The Employment Effects of Non-compete Contracts: Job Retention versus Job Creation

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Abstract

This paper studies the labor market effects of Non-Compete Agreements (NCAs) that constrain employee mobility, in a search model featuring random hiring and endogenous separation. Non-compete clauses limit workers' job opportunities; thus, an unemployed worker who is bound by NCAs has a lower job finding rate relative to the unconstrained worker. Moreover, since NCAs encourage firm investment through the lengthening of job tenure, firms prefer to include them and are incentivized to create vacancies for jobs that have a higher probability of including NCAs in their contracts. Hence, the average job finding rate increases with the incidence of NCAs through increased labor market tightness. Conversely, a higher incidence of NCAs also increases the proportion of job seekers that are constrained by NCAs, making job vacancies more difficult to fill. Therefore, the average job finding rate drops through decreasing labor market tightness. Estimated to the US, the model implies a decreasing job finding rate with the incidence of NCAs, consistent with the evidence found in US data. This fact appears as a trade-off for a lower job separation rate and higher firm investment in worker human capital implied by a higher incidence of NCAs. In equilibrium, the model predicts a higher unemployment rate associated with a higher incidence of enforceable NCAs in the economy. In addition, the paper shows that a restriction on the duration of NCAs is welfare improving.

JEL Classification: J41, J24, J64

Keywords: Non-compete agreements, training, labor-market

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1 Introduction

Interest in a general reduction in competition among firms is pronounced, and this interest has shifted the balance of bargaining power toward employers (Furman and Orszag (2018)). Barriers to competition tend to reduce efficiency and lead to lower output, employment, and wage growth. Among impediments to competition, non-compete agreements (hereafter, NCAs) in employment contracts and their labor market implications have become the focus of a heated controversy in the US media and political arena (Krueger and Ashenfelter (2018)). These contracts, which prevent an employee from joining rival firms for a defined duration, have spread throughout the US labor market. Indeed, a survey conducted by Prescott et al. (2016) shows that about 20% of US workers were bound by NCAs in 2014. Moreover, data from the National Longitudinal Survey of Youth reveal that about 17% of the active young population ages 33-34 were constrained by NCAs in 2017. Often justifiable for protecting firm investments (Shi (2022); Garmaise (2011); Meccheri (2009); Long (2004)), NCAs are now surprisingly used even for lower-paying jobs[1]. Evidence of the disagreement

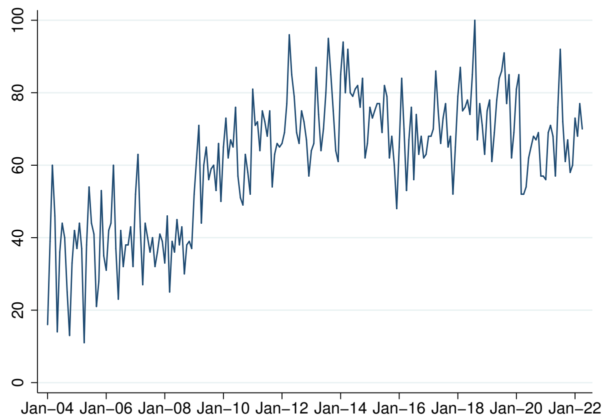


Figure 1: Google Trends results for the keyword search 'Non compete agreement' in the US.

over the benefit of such contracts is reflected through a call for the reform of NCAs by the Obama administration in 2016 and ongoing support for this reform by the Biden administration [2]. Similar debates exist in Austria and Canada, with Ontario becoming

[1]Dave Jamieson, "Jimmy John's makes Low-Wage Workers Sign 'Oppressive' Noncompete Agreements", Huffington Post, October 13, 2014, https://www.huffingtonpost.ca/entry/jimmy-johns-non-compete_n_5978180?ri18n=true

[2]For details, see "State Call to Action on Non-Compete Agreements," https://obamawhitehouse.archives.gov/sites/default/files/competition/noncompetes-calltoaction-final.pdf. See

the second jurisdiction in North America, after California, to prohibit NCAs.[3].

Despite these ongoing and important debates, research on the equilibrium and welfare effects of NCAs is still at an early stage. One reason is that detailed data on these labor contracts have only recently become available. The rare attempts at taking a structural approach toward understanding the equilibrium effects of NCAs for informed policy design have focused particularly on the managerial labor market (Shi (2022)) or the low-wage labor market (Potter et al. (2022)). This paper seeks to understand the pros and cons of NCAs based on a frictional labor-market model. It takes into account two important (different but complementary) dimensions of the provision of NCAs: their incidence and enforceability. My research is motivated by the significant correlations between the incidence of NCAs and aggregate labor market outcomes. Using data from the Longitudinal Employer-Household Dynamics (LEHD) and the Current Population Survey (CPS), I document that the transition rate from employment to unemployment is particularly low in US states that are experiencing a high incidence of NCAs. This relationship still holds at the national level across industries, suggesting that, on average, an employed worker experiences longer job tenure when she is more prone to signing non-compete agreements. More interestingly, the same pattern is observed for the transition rate from unemployment to employment, implying that, on average, job seekers are less likely to find jobs in an environment in which most employment contracts that are signed include non-compete clauses. Formally, I estimate that a 10 percentage point (p.p.) increase in the incidence of NCAs significantly lowers the job-finding rate and the transition rate of job separation to unemployment by 1.6 p.p. and 0.25 p.p., respectively, ceteris paribus.

As a robustness check, I take advantage of the enforcement reform of NCAs across the US during the period 1992-2010, as reflected in various state NCAs enforcement indexes (See Garmaise (2011)). Indeed, non-compete agreements are more likely to be popular among companies whose employees work in states that allow the inclusion of NCAs. I mainly focus on Florida, with its change in NCAs enforcement in 1996 as a case study. Indeed, Florida's 1996 strengthening of NCAs enforcement offers an attractive case study compared with legal changes in other states. The reasons for

also "Fact Sheet: Executive Order on Promoting Competition in the American Economy," The White House, July 9, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/07/09/fact-sheet-executive-order-on-promoting-competition-in-the-american-economy/

[3]See Ontario's Bill 27, October 25, 2021

choosing this case study, and highlighted in Kang and Fleming (2020), are twofold: (*i*) the legislation in Florida focused purely on restrictive covenants, notably NCAs, (*ii*) Florida has had a four-decade history with the laws governing non-competes, such that employers and employees were probably accustomed to them. The outcome variables considered in this paper are the job destruction and job creation rates from the Business Statistics Dynamics provided by the US Census Bureau. The analysis relies on the synthetic control method developed by Abadie et al. (2015) using the other states as a control group. As expected, the job flow rates drop after the NCAs reform. This finding suggests that more highly enforceable NCAs contribute toward reducing the labor market dynamism brought about by a fall in both job creation and job destruction rates.

To understand the underlying mechanism, I develop a job search model encompassing the signing of non-compete contracts at the hiring stage and in which firms optimally invest in worker human capital. In the model economy, the ex-ante homogeneous job seeker population becomes heterogeneous with respect to NCAs constraints after a transition from employment to unemployment. In this model, there is no on-the-job search[4]. I describe the model mechanism as follows. Since NCAs restrain workers' job opportunities, an unemployed worker who is bound by NCAs has a lower job-finding rate relative to the unconstrained worker. Moreover, since NCAs encourage firm investment by lengthening job tenure, they are attractive to firms and induce them to open vacancies in the economy that have a higher probability of including non-competition clauses in their contracts. Hence, the average job-finding rate increases with the incidence of NCAs and their enforceability through greater labor market tightness. Conversely, a higher incidence of enforceable NCAs increases the proportion of job seekers who are constrained by NCAs, which makes filling vacancies more difficult. Therefore, the average job-finding rate drops through decreasing labor market tightness. The model calibrated to the US economy implies a decreasing job-finding rate with the incidence of NCAs, consistent with the evidence found in the data. This fact appears as a trade-off for a lower job separation rate and higher firm investment in worker human capital implied by a higher incidence of NCAs. In equilibrium, the model predicts a

[4]Since our focus here is to explain the role of NCAs in the flow of workers into and out of unemployment but not to explain their effects on wage dynamics, the abstraction of on-the-job search is meaningful in this context.

higher unemployment rate associated with a higher incidence of enforceable NCAs in the economy.

Moreover, the NCAs employment trade-off translates to the one between the enhancement of aggregate productivity and an efficient level for the unemployment rate, making it theoretically ambiguous to predict the efficiency of NCAs. Our analysis suggests that a low level of the incidence of NCAs is desirable. The inefficiency arises in our model economy mainly because too few jobs are created in an environment with a high incidence of enforceable NCAs. To reduce this inefficiency, this paper proposes a cap on the duration of NCAs post-employment. One advantage of this policy is its simplicity and transparency (i.e., it is easily verifiable without cost for both workers and firms).[5]. Results show that an average duration of NCAs capped at 6 months leads to steady state welfare gains of about 6.8%. The gain is greater in a regime with a high level of NCAs enforcement.

This paper is complementary to the literature on the implications of NCAs in employment contracts on both the worker and firm side. On the firm side, non-compete contracts encourage firms to invest in employees' human capital or training and hence facilitate innovation (Garmaise (2011); Meccheri (2009); Long (2004); Callahan (1985)). This paper contributes theoretically to this literature by showing that NCAs partially help to lessen the hold-up problem. However, unlike in Shi (2022)), which considers Bertrand competition between three parties (incumbent employer, employee, and new potential employer) à la Cahuc et al. (2006), this paper relies on the higher job tenure incentive that NCAs generate. However, NCAs may also affect a firm's activities. In this sense, Starr et al. (2017), relying on the variation in the intensity of NCAs enforcement across the US, found that NCAs have an ambiguous effect of on start-up activity. Two mechanisms are underlined here. The first one is referred to as a «*screening effect* »: A greater degree of enforcement lowers the expected returns to spin-off activity by raising the probability of losing a lawsuit over violating the terms of a non-competition agreement. The second mechanism refers to the potential « *investment protection effect* » of NCAs, which potentially stimulates start-up activity and employment growth. This paper embraces the same idea in the search and matching framework, showing that job creation relies on the training motive effect of NCAs (leading to higher job

[5]See Shi (2022) for the same consideration

creation) and the proportion of job seekers constrained by NCAs (leading to lower job creation). First, as an empirical contribution, I show that the second effect dominates because the job-finding rate decreases in an environment with a higher incidence of enforceable NCAs. Second, the DMP model calibrated to the US economy and relying on the mechanism above delivers qualitatively the same result. *On the worker side*, Starr et al. (2019), using worker-level data, argues that NCAs, through their chilling effect on worker mobility, slow wage dynamics in the labor market. This paper finds that the incidence of enforceable NCAs has an ambiguous effect on wages because of the opposing effects on outside options and training in our DMP setup.

Since NCAs lead to a low separation rate and low probability of finding a job, they generate two opposite effects on unemployment. To the best of my knowledge, this paper is the first to study the equilibrium effect of NCAs on the unemployment rate in the context of a search and matching model.

Finally, in terms of an efficiency analysis of the provisions of NCAs, my work is closely related to Shi (2022) and Potter et al. (2022). My results align with the former, suggesting that a cap at NCAs duration is welfare enhancing, whereas they are in opposition with Potter et al. (2022)'s finding in term of job creation effect of NCAs. I show that the trade-off associated with NCAs and employment leans toward the negative side. Nevertheless, comparatively speaking, my findings have broader relevance.

The rest of the paper is organized as follows. Section 2 documents the relationship between the incidence of highly enforceable NCAs on aggregate job flow rates. Section 3 introduces the model. Section 4 provides a theoretical analysis of the effect of the incidence of enforceable NCAs on aggregate labor market outcomes. Section 5 presents a quantitative evaluation of the impact of a higher incidence of NCAs on job flow rates, investment, and the equilibrium unemployment rate. Section 6 highlights an efficiency analysis, followed by a policy evaluation, of NCAs. Sections 7 and 8 discuss and conclude.

