment in the equilibrium without a non-compete, while the second is a sufficient condition ensuring a positive wage in the equilibrium with a non-compete. These assumptions ensure that we are always comparing two non-trivial contractual outcomes.

[11] We prove formally that $\frac{di_0}{dw_0} > 0$ in Appendix A.4, which guarantees the unconstrained wage (without imposing the viability constraint) is above marginal product.

transitivity implies that the equilibrium investment is always strictly below the social optimum:

$$i_0^* < i^*$$

■

In the benchmark case, there are no inefficient quits, but the firm still under-invests because it doesn't internalize the investment's benefits to the worker upon a separation. This problem is compounded in the remaining cases where there are inefficient quits.

2.4.3 Dominance of the No-NC Contract over the Spot Market

We now compare the total joint surplus generated by the optimal wage-commitment contract without a non-compete agreement (No-NC) for a perfectly patient worker ($\beta = 1$) and the spot-market equilibrium. We show that the No-NC contract strictly dominates the spot market by supporting both a higher level of investment and more efficient separation decisions.

Proposition 6 (*Surplus Dominance of the No-NC Contract*)**.** *For the case of a perfectly patient worker ($\beta = 1$), the joint surplus from a No-NC contract is strictly greater than the joint surplus from the spot market equilibrium ($\Sigma_0^* > \Sigma_s^*$).*

Proof. The proof establishes the result by demonstrating that the No-NC contract achieves both a higher level of investment and more efficient separation decisions. The dominance in joint surplus follows directly from these two advantages.

1. Investment Dominance ($i_0^* > i_s^*$) An equilibrium investment level is determined where the firm's private marginal benefit of investment (PMB) equals its marginal cost (i). We show that for any given $i > 0$, the PMB is strictly higher under the No-NC contract than in the spot market. The respective marginal benefits are:

$$\text{PMB}_s(i) = r\underbrace{\left(1 - e^{-\lambda(w_s^* - \rho i)}\right)}_{\text{Pr(Stay)}} - \underbrace{\lambda\rho(ri - w_s^*)e^{-\lambda(w_s^* - \rho i)}}_{\text{(Rent-Sharing)}},$$
$$\text{PMB}_0^*(i) = r\underbrace{\left(1 - e^{-\lambda(r-\rho)i}\right)}_{\text{Pr(Stay under No-NC)}}$$

Let the separation thresholds be $v_T^s(i) = w_s^*(i) - \rho i$ and $v_T^0(i) = (r - \rho)i$. The spot-market PMB is strictly less than its first term, since the second term is strictly positive in equilibrium ($ri > w_s^*$).

Furthermore, because $w_s^*(i) < ri$, we know $v_T^s(i) < v_T^0(i)$. This allows us to construct the following strict inequality chain:

$$\text{PMB}_s(i) < r\big(1 - e^{-\lambda v_T^s(i)}\big) < r\big(1 - e^{-\lambda v_T^0(i)}\big) = \text{PMB}_0^*(i).$$

As the marginal benefit of investment is strictly greater under the No-NC contract for all $i > 0$, the equilibrium investment level must also be strictly greater, $i_0^* > i_s^*$.

2. Separation Efficiency The No-NC contract with $\beta = 1$ yields an efficient separation threshold conditional on its investment, $v_T^0 = (r-\rho)i_0^*$. In contrast, the spot market yields an inefficiently low threshold, $v_T^s < (r-\rho)i_s^*$, which causes excessive quits.

3. Joint Surplus Dominance Let the joint surplus function be $S(i, v_T)$, where $\Sigma_0^* = S(i_0^*, (r-\rho)i_0^*)$ and $\Sigma_s^* = S(i_s^*, v_T^s)$. We can now conclude that $\Sigma_0^* > \Sigma_s^*$ via the following decomposition:

$$\Sigma_0^* = S(i_0^*, (r-\rho)i_0^*) > S(i_s^*, (r-\rho)i_s^*) > S(i_s^*, v_T^s) = \Sigma_s^*.$$

The first inequality holds because $i_0^* > i_s^*$ (from Step 1) and the joint surplus function is increasing in investment in the relevant range. The second inequality holds because $(r-\rho)i_s^* > v_T^s$ (from Step 2) and the joint surplus is increasing in the separation threshold for $v_T < (r-\rho)i$. Therefore, the No-NC contract strictly dominates the spot-market equilibrium, illustrating the value of commitment. ■

2.5 Comparing NC to No-NC Contracts: Investment, Wage-Tenure Profiles, Contract Choice

2.5.1 Non-Compete Agreements Raise Investment

Proposition 7. *Let $i_0(w_0)$ be the firm's optimal investment response to a given wage w_0 in the absence of a non-compete agreement. Let i_1 be the equilibrium investment with a non-compete agreement. For any wage w_0 that satisfies the firm's viability constraint, $w_0 \le r \cdot i_0(w_0)$, it holds that*

$$i_1 > i_0(w_0)$$

provided $\rho > 0$.

Proof. The proof establishes the result by demonstrating that for any viable investment choice under the no-non-compete (No-NC) rule, there is a strict incentive to increase investment under non-compete (NC) rules. First, for any given wage w_0, the firm's investment response $i_0(w_0)$ is determined by the first-order condition (FOC) of its profit maximization problem in the No-NC regime:

$$i_0(w_0) = r\big(1 - e^{-\lambda(w_0 - \rho i_0)}\big) - \big(ri_0 - w_0\big)\lambda\rho e^{-\lambda(w_0 - \rho i_0)} \tag{8}$$

Let $\mathrm{NMB}_1(i,w) = r(1-e^{-\lambda w}) - i$ be the Net Marginal Benefit of investment under the NC regime. The NC equilibrium investment i_1 is part of a pair (i_1, w_1) that solves $\mathrm{NMB}_1(i_1, w_1) = 0$.

Now, consider any wage w_0 and its corresponding investment response $i_0 \equiv i_0(w_0)$ that satisfy the viability constraint $w_0 \le ri_0$. We evaluate NMB_1 at this point (i_0, w_0) and substitute for i_0 using its FOC from (8):

$$\begin{aligned}
\mathrm{NMB}_1(i_0, w_0) &= r(1-e^{-\lambda w_0}) - i_0 \\
&= r(1-e^{-\lambda w_0}) - \Big[r\big(1 - e^{-\lambda(w_0 - \rho i_0)}\big) - \big(ri_0 - w_0\big)\lambda\rho e^{-\lambda(w_0 - \rho i_0)}\Big] \\
&= r\left(e^{-\lambda(w_0 - \rho i_0)} - e^{-\lambda w_0}\right) + (ri_0 - w_0)\lambda\rho e^{-\lambda(w_0 - \rho i_0)} \\
&= \underbrace{re^{-\lambda w_0}\left(e^{\lambda\rho i_0} - 1\right)}_{\text{Term A}} + \underbrace{(ri_0 - w_0)\,\lambda\rho e^{-\lambda(w_0 - \rho i_0)}}_{\text{Term B}}
\end{aligned}$$

The sign of this expression is determined as follows:

1. **Term A** is strictly positive, since $r, \lambda, i_0 > 0$ and we assume $\rho > 0$.

2. **Term B** is non-negative. This follows directly from our premise that the wage w_0 satisfies the viability constraint $w_0 \le ri_0$, which ensures $(ri_0 - w_0) \ge 0$.

Therefore, for any viable wage w_0 and its investment response i_0,

$$\mathrm{NMB}_1(i_0, w_0) > 0$$

Since $\mathrm{NMB}_1(i,w)$ is strictly decreasing in i, the NC equilibrium investment i_1 where $\mathrm{NMB}_1 = 0$ must be greater than i_0. Because this holds for any wage satisfying the viability constraint, it must also hold for the specific wage chosen in the No-NC equilibrium. If $\rho = 0$, both terms are zero, yielding $i_1 = i_0$. ■

Corollary 1. *For the benchmark case of a perfectly patient worker ($\beta = 1$), the non-compete agreement alters the structure of the equilibrium contract in the following ways:*

(a) The equilibrium wage is strictly higher ($w_1 > w_0$).

(b) The equilibrium quit probability is strictly lower ($q_1 < q_0$).

(c) The comparison of the upfront bonuses (B_1 vs. B_0) is ambiguous, as it depends on a trade-off between the wage level and the option value of quitting.

Proof. The proofs rely on the main proposition that equilibrium investment is higher with a non-compete, $i_1 > i_0$. For the entirety of this proof, we use the benchmark condition that for $\beta = 1$, the equilibrium wage is set at the viability frontier, so $w_1 = ri_1$ and $w_0 = ri_0$.

Proof of (a): Wages. The comparison is immediate from the wage rules and the main proposition:

$$w_1 = ri_1 > ri_0 = w_0.$$

Proof of (b): Quit Probabilities. The quit probability is lower if the worker's retention threshold is higher. We must show that the NC threshold (w_1) is greater than the No-NC threshold ($T_0 = w_0 - \rho i_0$). Using the wage rule $w_0 = ri_0$:

$$T_0 = ri_0 - \rho i_0 = (r - \rho)i_0.$$

We can now construct a direct chain of inequalities:

$$w_1 = ri_1 > ri_0 > (r - \rho)i_0 = T_0.$$

The steps follow from the NC wage rule, the main proposition ($i_1 > i_0$), the fact that $\rho > 0$, and the expression for T_0. Since $w_1 > T_0$, it follows that the quit probability is lower, $q_1 = e^{-\lambda w_1} < e^{-\lambda T_0} = q_0$.

Proof of (c): Bonus Ambiguity. The upfront bonus B is set by the worker's participation constraint, $B_\delta = \mu^0 - \beta E_\delta[U_W]$ (with $\beta = 1$ for this proof). The comparison of B_1 and B_0 is therefore determined by the sign of the difference $E_0 - E_1$. Using the expressions for the worker's expected utility in each regime:

$$\begin{aligned}
E_1 &= w_1 + \frac{1}{\lambda}e^{-\lambda w_1} \\
E_0 &= w_0 + \frac{1}{\lambda}e^{-\lambda T_0} \quad \text{where } T_0 = w_0 - \rho i_0
\end{aligned}$$

We can write the difference, $E_0 - E_1$, as the sum of two competing economic forces:

$$E_0 - E_1 = \underbrace{(w_0 - w_1)}_{\text{Wage Effect}} + \underbrace{\frac{1}{\lambda}\left(e^{-\lambda T_0} - e^{-\lambda w_1}\right)}_{\text{Option Value Effect}}$$

We now sign each component based on the results from parts (a) and (b):

1. **Wage Effect:** From part (a), we know $w_1 > w_0$, so this term is **negative**. The No-NC contract provides a lower wage, which reduces the worker's ex-ante utility.

2. **Option Value Effect:** From part (b), we know the No-NC retention threshold is lower ($T_0 < w_1$), which means the probability of quitting is higher ($e^{-\lambda T_0} > e^{-\lambda w_1}$). This term is therefore **positive**. The No-NC contract provides a more valuable option to quit for a better outside offer.

Since the total difference in expected utility is the sum of a negative effect and a positive effect, the sign of $E_0 - E_1$ cannot be determined without specific parameter values. Therefore, the ordering of the upfront bonuses, B_1 versus B_0, is ambiguous. ■

Corollary 2. *Compensating Wage Differential: If the equilibrium wage with a non-compete is strictly lower than the equilibrium wage without a non-compete ($w_1 < w_0$), then the upfront bonus must be strictly higher ($B_1 > B_0$), assuming the worker has a positive discount factor ($\beta > 0$).*

Proof. The upfront bonus B_δ is set to make the worker's participation constraint bind:

$$B_\delta + \beta E_\delta[U_W] = \mu^0 \quad \Longrightarrow \quad B_\delta = \mu^0 - \beta E_\delta[U_W]$$

where $E_\delta[U_W]$ is the worker's ex-ante expected future utility in regime $\delta \in \{0,1\}$. To prove that $B_1 > B_0$, we must therefore show that the premise $w_1 < w_0$ implies that the worker's expected utility is lower with a non-compete, $E_1[U_W] < E_0[U_W]$.

The expected utilities in each regime are given by:

$$E_1[U_W] = w_1 + \frac{1}{\lambda} e^{-\lambda w_1}$$
$$E_0[U_W] = w_0 + \frac{1}{\lambda} e^{-\lambda (w_0 - \rho i_0)}$$

Let us define an auxiliary function $h(w) = w + \frac{1}{\lambda} e^{-\lambda w}$, which represents the worker's expected utility under a non-compete contract with wage w. The derivative is $h'(w) = 1 - e^{-\lambda w}$, which is strictly positive for any $w > 0$. Thus, $h(w)$ is a strictly increasing function of the wage.

The proof proceeds with a direct chain of inequalities.

1. **Comparing E_1 to $h(w_0)$:** By definition, $E_1 = h(w_1)$. The premise of the proposition is that $w_1 < w_0$. Since $h(w)$ is strictly increasing, it directly follows that:

$$E_1 = h(w_1) < h(w_0)$$

2. **Comparing $h(w_0)$ to E_0:** Now we compare $h(w_0)$ to the worker's utility without a non-

compete, E_0.

$$h(w_0) = w_0 + \frac{1}{\lambda} e^{-\lambda w_0}$$
$$E_0 = w_0 + \frac{1}{\lambda} e^{-\lambda(w_0 - \rho i_0)}$$

In the No-NC regime, a positive investment level ($i_0 > 0$) requires a positive wage ($w_0 > 0$). Assuming $\rho > 0$, the exponent in the expression for E_0 is larger than the exponent in $h(w_0)$:

$$-\lambda(w_0 - \rho i_0) > -\lambda w_0$$

Therefore:

$$E_0 = w_0 + \frac{1}{\lambda} e^{-\lambda(w_0 - \rho i_0)} > w_0 + \frac{1}{\lambda} e^{-\lambda w_0} = h(w_0)$$

Combining our results from steps 1 and 2, we have the complete chain of inequalities:

$$E_1 < h(w_0) < E_0$$

This proves that $E_1[U_W] < E_0[U_W]$. Given that B_δ is inversely related to $E_\delta[U_W]$ (and $\beta > 0$), it follows that $B_1 > B_0$. The reasoning is that, given the premise $w_1 < w_0$, the worker's utility is lower with a non-compete for two reasons. First is the direct effect of the lower wage. Second, is that the quit option value is lower with a non-compete. Both effects reduce the worker's expected utility, requiring a larger upfront bonus B_1 to ensure participation. ■

2.5.2 Incentives to Use Non-Compete Agreements

Proposition 8. *When skills are entirely firm-specific ($\rho = 0$), the hold-up problem vanishes and the no-non-compete (No-NC) contract is identical to the non-compete (NC) contract, yielding the same joint surplus, $\Sigma_0^* = \Sigma_1^*$. For $\rho > 0$, the relative attractiveness of the No-NC contract is determined by the total derivative $\frac{d\Sigma_0^*}{d\rho}$, which measures how the No-NC surplus changes as skills become more industry-specific. An increase in Σ_0^* makes the No-NC contract more attractive.*

(i) For a general worker patience $\beta \in (0,1]$, the effect of ρ on the No-NC surplus is ambiguous.

(ii) For a perfectly patient worker ($\beta = 1$) where the equilibrium wage is at the firm's viability constraint ($w_0^* = ri_0^*$), the effect simplifies and its sign is determined by the term $f \equiv 1 - \lambda r^2 e^{-\lambda \Delta i_0^*}$, where $\Delta = r - \rho$.

(iii) Under the conditions of (ii), an increase in skill generality, ρ, makes the No-NC contract less attractive and favors a non-compete, while the effects of quit risk, λ, and productivity,

r, are ambiguous.

Proof. The total derivative of the maximized No-NC surplus is given by applying the Envelope Theorem to the joint surplus function:

$$\frac{d\Sigma_0^*}{d\rho} = \frac{\partial \Sigma_0}{\partial \rho} + \frac{\partial \Sigma_0}{\partial i_0}\frac{di_0^*}{d\rho}.$$

Proof of (i): The General Case. For arbitrary β, the direct effect is $\partial\Sigma_0/\partial\rho = i_0^* e^{-\lambda T_0^*}[\beta - \lambda(ri_0^* - w_0^*)]$, which is of ambiguous sign. The indirect effect is the product of $\partial\Sigma_0/\partial i_0 = \beta\rho e^{-\lambda T_0^*} > 0$ and the investment response $di_0^*/d\rho$, which is also of ambiguous sign.

