Online Appendix to "Optimal Regulation of Noncompete Contracts"

(Not for publication)

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This document is the online appendix to the paper "Optimal Regulation of Noncompete Contracts" and is organized into two sections. Section E provides the motivational background behind the model assumptions and supplementary derivations of the results presented in the paper. Section F contains the data appendix, including the procedures for collecting the noncompete contract data and merging the datasets, the description of the final data sample, and supplementary empirical results.

E Supplementary Materials and Derivations

E.1 Noncompete Law

In this section I provide the institutional details that motivates modeling firms resorting to noncompete clauses as a means to achieve buyout payments.

First, a noncompete clause often comes with a buyout option in practice, which the employee can exercise to buy out the clause. The buyout option could be ex-ante stipulated, as it is case in the contract example in Figure F.3.[1] Even when the buyout option is not ex-ante stipulated, it could be ex-post bargained.

Second, buyouts of noncompetitive exclusions are also reflected in law. For example, Texas law requires that a noncompete contract contain a buyout option for some occupations. The state of New York follows the "employee choice doctrine"—the employee chooses to

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[1]Similar contractual arrangements are common in the market for soccer players. To poach a player under contract, the acquiring club needs to pay the current club a transfer fee, as examined by Terviö (2006).

either be subject to exclusion or have some compensation clawed back. For this reason, a buyout clause is often called a "forfeiture-for-competition" clause. Buyouts are preferable to enforcement: the former involves a zero-sum transfer between the parties, while the latter is mere "money burning."[2]

E.2 Derivation of Social Values

In this section, I specify the planner's problem and derive the HJB equations (24) and (25) for the social value functions.

I first define the planner's problem. The planner chooses the contract $\{i(z,\kappa),\mathcal{M}(z,\kappa)\}$ on behalf of the agents, subject to the same information constraints faced by the agents. Further, the investment decisions are left in the hands of the firms, as is standard in studies concerning the provision of investment incentives. Given the one-to-one mapping from the noncompete terms $\mathcal{M}(z,\kappa)$ to the poaching threshold $\bar{\theta}^n(z,\kappa)$ and in turn the investment outcomes, the planner's contract design problem is equivalent to one where the planner chooses $\left\{i(z,\kappa),\bar{\theta}^c(z),\bar{\theta}^n(z,\kappa)\right\}$ directly and $\{\mu^c(z),\mu^n(z,\kappa)\}$ indirectly. Recall the following notations:

$$\begin{aligned}\bar{\theta}(z,\kappa) &\equiv \bar{\theta}^c(z)\mathbf{1}_{\{i(z,\kappa)=c\}}+\bar{\theta}^n(z,\kappa)\mathbf{1}_{\{i(z,\kappa)=n\}}\\ \mu(z,\kappa) &\equiv \mu^c(z)\mathbf{1}_{\{i(z,\kappa)=c\}}+\mu^n(z,\kappa)\mathbf{1}_{\{i(z,\kappa)=n\}}.\end{aligned}$$

Formally, the planner makes these choices to maximize the discounted social welfare:

$$\int_0^\infty e^{-\rho t}\left[\iint (z-c(\mu(z,\kappa))z-i(z,\kappa)\kappa z)g(z,\kappa,t)dzd\kappa\right]dt$$

subject to the KF equation (16) and the investment constraint (21).

Next, to derive the social value functions, I apply the tools from Nuño and Moll (2017) for optimal control problems with a continuum of heterogeneous agents in continuous time. For ease of exposition, I introduce the following compact notations. Let $L^2(\Phi)$ be the space of functions that is Lebesgue-integrable over Φ. The inner product $\langle u,f\rangle_\Phi = \int_\Phi ufdx$, $\forall u,f \in L^2(\Phi)$ helps to keep track of the equations. In this environment, $z \in \mathbb{Z} = \mathbb{R}^+$, $\kappa \in \mathbb{K}$, $\theta \in \bar{\Theta}^i = \left[\bar{\theta}^i,\infty\right) \subset \Theta$, $\forall i \in \{c,n\}$, $\theta \in \bar{\Theta} = \left[\bar{\theta},\infty\right) \subset \Theta$, $t \in \mathbb{T} = \mathbb{R}^+$, and $\Phi = \mathbb{Z}\times\Theta\times\mathbb{K}\times\mathbb{T}$.