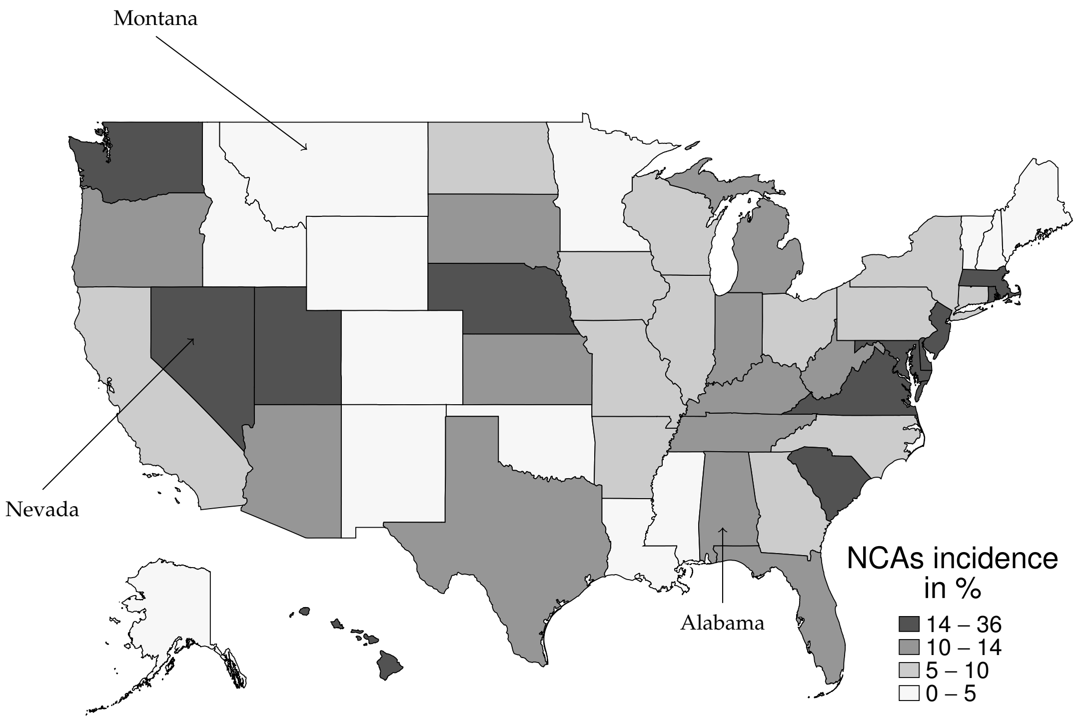
2 Empirical evidence

This section presents empirical evidence on the NCAs and their impact on the labor market. More precisely, we study the intertwined relationship between NCAs incidence and transition rates into and from employment.

Data on NCAs incidence come from the Non-compete survey in the US (Starr et al. (2021)). The survey was designed in 2014 to shed light on the use of NCAs in the US labor market. The data are representative of the US workforce and cover people aged between 18 to 75 who are either unemployed or employed in the private sector or a public healthcare system. It is, at this date, the only representative survey informing on the use of NCAs in the US. The final sample contains 11,505 respondents from all states, industries, occupations, and other demographic categories. I focus on the incidence of NCAs, defined as the proportion of workers bound by an NCAs contract and measured at the state or industry level. The data report heterogeneity in the use of NCAs across States, industries, and education levels in the US. Figure 2 maps State level NCAs incidence in the US for the survey's year (2014). Darker shades encode higher NCAs incidence. It highlights that States with NCAs incidence above 15% or below 5% can be found throughout the country. The cross-sectional standard deviation is 2.3 percentage points.

In addition to Non-compete survey data, I collect the NCAs enforceability index across

Figure 2: NCAs incidence across US States



States. The index scores the enforceability of the NCAs contracts based on legislation and case law. In other words, It measures, across states, the degree to which the Non-compete clauses effectively constrain workers who signed them, with a higher score indicating a strong NCAs enforcement. The NCAs enforceability index widely used in the literature comes from Bishara (2011)[6]. Nevertheless, I borrow the state-level weighted index constructed by Starr (2019) and built on Bishara (2011) index for year 2009 [7].

Data on the job flow rates come from the Longitudinal Employer-Household Dynamics (LEHD) program. I supplement those data with the Current Population Survey data to obtain the micro-level transition rates between unemployment and employment monthly over time. I truncate the CPS data to the same period covered by the Non-compete survey. I depict the empirical evidence into two facts:

FACT 1: *On average, the job separation rate decreases with NCAs incidence*

The panel (a) in Figure 3 shows a scatter plot of the proportion of workers bound by NCAs, named NCAs incidence (x-axis) and transition rate from employment to non-employment (y-axis) across states and industries in 2014. The plots show a decreasing pattern between the incidence of NCAs and job separation rates. The correlation coefficient is -0.51 with a standard error (s.e.) of 0.12 across States. This negative correlation is stronger across industries at the aggregate level (See panel (b)) with a correlation coefficient equal to -0.65 and an associated standard error of 0.20.

To formally test the relationship, I embed data on the State-industry combination of NCAs incidence into the CPS data and exploit its panel dimension. The panel version of the CPS data is constructed following Shimer (2012). More precisely, I match individuals over two consecutive months in the CPS basic monthly files following Albert (2021) to compute job flow rates. As stressed before, NCAs incidence in State-industry combination data come from the Non-compete survey (Prescott et al. (2016))[8]. The

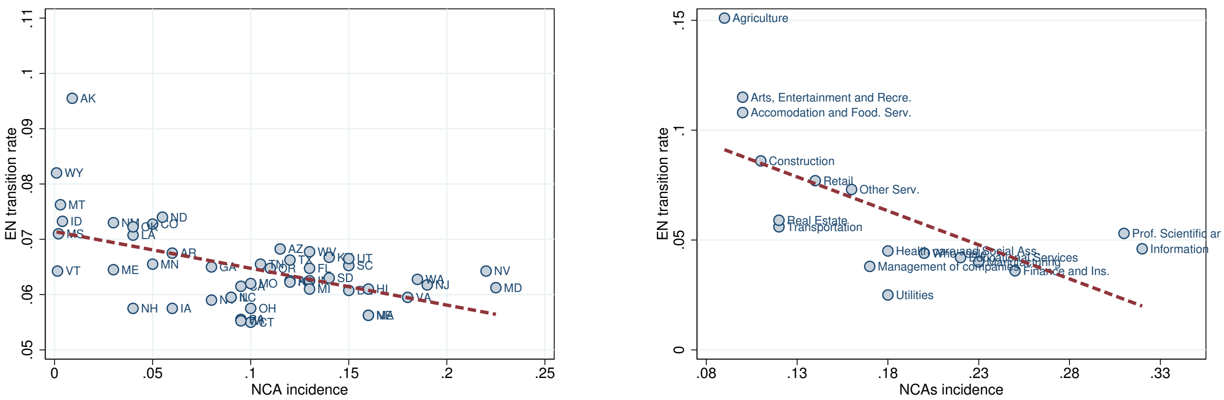
[6]Bishara (2011) looks at the following dimensions across jurisdictions: whether a State statute of general enforceability exists, the scope of employer's protectable interest, plaintiff's burden of proof, consideration provisions, modification of overly broad contracts, and enforceability upon firing.

[7]2009 is the most recent year for which the index is constructed. Despite some recent changes in 2015 and 2016, which I view as non-significant, 2009 measures are a good proxy for the level of enforceability in 2014 (See Starr et al. (2019) for the same consideration)

[8]I thank Evan Starr for making these data available to me

exercise here is to understand how likely employed workers are to lose their job or transition to unemployment in a State-industry combination with a high incidence of NCAs.

Figure 3: NCAs incidence and job Separation rate in US, 2014



(a): States

(b): Industries

Notes: Panel (a) shows the relationships across States. Panel (b) highlights it across industries at 2-digit code using NAICS 2017. Across States, the correlation coefficient is -0.51 (s.e. 0.12) and -0.65 (s.e. 0.20) across industries. EN data come from LEHD, 2014 and NCAs incidence from Non-competes survey, 2014 (Starr et al. (2021)).

I run the following linear probability specification:

$$y_{isjot} = \alpha(\text{NCA incidence})_{sj} + X_i\beta + \eta_s + \varepsilon_{isjot} \qquad (1)$$

where y_{isjot} is a dummy variable that equals one if EU transition occurs for worker i and 0 otherwise, in State s, industry j and occupation o happened in period t. It could also be a dummy variable that equals one if UE transition occurs and 0 otherwise. X includes worker demographics controls such as gender, race, education level, age, age squared, and immigrant status. The specification also controls for state, industry, and state by occupation fixed effects to ensure that any of those heterogeneities between workers explaining the transitions is a driving force. A period is a month, but I restrict the sample period years to 2012-2014 since the NCAs incidence measure comes from a survey realized in 2014 [9]. Table 1 reports the regression results for the job separation rate. It shows that a ten percentage point increase in NCAs incidence (about one standard deviation in the State-industry NCAs incidence in our sample) lowers the job separation rate by 0.25 p.p, after controlling for state fixed effects and covariates.

[9] the results are robust to change of this period (only 2014 or 2013-2014)

The result is statistically significant at 1% level. Columns 4 and 5 of the table 1 report that the negative and significant effects hold even after controlling for industry and State-occupation fixed effects.

However, what matters is not the incidence of NCAs per se but the incidence of enforceable NCAs. Hence, I interact the NCAs incidence with the index of NCAs enforcement across States. I normalized the index to California at 0 (lowest NCAs enforcement regime) and Florida at 1 (highest enforcement regime). Results are reported in table A1 in appendix A. It shows that the magnitude of the negative effect between NCAs incidence and the job separation rate is larger in higher-enforcement states. Particularly, in a high-enforcement state like Florida, job separation decline amounts to 0.29 percentage points monthly compared to a low-enforcement State like California. In sum, on average, an employed worker experiences longer job tenure when performing in an environment with a higher probability of signing an enforceable non-compete contract. This fact is in line with previous studies (Shi (2022), Starr et al. (2019)) and consistent

Table 1: NCAs incidence and job separation rate

	(1)	(2)	(3)	(4)	(5)
NCAs incidence	-0.026^{***}	-0.019^{***}	-0.025^{***}	-0.012^{***}	-0.006^{**}
	(0.0043)	(0.0038)	(0.0054)	(0.0021)	(0.0028)
Demographics	No	Yes	Yes	Yes	Yes
Year/state FE	No	No	Yes	Yes	Yes
State by occupation FE	No	No	No	Yes	Yes
Industry FE	No	No	No	No	Yes
N. Obs.	250876	250876	250876	250402	250402

Note.- Dependent variable is the probability of a EU transition. Data come from the CPS monthly basic files 2012-2014. Demographic controls include *gender, race, age and age squared, education level and immigrant status*. Standard errors in parenthesis, clustered at state level.

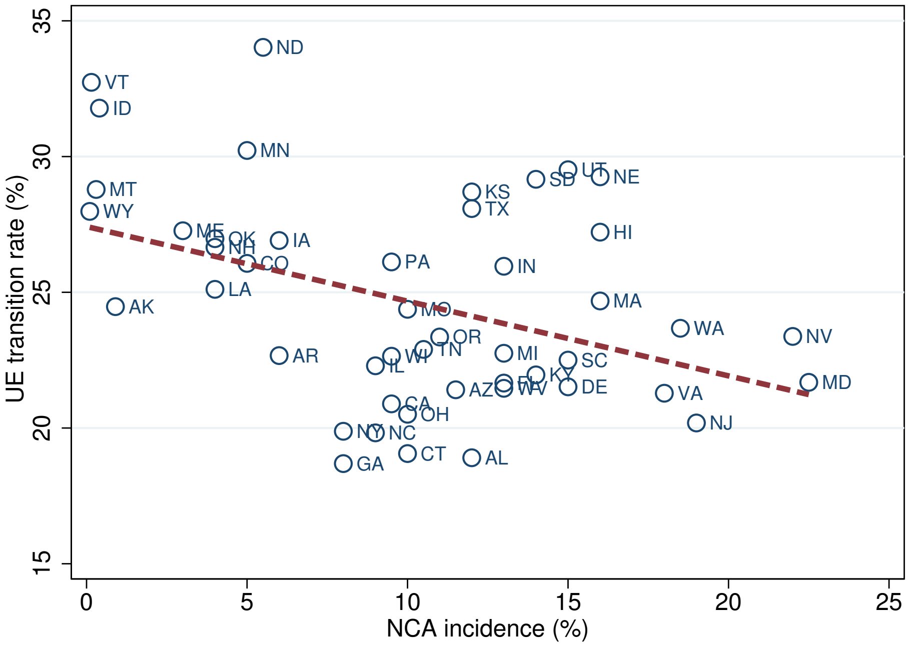
$^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$

with the nature and patterns of Non-compete agreements which are to impede worker mobility.

FACT 2: *On average, the job-finding rate declines with NCAs incidence*

I next examine the relationship between job finding rate and NCAs incidence. Figure 4 shows a scatter plot of the job-finding rate against NCAs incidence across US states in 2014 using the panel dimension of CPS data as explained above. As we can see, NCAs incidence seems not only to affect the job separation rate but also the rate at which job seekers find a job. The correlation coefficient is -0.48 with a standard error (s.e.) of 0.13 in raw data. The result suggests that job seekers in states with a high NCAs incidence have, on average, a low probability of finding a job. I formally test

Figure 4: NCAs incidence and job finding rate across States, 2014



Note.-. Across States, the correlation coefficient is -0.48 (s.e. 0.13). UE data come from CPS, 2014 and NCAs incidence from Non-competes survey, 2014 (Starr et al. (2021)).

the correlation as in fact 1, using the same specification as in equation 1 and controls. Table 2 reports the regression results. It shows that a ten percentage point increase in NCAs incidence (about one standard deviation in the State-industry NCAs incidence in our sample) lowers the job-finding rate by 1.6 p.p, after controlling for State fixed effects and covariates. The result is statistically significant at 1% level. The interaction with the strength of NCAs enforcement reveals in table A1 in appendix A that the magnitude of the NCAs incidence is larger in higher-enforcement states. Particularly, in a high-enforcement state like Florida, the job-finding rate decline amounts to 1.55 percentage points monthly compared to a low-enforcement State like California, after one standard deviation increase in NCAs incidence (about 10%). In sum, on average, job seekers are less likely to find a job in an environment where most employment contracts signed include Non-compete clauses. This fact is consistent with the theory that the incidence of NCAs contracts might inhibit the entry of new firms (See House (2016), Nunn (2016)).