Proof of (ii) and (iii): The Benchmark Case ($\beta = 1, w_0^* = ri_0^*$). Under these assumptions, let $s \equiv e^{-\lambda\Delta i_0^*}$. The components of the total derivative simplify to $\partial\Sigma_0/\partial\rho = i_0^* s$ and $\partial\Sigma_0/\partial i_0 = \rho s$. The investment response is $di_0^*/d\rho = -r\lambda i_0^* s/(1-\lambda r\Delta s)$, where the denominator is positive by the second-order condition. Substituting these into the total derivative yields:

$$\frac{d\Sigma_0^*}{d\rho} = i_0^* s + (\rho s)\left(-\frac{r\lambda i_0^* s}{1-\lambda r\Delta s}\right) = \frac{i_0^* s\left(1-\lambda r^2 s\right)}{1-\lambda r\Delta s}.$$

The sign is determined by the term $f \equiv 1-\lambda r^2 s$. We now find the derivative of f with respect to ρ to prove part (iii). The function f depends on ρ directly through $\Delta = r-\rho$ and indirectly through $i_0^*(\rho)$. Applying the chain rule:

$$\begin{aligned}\frac{df}{d\rho} &= \frac{d}{d\rho}\left(1-\lambda r^2 e^{-\lambda(r-\rho)i_0^*(\rho)}\right)\\ &= -\lambda r^2 s\cdot\left[-\lambda\frac{d}{d\rho}\left((r-\rho)i_0^*(\rho)\right)\right]\\ &= \lambda^2 r^2 s\left[(-1)i_0^* + (r-\rho)\frac{di_0^*}{d\rho}\right] = \lambda^2 r^2 s\left[\Delta\frac{di_0^*}{d\rho} - i_0^*\right].\end{aligned}$$

Substituting the expression for $di_0^*/d\rho = \frac{r\lambda i_0^* s}{r\lambda\Delta s - 1}$:

$$\begin{aligned}\frac{df}{d\rho} &= \lambda^2 r^2 s\left[\Delta\left(\frac{r\lambda i_0^* s}{r\lambda\Delta s-1}\right) - i_0^*\right]\\ &= \lambda^2 r^2 s\left[\frac{r\lambda\Delta i_0^* s - i_0^*(r\lambda\Delta s-1)}{r\lambda\Delta s-1}\right] = \frac{\lambda^2 r^2 s i_0^*}{r\lambda\Delta s-1}.\end{aligned}$$

The numerator is strictly positive. The denominator is strictly negative by the second-order condition of the firm's profit maximization. Thus, $\frac{df}{d\rho} < 0$, which shows that the sign-determining function $f(\rho)$ is strictly decreasing. This monotonicity implies that the sign of $\frac{d\Sigma_0^*}{d\rho}$ can switch at most once, from positive to negative. While the ultimate contract choice depends on the total surplus level (the integral of the derivative from $\rho = 0$), the sign of the derivative indicates the direction of the marginal incentive. Since $\frac{df}{d\rho} < 0$, an increase in skill generality ρ increases the marginal incentive to adopt a non-compete, confirming the conclusion in part (iii). The effects of λ and r remain ambiguous as they involve countervailing direct and indirect effects. ■

As a direct corollary, the model predicts that in the limiting case where $\rho > r$, a non-compete agreement is always used. The reasoning is that when a firm's investment makes a worker more productive for a competitor than for the firm itself, a standard employment contract (No-NC) becomes untenable. The firm anticipates that the worker will always be poached post-investment and thus refuses to invest, leading to zero surplus. The non-compete makes the employment relationship viable, as it allows the firm to realize the internal returns on its investment without the certainty of the worker being hired away.

Corollary 3. *When the worker is perfectly patient ($\beta = 1$), if the non-compete (NC) contract is preferred over the no-non-compete (No-NC) contract, it is also preferred over the spot market. This result follows by transitivity.*

Proposition 9 (Non-Compete Always Chosen for Impatient Workers)**.** *When the worker is completely impatient ($\beta = 0$), the firm's expected profit is strictly higher under a Non-Compete (NC) contract than under a No-Non-Compete contract for any values of $r, \rho > 0$. Moreover, because the impatient worker values only the up-front transfer, the bonus always satisfies*

$$B_\delta = \mu^0$$

under either contract. Consequently, when $\beta = 0$, the firm will unambiguously choose the NC contract.

Proof. Let the firm's expected profit for a given contract (w, i) and skill-generality parameter $\rho \geq 0$ be denoted by $\Pi(w, i; \rho)$:

$$\Pi(w, i; \rho) = (ri - w)(1 - e^{-\lambda(w - \rho i)}) - \frac{1}{2}i^2$$

The profit function under an NC agreement, Π_1, is identical to this general function evaluated at $\rho = 0$. The No-NC profit, Π_0, corresponds to the case where $\rho > 0$. The firm's problem is to choose a wage w to maximize its profit, anticipating its own investment response, $i^*(w)$. The firm's value function is $V(w; \rho) = \Pi(w, i^*(w; \rho); \rho)$. The maximized equilibrium profits are $V_1^* = \max_w V(w; 0)$ and $V_0^* = \max_w V(w; \rho)$. Let w_0^* be the wage that maximizes profits in the No-NC regime, so

$V_0^* = V(w_0^*;\rho)$. By the definition of a maximum, $V_1^* \geq V(w_0^*;0)$. The proof is complete if we can show that $V(w_0^*;0) > V_0^*$. We prove this by showing that the difference $V(w_0^*;0) - V_0^*$ is strictly positive.

$$V(w_0^*;0) - V_0^* = \Pi(w_0^*, i^*(w_0^*;0);0) - \Pi(w_0^*, i^*(w_0^*;\rho);\rho)$$

We decompose this difference by adding and subtracting the term $\Pi(w_0^*, i^*(w_0^*;\rho);0)$:

$$\begin{aligned} V(w_0^*;0) - V_0^* = &[\Pi(w_0^*, i^*(w_0^*;0);0) - \Pi(w_0^*, i^*(w_0^*;\rho);0)] \\ &+ [\Pi(w_0^*, i^*(w_0^*;\rho);0) - \Pi(w_0^*, i^*(w_0^*;\rho);\rho)] \end{aligned}$$

We now prove that both bracketed terms are strictly positive.

1. *The Hold-up Gain:* The second bracketed term compares the profit from the *same* contract, $(w_0^*, i^*(w_0^*;\rho))$, under two different legal regimes. Let $i_0^* = i^*(w_0^*;\rho)$.

$$\begin{aligned} \Pi(w_0^*, i_0^*;0) - \Pi(w_0^*, i_0^*;\rho) &= (ri_0^* - w_0^*)\left[(1 - e^{-\lambda w_0^*}) - (1 - e^{-\lambda(w_0^* - \rho i_0^*)})\right] \\ &= (ri_0^* - w_0^*)e^{-\lambda w_0^*}\left[e^{\lambda \rho i_0^*} - 1\right] \end{aligned}$$

   Since $ri_0^* - w_0^* > 0$, and for $\rho > 0$ and $i_0^* > 0$ the term in brackets is positive, this "Hold-up Gain" is strictly positive.

2. *The Investment Gain:* The first bracketed term evaluates the profit under the NC regime ($\rho = 0$) at two different investment levels: the optimal one for that regime, $i_1^* = i^*(w_0^*;0)$, versus the suboptimal one, $i_0^* = i^*(w_0^*;\rho)$.

$$\Pi(w_0^*, i_1^*;0) - \Pi(w_0^*, i_0^*;0)$$

   By definition, for a given wage w_0^*, the investment i_1^* is chosen to uniquely maximize the function $\Pi(w_0^*, i;0)$ with respect to i. As established in the text, the optimal investment response is strictly higher under an NC, so $i_1^* > i_0^*$. Because i_1^* is the unique maximizer, the profit it generates must be strictly greater than the profit generated by any other investment level, including i_0^*. Therefore, this "Investment Gain" is strictly positive.

Since both components of the difference are strictly positive, their sum must be strictly positive. This proves that $V(w_0^*;0) > V_0^*$. The full chain of inequalities is:

$$V_1^* \geq V(w_0^*;0) > V_0^*$$

Thus, the firm's equilibrium profit is strictly higher with a Non-Compete contract. ■

Our model predicts that for a completely impatient worker $\beta = 0$, the upfront bonus is fixed at the worker's reservation utility ($B_\delta = \mu^0$) regardless of the contract's structure. Consequently, the worker receives no ex-ante payment to compensate for the additional restrictions of a non-compete agreement. Meanwhile, the firm strictly prefers the non-compete because it lowers turnover and increases expected profits. This scenario, where workers heavily discount the future, provides a lens through which to view the prevalence of non-compete agreements for low-wage workers. A large body of research in economics suggests that financial pressures can lead individuals to exhibit higher effective discount rates. For example, liquidity constraints may force households to prioritize immediate cash over future income streams, leading to consumption behavior that appears impatient (Zeldes 1989; Lawrance 1991). More recent work in behavioral economics posits that the cognitive load imposed by financial scarcity can itself deplete mental bandwidth and foster a focus on short-term needs (Shah, Mullainathan, and Shafir 2012). Our model shows that under such conditions of worker impatience, firms have a clear profit-based incentive to use non-compete agreements.

2.6 Allowing for Renegotiation of the Non-Compete Agreement

2.6.1 Firm Holds All Bargaining Power

We extend the model to allow for renegotiation after labor demand conditions v are realized. Now the firm can restructure the non-compete agreement and contractual wages after investment is sunk but before trade or separation occurs. In particular, the firm can now match outside offers or allow the worker to leave for an industry competitor in exchange for a buyout payment. If the worker rejects the firm's new offer, the original contract terms still hold. Thus, renegotiation is by mutual consent, as in MacLeod and Malcomson (1993). The timing is as follows:

1. The firm offers an initial contract with a non-compete agreement $(w_1, B_1, \delta = 1)$ and the worker accepts or rejects.
2. The firm chooses an investment level i_1 at cost $\frac{1}{2}i_1^2$.
3. Labor demand conditions $v \sim F$ are realized and *observed by all parties.*
4. The firm offers a renegotiated contract $\{\bar{w}, \bar{\tau}, \bar{\delta}\}$, where:
   - $\bar{w}$ is the new wage if the parties trade,
   - $\bar{\tau}$ is the termination payment from the worker to firm upon separation,
   - $\bar{\delta} \in \{0,1\}$ is the revised non-compete status of the contract. If $\bar{\delta} = 0$, the firm waives the non-compete agreement and the worker's outside option is $v + \rho i_1$; otherwise, it remains v.

5. The worker accepts or rejects the revised offer. If rejected, the original contract governs. The parties then decide whether to trade or separate.

LEMMA 1 (Equilibrium Renegotiation)**.** *In the renegotiation subgame, the firm offers a contract that the worker accepts. This contract implements the efficient action (trade or separation) and ensures the worker obtains flow utility* $\max\{w_1, v\}$.

Proof. After the realization of v, the firm offers a take-it-or-leave-it contract $\{\bar{w}, \bar{\tau}, \bar{\delta}\}$. The worker will accept if the contract yields at least $\max\{w_1, v\}$, which is the best available utility under the original contract where the non-compete is enforced.

Case 1: Trade is efficient. This occurs when

$$ri_1 \geq v + \rho i_1.$$

The firm prefers to trade. It sets $\bar{\delta} = 1$ to enforce the non-compete, so the worker's fallback option remains $\max\{w_1, v\}$. The firm offers:

$$\bar{w} = \max\{w_1, v\}, \quad \bar{\delta} = 1.$$

Separation does not occur, so the termination payment $\bar{\tau}$ is irrelevant. The worker accepts and earns utility $\bar{w}$, and the firm earns profit $ri_1 - \bar{w}$.

Case 2: Separation is efficient. This occurs when

$$v + \rho i_1 > ri_1.$$

The firm sets $\bar{\delta} = 0$ to waive the non-compete and allow the worker to quit and access $v + \rho i_1$. To ensure the worker is indifferent between accepting and rejecting, the firm sets:

$$v + \rho i_1 - \bar{\tau} = \max\{w_1, v\} \quad \Rightarrow \quad \bar{\tau} = v + \rho i_1 - \max\{w_1, v\}.$$

The firm earns $\bar{\tau}$, and the worker earns $\max\{w_1, v\}$. The worker accepts.

Conclusion. In both cases, the firm implements the efficient action and extracts the surplus above $\max\{w_1, v\}$. ■

Proposition 10 (Renegotiation Ensures Efficient Investments and Allocations)**.** *In the model with renegotiation and industry-specific skills:*

1. *Efficient Turnover: For any investment level* i_1*, there is trade if and only if* $v \leq (r - \rho)i_1$.

2. *Efficient Investment: The firm chooses the efficient investment level i^* that solves*

$$(r-\rho)F\big((r-\rho)i^*\big)+\rho=i^*,$$

which maximizes expected total surplus.

Proof. (1) Efficient Turnover. From Lemma 1, the firm compares its profit under trade versus separation:

$$\text{Trade: } ri_1-\max\{w_1,v\}, \quad \text{Separation: } v+\rho i_1-\max\{w_1,v\}.$$

The firm prefers trade if and only if:

$$ri_1 \geq v+\rho i_1 \quad \Leftrightarrow \quad v \leq (r-\rho)i_1.$$

This implements the socially efficient cutoff rule.

(2) Efficient Investment. The firm chooses i_1 to maximize expected profit:

$$\begin{aligned}\Pi(i_1)=&\int_{-\infty}^{(r-\rho)i_1}\big(ri_1-\max\{w_1,v\}\big)\,dF(v)\\&+\int_{(r-\rho)i_1}^{\infty}\big(v+\rho i_1-\max\{w_1,v\}\big)\,dF(v)-\frac{1}{2}i_1^2.\end{aligned}$$

Let $\Sigma(i_1)$ denote expected total surplus. Then:

$$\Pi(i_1)=\Sigma(i_1)-\mathbb{E}[\max\{w_1,v\}].$$

Since $\max\{w_1,v\}$ does not depend on i_1, the firm maximizes $\Sigma(i_1)$. Differentiating:

$$\frac{d\Sigma}{di_1}=(r-\rho)F((r-\rho)i_1)+\rho-i_1.$$

Setting $\frac{d\Sigma}{di_1}=0$ yields the efficient investment condition:

$$(r-\rho)F((r-\rho)i^*)+\rho=i^*. \qquad \blacksquare$$

When renegotiation of the original contract is feasible and the firm can tailor the buyout payment to demand conditions, we show that non-compete agreements achieve the first-best. We view this model as more applicable to contracting between firms and chief executive officers, where firms share highly sensitive information to the CEO and both parties may have access to specialized lawyers. Indeed, this model aligns with the empirical findings by Kini, Williams, and Yin (2021), who show that more than 60% of new CEOs have non-compete agreements after 2010 and that the CEO is more likely to have a non-compete if the CEO's skills are easily transferable to other firms in the industry.

2.6.2 Expectation Damages

We now analyze the game under a different, common legal remedy: expectation damages. In this scenario, the payment from the worker to the firm upon separation is designed to make the firm whole, as if the contract had been fulfilled (Shavell 1984). We model this by contractually fixing the termination fee at the level of the firm's profit from trade at the original wage, $\bar{\tau} = ri_1 - w_1$. As before, separation requires mutual agreement.

Proposition 11 (Inefficient Under-separation and Over-investment under Expectation Damages)**.** *When the termination fee is fixed by expectation damages, the equilibrium outcome is inefficient relative to the social planner's benchmark.*

(a) ***Inefficient Stays (Job Lock):*** *Separation occurs less frequently than is socially optimal.*

(b) ***Over-investment:*** *The firm chooses the maximum possible level of investment, $i_1 = r$, which is strictly higher than the socially optimal level i^*.*

Proof. The proof proceeds by first deriving the conditions under which each party agrees to separate, then combining them into a unified separation rule.

Derivation of Separation Conditions For separation to occur, both the firm and the worker must find it in their interest to terminate the contract and exchange the damage payment.

The Firm's Decision. The firm prefers to separate if its payoff from receiving the damage payment exceeds its payoff from continuing the relationship. The actual wage paid if the relationship continues is $\max\{w_1, v\}$.

$$\begin{aligned} \text{Profit from Separation} &> \text{Profit from Continuing} \\ \bar{\tau} &> ri_1 - \max\{w_1, v\} \\ ri_1 - w_1 &> ri_1 - \max\{w_1, v\} \\ w_1 &< \max\{w_1, v\} \end{aligned}$$

This inequality holds if and only if $v > w_1$. Thus, the firm has an incentive to separate only when the worker's outside offer is greater than the contracted wage.

The Worker's Decision. The worker agrees to separate if their utility from moving to an industry competitor is at least as great as their alternative. The worker's value at a competitor is $v+\rho i_1$, from which they must pay the damages $\bar{\tau}$.

$$
\begin{aligned}
\text{Utility from Separation to Competitor} &\geq \text{Utility from Alternative} \\
v+\rho i_1 - \bar{\tau} &\geq \max\{w_1, v\} \\
v+\rho i_1 - (ri_1 - w_1) &\geq v \quad \text{(since } v > w_1 \text{ for the firm to agree)} \\
\rho i_1 - ri_1 + w_1 &\geq 0 \\
w_1 &\geq (r-\rho)i_1
\end{aligned}
$$

Thus, the worker agrees to the separation only if the contracted wage is greater than or equal to the productivity gap $(r-\rho)i_1$.

Inefficient Under-Separation The non-compete is waived and separation to the industry competitor occurs only if *both* derived conditions are met.

- If the contract is structured such that $w_1 < (r-\rho)i_1$, the worker's condition is never met. Separation is impossible.
- If the contract is structured such that $w_1 \geq (r-\rho)i_1$, separation occurs if and only if $v > w_1$.

The socially efficient rule is to separate when $v > (r-\rho)i_1$. In either case, the actual separation cutoff is at or above the efficient cutoff, leading to **under-separation** (job lock). Specifically, inefficient lack of turnover to the industry-competitor occurs when $(r-\rho)i_1 < v < w_1$.

Over-investment The firm, when designing the contract ex-ante, is drawn to the regime where $w_1 \geq (r-\rho)i_1$ because it provides perfect insurance. In this regime, the firm's second-period operating profit is *always* $ri_1 - w_1$:

- If $v \leq w_1$, the worker stays and the firm's profit is $ri_1 - w_1$.
- If $v > w_1$, the worker leaves to the industry competitor and the firm receives a damage payment of $\bar{\tau} = ri_1 - w_1$.