[2] Naidu (2010) finds that recruitment restrictions in the form of "enticement" fines in the postbellum U.S. South lowered the mobility of sharecroppers. While enticement fines have long been vestigial due to the anti-enticement laws, noncompete buyouts avoid the controversy but have a similar effect.

The KF equation (16) can be rewritten as:

$$g_t = (\mathcal{A})^* g + \lambda\Big[p\Big\langle g\Big(\frac{z}{\theta},\cdot\Big)-g,f\Big\rangle_{\bar{\Theta}} + (1-p)\Big\langle g\Big(\frac{z}{\theta},\cdot\Big)-g,f\Big\rangle_{\bar{\Theta}^c}\Big], \tag{E.1}$$

where $(\mathcal{A})^*$ is the adjoint operator of $\mathcal{A}$:

$$(\mathcal{A})^* g = -\mu z g_z + \frac{1}{2}\sigma^2 z^2 g_{zz} + \delta(h\phi - g).$$

The Lagrangian for this problem is

$$\begin{aligned}\mathcal{L} = &\Big\langle e^{-\rho t}, \langle z - c(\mu)z - i\kappa z, g\rangle_{\mathbb{Z}\times\mathbb{K}}\Big\rangle_{\mathbb{T}} \\ &+\Big\langle e^{-\rho t} S, -g_t (\mathcal{A})^* g + \lambda\Big[p\Big\langle g\Big(\frac{z}{\theta},\cdot\Big)-g,f\Big\rangle_{\bar{\Theta}} + (1-p)\Big\langle g\Big(\frac{z}{\theta},\cdot\Big)-g,f\Big\rangle_{\bar{\Theta}^c}\Big]\Big\rangle_{\mathbb{Z}\times\mathbb{K}\times\mathbb{T}} \\ &+\Big\langle e^{-\rho t}\xi^c, J_z^c(z) - c'(\mu^c)\Big\rangle_{\mathbb{Z}\times\mathbb{T}} + \Big\langle e^{-\rho t}\xi^n, J_z^n(z,\kappa) - c'(\mu^n)\Big\rangle_{\mathbb{Z}\times\mathbb{K}\times\mathbb{T}},\end{aligned}$$

where $S \equiv S(z,\kappa,t)$ is the Lagrange multiplier associated with equation (E.1), and $\xi^c \equiv \xi^c(z,t)$ and $\xi^n \equiv \xi^n(z,\kappa,t)$ are the multipliers for the first-order conditions in (21).

Modifying the second line in the Lagrangian, I obtain

$$\begin{aligned}&\Big\langle e^{-\rho t} S, -g_t + (\mathcal{A})^* g + \lambda\Big[p\Big\langle g\Big(\frac{z}{\theta},\cdot\Big)-g,f\Big\rangle_{\bar{\Theta}} + (1-p)\Big\langle g\Big(\frac{z}{\theta},\cdot\Big)-g,f\Big\rangle_{\bar{\Theta}^c}\Big]\Big\rangle_{\mathbb{Z}\times\mathbb{K}\times\mathbb{T}} \\ =&\Big\langle e^{-\rho t} g, S_t - \rho S + \mathcal{A}S + \lambda[p\langle S(z\theta,\cdot)-S,f\rangle_{\bar{\Theta}} + (1-p)\langle S(z\theta,\cdot)-S,f\rangle_{\bar{\Theta}^c}]\Big\rangle_{\mathbb{Z}\times\mathbb{K}\times\mathbb{T}} + \langle S(\cdot,0), g(\cdot,0)\rangle_{\mathbb{Z}\times\mathbb{K}},\end{aligned}$$

where the infinitesimal operator $\mathcal{A}$ is defined as

$$\mathcal{A}S = \mu z S_z + \frac{1}{2}\sigma^2 z^2 S_{zz} + \delta\big(\langle S, h\phi\rangle_{\mathbb{Z}\times\mathbb{K}} - S\big).$$