Table 2: NCAs incidence and job finding rate

	(1)	(2)	(3)	(4)	(5)
NCAs incidence	-0.136^{***}	-0.122^{***}	-0.160^{***}	-0.093^{*}	-0.142^{*}
	(0.0376)	(0.0349)	(0.0321)	(0.0533)	(0.0845)
Demographics	No	Yes	Yes	Yes	Yes
Year/state FE	No	No	Yes	Yes	Yes
State by occupation FE	No	No	No	Yes	Yes
Industry FE	No	No	No	No	Yes
Observations	19141	19141	19141	18500	18500

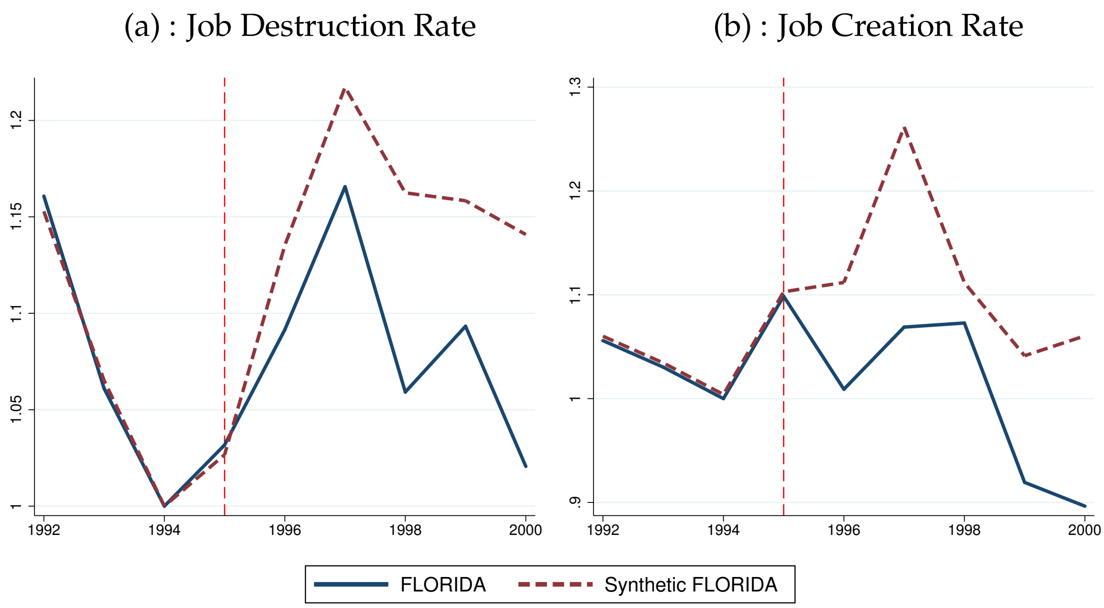
Note.- Dependent variable is the probability of a EU transition. Data come from the CPS monthly basic files 2012-2014. Demographic controls include *gender, race, age and age squared, education level and immigrant status*. Standard errors in parenthesis, clustered at state level.
$^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$

2.1 Robustness

Given that the NCAs incidence data is cross-sectional, one key concern from the previous results is the persistence over time of the findings presented above. To mitigate that issue, I study the change in job creation and destruction rates following an NCAs enforcement reform. To do so, I take advantage of the NCAs enforcement reform across States during the period 1992-2010 materialized in variation in State NCAs enforcement index (See Garmaise (2011)). Indeed, it is more likely that NCAs are popular among companies with employees working in States where they are allowed. I mainly focus on Florida State's change in NCAs enforcement in 1996 as a case study. A fundamental change in Florida's NCAs law was the introduction of a presumption of injury to a firm when a non-compete agreement is violated. Florida's 1996 strengthening of NCAs enforcement offers an attractive case study compared to law changes in other states. Indeed, Florida provides a close to the ideal site because (i) the legislation focused purely on restrictive covenants, notably NCAs, (ii) it was intended to strengthen enforcement in the state, and (iii) Florida has had a four-decade history with the laws governing non-competes, such that employers and employees were probably familiar with and accustomed to NCAs.

By assumption, the facts found above imply that conditional on the unemployment rate, the job creation (JCR) and job destruction (JDR) rates would fall after 1996 Florida's NCAs reform, making them more enforceable. I focus on the job creation rate from establishment births over the last 12 months or, clearly, the job creation from establishments with firm age equal to zero. The reason is that for those firms, it is more

Figure 5: Effect of NCAs enforcement strengthening on job flow rates in Florida



likely that they are in a growing stage and would like to hire, an incentive that the strengthening of NCAs might chill. For a more robustness check, I do the same exercise on high-growth firms, predominantly young firms with 65% less than 10 years old according to Haltiwanger (2015). I consider firms aged 10 years or less, and the results here still hold (See figure A1 in appendix A). The analysis uses data from the Business Statistics Dynamics provided by the U.S. Census Bureau. It relies on the synthetic control method developed by Abadie et al. (2015) using the others States as a control group. The synthetic control method is well known and requires little description. The idea is to find a combination of comparison units (here, the other States except for Florida) named synthetic unit that better reproduces the characteristics of the interested unit (here, Florida) in terms of the outcomes (here, job flows rates) predictors before the reform. Synthetic controls are more suitable when the units of analysis are aggregate entities such as counties, States, regions, and countries. They are attractive because of their simple interpretability and transparency. Here, the States' characteristics that I matched are the unemployment rate, the GDP growth rate, the logarithm of the population aged 16 years or more, and the black population ratio. Figure 5 shows the results obtained after normalizing values relative to the 1994 value. An essential advantage of normalizing the values is that I can account for the time-invariant difference between Florida and other states (See Kang and Fleming (2020)). As expected, we can see that the job flow rates decreased following the reform, and the effect lasted some years after. I carried out placebo tests asking whether the results could be driven entirely by some randomness. In other words, How often would we obtain results of this magnitude if we had chosen a state randomly for the study instead of Florida? Hence, placebo tests repeat the analysis using States alternately in the control group and ask whether the conjectured effect on the job flow rates is present or not and whether the magnitude is as large as the one found with Florida.

Figure A2 in appendix A shows the distribution of estimated job flows rate gaps for states in the control group that comes from the iterative procedure. The result shows that the estimated gap for Florida during the 1996-2000 period is unusually large relative to the distribution of the gaps for the states in the control group.

3 Model

In this section, I develop a theoretical framework to account for the aforementioned facts. The model helps to understand the possible mechanism underlining the declining labor market dynamism generated by using NCAs contracts. It also offers a framework to analyze the implication of NCAs regarding unemployment rate, productivity, and welfare.

3.1 Environment

I employ a modified version of the search and matching model in the spirit of Mortensen and Pissarides (1994). Time is discrete and the horizon infinite. There is a continuum of ex-ante identical workers of measure one, infinitely lived and risk-neutral. They derive utility from consumption and maximize the present discounted value of their utility. On the other side of the market, there is a larger continuum of risk-neutral firms with the same discount rate β as workers. The labor market is frictional. There exists a constant return to scale matching technology $M = m(u, v)$, with the unemployment rate u and the vacancy rate v as inputs. The labor market tightness $\theta = v/u$ is a sufficient statistic for the job finding and vacancy filing rates. A vacancy is matched to a worker during a period with probability $q = m(\frac{1}{\theta}, 1)$. A worker finds a job with probability $f = \theta q(\theta)$. Once matched, a pair firm-worker (a job) operates under an NCAs contract with probability ϕ. Non compete agreements contract status $b = 0, 1$ determine the set of feasible contracts. Working with an NCAs contract sets $b = 1$ and restricts the worker's post-employment mobility. In this environment, firms offer training to the employed worker, enhancing the match productivity at $C(i)$ cost. Training is match-specific, and the match productivity is $p + i$ where $p > 0$ denotes the common productivity, assumed exogenous. Furthermore, an employed worker is subject to an i.i.d idiosyncratic preference shock ε that alters her decision to continue the match leading to endogenous job separation. In addition, the match could be dissolved at an exogenous rate δ. The preference shock is only observable by the employee. There is no on-the-job search, and the job-to-job transition is through an unemployment spell.

3.2 Employment and unemployment values

Workers are either employed or unemployed and searching for a job. The ex-ante homogeneous job seeker population becomes heterogeneous with respect to NCAs constraints after transitioning from employment to unemployment. Thus, due to match separation, workers are of four types: employed bound by NCAs, employed unbound by NCAs, unemployed bound by NCAs, and unemployed unconstrained by NCAs. The timing of events and decisions is as follows: First, a firm with a vacant job matches with a worker and then randomly decides to assign or not an NCAs contract to the worker. Once the contract is assigned, the firm decides how much to invest in workers' firm-specific skills, conditional on the type of contact. The firm and worker then bargain the wage. Subsequently, production takes place, and profit is shared. Second, the employed worker observes the preference level ε and decides whether to quit or continue the match, which implies an endogenous separation rate. If she quits but was under NCAs contract before job separation, she becomes unemployed, and the NCAs are binding one period ahead with probability χ. If the match continues, the worker is subject to the same NCAs status, and there is no contract renegotiation. Furthermore, all matches are exogenously destroyed with per-period probability δ. The problem of employed workers is defined by a continuation decision :

$$W^c(b,i,\varepsilon) = \max\left\{ \underbrace{W(b,i)+\varepsilon}_{\text{stay}}, \underbrace{U(b)}_{\text{quit}} \right\} \tag{2}$$

Where $U(b)$ is the value of quit, equivalently the value of being unemployed with NCAs status b (with the associated optimal quit policy $x(b,i,\varepsilon) \in \{0,1\}$)
The value of being employed is, then, given by :

$$W(b,i) = w(b,i) + \beta\Big\{\delta U(b) + (1-\delta)\mathbb{E}_\varepsilon W^c(b,i,\varepsilon)\Big\} \tag{3}$$

As shown later, a threshold exists for preference shock $\bar{\varepsilon}(b,i)$ under which the employee decides to quit. The expectation in equation (3) is only taken over preference shock because, as long as the match continues, an employed worker in state (b,i) remains in this state.

An unemployed worker receives unemployment benefit z while searching for a job. Let us assume that in expectation, the worker bound by NCAs starts with $\bar{i}_1$ and the unbound one with $\bar{i}_0$. The value of the unemployed worker unconstrained by NCAs is given by :

$$U(0) = z + \beta\Big\{f(\theta)[\phi\, W(1,\bar{i}_1) + (1-\phi)\, W(0,\bar{i}_0)] + [1-f(\theta)]U(0)\Big\} \tag{4}$$

Conditional on finding a job, the unbound unemployed worker is employed with NCAs with probability ϕ and is free of NCAs with counter probability. The path of unemployed worker constrained by NCAs is however slightly different and separates into two cases depending on whether the non-compete clause turns out to be enforceable or not. Unemployed value of worker bound by NCAs $U(1)$ satisfies:

$$U(1) = z + \beta(1-\chi)\Big\{f(\theta)[\phi\, W(1,\bar{i}_1) + (1-\phi)\, W(0,\bar{i}_0)] + [1-f(\theta)]U(0)\Big\} + \beta\chi\mathbb{E}[U(b')] \tag{5}$$

Where b' stands for next period NCAs status. Since the NCAs constraint lasts a finite period, there is a law of motion for the status of NCAs in the post-employment period (unemployed spell). I assume that the unemployed worker bound by NCAs becomes unconstrained next period with probability μ. Hence, NCAs unemployment status b' remains 1 with probability $1-\mu$ and becomes 0 with counter probability. This probability is assumed exogenous and will be recovered later from the average duration of NCAs. χ stands for the NCAs enforcement probability and accounts for the tightness of NCAs constraint. The higher is χ, the more stringent are the NCAs. We could allow the enforcement probability χ to be endogenously linked to the probability of relaxing NCAs constraint μ. The reason is that the probability parameter μ is related to the duration of NCAs restriction, and the lower the duration, the easier it is to enforce NCAs clauses. However, I choose to exogenous χ and link μ to the average NCAs duration across States. Hence, I can account for factors related to NCAs enforcement other than their duration.