Anticipating this perfect insurance, the firm's problem is to choose investment i_1 to maximize its profit:

$$\max_{i_1 \geq 0} \quad \Pi(i_1) = (ri_1 - w_1) - \frac{1}{2}i_1^2$$

The first-order condition is $\frac{d\Pi}{di_1} = r - i_1 = 0$, which implies $i_1 = r$. The firm's dominant strategy is to offer a contract satisfying the insurance condition and to choose the maximum investment level,

$i_1 = r$. The moral hazard arising from expectation damages results in over-investment relative to the social optimum $i^* < r$. ■

2.6.3 Training Repayment Programs

We now analyze a modification to the renegotiation game to incorporate a Training Repayment Agreement Program (TRAP), as studied in, for example, Feess and Muehlheusser (2003). The game structure is as follows: after the firm makes an investment i_1 at cost $\frac{1}{2}i_1^2$ and the worker's outside offer v is realized, the parties can renegotiate. Under the TRAP, if the parties mutually agree to waive the non-compete agreement, the worker must pay the firm a contractually fixed termination fee of $\bar{\tau} = \frac{1}{2}i_1^2$. For this separation to occur, it must be preferable to continued trade for both parties. This creates two critical constraints that must be satisfied simultaneously: a Firm Incentive Constraint (FIC), where the firm will only agree to waive the non-compete agreement if receiving the fee is more profitable than continuing the match, and a Worker Participation Constraint (WPC), where the worker will only agree to pay the fee if the resulting mobility is sufficiently valuable.

Proposition 12 (Inefficient Matching and Investment under TRAPs)**.** *Relative to the social planner's benchmark, Training Repayment Agreement Programs (TRAPs) create inefficiently low separation and an inefficient level of investment.*

1. ***Under-separation:*** *TRAPs lead to under-separation. In the regime where separation is possible ($i_1 \leq 2\rho$), the threshold for separation is higher than the socially efficient threshold. In the regime where investment is high ($i_1 > 2\rho$), socially efficient separations are completely foreclosed as the worker will never agree to pay the fee.*

2. ***Inefficient Investment:*** *TRAPs lead to an inefficient level of investment. The firm's chosen investment will either be unambiguously excessive (if it chooses a high-investment strategy to prevent separation) or will be determined by the worker's participation constraint rather than by social efficiency, with the direction of the inefficiency being ambiguous.*

Proof. The proof compares the equilibrium outcomes under the TRAP with the social planner's benchmark, where separation is efficient (conditional on investment) if $v > v_{eff} = (r-\rho)i_1$ and investment i^* is chosen to maximize expected total surplus.

1. Under-separation. The proof of under-separation first requires establishing the conditions under which separation is possible. Separation requires both the firm's and the worker's participation constraints to be satisfied. We first derive the Worker Participation Constraint (WPC). The worker agrees to the TRAP's separation terms only if their utility from doing so is greater than or equal to their utility from rejecting the offer. Formally:

$$\underbrace{v+\rho i_1-\frac{1}{2}i_1^2}_{\text{Utility from Accepting Separation}} \geq \underbrace{\max\{w_1,v\}}_{\text{Utility from Rejecting}}$$

For separation to be a relevant consideration, the worker's outside offer v is typically high, so we analyze the case where $v > w_1$. The participation constraint simplifies to:

$$v+\rho i_1-\frac{1}{2}i_1^2 \geq v \quad \Rightarrow \quad \rho i_1 \geq \frac{1}{2}i_1^2 \quad \Rightarrow \quad i_1 \leq 2\rho$$

This derivation shows that separation is only possible if the firm's investment is within the regime $i_1 \leq 2\rho$. If $i_1 > 2\rho$, the worker will always reject the separation offer.

Next, we consider the Firm's Incentive Constraint (FIC), which defines the firm's separation cutoff, $v_c = ri_1 - \frac{1}{2}i_1^2$. For the cases where $i_1 \leq 2\rho$, we compare this firm cutoff to the planner's efficient cutoff, $v_{eff} = (r-\rho)i_1$. The difference is:

$$v_c - v_{eff} = \left(ri_1 - \frac{1}{2}i_1^2\right) - (r-\rho)i_1 = i_1\left(\rho - \frac{i_1}{2}\right)$$

Since we are in the regime where $i_1 \leq 2\rho$ (which implies $\rho \geq i_1/2$), the term $(\rho - i_1/2)$ is non-negative. Thus, $v_c \geq v_{eff}$. The firm requires a higher outside offer v to release a worker than is socially optimal, leading to under-separation.

2. Inefficient Investment. The firm chooses i_1 to maximize its own profit by anticipating the outcomes of its two main strategies.

Strategy A (High Investment): Choose $i_1 > 2\rho$. This violates the WPC, making separation impossible. The firm maximizes $\Pi(i_1) = \mathbb{E}[ri_1 - \max\{w_1,v\}] - \frac{1}{2}i_1^2$, which yields the solution $i_1 = r$.

Strategy B (Low Investment): Choose an investment i_1 in the range $[0,2\rho]$. In this regime, the firm's expected profit is $\Pi(i_1) = \int_{-\infty}^{v_c}(ri_1 - v)\,dF(v) + \int_{v_c}^{\infty}(\frac{1}{2}i_1^2)\,dF(v) - \frac{1}{2}i_1^2$. To find the optimal investment within this interval, we analyze the first-order condition:

$$\frac{d\Pi}{di_1} = (r-i_1)F\left(ri_1 - \frac{1}{2}i_1^2\right)$$

For any investment level $i_1 < r$, this derivative is non-negative. Because the profit function is monotonically increasing with respect to investment in this regime, the firm is incentivized to choose the highest possible investment level permitted by the constraint. The profit is therefore maximized at the boundary of the interval, which is precisely $i_1 = 2\rho$.

The firm's final choice is to compare $\Pi(r)$ with $\Pi(2\rho)$. Neither $i_1 = r$ nor $i_1 = 2\rho$ is chosen to satisfy the social planner's first-order condition, so investment is always inefficient. If the firm adopts Strategy A ($i_1 = r$), there is no separation in equilibrium and the result is unambiguously over-investment: $i^* < r$. If the firm adopts Strategy B ($i_1 = 2\rho$), the investment level is inefficient, but it could be higher or lower than the social optimum (i^*) depending on the model's parameters.

■

3 Empirical Set-up

3.1 Data and Descriptive Relationships

We use data from the National Longitudinal Survey of Youth 1997 (NLSY97) to understand the characteristics of non-compete signers and analyze the effects of such agreements on worker outcomes, including wages, job mobility, and employer-provided investment. This data set is a nationally representative panel that tracks the outcomes of individuals aged 12-16 in 1997. The survey runs annually from 1997-2011, and then biannually from 2011-2021. The survey includes information on the workers' employment history, including hourly wages for each job held, as well as detailed information on worker demographics and job information.

Importantly, the NLSY97 starts measuring whether non-compete agreements are used within employment contracts starting in 2017, when survey respondents are between ages 32-36. In 2017, all working respondents are asked whether they currently have a non-compete agreement. In the following survey years, all individuals who obtain *new* jobs are asked about their non-compete status. We assume throughout that non-compete status is fixed for the duration of the employment relationship.[12]

Throughout the analysis, we focus on the 2013-2021 time period and individuals who sign non-compete agreements after 2013, allowing us to estimate the impact of NC's for up to 6 years. We focus on employed workers and remove observations with real hourly wages below 3 or above 200, following Deming (2017).[13] When individuals hold multiple jobs in a survey year, we restrict attention to their primary job which we define as the current or most recent employer as of the interview date. If multiple jobs are current, the main job is the one with the longest tenure.

Using the 2017 cross section, we find that 14% of workers report having a non-compete agreement in their contract. More than 90% of affirmative respondents reported being "Very Confident"

[12] As support for this assumption, Starr, Prescott, and Bishara (2021) conducts a large survey that asks about the timing of non-compete agreements and find that in the vast majority of cases a non-compete agreement is signed prior to or immediately after starting the job, with only 2.2% associated with promotions or raises.

[13] We construct real hourly wages by deflating nominal hourly pay by annual CPI indices from BLS, setting 2017 as our base year.

in their answer. There is substantial heterogeneity in non-compete usage across the 17 (two-digit) industries considered. Table A2 shows that among industries with more than 100 respondents, non-compete agreements are most commonly used in Professional and Related Services (26%) and least commonly used in Public Administration (8%). Figure A1 further shows that NCs are used more frequently in high mobility industries, consistent with our theoretical predictions.

We are interested in the relationships between non-compete agreements and various labor market outcomes. We observe the employment history of each worker, including job identifiers and hourly wages at each job, allowing us to assess the impact of signing an NC on wages, wage growth, and job mobility. We consider log wages and job tenure as our main outcome variables throughout the analysis. We prefer to use job tenure as our main metric for identifying the effects of NC's on job mobility since it does not require defining what constitutes a job transition. As robustness we explore other measures of job mobility, such as using an indicator variable for whether an individual changed main employers between survey years, and come to similar conclusions. The NLSY97 also asks a variety of questions about formal employer-provided training programs. As a default, we report statistics pertaining to whether an individual was involved in a formal training program, but also consider whether this training was paid for and/or provided by the employer.

In Table 1 we report summary statistics for the 2017 cross-section, comparing workers with and without non-compete agreements. Consistent with our theory, we observe that non-compete signers have higher wages, earning 21 log points more. They also have slightly longer job tenures and 4pp lower job mobility rates between 2017 and 2019. Since non-compete agreements legally restrict within-industry job mobility, we also consider whether non-compete signers have lower rates of job mobility within industry. We find that NC signers have 2pp (17%) lower within-industry mobility rates. We note within-industry mobility only accounts for approximately one-third of all job mobility for both groups This statistic is consistent with Parent (2000) who also finds, using NLSY79, that about two-thirds of job changes are between one-digit industries. The frequency of between-industry job mobility is also documented in, for example, Neal (1999) and Kambourov and Manovskii (2008). The prevalence of inter-industry job transitions, especially among younger and more mobile workers, therefore suggests that the constraints of NCs may be less binding than previously believed.

Despite higher wages, there is no significant relationship between signing an NC and wage growth or formal employer training in the cross-section. However, we note that firm investment in human capital is a broader notion than formal training programs and may not be fully captured by our training variables. Indeed, in 2017 only about 11% of workers report having formal training in their current job.[14] There are also substantial differences in the types of workers that have

[14]In contrast to the firm-level investment measures in Shi (2023), we measure training at the individual-level. Our sample of workers is also approximately 10 years younger than her sample of executives (mean age of 35 in our study

Table 1: Respondent Characteristics by Non-Compete Status in 2017

	NC	no NC	Difference	P Value	N: NC	N: No NC
Job Mobility						
Tenure (Yrs)	5.24	5.11	0.12	0.50	699	4185
1(Main Job Separation btwn 2017 and 2019)	0.33	0.37	-0.04	0.04	705	4263
1(Main Job Mobility btwn 2017 and 2019)	0.28	0.31	-0.04	0.05	705	4263
1(Within-Industry Job Mobility btwn 2017 and 2019)	0.10	0.12	-0.02	0.08	686	4176
Wages and Wage Growth						
Log(Starting Wage)	2.94	2.76	0.19	0.00	705	4263
Log(Wage in 2017)	3.21	3.00	0.21	0.00	705	4263
$Log(Wage_{2017}) - Log(Wage_{2015})$	0.13	0.12	0.02	0.22	628	3778
$Log(Wage_{2019}) - Log(Wage_{2017})$	0.11	0.10	0.01	0.56	632	3753
Demographics						
Age	35.03	34.96	0.07	0.25	705	4263
1(Male)	0.58	0.50	0.08	0.00	705	4263
1(High School Degree or Higher)	0.89	0.86	0.03	0.01	699	4224
1(Bachelors Degree or Higher)	0.52	0.42	0.10	0.00	699	4224
ASVAB Percentile	57.50	52.06	5.44	0.00	582	3473
1(Black)	0.14	0.16	-0.02	0.13	705	4263
1(Hispanic)	0.11	0.13	-0.01	0.33	705	4263
Wage Bargaining and Negotiation						
1(Possible to Keep Previous Job)	0.46	0.45	0.01	0.74	304	1848
1(Negotiate Job Offer)	0.40	0.33	0.08	0.02	249	1454
Training						
1(Received Some Training)	0.09	0.11	-0.02	0.12	705	4263
1(Received Training Run by Employer)	0.01	0.03	-0.01	0.03	705	4263
1(Received On-Site Training by Non-Employer)	0.01	0.01	0.00	0.64	705	4263
1(Employer Paid for Training)	0.06	0.08	-0.02	0.08	705	4263
1(Employer Paid for Mandatory Training)	0.03	0.04	-0.01	0.26	705	4263
1(Employer Paid for Voluntary Training)	0.03	0.04	-0.01	0.16	705	4263
Job Tasks						
1(Use Math Skills Frequently)	0.37	0.27	0.10	0.00	661	3808
1(Supervise Frequently)	0.37	0.31	0.06	0.00	662	3802
1(Problem Solve Frequently)	0.85	0.74	0.11	0.00	661	3807
Other Firm Characteristics						
1(Dislike Job)	0.05	0.06	-0.01	0.57	645	3792
1(Unionized Worker)	0.11	0.16	-0.05	0.00	636	3743
Firm Size	986.28	1134.72	-148.43	0.65	595	3377

Note: The sample includes respondents with valid NC status for the main employer in 2017. All wage variables are measured in terms of real dollars earned per hour. Respondents earning real wages below 3 dollars or above 200 dollars are dropped. The training variables capture whether the respondent received training under any employer in 2017. Means weighted by nationally representative sample weights and p-values from a two-sided t-test are reported. Sample sizes vary due to missing values of the outcome variable. For details on variable definitions, refer to Table A1

versus mean age of 45 in Shi (2023)). Nevertheless, we arrive at similar differences in job tenure among those with and without non-compete agreements (0.12 years in our sample versus 0.10 years among the sample of executives).

non-compete agreements. Non-compete signers are much more likely to be male and less likely to be Black or Hispanic. They also have characteristics positively associated with higher wages, with 52% having a bachelors degree or higher (relative to 42% for non-compete signers) and higher ASVAB test scores, which we use as a proxy for cognitive ability.[15] Workers that sign non-compete agreements are more likely to perform tasks requiring mathematical skills, leadership, and problem solving, less likely to be unionized, and more likely to negotiate over wages. Interestingly, we find no significant differences in terms of job satisfaction or firm size.

In Table 2 we assess whether these differences are driven by observable worker or job characteristics rather than NCs themselves by estimating the following equation via Ordinary Least Squares

$$Y_i = \beta_0 + \beta_1 * NC_i + \beta_2 * X_i + \varepsilon_i \tag{9}$$

where Y_i is the outcome of interest for worker i, X_i is a vector of observable characteristics for the worker and their current job, and β_1 is the relationship between Y_i and NC usage. We consider dependent variables log wages in 2017, log wage growth, job tenure, indicators for whether the worker changed jobs between 2017 and 2019, whether the worker received formal training, and whether the employer paid for that training. We report results with no controls, "basic" controls which includes sex, education, tenures, and potential experience, and "advanced" controls which further adds ASVAB test score percentiles, firm size, and industry and occupation fixed effects.

The estimated cross-sectional wage premium for signing a non-compete agreement declines as we add control variables, falling from 21.1 to 8.1 log points, which implies that differences in wages are partly attributable to the fact that, on average, workers who sign NCs have characteristics that are positively associated with wages. The relationship between non-compete agreements and the other dependent variables is largely insensitive to the inclusion of observable covariates, still finding that NC signers have slightly lower job mobility rates and insignificant differences in terms of wage growth, formal training, and job tenure. In Table A3 we report results based on the 2019 cross-section and find they are qualitatively similar.

Even in the fully saturated model of Equation (9) we cannot rule out the possibility that there are omitted variables correlated with NC usage and labor market outcomes of interest. For example, if NC signers have higher unobserved ability, then our estimated wage coefficients from Equation (9) will be upward biased. The following subsection outlines our empirical strategy for identifying the causal impact of NC's on worker labor market outcomes.

[15] The ASVAB is a standardized test on science, math and language skills.