The Lagrangian is rearranged to

$$\begin{aligned}\mathcal{L} = &\Big\langle e^{-\rho t} g, z - c(\mu)z - i\kappa z + S_t - \rho S + \mathcal{A}S + \lambda[p\langle S(z\theta,\cdot)-S,f\rangle_{\bar{\Theta}} + (1-p)\langle S(z\theta,\cdot)-S,f\rangle_{\bar{\Theta}^c}]\Big\rangle_{\mathbb{Z}\times\mathbb{K}\times\mathbb{T}} \\ &+\langle S(z,\kappa,0), g(z,\kappa,0)\rangle_{\mathbb{Z}\times\mathbb{K}} + \Big\langle e^{-\rho t}\xi^c, J_z^c(z) - c'(\mu^c)\Big\rangle_{\mathbb{Z}\times\mathbb{T}} + \Big\langle e^{-\rho t}\xi^n, J_z^n(z,\kappa) - c'(\mu^n)\Big\rangle_{\mathbb{Z}\times\mathbb{K}\times\mathbb{T}}.\end{aligned}$$

The Lagrange multiplier $S(z,\kappa,t)$ is the shadow social value associated with a worker employed at a match productivity z and of cost type κ. Given that there is no aggregate state variables, $S(z,\kappa,t) = S(z,\kappa)$ and $S_t(z,\kappa,t) = 0$. From the rearranged Lagrangian, I obtain:

$$\rho S = z - c(\mu)z - i\kappa z + \mathcal{A}S + \lambda[p\langle S(z\theta,\cdot)-S,f\rangle_{\bar{\Theta}} + (1-p)\langle S(z\theta,\cdot)-S,f\rangle_{\bar{\Theta}^c}].$$

Let $S \equiv S^c \mathbf{1}_{\{i=c\}} + S^n \mathbf{1}_{\{i=n\}}$. If $i = c$, $S = S^c$ satisfies the HJB equation (24); otherwise, if $i = n$, $S = S^n$ satisfies the HJB equation (25).

E.3 First-Best Allocation

Now I characterize the first-best allocation, a useful benchmark to compare with for the equilibrium outcome and the constrained social optimum. Consider a planner who chooses the allocation directly. Compared to the constrained efficient allocation, here, the planner also chooses investment directly. Therefore, there is no need of noncompete clauses to provide incentives for investments. Formally, the planner chooses $\{\bar{\theta}^{fb}(z), \mu^{fb}(z)\}$ to maximize

$$\int_0^\infty e^{-\rho t} \left[\int \big(z - c\big(\mu^{fb}(z)\big) z\big) g(z,t) dz \right] dt$$

subject to the KF equation for the distribution $g(z,t)$:

$$g_t(z,t) = -\mu^{fb}(z) z g_z + \frac{1}{2}\sigma^2 z^2 g_{zz} + \delta(h-g) + \lambda \int_{\bar{\theta}^{fb}(z)}^\infty \left[g\left(\frac{z}{\theta}, t\right) - g(z,t) \right] dF(\theta).$$

Note that it is without loss of generality to restrict the optimal choices to be independent of the aggregate state.

Let $S^{fb}(z)$ denote the social value function associated with a worker employed at match productivity z. Following the same steps as in Section E.2, I derive the HJB equation for the social value function from the planner's problem above:

$$\begin{aligned} \rho S^{fb}(z) = \max_{\bar{\theta}^{fb}, \mu^{fb}} \Bigg\{ & z - c\big(\mu^{fb}\big) z + \mu^{fb} z S_z^{fb}(z) + \frac{1}{2}\sigma^2 z^2 S_{zz}^{fb}(z) + \lambda \int_{\bar{\theta}^{fb}} \big[S^{fb}(z\theta) - S^{fb}(z) \big] dF(\theta) \\ & + \delta \left[\int S^{fb}(z) dH(z) - S^{fb}(z) \right] \Bigg\}. \end{aligned}$$

The solutions turn out to be independent of the individual state z in the following lemma, $\bar{\theta}^{fb}(z) = \bar{\theta}^{fb}$ and $\mu^{fb}(z) = \mu^{fb}$.