Note that the training level of a typical firm has no impact on the worker's fallback position $U(0)$ or $U(1)$, which depends on the equilibrium level of training. In other words, the training level corresponds to the best response to the symmetric equilibrium profile of strategies where all firms choose either $\bar{i}_0$ and $\bar{i}_1$. The equilibrium is indeed defined by $i(b) = \bar{i}_b$, but $\bar{i}_b$ thereby $U(b)$ are taken as given when the firm chooses its optimal training level.

3.3 Job creation

Let V denote the value of expected profit from a vacant job. In the present framework, firms are assumed to post vacancies that might be filled by NCAs job with probability ϕ and by No NCAs job with probability $1-\phi$. Moreover, each type of implicit vacancy involves training the employee by the amount i at cost $C(i)$.

The value of expected profit of a vacant job V in the economy is given by:

$$V = -\kappa + \beta \max_{i(0),i(1)} \left\{ q(\theta) \left[\tilde{\eta} \left\{ \phi[J(1,i(1)) - C(i(1))] + (1-\phi)[J(0,i(0)) - C(i(0))] + (1-\tilde{\eta})V \right\} \right] + [1-q(\theta)]V \right\} \tag{6}$$

Where

$$\tilde{\eta} = \eta + (1-\chi)(1-\eta)$$

stands for the probability that the match is allowed, in the sense that once randomly met, the NCAs constraint does not distort the match to be successful. η represents the endogenous probability of meeting unemployed workers unconstrained by NCAs. $J(b,i)$ is the value of filled job with NCAs status $b = 0,1$ and training i. The explanation of the vacant job bellman equation 6 is standard. The vacancy posting requires a cost of recruiting κ, and with probability, $q(\theta)$, the vacancy encounters an unemployed worker either bound by NCAs or free of NCAs. Once the match is successful, which happens with probability $\tilde{\eta}$, the vacancy is filled with NCAs contract at rate ϕ and without NCAs at counter rate $(1-\tilde{\eta})$ or remains vacant otherwise.

The free entry condition of supplying a vacant job is $V = 0$ and implies job creation condition:

$$\frac{\kappa}{\beta q(\theta)} = \max_{i(0),i(1)} \tilde{\eta}\Big\{\phi[J(1,i(1)) - C(i(1))] + (1-\phi)[J(0,i(0)) - C(i(0))]\Big\} \quad (7)$$

This optimization problem from the job creation condition directly implies that the optimal training investment is described by:

$$i(b) = \text{argmax}\Big\{J(b,i) - C(i)\Big\}$$

Let $w(b,i)$ be the wage from an occupied job with worker of NCAs status b and training intensity i. The value of filled job with NCAs status $b = 0,1$ and training i, $J(b,i)$ satisfies:

$$J(b,i) = p + i - w(b,i) + \beta\Big\{\delta V + (1-\delta)[(1 - G(\bar{\varepsilon}(b,i)))J(b,i) + G(\bar{\varepsilon}(b,i))V]\Big\} \quad (8)$$

Firm's instantaneous payoff consists of production after training minus wage paid. A match is exogenously severed with probability δ and with counter probability endogenously blown up with quit probability $G(\bar{\varepsilon}(b,i))$. In that case, the job becomes vacant next period and firm receives V. From now and later on, denote $\tilde{G}(\bar{\varepsilon}(b,i)) = (1-\delta)\, G(\bar{\varepsilon}(b,i)) + \delta$, the job separation rate.

NCAs and firm's investment choice. As training is firm-sponsoring and incurs a cost $C(i)$, a firm will choose a training level that maximizes the net value of filled job

$J(b,i) - C(i)$, given the unemployment rate, labor market tightness, and unemployment value. Hence, training is set so that the marginal benefit of filling a vacancy with a pair (b,i) equals the marginal cost of training. That is :

$$\frac{\partial J(b,i)}{\partial i} = C'(i) \tag{9}$$

Using equation 8, optimal investment condition can be rewritten as

$$C'(i) = \underbrace{\frac{1}{1-\beta(1-\tilde{G}(\bar{\varepsilon}(b,i))}}_{\text{Average match duration}} \left[\underbrace{1 - \frac{\partial w(b,i)}{\partial i}}_{\text{Direct marginal profit}} \overbrace{-\beta \frac{\partial \tilde{G}(\bar{\varepsilon}(b,i))}{\partial i} J(b,i)}^{\text{Expected marginal benefit from } \Delta \text{ in quit proba.}} \right] \tag{10}$$

An increase of one unit of training intensity incurs a marginal cost of $C'(i)$ and generates a marginal benefit which corresponds to the RHS of Eq.(10). The return to training can be decomposed in two terms: (i) training raises productivity and wages through rent sharing, which gives rise to a direct return to training ; (ii) training also makes the employment relationships more stable. The more productive the match, the less easily it is destroyed; thus, the second effect corresponds to a return to job stability.

Notice that the separation rate $\tilde{G}(\bar{\varepsilon}(b,i))$ only depends on training intensity i through wage $w(b,i)$. Hence, if wages were independent of training, then the marginal benefit of training would only depend on the average match duration. Thus, higher training intensity will be associated with job type with high match duration. As shown later, this result holds after wage adjustment, which makes the role played by the wage meaningful in determining optimal training level.

3.4 Wage bargaining

I follow the search and matching literature and assume that wages are determined by Nash Bargaining. Consider a firm-worker match currently associated with the pair (b,i) such that it generates a positive surplus. Nash Bargaining implies that the wage, $w(b,i)$, solves :

$$(1-\rho)\left(W(b,i) - U(b)\right) = \rho\left(J(b,i) - V\right) \tag{11}$$

where $\rho \in [0,1]$ denotes the worker's exogenous bargaining power. Bargaining outcomes then yields a share ρ of the total surplus of the job $S(b,i)$ to the worker and a share $1-\rho$ to firm. The surplus sharing rule reads :

$$W(b,i) - U(b) = \rho S(b,i) = -\bar{\varepsilon}(b,i) \quad ; \quad J(b,i) - V = (1-\rho)S(b,i) \tag{12}$$

Using employed worker value function, filled job value together with optimal condition (11), it is straightforward to show that wage curve is given by :

$$w(b,i) = \rho(p+i) + (1-\rho)\left[(1-\beta)U(b) - \underbrace{\beta\,(1-\delta)\int_{-\rho S(b,i)} \varepsilon dG(\varepsilon)}_{\gamma(b,i)}\right] \tag{13}$$

As standard, the wage is a weighted average of the match productivity and reservation wage. However, here, the standard reservation wage $(1-\beta)U(b)$ as in Mortensen and Pissarides (1994) is distorted by the nuisance quantity $\gamma(b,i)$. This quantity is the average value of preference shock received by the worker. On average, a positive preference shock implies an increase in the utility of working and a decrease in its opportunity cost. Therefore, the reservation wage decreases. Given training level i and assuming that worker bound or unbound by NCAs has the same outside option value U, a worker with a high probability of retention or stay will receive a higher wage. In short, the bargained wage of each worker type depends on the level of training received, the associated separation rate, and how much NCAs impact the worker's outside option.

Using the value functions and surplus sharing rule, it is straightforward to show (See appendix B) that the total surplus of job (b,i) satisfies:

$$S(b,i) = p + i + \beta\,[1 - \tilde{G}(-\rho S(b,i))]S(b,i) - (1-\beta)U(b) + \beta(1-\delta)\int_{-\rho S(b,i)} \varepsilon dG(\varepsilon) \tag{14}$$

where:

$$(1-\beta)U(0) = z + \beta f\left[\phi\rho S(1,i(1)) + (1-\phi)\rho S(0,i(0)) + \phi\Delta U\right] \tag{15}$$

$$(1-\beta)U(1) = z + \beta\Bigg[f\rho(1-\chi)\mathbb{E}[S(b,i(b))] + [f(1-\chi)\phi - (1-\mu)(1-\chi) - \mu]\Delta U\Bigg] \quad (16)$$

$$(1-\beta)\Delta U = \beta\Bigg[-f\chi\rho\mathbb{E}[S(b,i(b))] - [f\phi\chi + (1-\chi)(1-\mu) + \mu]\Delta U\Bigg] \quad (17)$$

and where $\Delta U = U(1) - U(0)$. I set $\bar{i}_b = i(b)$ as unique symmetric equilibrium, since all firm solve the same investment problem (See also Acemoglu and Pischke (1999)). From equation (17), employed workers constrained by NCAs have lower outside options than their peers unbound by NCAs. This result is stressed in lemma 1.

Lemma 1 *Assuming that both types of jobs exist in equilibrium (positive match surpluses), then employed workers constrained by NCAs have lower outside options than their peers unbound by NCAs, that is* $U(1) < U(0)$.

Proof: See Appendix B.1

The result in lemma 1 is quite intuitive. Since NCAs limit the opportunities of NCAs workers outside her match, the probability of finding a job upon separation is lower than for workers unbound by NCAs.

Equilibrium. A stationary equilibrium consists of policy functions $i(b)$, $\bar{\varepsilon}(b,i(b))$, value functions $W(b,i(b))$, $U(b)$, $J(b,i(b))$, $S(b,i(b))$ and wage function $w(b,i(b))$, labor market tightness θ and unemployment rate such that :

(i) The value functions solve (3) to (8)

(ii) Wage is given by (13)

(iii) Training policy function satisfies (10)

(iv) Free entry (7) pins down labor tightness

(v) Quit decision policy function satisfies $\bar{\varepsilon}(b,i(b)) = -\rho S(b,i(b))$ and

(vi) Unemployment rate u is derived from law of motion of each type of unemployment $u(0)$ and $u(1)$ which read :

$$\Big[\mu + (1-\chi)f(\theta)\Big]u(1) = \phi\,(1-u)\tilde{G}(\bar{\varepsilon}(1,i(1))) \tag{18}$$

$$u(0)\,f(\theta) = \mu\,u(1) + (1-\phi)\,(1-u)\tilde{G}(\bar{\varepsilon}(0,i(0))) \tag{19}$$

Since $u = u(0) + u(1)$, we get:

$$u = \frac{\lambda\Big[\mu + (1-\chi)f\Big] + f\phi\chi\tilde{G}(\bar{\varepsilon}(1,i(1)))}{f\phi\chi\tilde{G}(\bar{\varepsilon}(1,i(1))) + \Big[\mu + (1-\chi)f\Big](f+\lambda)} \tag{20}$$

where $\lambda = (1-\phi)\,\tilde{G}(\bar{\varepsilon}(0,i(0))) + \phi\,\tilde{G}(\bar{\varepsilon}(1,i(1)))$; $f = f(\theta)$

From this expression, we see that unemployment rate is increasing in the job destruction rates for the various types of jobs contract and a decreasing function of the exit rate from unemployment $f(\theta)$. Finally, when $\phi = 0$ (economy without NCAs), we get the familiar expression $u = \dfrac{\lambda}{\lambda + f}$.

The endogenous fraction of unemployed workers constrained by NCAs $(1-\eta)$ is given by:

$$1 - \eta = \frac{u(1)}{u} = \frac{\phi\tilde{G}(\bar{\varepsilon}(1,i(1)))}{\mu + (1-\chi)f}\frac{1-u}{u} \tag{21}$$

which closes the model.

4 Qualitative insights

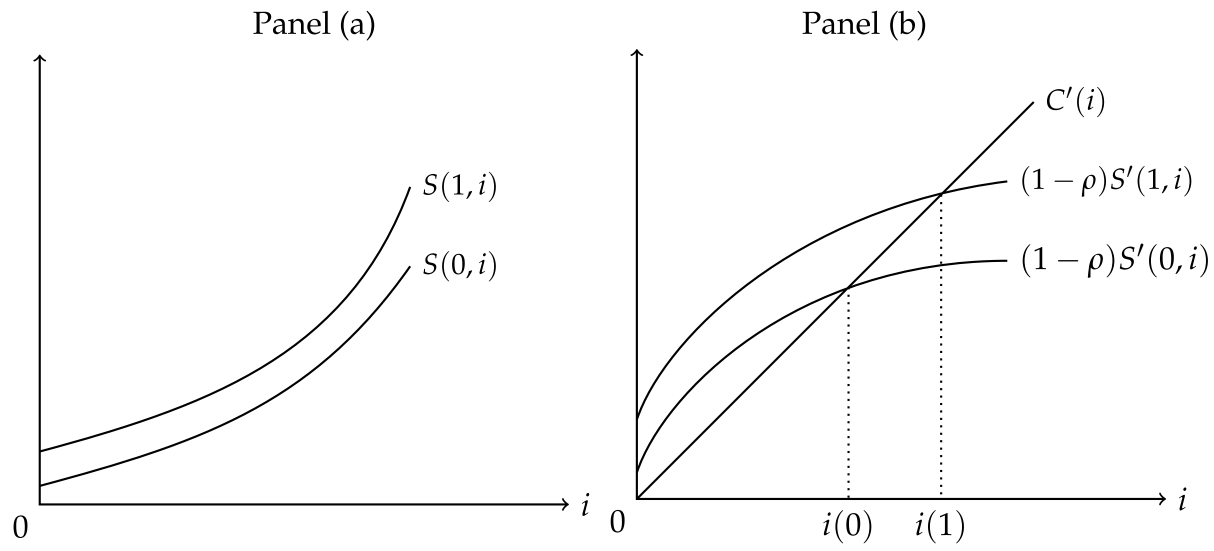
Before turning to quantitative analysis, I provide qualitative insights into the model. I abstract from unemployment to focus on how NCAs interact with training, separation rate, and labor tightness.