Table 2: Estimated Effects of Non-Compete Agreements using the 2017 Cross-Section

Panel 1: Wages and Wage Growth

Dependent Variables:	Log(Wage)			Wage Growth		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
1(NC)	0.211***	0.144***	0.081***	0.009	0.007	0.004
	(0.027)	(0.022)	(0.024)	(0.014)	(0.014)	(0.018)
Controls	None	Basic	Advanced	None	Basic	Advanced
Weighted Dependent Variable Mean	3.04	3.04	3.04	0.088	0.088	0.088
Fit statistics						
Observations	4,968	4,836	3,141	4,968	4,836	3,141
R^2	0.017	0.296	0.456	0.0001	0.0005	0.026

Panel 2: Training

Dependent Variables:	1(Any Training)			1(Emp Paid for Training)		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
1(NC)	-0.019	-0.025*	-0.017	-0.018*	-0.026**	-0.022
	(0.013)	(0.013)	(0.017)	(0.010)	(0.011)	(0.014)
Controls	None	Basic	Advanced	None	Basic	Advanced
Weighted Dependent Variable Mean	0.112	0.112	0.112	0.071	0.071	0.071
Fit statistics						
Observations	4,968	4,836	3,141	4,968	4,836	3,141
R^2	0.0005	0.007	0.048	0.0006	0.012	0.063

Panel 3: Job Mobility

Dependent Variables:	Tenure (Yrs)			1(Job Mobility 2017-2019)		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
1(NC)	0.125	0.002	-0.267	-0.036*	-0.026	-0.032
	(0.197)	(0.198)	(0.234)	(0.020)	(0.020)	(0.024)
Controls	None	Basic	Advanced	None	Basic	Advanced
Weighted Dependent Variable Mean	5.08	5.08	5.08	0.304	0.304	0.304
Fit statistics						
Observations	4,884	4,836	3,141	4,968	4,917	3,177
R^2	9.34×10^{-5}	0.017	0.083	0.0008	0.011	0.039

Notes: Standard errors are heteroskedasticity-robust. The sample restricts to individuals who report NC status and have real wages between 3 and 200 in 2017. Basic controls include sex, education, tenure, and potential experience. Advanced controls further add industry and occupation fixed effects, ASVAB percentile, and firm size. Tenure controls not included in the job mobility panel. All regressions are weighted so as to be nationally representative. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

3.2 Estimating Equations

To isolate the causal effects of signing an NC, we adopt a stacked DiD research design where for each survey year c we construct a "clean" dataset containing only those who we observe first signing a non-compete agreement in year c (the treatment group) and an associated c-specific control group. Specifically, for each cohort c, both the treated and the control group consist of workers who transitioned to a new job with known NC status between year c and the previous survey year. The treated are the job movers in year c who first sign an NC in year c, and the control group are the job movers in year c who do not sign an NC over the sample period (the never-treated). Denote G_c as the set of treated workers in cohort c.

We focus on years 2013-2021 and cohorts $c \in \{2015, 2017, 2019, 2021\}$ to understand the effects of non-compete agreements over a reasonable time horizon without pushing our assumption that NC status is invariant over the employment relationship too far.[16] We then "stack" the data for each cohort c and estimate

$$Y_{itc} = \alpha_{ic} + \lambda_{tc} + \sum_{k \in \{-6,-4,0,2,4,6\}} \beta^k d_{i,t-k,c} + \varepsilon_{itc} \tag{10}$$

where Y_{itc} is the outcome variable of interest and d_{itc} is an event indicator equal to 1 for all $t \geq c$ and workers i who we first observe signing a non-compete agreement at time $t = c$ ($i \in G_c$).

For ease of presentation, and to generate more precise estimates, we also estimate the effects of NC's aggregated over the pre- and post-treatment time periods by replacing the dynamic indicator variables $d_{i,t-k,c}$ in equation (10) with a single treatment indicator for the post-treatment period

$$Y_{itc} = \alpha_{ic} + \lambda_{tc} + \beta^{Agg} d^{Agg}_{i,t,c} + \varepsilon_{itc} \tag{11}$$

where $d^{Agg}_{i,t,c}$ equals one for treated individuals i in years $t \geq c$ and β^{Agg} is our coefficient of interest. In all of our estimates we cluster our standard errors at the individual level. Equations (10) and (11) form our main empirical specifications.

Our approach has a number of advantages. First, the inclusion of cohort-specific individual (α_{ic}) and time (λ_{tc}) fixed effects ensures that workers who were first treated in other years are never implicitly used as the control group, bypassing the "bad comparison problem" of the standard two-way fixed effects (TWFE) estimator (e.g. Baker, Larcker, and Wang 2022; Sun and Abraham 2021).

[16] We note that NC status is unobserved for jobs ending prior to 2017. This implies that treated workers in cohort 2015 are necessarily job stayers between 2015 and 2017. We impose the same restriction for the control group. Unobserved pre-2017 NC status also implies that some of the jobs held prior to year c for both the treatment and control group may have had a non-compete agreement. We confirm our results are not sensitive to restricting to later cohorts (that are unaffected by this issue), giving confidence that this issue is not of consequence (see section 4.3.2).

Second, while other difference-in-difference approaches also restrict the control group to the never-treated (e.g., Callaway and Sant'Anna (2021)), our approach permits the additional flexibility needed to isolate the effect of NC signage. Note that a challenge to constructing a suitable control group in our context is that we do not observe within-job variation in the treatment variable. This implies that any worker who moves from $NC_{i,t-1} = 0$ to $NC_{i,t} = 1$ (and vice versa) is necessarily a job mover in our data, so that a change in treatment status is always accompanied by job mobility.[17] Due to the well-known fact that job mobility is associated with changes in labor market outcomes, the estimated coefficients from equation (10) or (11) using all never-treated observations as the control group would pick up both the effects of NCs and the effects of job mobility. Our procedure allows us to address this concern by flexibly defining the control group for each cohort such that we always compare movers to movers.

Finally, the inclusion of individual-cohort fixed effects also addresses the concern of selection into non-compete agreements based on time-invariant unobservable characteristics by focusing on within-worker changes. Similar stacked research designs have been used in a number of contexts, including firm responses to liability risk (Gormley and Matsa (2011)), the effects of minimum wage increases (Cengiz et al. 2019), and the effects of state-level changes to NC enforceability (Johnson, Lavetti, and Lipsitz (2023)), among others.

3.3 Identifying Assumptions

The key assumption for interpreting the coefficient estimates from equation (10) $\hat{\beta}^k, k \geq 0$ as the causal effect of signing an NC is that, for each cohort c, NC signers and those in their cohort-specific control group (the set of individuals who never sign an NC between 2013 and 2021 and who also move jobs in year c) must have similar trends in potential outcomes (i.e., a parallel trends assumption). Formally, we assume that

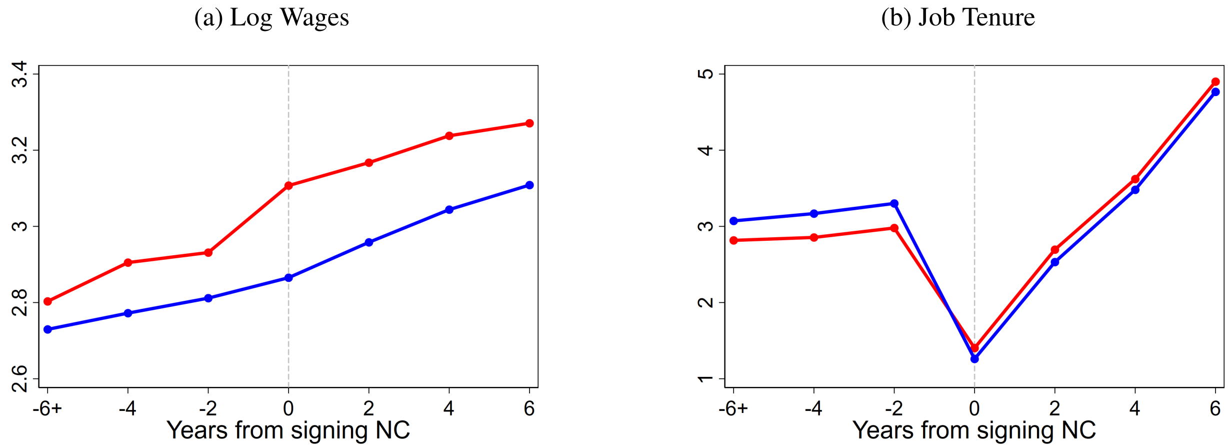
$$E[\varepsilon_{itc} | d_{itc}, \alpha_{ic}, \lambda_{tc}] = 0. \tag{12}$$

Under this assumption, the coefficients $\beta^k, k \geq 0$ from equation (10) and β^{agg} from equation (11) represent the causal effect of signing a non-compete agreement.

Since NC status is not randomly assigned, but rather is selected into based on the optimal decisions of the worker and firm, the key issue for identification is whether the non-compete dummy variable d_{itc} is uncorrelated with the error term conditional on the fixed effects. As pointed out by Ghanem, Sant'Anna, and Wüthrich (2022), parallel trends can still be justified in settings with

[17] This problem is not simply due to the structure of the NLSY97 (which does not ask about NC status across survey years within the same job), but due to the standard timing of NC signage. NC's are most often signed upon starting a new job (Starr, Prescott, and Bishara (2021)), so we would expect very little within-job variation in the treatment variable and a high correlation with job mobility in either case.

Figure 4: Means Relative to Event Time



Note: Figure reports means of log wages and job tenure aggregated over all cohorts in the stacked data. See text for data construction. Red lines correspond to NC signers (treatment group) and blue lines to non-NC signers (control group).

selection into treatment based on time-invariant and time-varying unobservables but requires assumptions both on the time-series properties of the error term and the nature of the underlying selection mechanisms. Since the individual fixed effects in our specifications control for selection based on time-invariant worker characteristics, it is selection based on time-varying unobservables that could potentially invalidate the identifying assumption given in Equation (12).

We now consider two types of selection based on time-varying unobservables and discuss how they relate to Equation (12). The first is selection based on job-level characteristics. Intuitively, certain types of jobs may be more likely to include non-compete agreements in their workers contracts, such as jobs that involve accessing a firms intangible capital, developing client relationships, managing teams, or where on-the-job training is important. If these job-level characteristics are associated with higher wages, for example, the wage estimates from equation (10) or (11) could be upward biased. In Section 4.3.1 we re-estimate our results controlling for industry, occupation, and firm size deciles, all of which are theoretically correlated with job productivity and empirically correlated with wages (Manning 2013). We find that our results are nearly identical, offering assurance that unobservable job characteristics are not biasing our estimates.

A second source of selection are shocks to worker characteristics. For equation (12) to hold, we need to rule out that workers are subject to shocks, observable to potential employers but unobservable to the econometrician, that form the basis of selection into NCs and that would have led to higher wages even in the absence of an NC. The main shock we have in mind are shocks to the workers productivity or shocks that otherwise signal productivity to employers. A worker may have just obtained a certification or formal credential that makes the worker more marketable, or may have had a good performance (e.g., high sales, favorable client reviews, etc.) that signals skill and competence to potential employers. Such shocks could make such a worker more desirable for jobs using non-compete agreements while simultaneously increasing their potential untreated wages, introducing a positive correlation between the error term and treatment dummy and thus leading to upward biased wage estimates.

We do not think this type of unobservable shock is biasing our estimates for two reasons. First, if the shock was something that affected wages in the pre-period, we would expect higher wage growth of NC signers between $t = -4$ and $t = -2$. We do not observe this pattern in our event studies. We plot the means of our main outcome variables separately for treatment and control groups and find that both groups have similar pre-trends (Figure 4). Second, if such shocks are associated with promotions (e.g., moving into management) then we should expect that part of our baseline estimates would be explained by workers changing industries or occupations. The fact that NC signers do not have faster wage growth prior to signing and that our results hold when controlling for job-level characteristics such as occupation and industry (which partially controls for between-firm promotions) suggests that this form of selection is not of first-order importance.

As further robustness, we also try alternative empirical specifications, such as the standard two-way fixed effects estimator or using the later-treated as the control group. We leave the details of these exercises and their results to 4.3.3, but note here that our results are highly robust in each case.

4 Results

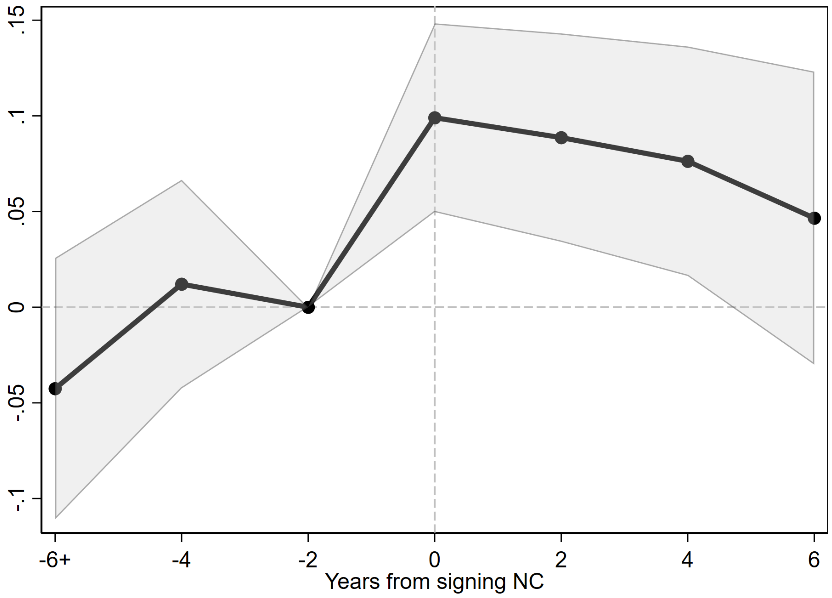
4.1 The Effect of Signing an NC on Labor Market Outcomes

We present our main results in figure 5. Panel (a) plots the dynamic wage effects following equation (10), finding that NC's raise wages sharply at the time of signing but that this effect declines monotonically with time. Specifically, NC's raise wages by 9.9 log points at the time of signing and 4.7 log points by 6 years post-signing. This result indicates that while NC signers enjoy an upfront wage premium, their annual wage growth is about 1 log point lower. This statistic is almost identical to Shi (2023)'s descriptive wage patterns for executives. Panel (b) likewise reports our dynamics estimates for job tenure. Consistent with NC's reducing job mobility, we find that NC's increase job tenure by about 0.35 years (4 months) and that this effect accumulates over time. Six years later NC signers have job tenure about 0.5 years (6 months) longer.

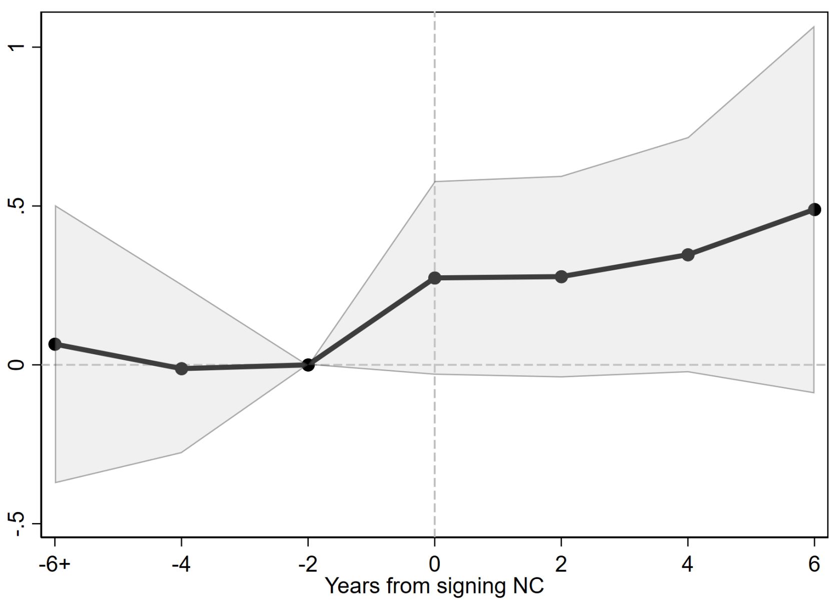
In Table 3 we report aggregated estimates from equation (11) for log wages, job tenure, and an indicator for job mobility. Aggregating across post-periods is useful as it facilitates comparisons across many outcomes and specifications and improves the precision of our estimates. Consistent

Figure 5: The Dynamic Effects of Signing an NC

(a) Log Wages



(b) Job Tenure



Note: Estimates are from stacked difference-in-differences estimation (equation (10) in the text) over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers who never held a NC during the event window and who also changed jobs between year c and the preceding survey year. Job mobility is defined as changing main employers between the current and preceding survey year. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

with our theory, we find that non-compete agreements increase wages (by 9.4 log points), increase job tenure (by about 0.29 years or 3.4 months) and decrease the bi-annual rate at which workers change main employers (by 3.6 percentage points). The wage estimate is significant at the 1% level, and the job mobility effects are significant at the 10% level.

These effects are also economically significant. To interpret the magnitude of these estimates, note that a wage increase of 9.4 log points is almost the same expected wage growth that the average worker would expect to receive over two years (see Table 2) or from one additional year of schooling (Card (1999)). In terms of mobility, NC's increase tenure by about 6% and decrease the instances of bi-annual changes in main employer by about 12% relative to the 2017 average. Surprisingly, we find no effect on the rate at which workers move to another employer within the same industry, though we note that the sample size of treated within-industry job movers is quite small.[18]

Having established that NC's raise wages and reduce job mobility, the next panel explores whether NC's cause other changes to a workers labour market situation, including hours worked, an indicator for self-reported job dissatisfaction, an indicator for formal training, and an indicator for whether that training was paid for by the employer. We find no significant effect on hours worked or job satisfaction. Somewhat surprisingly, we also find that non-compete agreements have no impact on the incidence of employer-provided training. This result runs contrary to the theoretical expectation that non-compete agreements mitigate the hold-up problem, thereby *increasing* employer-provided investments. There are two ways to rationalize this result. It could be the case that firms use NC's as a way to avoid outside competition without investing in worker productivity. But it could equally be the case that non-compete agreements do raise employer provided investments, just in ways that are difficult to measure. For example, firms may invest in their workers through informal on-the-job training where workers learn and develop skills through the tasks they are assigned and interactions with their team. Since investment in human capital is unobserved, it is not clear to what extent this variable accurately captures the total investments firms are making in their workers. The fact that less than 10% of workers report receiving any kind of formal training in 2017 (see Table 2) suggests this may not be a holistic measure of firm investment. Moreover, formal training is reported as an indicator (extensive margin), which abstracts from any notion of the intensity of training (intensive margin).