Lemma E.1 (First Best)**.** *The first-best allocation is characterized by*

$$\bar{\theta}^{fb} = 1 \tag{E.2}$$

$$c'\big(\mu^{fb}\big) = \frac{1 - c\big(\mu^{fb}\big)}{r - \mu^{fb} - \lambda \int_1^\infty (\theta - 1) dF(\theta)}. \tag{E.3}$$

The first-best investment level is larger than the equilibrium levels: $\mu^{fb} > \mu^n > \mu^c$. The

magnitude of underinvestment is

$$\frac{\mu^{fb}-\mu^c}{\mu^c-\frac{1}{2}\sigma^2} \approx \varepsilon \frac{\lambda \int_1^\infty (\theta-1)dF(\theta)}{r-\mu^c}. \tag{E.4}$$

Proof. Since $S(z)$ is strictly increasing in z, the poaching threshold is $\bar{\theta}^{fb} = 1$. Further, I guess and verify that this function is linear in z, i.e.,

$$S^{fb}(z) = s^{fb} z + \frac{\delta}{\delta+\rho} \int S^{fb}(z) dH(z).$$

This guess implies that the first-order condition with respect to the investment is $c'\big(\mu^{fb}\big) = s^{fb}$, suggesting that the investment level is independent of productivity. Further, I obtain the expression for s to be equal to the right-hand side of equation (E.3).

Further, the ordering of the investment levels follows from the relation that $s^{fb} > j^n > j^c$. Finally, to derive the investment equation (E.4), I follow the same steps in the proof for Proposition 2 in Appendix A.3. I first take the log difference of the first-order conditions in (E.3) and (21):

$$\log\big(c'\big(\mu^{fb}\big)\big) - \log(c'(\mu^c)) = \log\big(s^{fb}\big) - \log(j^c) \approx \frac{\lambda \int_1^\infty (\theta-1)dF(\theta)}{r-\mu^c}.$$

Next, I adjust the left-hand side with the first-order derivative with respect to investment:

$$(\mu^{fb}-\mu^c)\frac{c''(\mu^c)}{c'(\mu^c)} \approx \frac{\lambda \int_1^\infty (\theta-1)dF(\theta)}{r-\mu^c}.$$

Equation (E.4) follows from the equation above.

□

In the first-best allocation, as characterized in equation (E.2), the workers are reallocated whenever the entrant productivity exceeds the incumbent level. Further, in equation (E.3), the marginal cost of investment equals the marginal social value, which includes not only the payoff to the incumbent match but also the spillovers to future entrants.

Under perfect information, the first-best allocation can be implemented. For example, if all the bargaining power is assigned to the incumbent firms: they make a take-it-or-leave-it offer of buyout payment contingent on entrant match quality θ, to extract rent fully without distorting worker allocation. The incumbent matches fully capture the external payoff and thus are incentivized to invest at the socially efficient level. However, given the information friction in the model, rent extraction inevitably involves mobility distortion.

F Data Appendix

F.1 Employment Contract Data

I collect the executive employment contracts included in company filings in the SEC Edgar database during year 1994-2015. The SEC requires that public-listed firms disclose contracts material to their business. Management employment contracts and compensatory plans involving directors or executive officers are deemed material. Relevant forms of contracts include employment agreements, letters of employment, amendments to existing employment agreements, noncompete agreements, retention agreements, and separation and severance agreements. These contracts potentially contain information on noncompete arrangements.

F.1.1 Contract Classification

To gather the contracts, I search with an automated crawler across the SEC's EDGAR database. All material contracts are appended as exhibits under "exhibit 10" designation in annual and quarterly reports (10K and 10Q forms, respectively) and current reports for major events (8K forms). Therefore, I narrow the search to documents under that designation. One issue is that very often companies do not clearly indicate the type of the contract when filing it. Hence, it is important to filter out other types of contracts. For instance, supplier agreements and joint venture agreements have similar legal concerns and hence similar wordings as employment contracts. To classify whether a document is an employment agreement, I use machine-learning and textual-analysis tools. I undertake the following steps.

(i) I collect a subset of contracts, which have sufficient information in the document title. The document title enables me to label these contracts into employment or non-employment types.[3] In this step, I obtain a labeled dataset containing 18,904 employment contracts and 11,932 non-employment contracts.