Proposition 1 *Conditional on training i, NCAs match surplus is higher than No NCAs match surplus. That is :*

$$S(i,1) - S(i,0)\,|_i > 0$$

The proof is in appendix B.2. Proposition 1 states that if both types of workers (NCAs and No NCAs) received the same level of training, the match surplus would be higher in NCAs' jobs than in No NCAs' jobs for any level of training. The reason is that holding training constant across job types, the only difference between their surpluses comes from the outside options values. Hence, as surplus decreases in the outside

Figure 6



value, from lemma 1, NCAs surplus is higher. Panel (a) in figure 6 illustrates this result. Consequently, NCAs worker receives higher training and experiences a lower separation rate, a result highlighted in proposition 2 above.

Proposition 2 *NCAs worker receives higher training and experiences a lower separation rate*

The proof of proposition 2 is straightforward (See appendix B.3) and the result is intuitive. The analysis of proposition 1 suggests that conditional on training, NCAs worker experiences lower separation than No NCAs worker. Hence, conditional on training level i, NCAs match duration is higher. Therefore the marginal benefit of investment is higher for NCAs job [10]. This result is illustrated in panel (b) of figure 6. The result implies, among others, that the optimal training policy is decreasing in outside value of workers. This is consistent with Acemoglu and Pischke (1998) finding that a lower probability that the worker meets a new employer increases the value of human capital to the incumbent firm [11].

[10] I show that the marginal benefit is increasing in the match surplus and only depends on the latter (sufficient statistic in the model) (See appendix B).

[11] Although there is no on-the-job search in this model, the new employer contact rate stands here for the probability to find a job.

NCAs and equilibrium labor tightness. Let us analyze the effect, given a level of the probability of entering NCAs contract ϕ, of an increase in the policy instrument χ, which is the NCAs enforcement probability, on job creation decision. Since the effects of ϕ and χ are complementary, the results presented here are isomorphic to an increase in ϕ, given a certain level of χ. From the free entry condition (equation 7), we can see that the impact of tightening in NCAs enforcement on job creation depends on its net effect on the expected profit of filling a vacancy. Since a firm's investment is higher with NCAs, the incidence of higher NCAs enforcement increases the expected profit of filling a vacancy. Therefore firms will be keener to open more vacancies, increasing the labor tightness.

$$\begin{aligned}
\frac{\kappa}{q(\theta)} &= \beta \left\langle \underbrace{\tilde{\eta}\Big\{\phi[J(1,i(1)) - C(i(1))] + (1-\phi)[J(0,i(0) - C(i(0))]\Big\}}_{\text{Expected Marginal Benefit of filling vacancy (MB)}} \right\rangle \\
&= \beta\,\tilde{\eta}\,\overline{MB}
\end{aligned}$$

$$\begin{aligned}
\frac{d\ln(MB)}{d\chi} &= \frac{d\ln(\tilde{\eta})}{d\chi} + \frac{d\ln(\overline{MB})}{d\chi} \\
&= \underbrace{\frac{1}{\tilde{\eta}}\left[-\eta + (2-\chi)\frac{\partial \eta}{\partial \chi}\right]}_{\text{Composition of job seekers w.r to NCAs constraint effect (-)}} + \underbrace{\frac{1}{\overline{MB}}\frac{\partial \overline{MB}}{\partial i}\frac{\partial i}{\partial \chi}}_{\text{Training effect (+)}}
\end{aligned}$$

However, the incidence of higher enforcement NCAs influences negatively the marginal benefit of filling a vacancy in two ways: (*i*) directly through $\tilde{\eta}$ and (*ii*) indirectly (a general equilibrium effect) through η, the probability to meet unemployed worker unconstrained by NCAs. These adverse effects, which I called composition of job seekers with respect to NCAs constraint effect, counteract the positive training motive effect, lowering labor tightness and may dominate. Intuitively, a tightening in NCAs enforcement will spread highly enforceable NCAs among unemployed workers. Hence, it becomes difficult for firms to fill a vacancy, lessening the expected profit.

5 Quantitative analysis

In this section, I calibrate the model and analyze the equilibrium effect of Non-compete agreements in a steady state. The parameters are set to match a set of moments describing the dynamics of the US labor market prior to the 2009 recession.

5.1 Calibration

5.1.1 Parameters set externally

The model period is a month. Thus, I set the discount rate $\beta = 0.9967$ so that the model implies a steady-state annualized real interest rate of about 4%. The matching function is assumed to be Cobb-Douglas: $m(u, v) = A\, u^{\alpha} v^{1-\alpha}$. As standard in search literature, I choose a conservative value for the elasticity $\alpha = 0.5$. The bargaining power ρ is equal to α to ensure that the Hosios condition is fulfilled in the benchmark economy (with NCAs). In the benchmark economy, the exogenous probability for a worker to be bound by NCAs is set to $\phi = 0.20$ in line with evidence from 2014's Non-compete survey in the US (Starr et al. (2019)). Also, like in Shi (2022), I use an average duration of NCAs restriction of 1.6 years, consistent with the data. Hence, I calibrate the probability of being unconstrained by NCAs after separation to $\mu = 0.052$. The instantaneous return of unemployment, z, is equal to 40% of the productivity p, which value is normalized to one, consistently with Shimer (2005). The benchmark calibrated value of enforcement probability χ is set to 0.7. This value corresponds to the mean of the NCAs enforceability index developed by Bishara (2011) and improved by Prescott et al. (2016). The index is normalized with values between 0 and 1. The calibrated value is also consistent with Shi (2022), who finds an enforcement probability of 0.4 in a low-enforcement regime like California. With a value of a full-enforcement regime like Florida equals 1, the calibrated value appears to be the average-enforcement regime's value. Finally, I assume a normal distribution for the preference shock with mean m and standard deviation σ. I normalize the mean to zero and internally estimate the standard deviation σ. The resulting calibrated parameters are presented in panel A of the table 3.

5.1.2 Internal calibrated parameters

I assume $C(i) = c\, i^2$ as the functional form for the training cost function that is increasing and convex in training intensity i. I jointly estimate the parameters κ, c, σ, A, δ, respectively, the per-unit cost of vacancy, the training cost parameter, the preference shock distribution standard deviation, the match efficiency parameter, and the exogenous separation rate.

I target a monthly job-finding rate of 0.34 as in Carlsson and Westermark (2022) and Fujita and Ramey (2012). Using Federal Reserve Bank data, I find an average value of labor market tightness, θ of 0.52 over the period targeted. This value of θ yields an estimated efficiency parameter A equals 0.66 together with the targeted monthly job finding rate. The vacancy cost κ is recovered from the free entry condition given the targeted labor tightness value of 0.52. Furthermore, the standard deviation for the preference shock distribution is estimated to match the average job separation rate. The value targeted is 0.02 as in Carlsson and Westermark (2022) and consistent with Bils et al. (2011) who estimated the job separation rate from the Survey and Income Participation Program (SIPP) data over the targeted period. The 2 percent of the average job separation rate and the estimated job finding rate imply a steady-state value of the unemployment rate of 5.81 percent, which closely maps to the value in data over the period.

Table 3: Baseline Calibration of the Model

Panel A: calibrated parameters		
β	Discount rate	0.9967
ρ	Bargaining power	0.5
ϕ	fraction of bound worker	0.2
μ	Proba. of being unconstrained	0.052
χ	NCAs enforcement Probability	0.7
z	Unemployment benefit	0.40
p	Common productivity	1
m	Preference shock mean	0
Panel B: Moment-matched parameters		
A	Matching efficiency	0.660
κ	vacancy cost	0.725
c	Training cost parameter	258.00
δ	Exogenous job separation rate	0.0196
σ	Preference shock std.	0.513

Finally, the exogenous separation rate δ, and the training cost parameter c are estimated by targeting respectively the ratio of the average job tenure in NCAs job versus No NCAs jobs and the corresponding hourly wage ratio. Using data from the 1997's National Longitudinal Youth Survey (NLSY97), I compute that, on average, NCAs worker has 73.42 weeks of job tenure with an employer while No NCAs worker spend 62.42 weeks in employment relation. It implies a ratio of 1.17 of job tenure. Furthermore, Rothstein and Starr (2022), using NLSY97 estimated that worker bound by NCAs earns 5 percent more everything else equal. This estimate implies a targeted wage ratio of 1.05 for the baseline calibration.

Panel B of Table 3 summarizes the resulting internally estimated parameters. Table A2 in appendix A reports the targeted moments and shows that the calibrated model fits the data moments well.

5.2 Accounting for the stylized facts

I now assess the model's ability to account for the facts 1 and 2 outlined in Section 2. To do so, I simulate the model to generate artificial data comparable with the data used in the empirical analysis of Section 2.

Fact 1. I examine whether the model can account for the negative cross-sectional association between the incidence of NCAs and the job separation rate on average. Specifically, I replicate the cross-section relationships between both variables across States and Industries according to figure 3. To do so, I vary the parameter ϕ to get the same sequence of NCAs incidence across States and Industries as observed in the data [12]. Figure 7 shows that this exercise makes the model predict a statistically significant negative correlation between the incidence of NCAs and job separation rates. As we can see, the model's ability to account for the overall magnitude of the cross-sectional correlation is quite remarkable, especially across industries with a data-model correlation of about 0.80.

Fact 2. Second, I argue that the model is also consistent with the negative cross-

[12] Job separation rate data presented in figure 3 are quarterly, whereas the model is estimated monthly. Hence I estimated the monthly counterpart of the data before comparison. Since one quarter is equivalent to three months, we can infer the quarterly job separation rate s_q from the monthly rate s_m by using the relation $s_q = s_m + s_m(1 - s_m) + s_m(1 - s_m)^2 = 1 - (1 - s_m)^3$

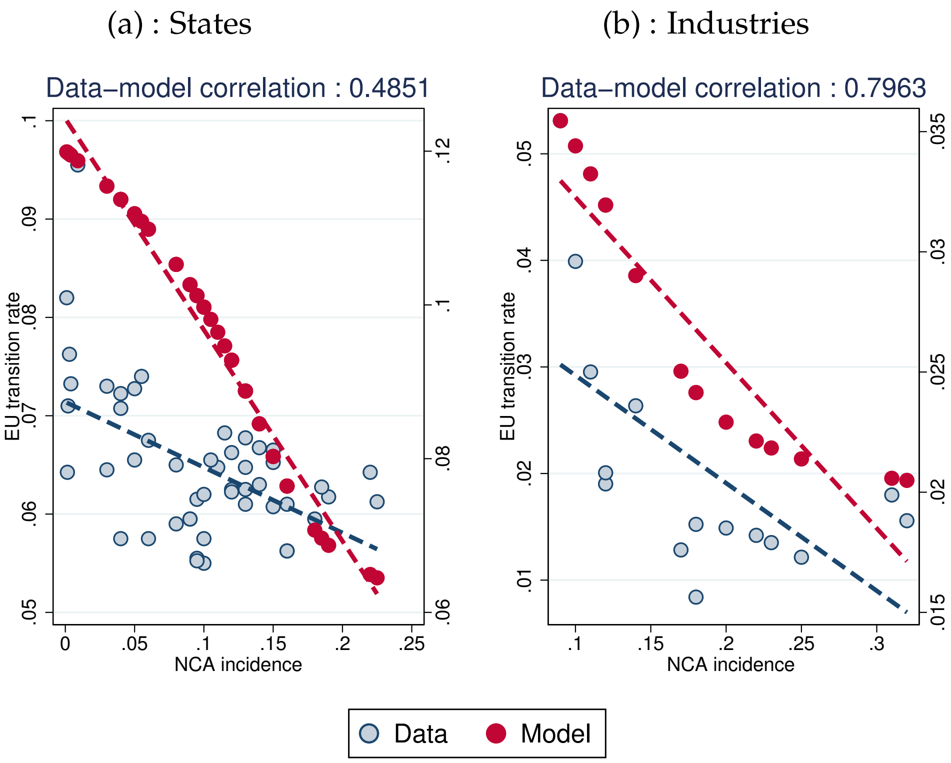


Figure 7: NCAs incidence and job separation rate : Data vs. Model

sectional association between the incidence of NCAs and the job-finding rate observed in the data. To examine this fact through the lens of our model, I proceed in a way analogous to the way I proceed for fact 1. Figure 8 shows a scatter plot in which each dot represents a state, with the x-axis and y-axis, respectively measuring the proportion of workers constrained by NCAs and the probability of transitioning to employment from non-employment. The figure shows that State displaying significant increases in the NCAs incidence also displays a large drop in the job-finding rate, consistent with fact 2. Of course, job-finding rates in the data are also driven by factors other than the prevalence or the use of NCAs studied in the paper. Hence, the correlation observed in the data in Figure 4 is not as tight as the model counterpart in Figure 8.