Since measuring firm investment directly is potentially difficult, our theory suggests an alterative: That one can infer the effects of NCs through observed wage dynamics. Specifically, if workers receive no training from an NC and are not compensated for restrictions on future mobility, then NCs should have no effect on period 0 wages and should decrease future wage growth,

[18] Specifically, there are about 150 instances of workers with NC's changing main employers after signing an NC (after time 0). This falls by about 2/3's (to about 50 instances) when conditioning on of within-industry changes.

Table 3: The Aggregate Effects of Signing an NC

(a) Wages and Mobility

	(1) Log Wages	(2) Tenure	(3) Change Main Emp.	(4) Change Main Emp., Within Ind.
Treat × Post	0.094***	0.287*	-0.036*	0.006
	(0.022)	(0.126)	(0.016)	(0.018)
Observations	22394	22040	21614	22004
Dependent Variable Mean	2.888	2.692	0.458	0.165
Unique Treated Workers	682	680	681	679
Unique Control Workers	3300	3263	3296	3285
R^2	0.770	0.588	0.598	0.388

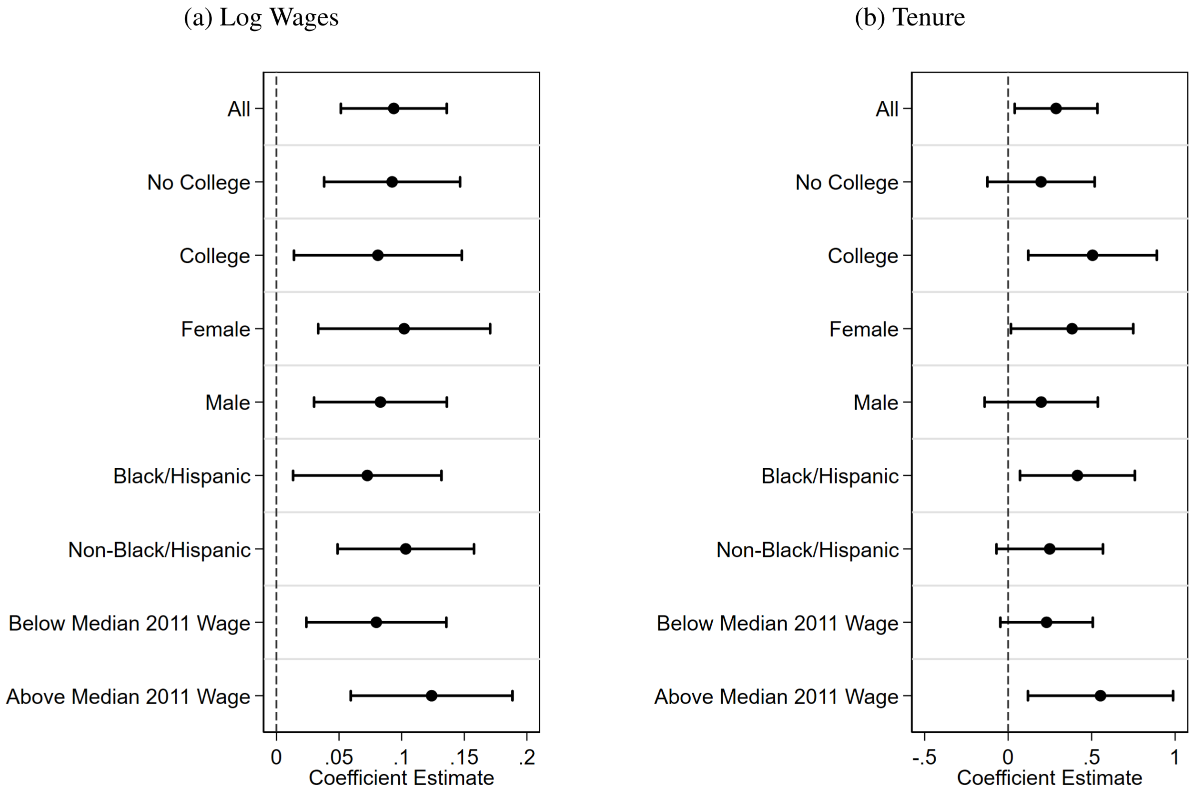
(b) Other Outcomes

	(1) Hours/Wk	(2) Job Dissat.	(3) Training	(4) Employer-Paid Training
Treat × Post	1.025	0.026	-0.023	-0.022
	(0.624)	(0.016)	(0.017)	(0.015)
Observations	22159	17686	22394	22394
Dependent Variable Mean	37.950	0.072	0.130	0.078
Unique Treated Workers	682	636	682	682
Unique Control Workers	3293	3039	3300	3300
R^2	0.511	0.401	0.459	0.455

Notes: This table reports estimates from stacked difference-in-differences estimation, aggregated over post-treatment years, over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers who never held a NC during the event window and who also changed jobs between year c and the preceding survey year. Job mobility is defined as changing main employers between the current and preceding survey year. Standard errors are clustered by worker and reported in parenthesis. Significance codes: ***: 0.01, **: 0.05, *: 0.1.

as workers are less able to command wage increases through credible outside offers. If workers receive no training from an NC but receive a compensating wage differential for the restrictions on future mobility, then NCs should raise wages in period 0 but still decrease future wage growth. If, on the other hand, NCs encourage human capital investments, then the effect of NCs on wage growth is ambiguous. The post-signing wage profile will be less negative if firms respond to NCs by investing in worker human capital and share those rents with workers (see Kodama, Kambayashi, and Izumi (2025) for a related discussion). The fact that wages are still 4.7 log points higher even 6 years after signing seems to suggest that a pure compensating differential story is unlikely.

Figure 6: The Effect of Signing an NC: Heterogeneity Across Worker Groups



Note: Coefficient estimates are from stacked difference-in-differences estimation, aggregated over post-treatment years, over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers who never held a NC during the event window and who also changed jobs between year c and the preceding survey year. Job mobility is defined as changing main employers between the current and preceding survey year. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

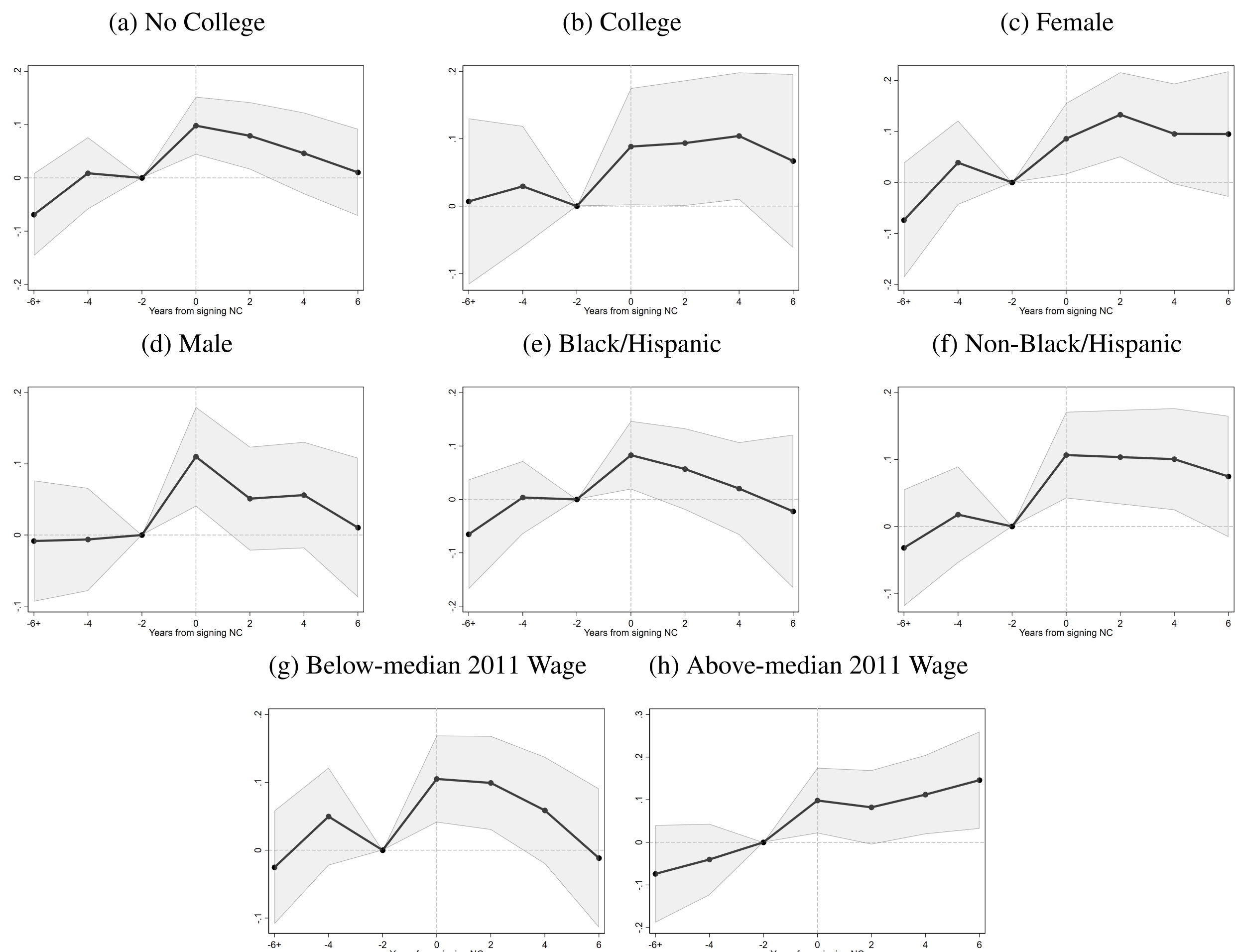
4.2 Heterogeneity

4.2.1 Worker Demographics

While NC's raise wages for workers on average, do they harm certain subgroups? This question is especially relevant in light of the discussion and enactment of banning non-compete agreements for low-skill or low-wage workers (e.g., Lipsitz and Starr (2022)). Figure 6 reports aggregated estimates for different subgroups of workers, grouping workers by education, sex, race, and income. The estimated wage effects are remarkably stable across subgroups, ranging from 7.3 log points (Black/Hispanic) to 12.4 log points (workers with above median pre-sample wages). While the estimated tenure effects are more pronounced for certain subgroups, most notably comparing by education or pre-sample wages, the evidence give little support that non-compete agreements have systematically adverse effects for certain subgroups.

However, these aggregate wage effects hide important dynamics. In Figure 7 we run our dynamic event study by worker subgroup and find that, while NC's lead to higher wage *levels* for all types of workers over the first 6 years, there are systematic differences in the relative wage *trajectories* across subgroups. For example, male workers tend to have a larger up front wage premium than females (11.0 log points vs 8.6 log points), but lower subsequent wage growth (the wage effect 6 years later is 1.0 log point for males and 9.5 log points for females). We find similar wage-experience profiles for workers with no college, low pre-sample wages, or who are black/hispanic. In contrast, college-educated, high-wage and non-black/hispanic workers have flat (or even increasing) wage-experience profiles.

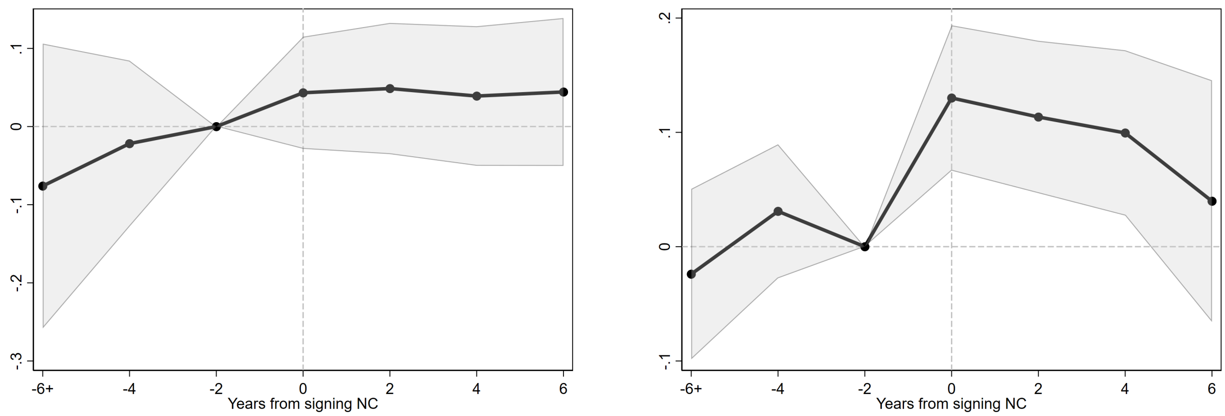
Figure 7: The Dynamic Wage Effects of Signing an NC by subgroup



Note: Estimates are from stacked difference-in-differences estimation (equation (10) in the text) over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers who never held a NC during the event window and who also changed jobs between year c and the preceding survey year. Job mobility is defined as changing main employers between the current and preceding survey year. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

Figure 8: The Effect of Signing an NC: Movers vs Stayers

(a) Movers (b) Stayers



Note: Coefficient estimates are from stacked difference-in-differences estimation, aggregated over post-treatment years, over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers who never held a NC during the event window and who also changed jobs between year c and the preceding survey year. For each cohort c, movers are workers who change main employer again the post-period. Stayers are those who remain in their $t = 0$ job in the post-period. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

4.2.2 Movers vs Stayers

To better understand the mechanisms driving these wage patterns (upfront wage premia followed by lower wage growth) we separately analyze NC signers who were job-stayers vs job-movers in the post-period. In particular, a worker is a treated-stayer in cohort c if they sign an NC at time c and remain in their $t = c$ job for all observed periods $t > c$. Similarly, a worker is a treated-mover in cohort c if they sign an NC at time c but we observe them leaving their $t = c$ job in the post-period. We compare these two groups of treated workers to the entire control group (all never-treated workers who are also movers at time c), but we note that the results are very similar if we define the control group as having the same mobility patterns (i.e. use control-movers and control-stayers as the comparison groups).[19]

We find that both the treated-movers and the treated-stayers experience positive wage effects, but that these effects are larger among the stayers. Workers who sign an NC at time 0 but leave that job in the post period (the treated-movers) have wages 4.3 log points higher at the time of signing and 4.4 log points higher 6 years later relative to the control group. Moreover, there is no clean break in the trend at the time of signing. In contrast, those who sign an NC at time 0 and remain in that job for the observed post-period have wages 12.1 log points higher at the time of signing

[19]Note that there is no observed post-period for the 2021 cohort. As a default, we include the 2021 cohort in the stayers group to retain sample size. However the results are again very similar if we simply exclude the 2021 cohort from this exercise.

and 3.3 log points higher 6 years later. Therefore, job stayers do experience lower wage growth than the control group (the difference is smaller when comparing to control-stayers), yet still have higher wages 6 years later.

4.3 Robustness

4.3.1 Job productivity as an omitted variable

Our main identifying assumption is that the error term in equations 10 and 11 are uncorrelated with the treatment dummy. One concern with this assumption is that, while we may be controlling for systematic differences in NC usage across *workers*, we are not doing so across *jobs*. NC usage could be correlated with firm productivity, introducing an omitted variable problem.

While our worker-level data prevents us from controlling for firm productivity directly, we re-estimate our aggregate effects from Table 3 sequentially controlling for industry, occupation, and firm size decile fixed effects. The industry and occupation fixed effects control for the possibility that non-compete agreements are used more intensively in certain high-paying sectors. Firm size is strongly correlated with firm productivity in standard labor market models (e.g., Manning (2013)), and we confirm it is strongly correlated with wages in the NLSY97 data (see Figure A2). We plot the results in Figure A3, where the black circle markers in Figure A3 report our baseline estimates, while the next three lines report estimates sequentially adding industry, occupation, and then finally firm size decile fixed effects.

We find that controlling for these detailed job-level characteristics hardly changes our results. The first panel reports our wage estimates. We find that our estimated wage effect falls only slightly, from 9.4 to 8.5 log points in the most saturated model. The fact that our results hardly change even with this rich set of controls gives confidence that the potential omitted variable problem (of NC's being correlated with other job-level characteristics that positively effect wages) is not driving our wage estimates. In the second and third panel we see that our job mobility estimates are also robust to controlling for these job-level characteristics. The tenure effect only changes from 0.29 to 0.24 years and the effect on the rate at which workers change main employers changes from -3.6 to -4.1 percentage points. Overall, we conclude that our baseline estimates are unlikely to be driven by unobserved job-level characteristics.

4.3.2 Data limitations on NC usage

Another possible objection is that our assumptions on the timing of NC signage is invalid. As discussed in Section 3.1, since we only observe NC status starting in 2017, we assume that the NC was signed at the beginning of the employment relationship, imposing that NC status does not change with job tenure. A potential violation of this would be if non-compete clauses were tied to promotions or raises within the same job. Starr, Prescott, and Bishara (2021) find that this happens very infrequently, with almost all non-compete agreements being signed at the beginning of the employment relationship.