5.3 The Effects of Non-Compete Agreements incidence

With the estimated model, I start by describing the decentralized equilibrium in figure 9. Hence, I simulate the model with various levels of the NCAs incidence ϕ.

The results indicate that NCAs worker receives higher training intensity and experiences a lower job separation rate in line with Proposition 2. The low separation rate for

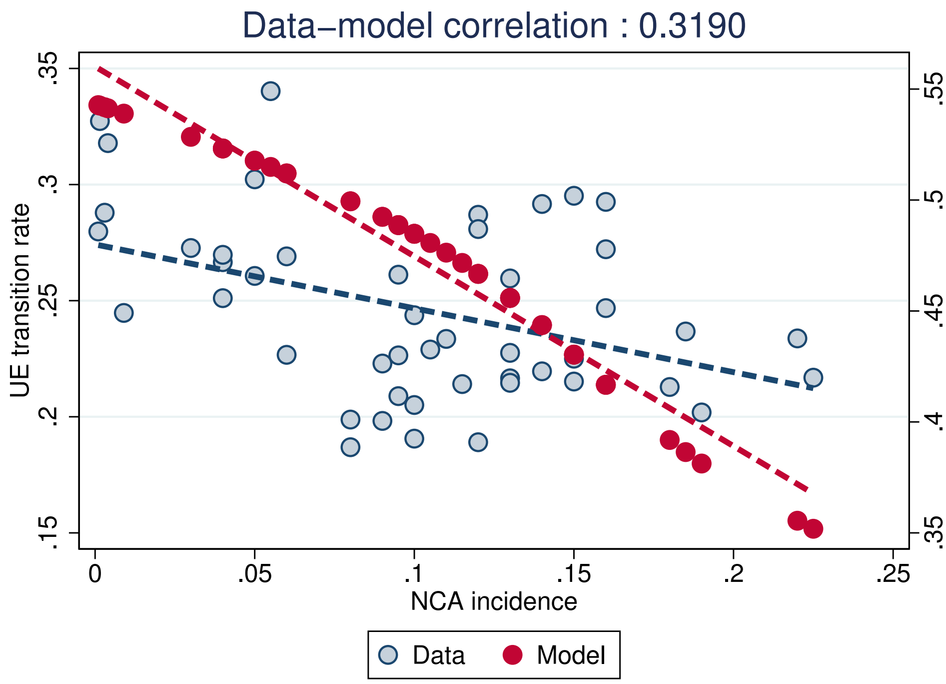
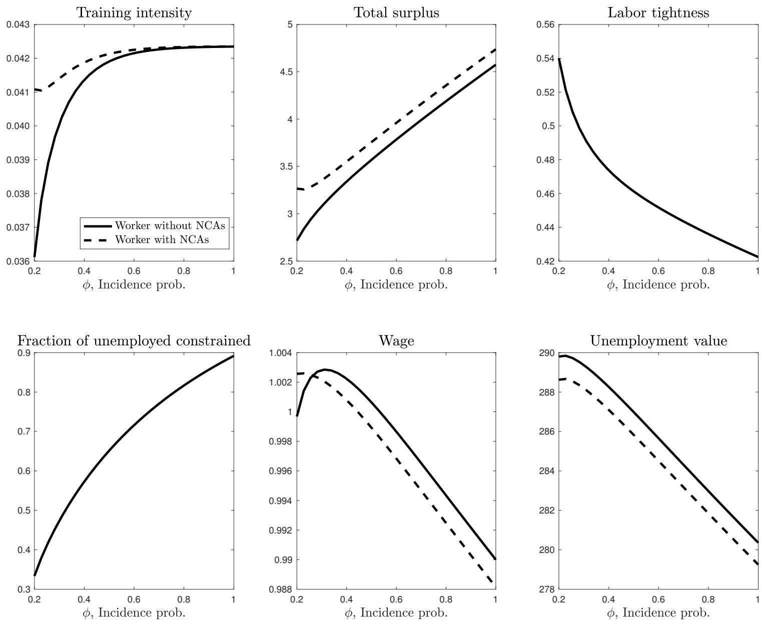


Figure 8: NCAs incidence and job finding rate : Data vs. Model

a worker with NCAs results from a combination of two effects going in the same direction: the drop in the separation initiated by the worker (a quit) and the one initiated by the employer (nil here because not explicitly modeled). Intuitively, as workers' outside options decline due to the NCAs signed, the latter is less willing to quit. The decline in the quit rate encourages the employer to invest in the worker's human capital. As a result, the employer is less likely to lay off the worker. Thus, the employer could extract the maximum possible of its investment.

Results also suggest that not only does the outside option value of NCAs workers decline as the NCAs incidence increases, but the outside option value of the unconstrained worker also drops, a result somewhat surprising. Nevertheless, this finding suggests that NCAs incidence exerts a negative externality on the unconstrained worker. The rationale behind this effect can be analyzed through two channels simultaneously at play. The first channel comes from the potential decline of labor market tightness, decreasing the probability of finding a job. The second channel derives from the fact that there is a positive probability that the NCAs unbound worker will become constrained in the future. This situation contributes to lessening the present value of the unconstrained unemployed worker. This pattern is consistent with the empirical finding in Starr et al.

Figure 9: Comparative Statics with respect to NCAs incidence proportion - ϕ



Note. All parameters except ϕ are fixed at their baseline values. Simulation starts from baseline value of ϕ

(2019) who examine the mobility constraint externalities of NCAs. Starr et al. (2019) find that in the US States with a higher incidence of enforceable NCAs, workers, including those unbound by NCAs, receive fewer job offers.

Speaking of earnings, NCAs worker receives lower wage than a worker without NCAs when the NCAs incidence is high. In our setting, training intensity and the unemployment value are the key determinants of the wage profile through Nash bargaining. Since the outside option value decreases when NCAs incidence is high, the pass-through wage effect is negative. The positive training effect of higher NCAs on wages helps reduce the negative effect of the outside options. However, the adjustment is not enough to increase the wage for the NCAs worker when NCAs incidence is sufficiently high. Indeed, as the results make apparent, when the probability of signing NCAs is high, there is no significant difference between NCAs workers and No NCAs workers regarding human capital investment.

Finally, training motive and the composition of job seekers relative to NCAs constraint are two opposing forces determining the NCAs' effect on job creation. Results show a decreasing pattern of labor tightness. The declining pattern observed for labor market tightness results from the general equilibrium effect of job seekers composition relative to NCAs constraint that appears to be dominant here. Indeed, the proportion of job seekers constrained by NCAs increases as NCAs incidence rises, and thus it becomes hard for firms to fill a vacancy. As a result, firms post fewer vacancies pushing downward the tightness of the labor market.

On average, the model implies a declining job finding rate and separation rate with NCAs incidence as shown in Figure 10. It suggests that the incidence of NCAs lowers labor turnover. Additionally, and in line with empirical evidence, an increase in the enforceability of NCAs decreases job flow rates, given a level of incidence of NCAs. As a result, it is not the NCAs incidence or their enforceability degree per se that harms labor market dynamics, but the combination of both. Subsequently, the effect of a higher incidence of enforceable NCAs on the unemployment rate is ambiguous. The unemployment rate rises if job flows into unemployment fall proportionally less than job flows out of unemployment. The model predicts a U-shaped curve for the unemployment rate, which suggests that higher NCAs incidence (with a threshold of about 20%) increases the unemployment rate (See figure 10).

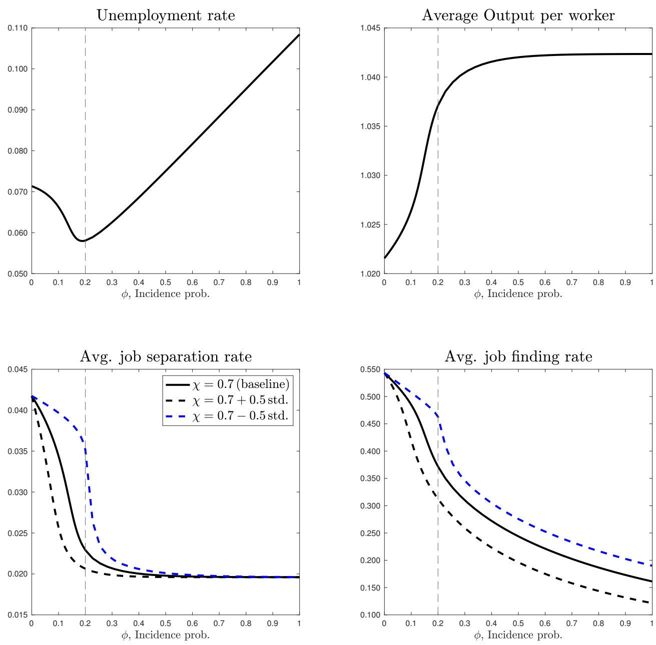
Furthermore, figure 10 shows a positive effect of the NCAs incidence on productivity through the associated higher firm investment. Hence the use of the NCAs generates a trade-off between the enhancement of aggregate productivity and an efficient level for the unemployment rate, making it theoretically ambiguous to predict the efficiency of NCAs. I now turn to the welfare effects induced by NCAs.

6 Welfare analysis

In this section, I quantitatively investigate the welfare effects of NCAs. In line with Charlot and Malherbet (2013), I consider that the planner chooses the job separation threshold, the labor market tightness θ, and training intensity with respect to each type of employment contract. Formally, the planner maximizes social welfare, defined as the sum of the discounted stream of aggregate output net of search and training costs,

$$\max_{\theta, \varepsilon(b), i(0), i(1)} \int_0^\infty e^{-rt} \left\{ Y + uz - \theta u \kappa - \tilde{\eta} \theta q(\theta) u \Big[\phi C(i(1)) + (1-\phi) C(i(0)) \Big] \right\} dt$$

Figure 10: Effects of NCAs incidence on productivity, unemployment, and job flows rates



Note. In each plot, the solid black curve shows the effect of the increase in the NCAs incidence when the enforcement probability is equal it baseline value, $\chi = 0.7$. The black and blue dashed curves show the same effect when enforcement probability increases by $+/-$ a half of a standard deviation value as in data (≈ 0.23). All other parameters are set as in Table 3. Dashed vertical lines indicate the calibrated value of ϕ.

Aggregate output Y is the sum of outputs for each type of job (With and without NCAs), i.e. $Y = Y^0 + Y^1$ which, at any moment in time t evolve according to:

$$\dot{Y}^1 = \tilde{\eta}\theta q(\theta)u\phi[p + i(1)] - \tilde{G}(\varepsilon(1, i(1))Y^1 \quad (22)$$

$$\dot{Y}^0 = \tilde{\eta}\theta q(\theta)u(1-\phi)[p + i(0)] - \tilde{G}(\varepsilon(1, i(0))Y^0 \quad (23)$$

At any moment in time, the unemployed, conditional to encounter an allowed match with probability $\tilde{\eta}$ can be hired on either NCAs contract at rate $\phi\theta q(\theta)$ or a job without NCAs contract with probability $(1-\phi)\theta q(\theta)$ and produce respectively $p + i(1)$ and $p + i(0)$. In the same time, a proportion $\tilde{G}(\varepsilon(b, i(b))\,, b = 0, 1$ of job of type b is destroyed.

The welfare properties of the decentralized economy are studied in two steps. As a first step, I study the welfare properties of a laissez-faire economy, i.e., an economy where a probability ϕ of signing NCAs is one ($\phi = 1$) and the NCAs duration is sufficiently large (μ=0), but there is a probability $\chi \in (0,1)$ that NCAs are enforced. Such an economy is isomorphic to a one with a strong bargaining power of employers. I show that an economy of this type is inefficient even if the hold-up problem is meaningless (higher firm investment). In the second step, I show that a cap on the NCAs duration is welfare-improving. The focus here on the capping non-compete duration as policy evaluation is for comparison with the literature (See. Shi (2022)).

6.1 The inefficiency of the laissez-faire economy

I first study the welfare properties of the laissez-faire equilibrium where $(\phi, \mu) = (1, 0)$. The result presented here also holds in a general case where $(\phi, \mu) \in (0,1) \times (0,1)$. Thus, the case $(\phi, \mu) = (1, 0)$ is reported for ease of presentation. Furthermore, I restrict myself to the case where $\beta \longrightarrow 1$. Hence, the objective of the planner becomes static and writes:

$$\max_{\theta, \varepsilon(1), i(1)} \tilde{\eta}\theta q(\theta) u \left\{ \frac{p + i(1)}{\tilde{G}(\varepsilon(1, i(1))} - C(i(1)) \right\} + uz - \theta u \kappa \tag{24}$$

the maximization problem is subject to the same constraint on labor market flows as the decentralized economy (20 and 21). Let ε^s, θ^s, and i^s denote the values of the endogenous variables chosen by the social planner.