A related data limitation is the fact that, as discussed in Section 3.2, we do not observe NC status in the pre-period for cohorts 2015 and 2017. To address this issue formally, we sequentially remove cohorts 2015 and 2017 from the sample and observe how our estimates change. Specifically, we re-calculate our aggregate estimates (1) using only cohorts 2017-2021, and (2) using only cohorts 2019-2021. In the latter case, restricting to these years and cohorts means we only use observations for which we observe NC status before and after the job move, providing more transparent estimates. The results from this exercise are given in Figure A4. Reassuringly, we find that our wage and job mobility rate estimates are not significantly different and if anything increase as we remove cohorts 2015 and 2017. Similarly, the point estimates for tenure are nearly identical. This exercise demonstrates that our results are not driven by measurement error in NC status and also gives confidence that our results are quite stable across cohorts. Finally, non-compete agreements are often bundled with other employment restrictions, such as non-disclosure agreements (NDAs) (Balasubramanian, Starr, and Yamaguchi (2024)). To the extent this is true in our data, we acknowledge that our estimates identify the causal effects of all of these restrictions simultaneously rather than NCs in isolation.

4.3.3 Alternative estimation methods: Later-treated and TWFE

Even though we control for individual fixed effects, one may still have concerns about selection. For example, workers who sign NC's may have higher returns on employer-provided investment, and this might not be fully captured by an additively separable worker fixed effect. To address this potential concern, we re-estimate equation 10, this time defining the control group for each cohort c as job-movers at time c who do not have an NC at time c but who do sign an NC in a later survey year $t > c$ (later-treated job-movers). In this comparison, we compare NC signers to NC signers, exploiting only variation in the timing of signage. We plot the results in Figure A5.

Relative to our baseline estimates (Figure 7), we observe a larger initial wage effect but stronger negative wage growth in the post-period. Given that the later-treated are necessarily workers who move into NC contracts in the post-period, we would expect them to have larger wage increases and therefore the sharper negative wage growth in this alternative set-up in unsurprising. Although the wage effects after time zero are difficult to interpret, the fact that the initial wage effect is even stronger in this set-up gives assurance that our main estimates are not being driven by some fundamental difference between those who do and do not sign non-compete agreements.

Finally we present two sets of estimates from the standard two-way fixed effect estimator (TWFE). Here, we step away from our stacked research design and do not restrict attention to job movers. We then estimate the following equations

$$w_{it} = \alpha_i + \lambda_t + \beta^{TWFE-d} d_{it}^{Agg} + \varepsilon_{it} \tag{13}$$

$$w_{it} = \alpha_i + \lambda_t + \beta^{TWFE-NC} NC_{it} + \varepsilon_{it} \tag{14}$$

where w_{it} is log wages for individual i in year t, NC_{it} is the NC status in individual i's main employer at time t, and as before d_{it}^{Agg} is an indicator variable equal to one beginning in the first year the worker signs an NC, and zero otherwise.

The fundamental difference between equation 13 and our main specification in equation 11 is that here the control group is effectively any worker not currently holding an NC, as opposed to restricting to the never-treated job movers in 11. Both of these regressions use d_{it}^{Agg} as the independent variable, which is an *absorbing* treatment variable. Equation 14 further differs in that it uses current NC status NC_{it} as the independent variable, exploiting within-worker transitions both in and out of jobs with non-compete agreements. We focus on the 2017-2021 time period where such variation in NC_{it} is observed.

We report the estimates from equation 13 for the entire sample and across subgroups and find nearly identical results (see Figure A6a). The aggregate wage effect of signing an NC is 9.5 log points (relative to 9.4 in our baseline case, see Table 3) and there are similar patterns across subgroups. Specifically, as in our baseline estimates, workers with a college degree, who are non-black/hispanic or who had above-median wages in 2011 appear to experience larger wage gains from signing and NC than their counterparts. For example, the NC's increase wages by 11.0 log points for high-wage workers and 8.8 log points for low-wage workers. Finally, we find a smaller yet still significantly positive wage effect using equation 14. The aggregate wage effect under this specification is about 5.8 log points. Again, we find this estimate is larger for high-wage workers (8.9 log points) than low-wage workers (4.2 log points).

5 Conclusion

Economists have long been interested in the factors that promote human capital development, but the market for employer-provided training suffers a well-known failure: employers are reluctant to provide transferable skills if they must later pay for the worker's increased productivity (e.g. Becker 1962; Acemoglu and Pischke 1999). Our primary theoretical contribution is an asymmetric information model which shows that non-compete agreements can mitigate this problem by encouraging investment in industry-specific training, but at the cost of generating ex-post allocative inefficiencies. However, this same model demonstrates a critical distinction: for lower-wage workers who may have high discount factors and low returns on training, the non-compete agreement is not an efficiency tool but purely a transfer of surplus from workers to firms. In contrast, our renegotiation model, which applies more directly to executives, suggests that when buyout payments are unconstrained, non-compete agreements can be structured to achieve efficient investments and mobility.

While previous research has examined the causal effects of non-compete regulation, our study focuses on the causal effects of signing a non-compete agreement itself. As expected, we find that signing a non-compete lowers job mobility, raising job tenures by 6% and lowering rates of job-to-job transitions by 12%. Our findings on wages, however, reveal significant heterogeneity across the workforce. For high-wage, white, and college-educated workers, signing a non-compete leads to both immediately higher and persistently higher wages, suggesting a sustained positive impact. In stark contrast, for lower-wage, Black, and non-college-educated workers, the agreement presents a trade-off: while it is associated with higher immediate wages, this initial gain comes at the cost of lower subsequent wage growth. Although this dynamic results in higher total career earnings on average, the source of the underlying productivity gain remains a puzzle. Despite theoretical predictions that non-compete agreements should encourage employer investment in worker skills, we find no evidence of increased formal training for those who sign. This observation raises the question of whether non-compete signers become more productive through less observable channels, such as receiving more intensive on-the-job mentoring or building stronger, more collaborative relationships with managers. Understanding these informal mechanisms is crucial for providing deeper insight into how non-compete agreements influence long-term worker productivity and career trajectories.

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A Appendix

A.1 Social Planner’s Solution: Existence, Uniqueness, Comparative Statics

We show that for every parameter set (r,ρ,λ) where $r>\rho$, the surplus function $\mathscr{S}(i) = -\frac{1}{2}i^2 + ri + \frac{e^{-\lambda\Delta i}}{\lambda}$ admits exactly one maximizer $i^\star > 0$. The first derivative of the surplus function is $\mathscr{S}'(i) = r - i - \Delta e^{-\lambda\Delta i}$.

At the origin, the derivative is $\mathscr{S}'(0) = r - \Delta = \rho > 0$, implying that zero investment is never optimal. As $i \to \infty$, the exponential term vanishes and $\mathscr{S}'(i) \sim r - i \to -\infty$. Since $\mathscr{S}'(i)$ is continuous and changes sign from positive to negative, it must equal zero at least once for some $i > 0$.

To prove uniqueness, we examine the second derivative, $\mathscr{S}''(i) = -1 + \lambda\Delta^2 e^{-\lambda\Delta i}$. This second derivative is strictly decreasing in i.

- If $\lambda\Delta^2 \leq 1$, then $\mathscr{S}''(i) < 0$ for all $i \geq 0$. This means $\mathscr{S}(i)$ is globally strictly concave, and the critical point identified by the first-order condition is the unique global maximizer.
- If $\lambda\Delta^2 > 1$, then $\mathscr{S}''(i)$ starts non-negative at $i = 0$ and crosses zero exactly once at an inflection point $i_0 > 0$. For all $i > i_0$, the function $\mathscr{S}(i)$ is strictly concave. Because $\mathscr{S}'(0) = \rho > 0$ and $\mathscr{S}'(i)$ is non-decreasing on the interval $[0, i_0]$ (since $\mathscr{S}''(i) \geq 0$ on this interval), any solution to $\mathscr{S}'(i) = 0$ must lie in the region (i_0, ∞) where the function is strictly concave.

Thus, in all cases, there is a single critical point which is the unique global maximizer, $i^\star$.

Corollary 4. *At the optimal investment level $i^\star$, the surplus function must be locally concave. We prove that the second-order condition is strictly satisfied, i.e., $\mathscr{S}''(i^\star) < 0$.*

Proof. Suppose for contradiction that $\mathscr{S}''(i^\star) = -1 + \lambda\Delta^2 e^{-\lambda\Delta i^\star} \geq 0$. As shown in Appendix A.1, the function $\mathscr{S}''(i)$ is strictly decreasing in i. This implies that for all $i \in [0, i^\star)$, it must be that $\mathscr{S}''(i) > \mathscr{S}''(i^\star) \geq 0$. Therefore, the first derivative $\mathscr{S}'(i)$ must be strictly increasing on the interval $[0, i^\star]$. This leads to a contradiction, since we know $\mathscr{S}'(0) = \rho > 0$ and $\mathscr{S}'(i^\star) = 0$. A function cannot start at a positive value and be strictly increasing to a value of zero. Hence, the premise is false and it must be that $\mathscr{S}''(i^\star) < 0$. ∎

We now analyze how the optimal investment and quit probabilities respond to changes in the economic environment.

Proposition 13 (Comparative Statics of Investment)**.** *The optimal investment $i^\star$ responds to parameter changes as follows: (i) it is strictly increasing in internal productivity, $\partial i^\star/\partial r > 0$; (ii) it is strictly increasing in the outside option parameter, $\partial i^\star/\partial\lambda > 0$; and (iii) its response to external productivity ρ is ambiguous, with $\partial i^\star/\partial\rho \gtreqless 0$ if and only if $\lambda\Delta i^\star \lesseqgtr 1$.*

Proof. Let $\phi := \lambda\Delta i^\star$. Applying the implicit function theorem to Equation 2, we have $\partial i^\star/\partial x = -F_x/F_i$, where $F(i,x) = r - i - \Delta e^{-\lambda\Delta i}$. As shown in Corollary 4, the second-order condition ensures that the denominator $F_i = \mathscr{S}''(i^\star)$ is strictly negative. The signs of the comparative statics are therefore determined by the signs of the partial derivatives $F_x = \partial F/\partial x$:

$$
\begin{aligned}
F_r &= 1 - e^{-\phi}(1-\phi) > 0, \\
F_\lambda &= \Delta^2 i^\star e^{-\phi} > 0, \\
F_\rho &= e^{-\phi}(1-\phi).
\end{aligned}
$$

Since $F_i < 0$, the signs of $\partial i^\star/\partial r$ and $\partial i^\star/\partial\lambda$ are positive. The sign of $\partial i^\star/\partial\rho$ depends on the term $(1-\phi)$, proving the proposition. ∎

Higher internal productivity (r) and a less favorable distribution of outside options (higher λ, meaning lower mean $1/\lambda$) both unambiguously increase the incentive to invest. The effect of higher external productivity (ρ) depends on whether quits are common ($\phi < 1$) or rare ($\phi > 1$).

Corollary 5 (Comparative Statics of the Quit Probability)**.** *The equilibrium quit probability, $q^\star = e^{-\lambda\Delta i^\star}$, is strictly decreasing in internal productivity r and in the outside option parameter λ. The effect of external productivity ρ is ambiguous.*

Proof. Let $\phi := \lambda \Delta i^\star$. The derivative is $dq^\star/dx = -q^\star(d\phi/dx)$, so its sign is opposite to that of $d\phi/dx = d(\lambda \Delta i^\star)/dx$.

- For r: $d\phi/dr = \lambda\Delta(\partial i^\star/\partial r) + \lambda i^\star > 0$. Thus, $dq^\star/dr < 0$.
- For λ: $d\phi/d\lambda = \lambda\Delta(\partial i^\star/\partial\lambda) + \Delta i^\star > 0$. Thus, $dq^\star/d\lambda < 0$.
- For ρ: $d\phi/d\rho = \lambda\Delta(\partial i^\star/\partial\rho) - \lambda i^\star$. The sign is ambiguous as it involves the difference of two terms, with $\partial i^\star/\partial\rho$ itself having an ambiguous sign.

■

A.2 Necessary and Sufficient Conditions for a Non-Zero Wage with a Non-Compete

We analyze the conditions under which the firm offers a strictly positive wage, $w_1 > 0$, as part of an optimal contract with a non-compete agreement. Let $\Sigma_1(w_1)$ denote the joint surplus. Since $\Sigma_1'(0) = 0$, any move from $w_1 = 0$ raises surplus only if $\Sigma_1''(0) > 0$. Equivalently, if we define $H(w_1) \equiv \frac{d\Sigma_1}{dw_1}(w_1)$, then $H(0) = 0$ and local convexity at zero requires $H'(0) > 0$.

Recall that the firm's investment schedule is

$$i_1(w_1) \;=\; r\big(1 - e^{-\lambda w_1}\big),$$

so in particular $i_1(0) = 0$ and hence $\Sigma_1(0) = 0$. The first-order condition for an interior optimum is

$$H(w_1) = (\beta - 1)\big(1 - e^{-\lambda w_1}\big) + \lambda\left(r\, i_1(w_1) - w_1\right) e^{-\lambda w_1},$$

with $H(0) = 0$.

Proposition 14 (Condition for a Positive Wage with a Non-Compete)**.**

(a) A strictly positive equilibrium wage, $w_1^* > 0$, exists if and only if

$$\beta - 2 + \lambda r^2 \;>\; 0, \quad \textit{i.e.} \quad \beta > 2 - \lambda r^2.$$

(b) A sufficient condition for a positive wage for any $\beta \geq 0$ is

$$\lambda r^2 > 2.$$

Proof. Substitute $i_1(w_1) = r(1 - e^{-\lambda w_1})$ into $H(w_1)$:

$$H(w_1) = (\beta - 1)\big(1 - e^{-\lambda w_1}\big) + \lambda\left(r^2 - r^2 e^{-\lambda w_1} - w_1\right)e^{-\lambda w_1}.$$

Differentiate with respect to w_1:

$$\begin{aligned} H'(w_1) = {}& \lambda(\beta - 1)e^{-\lambda w_1} + \lambda\left(r^2 \lambda e^{-\lambda w_1} - 1\right)e^{-\lambda w_1} \\ & + \lambda\left(r^2 - r^2 e^{-\lambda w_1} - w_1\right)\left(-\lambda e^{-\lambda w_1}\right). \end{aligned}$$

Evaluating at $w_1 = 0$:

$$\begin{aligned} H'(0) &= \lambda(\beta - 1) + \lambda(\lambda r^2 - 1) + \lambda(r^2 - r^2 - 0)(-\lambda) \\ &= \lambda\beta - \lambda + \lambda^2 r^2 - \lambda \\ &= \lambda\left(\beta - 2 + \lambda r^2\right). \end{aligned}$$

Since $\lambda > 0$, $H'(0) > 0$ iff $\beta - 2 + \lambda r^2 > 0$, proving part (a).

For part (b), we require $\beta > 2 - \lambda r^2$ to hold even for the minimum possible value of patience, $\beta = 0$. This gives the condition $0 > 2 - \lambda r^2$, which simplifies to $\lambda r^2 > 2$. This ensures $H'(0) > 0$ for all $\beta \geq 0$, completing the proof. ■

A.3 Existence of the Boundary Wage

Here, we formally prove the existence of the boundary wage, w_{bound}. This is the wage satisfying the fixed-point condition $w = r\,i_0(w)$, where $i_0(w)$ is the firm's optimal investment response.

Proposition 15 (Existence and Positivity of the Boundary Wage)**.**

1. *There exists at least one non-negative boundary wage* $w_{\text{bound}} \geq 0$ *solving the equation* $w = r\,i_0(w)$.
2. *A strictly positive solution* $w_{\text{bound}} > 0$ *exists if and only if* $r\lambda\,(r - \rho) > 1$.

Proof. We define the function $\Phi(w) = r\,i_0(w)$ and seek a fixed point where $w = \Phi(w)$.

(a) Existence of a non-negative fixed point.

The firm's optimal investment $i_0(w)$ is the unique root of the first-order condition $H(i_0, w) = 0$, where

$$H(i,w) = r\big(1 - e^{-\lambda(w-\rho\,i)}\big) - (r\,i - w)\,\lambda\rho\,e^{-\lambda(w-\rho\,i)} - i.$$

The function $H(i,w)$ is twice continuously differentiable. Strict concavity of the firm's profit with respect to i is confirmed by the sign of $\partial H/\partial i$:

$$\frac{\partial H}{\partial i} = -2\lambda\rho r e^{-\lambda(w-\rho i)} - (ri - w)(\lambda\rho)^2 e^{-\lambda(w-\rho i)} - 1 < 0.$$

Given that $H(0,w) > 0$ for $w > 0$ and $H(i,w) \to -\infty$ as $i \to \infty$, the concavity of H in i guarantees a unique positive root $i_0(w)$ for any $w > 0$. The Implicit Function Theorem then ensures that $i_0(w)$ is a continuous function. Hence, $\Phi(w) = r\,i_0(w)$ is also continuous.

To prove the existence of a fixed point, we use Brouwer's Fixed Point Theorem. Let $i_{\text{bench}} \geq 0$ be the unique solution to $i = r(1 - e^{-\lambda(r-\rho)i})$. Define the set $S = [0, W_{\max}]$, where $W_{\max} = r\,i_{\text{bench}}$. This set is non-empty, compact, and convex. A rigorous analysis of the properties of $H(i,w)$ shows that for any $w \in S$, the root $i_0(w)$ satisfies $0 \leq i_0(w) \leq i_{\text{bench}}$, which ensures that Φ maps the set S into itself. Since $\Phi : S \to S$ is a continuous function on a compact, convex set, a fixed point $w_{\text{bound}} \in S$ must exist. This establishes part (a).