Proposition 3 (*Efficient job creation.*) *The values ε^s, θ^s and i^s solve:*

$$\frac{\kappa}{q(\theta^s)} + \frac{\tilde{\eta}\,\kappa\,\psi\,\theta^s}{\tilde{G}(\varepsilon^s)} + \tilde{\eta}(1-\psi)C(i^s) = \tilde{\eta}(1-\psi)\frac{p + i^s - z}{\tilde{G}(\varepsilon^s)} \tag{25}$$

where $\psi = -\theta^s \frac{q'(\theta^s)}{q(\theta^s}$ denotes the opposite of the elasticity of the matching function with respect to unemployment. These values can be directly compared to those obtained in the laissez-faire equilibrium.

Let ε^*, θ^* and i^* denote the equilibrium values of the key endogenous variables.

Proposition 4 (*Job creation in the laissez-faire economy.*) *The values ε^*, θ^* and i^* solve:*

$$\frac{\kappa}{q(\theta^*)} + \frac{\tilde{\eta}\,\kappa\,\rho\,\theta^*}{\tilde{G}(\varepsilon^*)} \frac{1}{1 - \chi(1 - \theta^* q(\theta^*))} + B\tilde{\eta}\,C(i^*) = \tilde{\eta}(1-\rho)\frac{p + i^* - z}{\tilde{G}(\varepsilon^*)} \tag{26}$$

where, $B = 1 + \dfrac{\rho\,(1-\chi)\theta^* q(\theta^*)}{\{1 - \chi[1 - \theta^* q(\theta^*)]\}\tilde{G}(\varepsilon^*)}$

The comparison of job creation condition in the equilibrium and centralized outcomes yields a necessary condition. For a given training intensity and job destruction rate, a necessary condition for the equilibrium to be constrained efficient is that the well-known Hosios-Diamond-Pissarides (HDP) condition $\rho = \psi$ holds. However, this condition is not sufficient here. It is easy to verify that $\theta^* < \theta^s$ under HDP and given a training intensity and a job destruction rate. To achieve efficiency, a second-order condition is that the worker's bargaining power ρ must be set to zero ($\rho = 0$). This result is similar to the one obtained by Acemoglu and Shimer (1999), who studied the efficiency of the search and matching model under the presence of match-specific investments. While the result appears in their paper for the hold-up problem, here it holds in the presence of incidence of NCAs, which help lessen the holp-up problem, but too few jobs are created.

Note that the inefficient job creation cannot be solved by giving all the bargaining power to the employer ($\rho = 0$); otherwise, workers do not get any return to the training that increases the productivity. Hence, doing so depresses wages and creates an excessive entry of firms.

This being said, I turn to the welfare effects of capping NCAs' duration. The exercise is to understand to which degree this policy helps improve welfare.

6.2 Policy evaluation: Capping NCAs duration

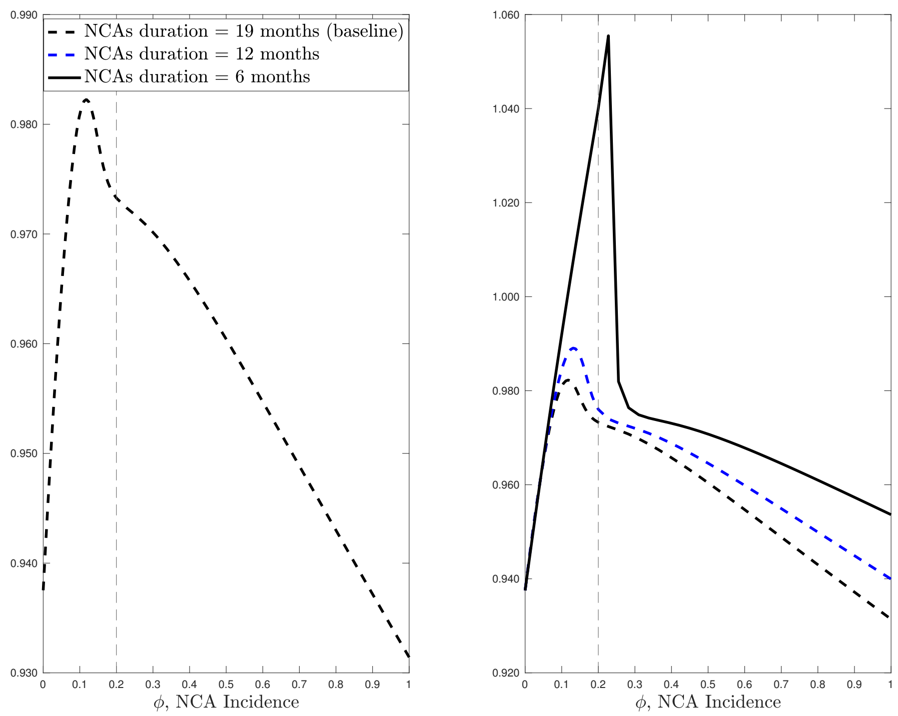
Given that there can be little job creation, there may be room for improving welfare by capping the NCAs' duration. One advantage of this policy is its simplicity and transparency (i.e., it is easily verifiable without cost for workers and firms). We are interested here in quantifying the effects of this policy.

Using the calibrated model, I compute the welfare gains pertain to the equilibrium allocation. Figure 11 depicts the result in the panel (a). As we can see, a low level of NCAs incidence is desirable as it would help the economy benefit from higher productivity and low job destruction without being too harmful to job creation. The desirable level of NCAs incidence is lower than the equilibrium benchmark value of 20%. The model predicts a desirable level of 11.79%.

Next, I investigate how the optimum changes when there is a cap on NCAs duration, i.e., when the probability of loosening the NCAs constraint in the future μ rises. Results in panel (b) of figure 11 show that a cap on NCAs duration improves the welfare. when considering the optimum decentralized equilibrium, the welfare gains range from about 0.7 percent to 7.5 percent when the NCAs duration is capped at a range between 6 months and 12 months. Nevertheless, NCAs duration capped at 6 months helps to increase welfare by 6.8% from the baseline equilibrium level of NCAs incidence set to 20% with an average enforcement regime ($\chi = 0.7$). These results are consistent with Shi (2022). The paper found that in a full-enforcement regime $\chi = 1$, the optimal cap estimated at 0.6 years, – about 6 months – results in welfare gains of 4.8%, relative to the laissez-faire equilibrium outcome. In a low-enforcement regime $\chi = 0.4$ that resembles California, the optimal cap results in welfare gains of 0.5%. The key difference is that, while her paper studies the effects of NCAs in the managerial labor market (high-skill labor), my results have broader relevance here.

Figure 11: Welfare effects of NCAs

(a) : Decentralized optimum (b) : Effect of Capping NCAs duration



Note. Dashed vertical lines indicate the calibrated value of ϕ.

7 Discussion

Multi-sector analysis. A potential limitation of the analysis presented throughout the paper concerns the one-sector model used in the paper. Since NCAs constrain a firm-to-firm labor reallocation within an industry, a multi-sector model would be appropriate. It would help reduce the negative effect of NCAs on the job-finding rate since unemployed workers bound by NCAs could direct their job search to an industry other than the previous one where they were working. Marx (2011) documents this potential involuntary career detour for the duration of the contract, in the case of technical professionals. Hence, the adverse effect of the NCAs on the job-finding rate depends on the number of sectors, the distribution of firms, and the incidence of NCAs across sectors. Therefore, the negative effect of NCAs on the job-finding rate could vanish as the number of sectors becomes sufficiently large. In my framework, a sensitivity test relying on the NCAs enforcement probability χ can capture, to a certain extent, the magnitude of this issue. However, notice that the more a worker received or has invested in industry or occupation-specific human capital, the more costly it is for him to switch occupation or industry. Therefore the higher is his incentive to wait in unemployment. In other words, A displaced worker might rationally prefer to wait through a long spell of unemployment instead of seeking employment at a lower wage in a job he is not trained for. Herz (2019) documents this theory and found that between 9% and 17% of total unemployment in the United States can be attributed to wait unemployment. This idea rationalizes the use of one sector framework since NCAs displaced workers received a higher intensity of industry-specific human capital. Furthermore, a multi-sector model would lead to an unnecessarily complicated model, along with the need to have data on worker transition rates across sectors conditional on NCAs contract status to estimate the model. Future work could extend the framework to a multi-sector model once comprehensive data on NCAs become available.

8 Conclusion

Non-compete contracts influence labor market outcomes by increasing job search frictions. This paper studies the equilibrium employment effects of the incidence of NCAs contracts. It documents that an increased incidence of enforceable NCAs is associated with a decline in labor market dynamism. Both job creation and destruction rates fall, generating an ambiguous effect on the unemployment rate in equilibrium. The model calibrated to US data predicts a higher unemployment rate, suggesting that the negative job creation effect dominates. The result can also be interpreted as unemployment mismatch implications of NCAs, in that workers with a sector-specific human capital endowment but constrained by NCAs are waiting for unemployment during their non-compete restriction period. This situation may generate a dispersion in the probability of finding a job across sectors leading to inefficiency.

Finally, I show that a restriction on the non-compete duration is welfare improving. This restriction helps the economy benefit from higher productivity and low job destruction without being too harmful to job creation.

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A Tables and Figures

Figure A1: Effect of NCAs enforcement strengthening on job creation rate in Florida - firms aged 10 years or less.

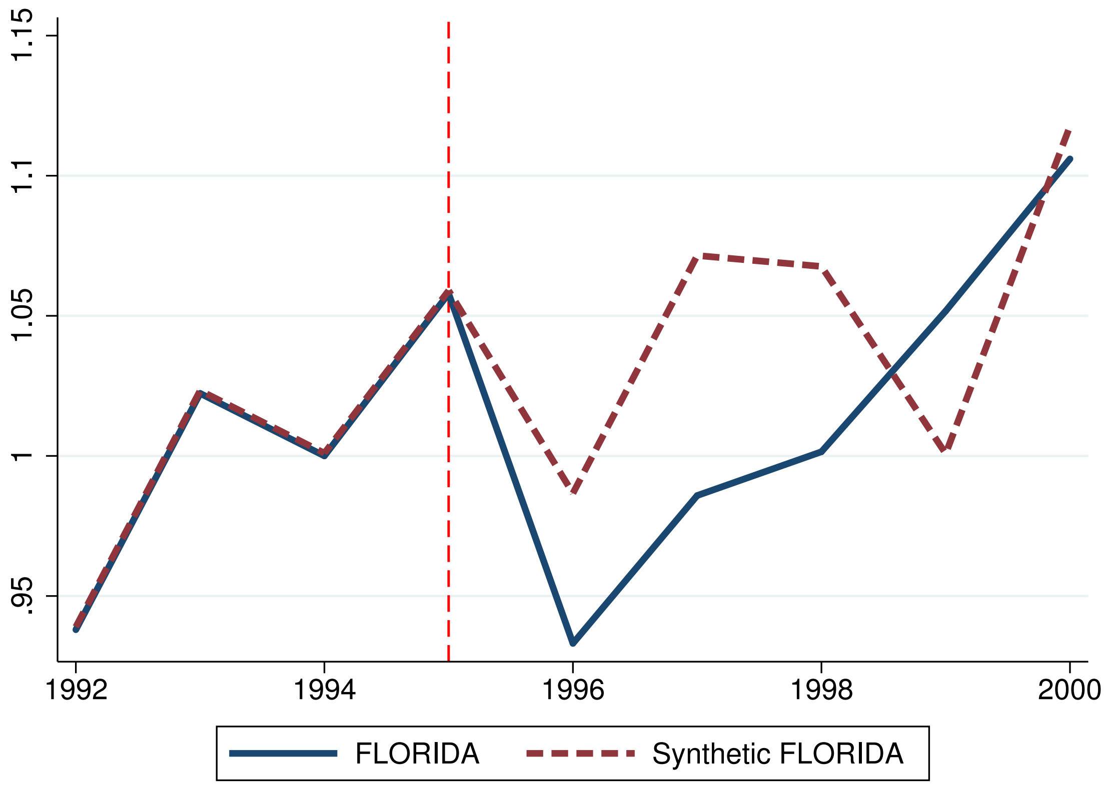
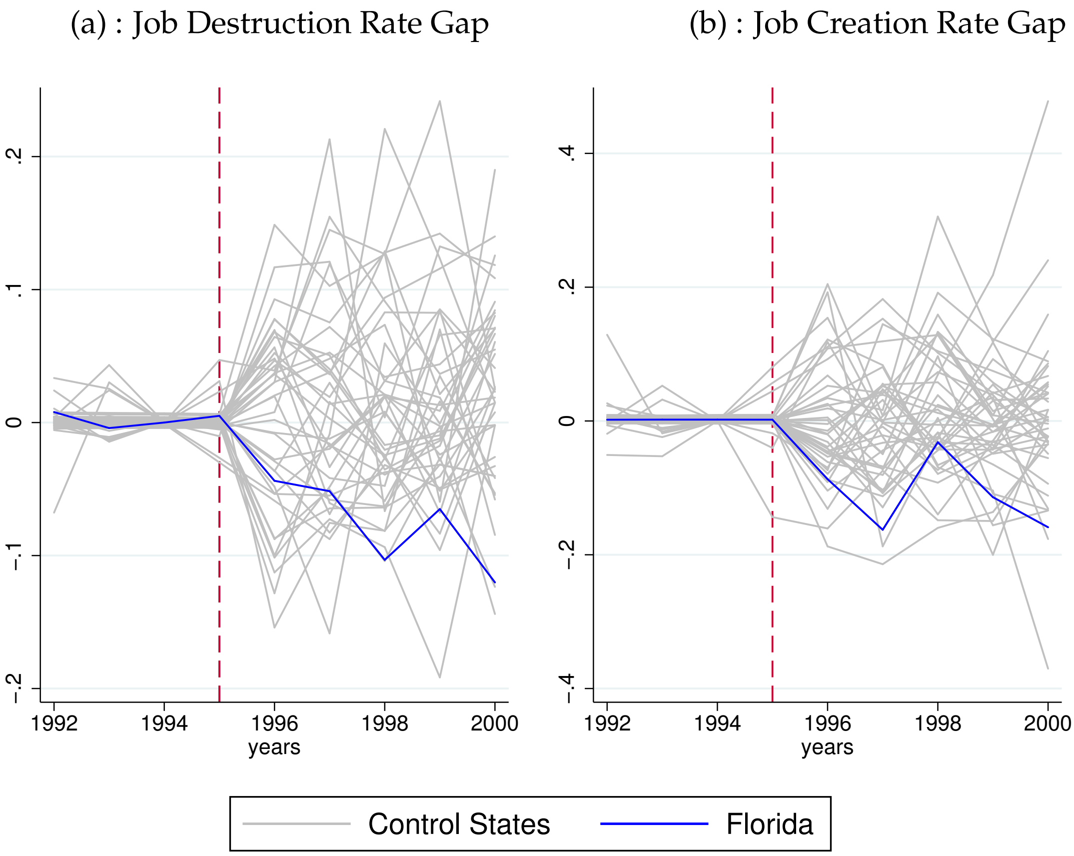


Table A1: NCAs incidence and employment transition rates

Dependent var.	Job losing (Y/N)		Job finding (Y/N)	
	(1)	(2)	(3)	(4)
NCAs inc. × Enforceability		-0.029^{***}		-0.155^{***}
		(0.0000)		(0.0005)
Controls.	Yes	Yes	Yes	Yes
Year/state FE	Yes	Yes	Yes	Yes
N. Obs	250,876	250,876	19,141	19,141

Note.- Standard errors in parenthesis, clustered at state level.$*_{p<0.1}$, $**_{p<0.05}$, $***_{p<0.01}$

Figure A2: Placebo test



-Notes: The gray lines represent the gap associated with each of the 46 runs (states included in the control group) of the placebo test. the blue line denotes the estimated gap for Florida

Table A2: Targeted moments

Moments	Data	Model
Average job finding rate	0.34	0.36
labor tightness	0.52	0.54
Average job separation rate	0.020	0.023
Wage ratio	1.05	1.003
job tenure ratio	1.17	1.16

B Proofs

B.1 Proof of Lemma 1

Recall that from equations (4) and (5) we have:

$$U(0) = z + \beta\Big\{f(\theta)[\phi\, W(1,\bar{i}_1) + (1-\phi)\, W(0,\bar{i}_0)] + [1-f(\theta)]U(0)\Big\} \tag{27}$$

$$U(1) = z + \beta(1-\chi)\Big\{f(\theta)[\phi\, W(1,\bar{i}_1) + (1-\phi)\, W(0,\bar{i}_0)] + [1-f(\theta)]U(0)\Big\} + \beta\chi\mathbb{E}[U(b')]$$

Replacing $U(0)$ in $U(1)$ expression yields:

$$U(1) = z + (1-\chi)[U(0)-z] + \beta\chi[\mu U(0) + (1-\mu)U(1)] \tag{28}$$

Rearranging equation (28) to obtain:

$$(1-\beta)U(0) = z + \big[\beta(1-\mu) - \frac{1}{\chi}\big]\Delta U \tag{29}$$

Where $\Delta U = U(1) - U(0)$.
Now, using equation (27) we obtain:

$$(1-\beta)U(0) = z + \beta f(\theta)\Big[\phi\, W(1,\bar{i}_1) + (1-\phi)\, W(0,\bar{i}_0) - U(0)\Big] \tag{30}$$

Hence, by using Nash bargaining conditions: $W(1,\bar{i}_1) - U(1) = \rho S(1,\bar{i}_1)$ and $W(0,\bar{i}_0) - U(0) = \rho S(0,\bar{i}_o)$, we can rewrite (30) as:

$$(1-\beta)U(0) = z + \beta f(\theta)\Big\{\rho\Big[\phi S(1,\bar{i}_1) + (1-\phi)S(0,\bar{i}_0)\Big] + \phi\Delta U\Big\} \tag{31}$$

Subtracting terms at each side of equations 29 and 31 yields:

$$\Big[-1 + \chi\beta[1-\mu-\phi f(\theta)]\Big]\Delta U = \chi\beta f(\theta)\rho\Big[\phi S(1,\bar{i}_1) + (1-\phi)S(0,\bar{i}_0)\Big] \tag{32}$$

There are two cases:

- <u>Case 1</u> : $1-\mu-\phi f(\theta) \leq 0$

In this case we have $\Big[-1+\chi\beta[1-\mu-\phi f(\theta)]\Big] < 0$ and assuming that both types of jobs exist in equilibrium $S(1,\bar{i}_1) > 0$ and $S(0,\bar{i}_0) > 0$ meaning positive surpluses, then (32) yields $\Delta U < 0$, that is $U(1) < U(0)$

- <u>Case 2</u> : $1-\mu-\phi f(\theta) > 0$

In this case we have $0 < 1-\mu-\phi f(\theta) < 1$, since $\mu + \phi f(\theta) > 0$. Hence $0 < \chi\beta[1-\mu-\phi f(\theta)] < \chi\beta < 1$. Finally $-1 < \Big[-1+\chi\beta[1-\mu-\phi f(\theta)]\Big] < 0$. Again, assuming that

both types of jobs exist in equilibrium $S(1,\bar{i}_1) > 0$ and $S(0,\bar{i}_0) > 0$ meaning positive surpluses, then (32) yields $\Delta U < 0$, that is $U(1) < U(0)$. Notice that if NCAs contract are unenforceable ($\chi = 0$) then $U(0) = U(1)$, that is workers constrained or not by NCAs have the same outside option value.
In all cases, we have $U(1) < U(0)$, so long as $\chi > 0$.

B.2 Proof of Proposition 1

From equation (3), we have:

$$W(b,i) = w(b,i) + \beta\Big\{\delta U(b) + (1-\delta)\mathbb{E}_\varepsilon \max\left\{W(b,i)+\varepsilon, U(b)\right\}\Big\} \tag{33}$$

But,

$$\max\Big\{W(b,i)+\varepsilon, U(b)\Big\} = \begin{cases} W(b,i)+\varepsilon & \text{if } \varepsilon \geq \bar{\varepsilon}(b,i) \\ U(b) & \text{otherwise} \end{cases}$$

where $\bar{\varepsilon}(b,i) = U(b) - W(b,i)$. Hence, rewriting equation (32) reads:

$$W(b,i) = w(b,i) + \beta\Big\{\delta U(b) + (1-\delta)(1-G(\bar{\varepsilon}(b,i)))\mathbb{E}_\varepsilon\big[W(b,i)+\varepsilon|\varepsilon > \bar{\varepsilon}(b,i)\big] + \\ (1-\delta)U(b)G(\bar{\varepsilon}(b,i))\Big\}$$

That is:

$$W(b,i) = w(b,i) + \beta\Big\{U(b)\tilde{G}(\bar{\varepsilon}(b,i)) + (1-\delta)(1-G(\bar{\varepsilon}(b,i)))W(b,i) + (1-\delta)\int_{\bar{\varepsilon}(b,i)} \varepsilon dG(\varepsilon)\Big\} \tag{34}$$

where $\tilde{G}(\bar{\varepsilon}(b,i)) = (1-\delta)\,G(\bar{\varepsilon}(b,i)) + \delta$. Now reorganizing and using $\bar{\varepsilon}(b,i) = U(b) - W(b,i)$ yields:

$$(1-\beta)W(b,i) = w(b,i) + \beta\left[(1-\delta)\,G(\bar{\varepsilon}(b,i)) + \delta\right]\bar{\varepsilon}(b,i) + \beta(1-\delta)\int_{\bar{\varepsilon}(b,i)} \varepsilon dG(\varepsilon) \tag{35}$$

Furthermore, from equation (8), we have:

$$J(b,i) = p + i - w(b,i) + \beta\Big\{\delta V + (1-\delta)[(1-G(\bar{\varepsilon}(b,i)))J(b,i) + G(\bar{\varepsilon}(b,i))V]\Big\} \tag{36}$$

With free-entry condition (V=0) and rearrangement, we obtain:

$$(1-\beta)J(b,i) = p + i - w(b,i) - \beta\left[(1-\delta)\,G(\bar{\varepsilon}(b,i)) + \delta\right]J(b,i) \tag{37}$$

Total surplus: $S(b,i) = W(b,i) + J(b,i) - U(b)$ and $\bar{\varepsilon}(b,i) = U(b) - W(b,i)$. Hence, by summing up equations (35) and (37) and subtracting $(1-\beta)U(b)$ reads:

$$(1-\beta)S(b,i) = p + i + \beta\left[(1-\delta)\,G(\bar{\varepsilon}(b,i)) + \delta\right]\bar{\varepsilon}(b,i) + \beta(1-\delta)\int_{\bar{\varepsilon}(b,i)} \varepsilon dG(\varepsilon) \tag{38}$$

$$-\beta\left[(1-\delta)\,G(\bar{\varepsilon}(b,i)) + \delta\right]J(b,i) - (1-\beta)U(b) \tag{39}$$

Using Nash bargaining: $W(b,i) - U(b) = \rho S(b,i)$ and $J(b,i) = (1-\rho)S(b,i)$. Therefore :

$$(1-\beta)S(b,i) = p + i - \beta\left[(1-\delta)\,G(-\rho S(b,i)) + \delta\right]S(b,i) - (1-\beta)U(b) \tag{40}$$

$$+\beta(1-\delta)\int_{-\rho S(b,i)} \varepsilon dG(\varepsilon) \tag{41}$$

Hence Total surplus $S(b,i)$ for $b = 0,1$ satisfies equation 41 and depends on training intensity i and NCAs job status b. From equation 41, conditional on training intensity i, the only difference between the NCAs total match surplus and the one without NCAs comes form difference in the outside option value U of both types of job. Since $U(1) < U(0)$ as shown in Lemma 1, the proposition 1 holds.

B.3 Proof of Proposition 2

Given Aggregate variables, η, u and θ, Firm's optimal investment $(i^\star(0), i^\star(1))$ for NCAs job and job without NCAs respectively solve:

$$(1-\rho)S'(0, i^\star(0)) = C'(i^\star(0)) \tag{42}$$

$$(1-\rho)S'(1, i^\star(1)) = C'(i^\star(1)) \tag{43}$$

Differentiate (41) for $b = 0,1$ give:

$$(1-\beta)S'(b,i) = 1 - \beta\left[(1-\delta)\,G(-\rho S(b,i)) + \delta\right]S'(b,i) + \tag{44}$$

$$\beta\,(1-\delta)\rho(1-\rho)S'(b,i)S(b,i)\frac{\partial G}{\partial \varepsilon}(-\rho S(b,i)) \tag{45}$$

I guess and verify that $\frac{\partial G}{\partial \varepsilon}(-\rho S(b,i)) = 0$ and therefore we obtain:

$$S'(b,i) = \frac{1}{1 - \beta[1 - \tilde{G}(-\rho S(b,i))]} \tag{46}$$

where $\tilde{G}(-\rho S(b,i)) = (1-\delta)\, G(-\rho S(b,i)) + \delta$. Optimal investment condition becomes for $b = 0, 1$:

$$\underbrace{\frac{1-\rho}{1-\beta[1-\tilde{G}(-\rho S(b,i))]}}_{\text{Marginal benefit}} = \underbrace{C'(i)}_{\text{Marginal cost}} \tag{47}$$

Using proposition 1, conditional on training, the marginal benefit of investing in NCAs job is higher relative to the job without NCAs. Hence NCAs worker receives higher training. Finally, total match surplus is higher with NCAs job. Since separation rate is decreasing function of match surplus, therefore NCAs worker experiences lower separation rate.