(b) Condition for a strictly positive fixed point.

We know $w = 0$ is always a fixed point since $i_0(0) = 0$ and thus $\Phi(0) = 0$. A strictly positive fixed point $w_{\text{bound}} > 0$ is guaranteed to exist if there is another fixed point besides zero. Since $W_{\max} = r\,i_{\text{bench}}$ is also a fixed point, a positive solution exists if and only if $W_{\max} > 0$, which requires $i_{\text{bench}} > 0$.

A positive solution $i_{\text{bench}} > 0$ to the equation $i = r(1 - e^{-\lambda(r-\rho)i})$ exists if and only if the slope of the right-hand side is greater than the slope of the left-hand side (which is 1) at the origin $i = 0$. The slope of the right-hand side at $i = 0$ is:

$$\frac{d}{di} r\left(1 - e^{-\lambda(r-\rho)i}\right)\Big|_{i=0} = r\lambda\,(r-\rho).$$

Hence, $i_{\text{bench}} > 0$ if and only if $r\lambda\,(r-\rho) > 1$. This is the necessary and sufficient condition for the existence of a strictly positive boundary wage, which completes the proof of part (b). ■

A.4 Properties of the Unconstrained Optimum Without a Non-Compete When $\beta = 1$

This section proves two key properties of the unconstrained optimal wage without a non-compete, w^*_{unc}, for the case of a perfectly patient worker ($\beta = 1$).

Proposition 16. *At any unconstrained optimal wage w^*_{unc} that maximizes the joint surplus:*

1. *The slope of the investment response function is strictly positive: $\frac{di_0}{dw_0} > 0$.*
2. *The optimal wage exceeds the worker's marginal product: $w^*_{unc} > ri_0(w^*_{unc})$.*

The proof for the first point proceeds by contradiction. The second point follows directly from the first.

Proof. The firm's choice of investment i_0 for a given wage w_0 is defined implicitly by the first-order condition of its own profit-maximization problem, which we can write as $G(i_0, w_0) = 0$:

$$G(i_0, w_0) \equiv r\left(1 - e^{-\lambda(w_0-\rho i_0)}\right) - \lambda\rho(ri_0 - w_0)e^{-\lambda(w_0-\rho i_0)} - i_0 = 0 \tag{15}$$

By the Implicit Function Theorem, the slope of the investment response function, $i_0(w_0)$, is:

$$\frac{di_0}{dw_0} = -\frac{\partial G/\partial w_0}{\partial G/\partial i_0} \tag{16}$$

The denominator, $\partial G/\partial i_0$, is the second derivative of the firm's profit with respect to investment. The second-order condition for a maximum requires $\partial G/\partial i_0 < 0$. Therefore, the sign of the slope is determined by the sign of the numerator:

$$\text{sign}\left(\frac{di_0}{dw_0}\right) = \text{sign}\left(\frac{\partial G}{\partial w_0}\right)$$

Calculating the numerator yields:

$$\frac{\partial G}{\partial w_0} = \lambda e^{-\lambda(w_0-\rho i_0)}\left[r + \rho + \lambda\rho(ri_0 - w_0)\right] \tag{17}$$

Thus, the sign of the slope $\frac{di_0}{dw_0}$ is determined by the sign of the term in the brackets. We now prove by contradiction that an unconstrained optimum cannot exist where $di_0/dw_0 < 0$. An unconstrained optimum w^*_{unc} must satisfy the first-order condition for maximizing the joint surplus. For $\beta = 1$, this condition is:

$$\lambda(ri_0 - w^*_{unc}) + \rho\left(\frac{di_0}{dw_0}\right)\Big|_{w^*_{unc}} = 0 \tag{18}$$

Let us hypothesize that an unconstrained optimum w^*_{unc} exists at a point where the slope of the investment curve is negative, i.e., $\frac{di_0}{dw_0} < 0$. Two conditions would have to be met simultaneously at this point.

We can rearrange the first-order condition:

$$\lambda(ri_0 - w^*_{unc}) = -\rho\left(\frac{di_0}{dw_0}\right)$$

Since we hypothesized $\frac{di_0}{dw_0} < 0$ and we know $\rho > 0$, the right-hand side of the equation must be strictly positive. This implies the left-hand side must also be positive. Since $\lambda > 0$, we must have:

$$ri_0 - w^*_{unc} > 0$$

The mathematical condition required for the slope $\frac{di_0}{dw_0}$ to be negative is that the following term is negative:

$$r + \rho + \lambda\rho(ri_0 - w^*_{unc}) < 0$$

We have reached a contradiction. Therefore, our initial hypothesis is false. Any unconstrained optimum must satisfy $\frac{di_0}{dw_0} \geq 0$.

Proof that $w^*_{unc} > ri_0$ This result now follows directly from the first-order wage equation. Rearranging to solve for w^*_{unc} gives:

$$w^*_{unc} = ri_0 + \frac{\rho}{\lambda}\left(\frac{di_0}{dw_0}\right) \tag{19}$$

Therefore, the unconstrained optimal wage is equal to the worker's marginal product plus a strictly positive term, which proves that $w^*_{unc} > ri_0$.

■

A.5 Appendix: Renegotiation Without Non-Compete

Proposition 17. *In a model without a non-compete agreement and renegotiation:*

1. *Efficient Turnover: The worker is retained if and only if it is socially efficient to do so.*
2. *Under-investment: The firm's equilibrium investment level is strictly less than the socially optimal level ($i^*_0 < i^*$).*

Proof. The proof is organized in two parts. First, we establish the efficiency of the separation decision. Second, we prove that the firm systematically under-invests.

Part 1: Proof of Efficient Turnover A social planner would retain the worker if and only if the surplus from staying, ri_0, is at least as large as the surplus from separating, $v + \rho i_0$. The efficient retention rule is therefore $v \leq (r - \rho)i_0$.

We show that private incentives align with this rule. After investment i_0 is sunk and the outside offer v is realized, the worker's reservation utility becomes their best available alternative. To prevent the worker from leaving, the firm must offer a wage at least as high as this reservation utility, which is $\max\{w_0, v + \rho i_0\}$.

Since the firm has all bargaining power, it will offer exactly this wage to retain the worker, but only if it is profitable to do so. The firm's retention decision is thus governed by whether output covers the new wage:

$$ri_0 \geq \max\{w_0, v + \rho i_0\}.$$

Assuming the initial contract is viable ($w_0 \leq ri_0$), this single condition for profitable retention becomes equivalent to the social efficiency condition, $ri_0 \geq v + \rho i_0$. If retention is efficient, the firm will profitably retain the worker. If retention is inefficient, the firm cannot make a profitable offer, and the worker separates. Thus, turnover is socially efficient.

Part 2: Proof of Under-investment We prove under-investment by comparing the marginal return on investment for the firm with that of a social planner. The social planner's marginal return is r if the match continues and ρ if it dissolves.

Now consider the firm's private marginal return on investment.

- When the worker separates (which occurs when $v > (r-\rho)i$), the firm's profit is zero, and its marginal return on investment is also zero. This is strictly less than the planner's marginal return of ρ.
- When the worker is retained (which occurs when $v \leq (r-\rho)i$), the firm's profit is $ri - \max\{w_0, v+\rho i\}$. The firm's marginal return is therefore either r (if no wage renegotiation is needed) or $r-\rho$ (if the wage must be increased to match the outside option). In all cases of retention, the firm's marginal return is less than or equal to the planner's marginal return of r.

This proof demonstrates that in every possible outcome, the firm's marginal return on investment is less than or equal to the social planner's, and in many outcomes (all separations and all retentions that require renegotiation), it is strictly less. Because the firm fails to internalize the full social value of its investment—particularly the skill-generality parameter ρ that either benefits a competitor or must be paid back to the worker in a higher wage—its total ex-ante Private Marginal Benefit is strictly lower than the Social Marginal Benefit. Therefore, the firm under-invests relative to the social optimum, $i_0^* < i^*$. ■

A.6 Appendix Tables and Figures

Table A1: Variables Dictionary

Variable	Definition
Job Mobility	
Tenure (Yrs)	Time in years working at a job
1(Main Job Separation btwn 2017 and 2019)	Worker transitions to a new main job, becomes unemployed, or exits the labor force
1(Main Job Mobility btwn 2017 and 2019)	Worker transitions to a new main job
1(Within-Industry Job Mobility btwn 2017 and 2019)	Worker transitions to a new main job within the same industry
Wages and Wage Growth	
Log(Starting Wage)	Log of starting wage for 2017 main job
Log(Wage in 2017)	Log of wage in 2017 for main job
$Log(Wage_{2017}) - Log(Wage_{2015})$	Difference between log of wage in 2017 and log of wage in 2015 for 2017 main job
$Log(Wage_{2019}) - Log(Wage_{2017})$	Difference between log of wage in 2019 and log of wage in 2017 for 2017 main job
Demographics	
Age	Computed as the survey year minus birth year
1(Male)	The respondent is male
1(High School Degree or Higher)	The respondent has attended at least 12 years of school
1(Bachelors Degree or Higher)	The respondent has attended at least 16 years of school
ASVAB Percentile	Percentile achieved on ASVAB test
1(Black)	The respondent is Black
1(Hispanic)	The respondent is Hispanic

Wage Bargaining and Negotiation	
1(Possible to Keep Previous Job)	The respondent was able to keep previous job when offered their main job
1(Negotiate Job Offer)	The respondent negotiated their main job offer
Training	
1(Received Some Training)	Received training in a survey year
1(Received Training Run by Employer)	Received training ran by employer in a survey year
1(Received On-Site Training by Non-Employer)	Received training on-site by non-employer in a survey year
1(Employer Paid for Training)	Employer paid for training in a survey year
1(Employer Paid for Mandatory Training)	Employer paid for mandatory training in a survey year
1(Employer Paid for Voluntary Training)	Employer paid for voluntary training in a survey year
Job Tasks	
1(Use Math Skills Frequently)	Respondent claims to use math at least once a week at main job
1(Supervise Frequently)	Respondent claims to supervise more than half the time at main job
1(Problem Solve Frequently)	Respondent claims to problem solve at least once a week at main job
Other Firm Characteristics	
1(Dislike Job)	Respondent claim to ’Dislike it somewhat’ or ’Dislike it very much’ when asked about main job
1(Unionized Worker)	Respondent’s contract was negotiated by a union or employee association for main job
Firm Size	Number of employees at respondent’s main job

Table A2: Confidence in Non-Compete Status by Industry

Industry	NC Confidence			Total	Share Very Confident	Share NC Usage
	Very Confident	Somewhat Confident	Not Confident			
AGRICULTURE, FORESTRY AND FISHERIES	33	0	1	34	0.97	0.07
CONSTRUCTION	293	14	4	311	0.94	0.11
OTHER SERVICES	152	9	2	163	0.93	0.13
TRANSPORTATION AND WAREHOUSING	211	12	7	230	0.92	0.14
EDUCATIONAL, HEALTH, AND SOCIAL SERVICES	1169	93	8	1270	0.92	0.08
ACS SPECIAL CODES	191	16	1	208	0.92	0.20
UTILITIES	29	3	0	32	0.91	0.11
INFORMATION AND COMMUNICATION	86	8	0	94	0.91	0.24
FINANCE, INSURANCE, AND REAL ESTATE	312	29	3	344	0.91	0.19
ENTERTAINMENT, ACCOMODATIONS, AND FOOD SERVICES	422	38	3	463	0.91	0.07
PUBLIC ADMINISTRATION	232	21	1	254	0.91	0.08
MANUFACTURING	412	42	4	458	0.90	0.18
MINING	24	3	0	27	0.89	0.24
WHOLESALE TRADE	104	12	1	117	0.89	0.27
RETAIL TRADE	458	49	5	512	0.89	0.15
PROFESSIONAL AND RELATED SERVICES	560	64	7	631	0.89	0.28
TOTAL	4688	413	47	5148	0.91	0.15

Note:
The sample consists of NLSY97 respondents who report non-compete, non-compete confidence, and industry status in their 2017 main job. Rows are organized by share 'Very Confident' in response to the non-compete confidence question. Active duty military respondents are dropped.

Table A3: Estimated Effects of NCs using the 2019 Cross-Section

Panel 1: Wages and Wage Growth

Dependent Variables:	Log(Wage)			Wage Growth		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
1(NC)	0.305***	0.220***	0.145***	0.005	0.006	0.028
	(0.051)	(0.044)	(0.052)	(0.033)	(0.033)	(0.043)
Controls	None	Basic	Advanced	None	Basic	Advanced
Weighted Dependent Variable Mean	3.14	3.14	3.14	0.111	0.111	0.111
Fit statistics						
Observations	1,638	1,585	762	1,638	1,585	762
R^2	0.034	0.302	0.574	2.96×10^{-5}	0.004	0.060

Panel 2: Training

Dependent Variables:	1(Any Training)			1(Emp Paid for Training)		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
1(NC)	0.011	-0.002	-0.028	0.015	-0.002	-0.031
	(0.029)	(0.029)	(0.043)	(0.024)	(0.024)	(0.038)
Controls	None	Basic	Advanced	None	Basic	Advanced
Weighted Dependent Variable Mean	0.120	0.120	0.120	0.078	0.078	0.078
Fit statistics						
Observations	1,638	1,585	762	1,638	1,585	762
R^2	0.0001	0.007	0.108	0.0004	0.020	0.139

Panel 3: Job Mobility

Dependent Variables:	Tenure (Yrs)			1(Main Job Mobility btwn 2019 and 2021)		
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
1(NC)	0.256	0.237	0.116	-0.051	-0.050	-0.064
	(0.184)	(0.187)	(0.226)	(0.036)	(0.037)	(0.052)
Controls	None	Basic	Advanced	None	Basic	Advanced
Weighted Dependent Variable Mean	5.64	5.64	5.64	0.249	0.249	0.249
Fit statistics						
Observations	1,616	1,585	762	1,638	1,607	771
R^2	0.003	0.008	0.098	0.001	0.010	0.068

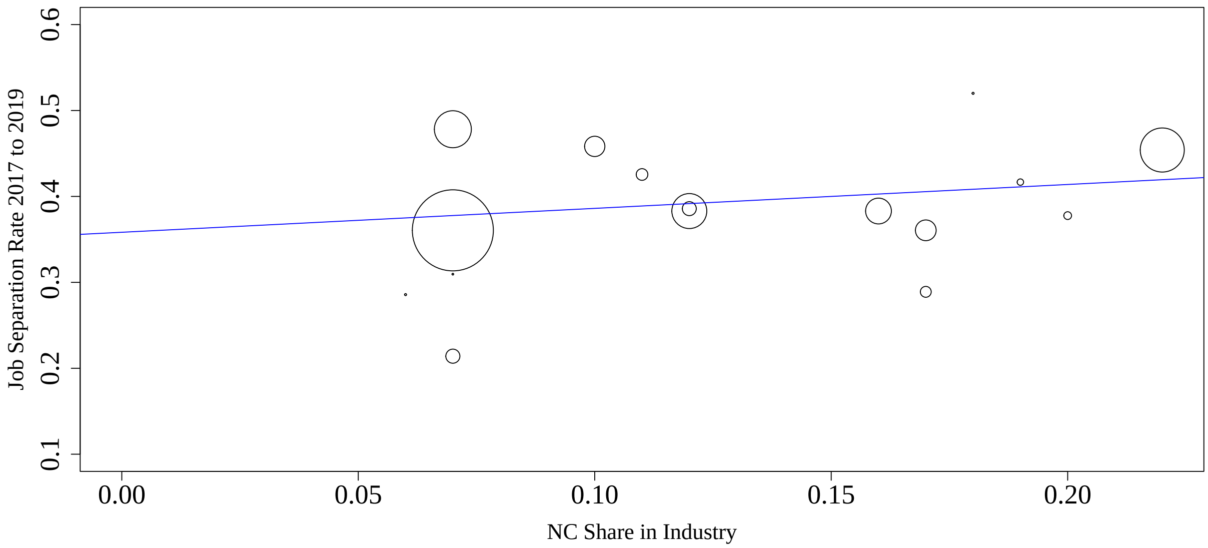
Notes: Standard errors are heteroskedasticity-robust. The sample restricts to individuals who report NC status and have real wages between 3 and 200 in 2019. Basic controls include sex, education, tenure, and potential experience. Advanced controls further add industry and occupation fixed effects, ASVAB percentile, and firm size. All regressions are weighted so as to be nationally representative. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Table A4: Wage Growth in Job Stayers vs Job Movers, by Non-Compete Status

Job Separation Condition	Wage Growth	Observations
Wage Growth Between 2017 and 2019		
Moved: No NC to NC	0.20	98
Moved: NC to NC	0.16	46
Moved: NC to No NC	0.12	100
Stayed: NC	0.11	458
Moved: No NC to No NC	0.11	839
Stayed: No NC	0.08	2595
Wage Growth Between 2019 and 2021		
Moved: No NC to NC	0.29	74
Moved: NC to NC	0.29	36
Moved: NC to No NC	0.22	80
Moved: No NC to No NC	0.13	716
Stayed: No NC	0.13	2519
Stayed: NC	0.11	442

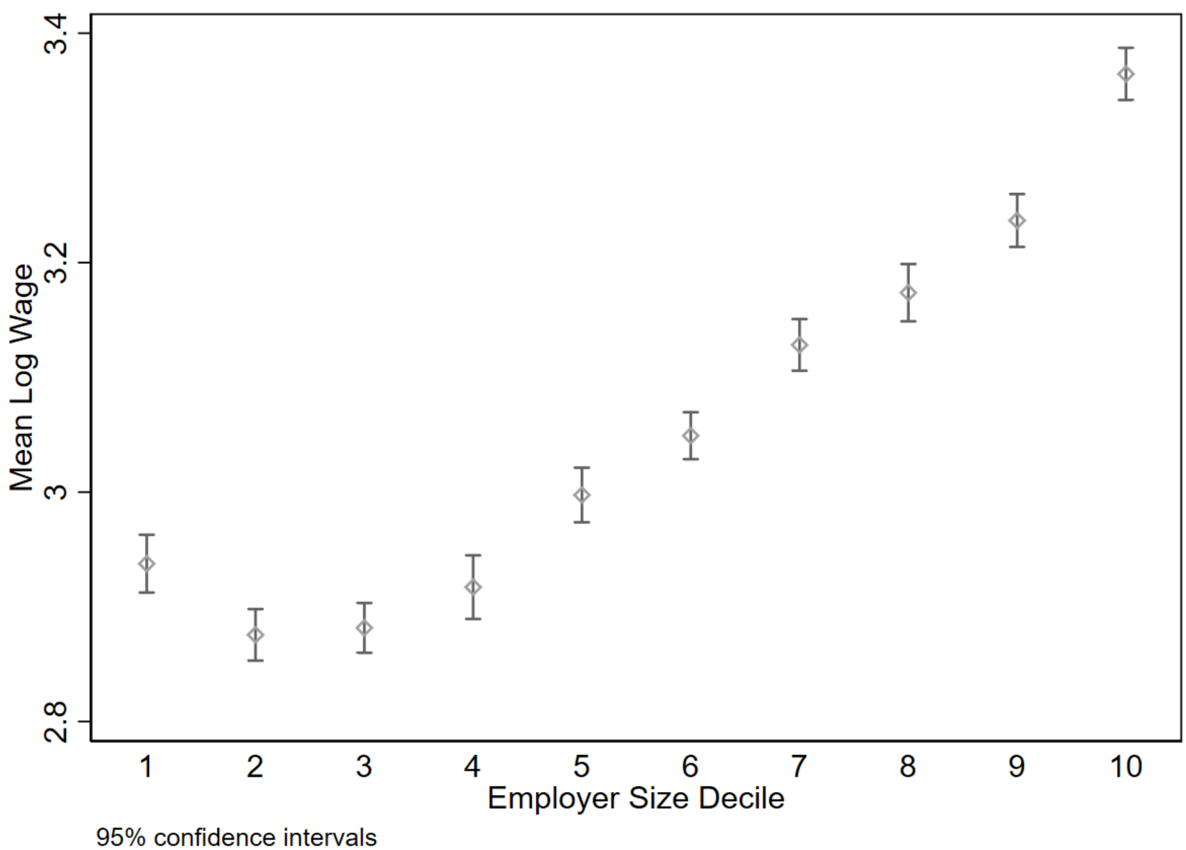
Note:
Wage growth based on condition of main job separation in the given period. The wage is measured for the main employer and in terms of dollars earned per hour. NC status in 2019 is only given if a job separation occurred between 2017 and 2019. If no separation occurred, the 2017 NC status was used in 2019. Similarly, NC status is provided in 2021 only if a job separation occurred between 2019 and 2021. If no separation occurred, the 2019 NC status was used in 2021.

Figure A1: Job Mobility vs Non-Compete Usage by Industry



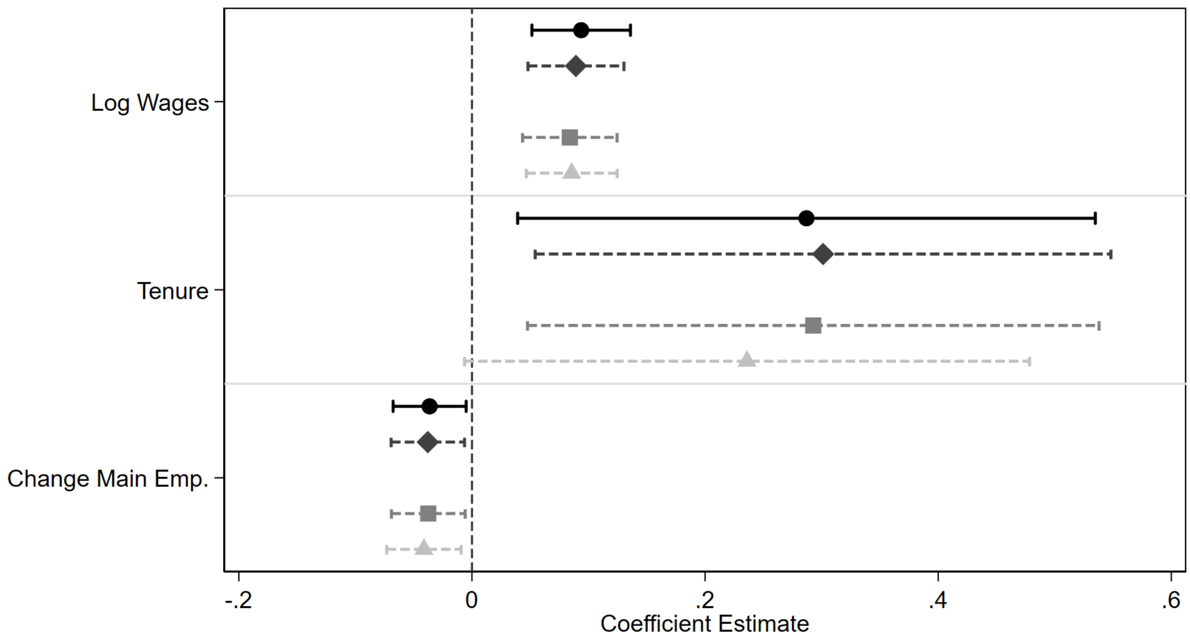
Note: The figure presents the rate of job separations in each industry between 2017 and 2019 versus non−compete usage by industry in 2017. The size of the circles are proportional to industry size and the line of best fit is weighted by industry size. The intercept is 0.36 and the slope is 0.28

Figure A2: Relationship Between Log Wages and Firm Size



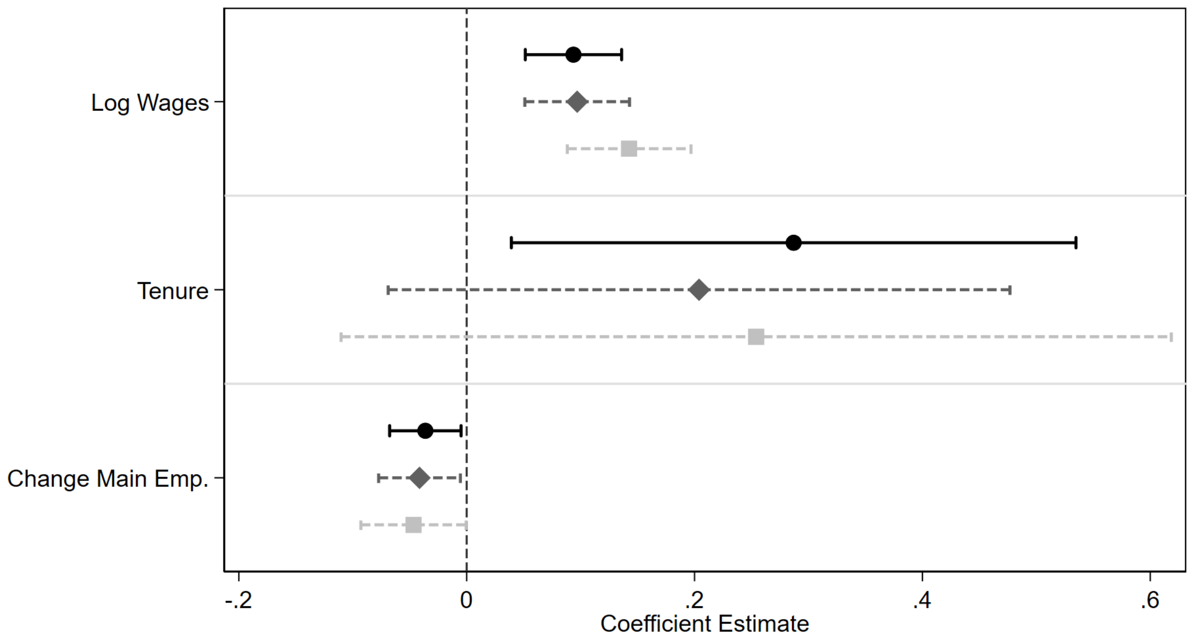
Note: Based on 2017 cross-section.

Figure A3: The Effect of Signing a Non-Compete Agreement: Robustness to Firm-Level Covariates



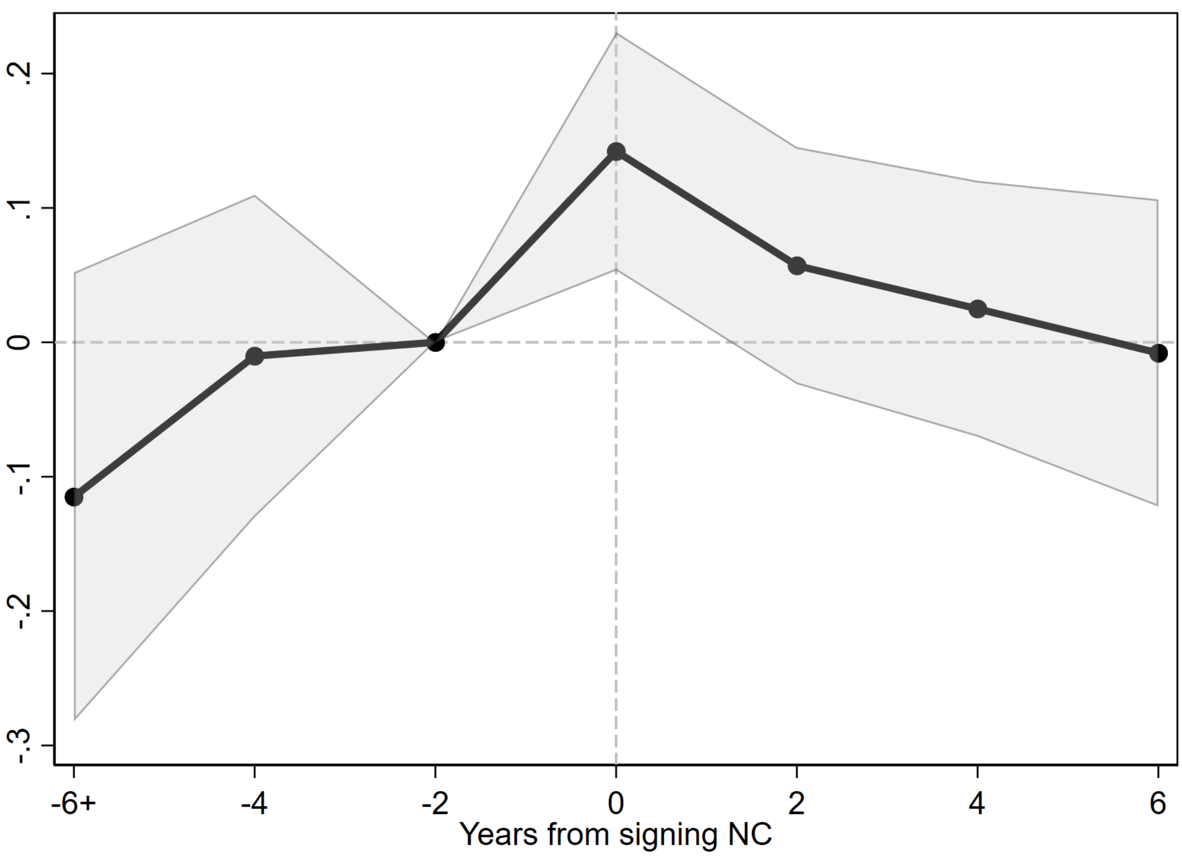
Note: Coefficient estimates are from stacked difference-in-differences estimation, aggregated over post-treatment years, over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers whom we do not observe holding a NC during the event window and who also changed jobs between year c and the preceding survey year. Job mobility is defined as changing main employers between the current and preceding survey year. The black circle markers report baseline estimates from the main text. The gray diamond markers with dashed lines report estimates controlling for industry fixed effects. The square markers further add occupation fixed effects, and the triangle markers further add firm size decile fixed effects. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

Figure A4: The Effect of Signing a Non-Compete Agreement: Robustness to Different Samples



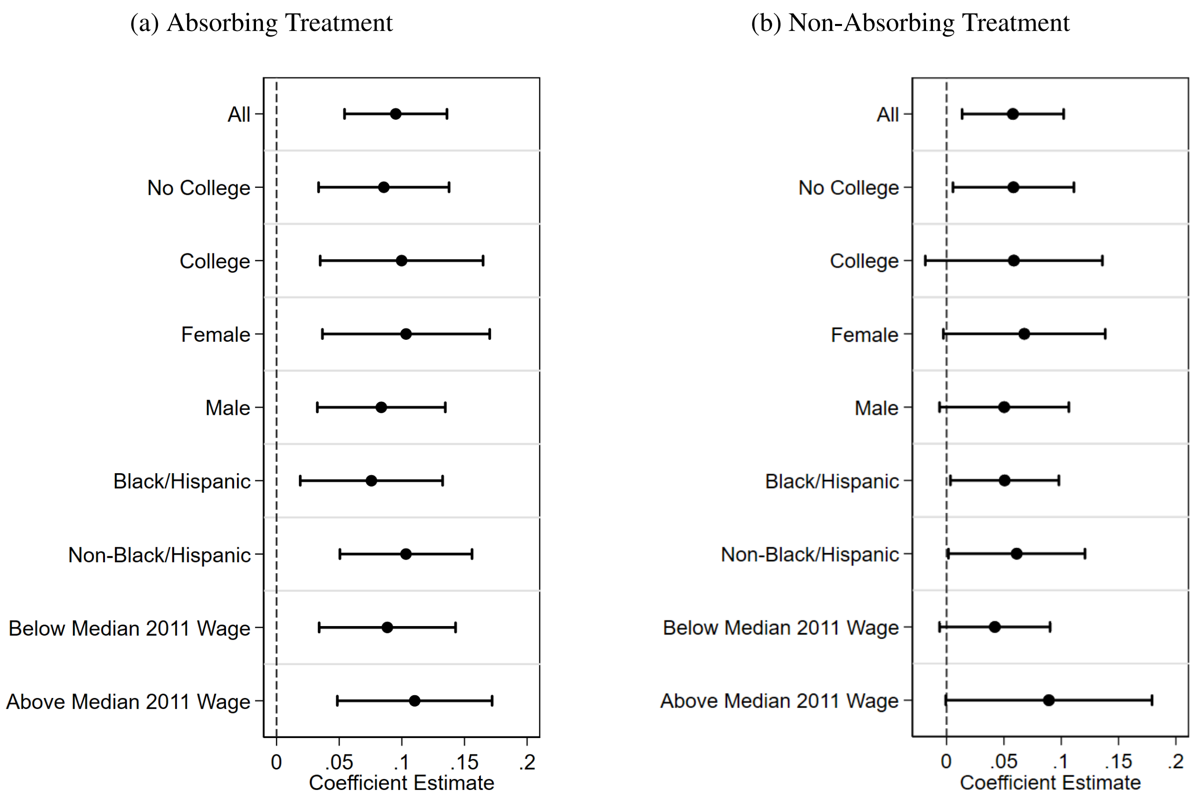
Note: Coefficient estimates are from stacked difference-in-differences estimation, aggregated over post-treatment years, over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers whom we do not observe holding a NC during the event window and who also changed jobs between year c and the preceding survey year. Job mobility is defined as changing main employers between the current and preceding survey year. The black circle markers report baseline estimates from the main text. The gray diamond markers with dashed lines report coefficient estimates when we restrict attention to years 2015-2021 and cohorts $\{2017, 2019, 2021\}$. The square markers further restrict attention to years 2017-2021 and cohorts $\{2019, 2021\}$. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

Figure A5: The Effect of Signing a Non-Compete Agreement on Wages: Later-treated as Control Group



Note: Coefficient estimates are from stacked difference-in-differences estimation, aggregated over post-treatment years, over a bi-annual sample period of 2013-2021 and using cohorts $c \in \{2015, 2017, 2019, 2021\}$. The treatment group for cohort c are those who we observe first signing an NC in year c. The control group consists of workers who (a) changed jobs between year c and the preceding survey year, (b) do not hold an NC in year c, and (c) sign an NC at some $t > c$ (the later-treated job movers). Standard errors are clustered by worker and confidence intervals are reported at the 95% level.

Figure A6: Wage Effects of Signing an NC: Two-way Fixed Effects (TWFE) Models



Note: Coefficient estimates are from two-way fixed effect (TWFE) models. Panel (a) reports coefficient estimates from equation 13 over a bi-annual sample period of 2013-2021. Panel (b) reports coefficient estimates from equation 14 over a bi-annual sample period of 2017-2021. Standard errors are clustered by worker and confidence intervals are reported at the 95% level.