(ii) I split the labeled dataset into 75% as the training set and 25% as the test set. I then use the word dictionary of the training set as word features and train a logistic regression classification algorithm. The classification algorithm yields an accuracy rate of over 97% in the test set. The top key words that classify a document as an employment contract are shown in Figure F.1. Word features such as "noncompete", "compete", and "retention" contribute to a document being classified as an employment contract. Interesting, third-person male pronouns such as "him","his" and "mr" are among the

[3]Some contracts were filed with an informative document title clearly indicating the contract type, while others were filed with uninformative document title such as "exhibit."

Figure F.1: Key words for classifying a document as an employment contract

top key words. This observation collaborates that the algorithm is reliable, since over 90% of the executives in the sample are male.

(iii) Using the classification algorithm, I scrap and classify all documents under "exhibit 10" designation. In total, I obtain 68,267 employment contracts.

F.1.2 Extracting Contractual Terms

I perform textual analysis to extract relevant details on the noncompete terms in the contracts. Of particular interest are contractual terms including (i) whether an employment contract includes a noncompete clause, and (ii) if so, the duration of the noncompete period. The noncompete duration is most commonly one year, eighteen months, or two years, but in some cases it can be as long as five years. The challenge here is that the information is buried in lengthy discussions of varying legal formats. I address this issue by carefully observing and applying the common features below.

To accurately identify the name of the executive that a contract binds, I apply four methods. First, I parse the content explicitly specifying the contracting parties and extract the texts that refers to the name of the employee. This is achieved by taking advantage of key word marks immediately following the executive name such as ("employee") as in the contract displayed in Figure F.2 and ("executive") as in the contract displayed in Figure F.3. This is the most accurate method and able to identify the names for most contracts. The second method is parsing out the employee name in the title of the contract if it is included. The third method, applicable to cases involving letters of employment, is to capture the name of the person to whom the letter is addressed. Finally, if all of the above fail, I find the name in the signature portion of the contract, which usually has a key mark "/s/" preceding it. The last one is the least reliable approach due to instances of a signature representing

Figure F.2: Example of a noncompete agreement

Exhibit 10.23

COVENANT NOT TO COMPETE
AND NON-DISCLOSURE AGREEMENT

PARTIES:

Eric Dean Sprunk ("EMPLOYEE")

and

NIKE, Inc., divisions, subsidiaries
and affiliates. ("NIKE"):

AGREEMENT:

In consideration of the foregoing, and the terms and conditions set forth below, the parties agree as follows:

1. **Covenant Not to Compete**.

(a) **Competition Restriction**. During EMPLOYEE's employment by NIKE, under the terms of any employment contract or otherwise, and for one year thereafter, (the "Restriction Period"), EMPLOYEE will not directly or indirectly, own, manage, control, or participate in the ownership,
management or control of, or be employed by, consult for, or be connected in any manner with, any business engaged anywhere in the world in the athletic footwear, athletic apparel or sports equipment and accessories business, or any other business which directly competes with NIKE or any of its parent, subsidiaries or affiliated corporations ("Competitor"). ***By way of illustration only***, examples of NIKE competitors include, but are not limited to: Adidas, FILA, Reebok, Puma, Champion, Oakley, DKNY, Converse, Asics, Saucony, New Balance, Ralph Lauren/Polo Sport, B.U.M, FUBU, The Gap, Tommy Hilfiger, Umbro, Northface, Venator (Foot lockers), Sports Authority, Columbia Sportswear, Wilson, Mizuno, Callaway Golf and Titleist. This provision is subject to NIKE's option to waive all or any portion of the Restriction Period as more specifically provided below.

Note: The figure displays snapshots of the contract. The full text of the contract can be found at https://www.sec.gov/Archives/edgar/data/320187/000119312510161874/dex1023.htm.

Figure F.3: Example of a noncompete agreement with a buyout option

Exhibit 10.3

EXECUTION VERSION

NON-COMPETITION AGREEMENT

This Non-Competiton Agreement (the "Agreement") is entered into as of June 29, 2016 by and between Engility Holdings, Inc. (the "Company") and Anthony Smeraglinolo (the "Executive").

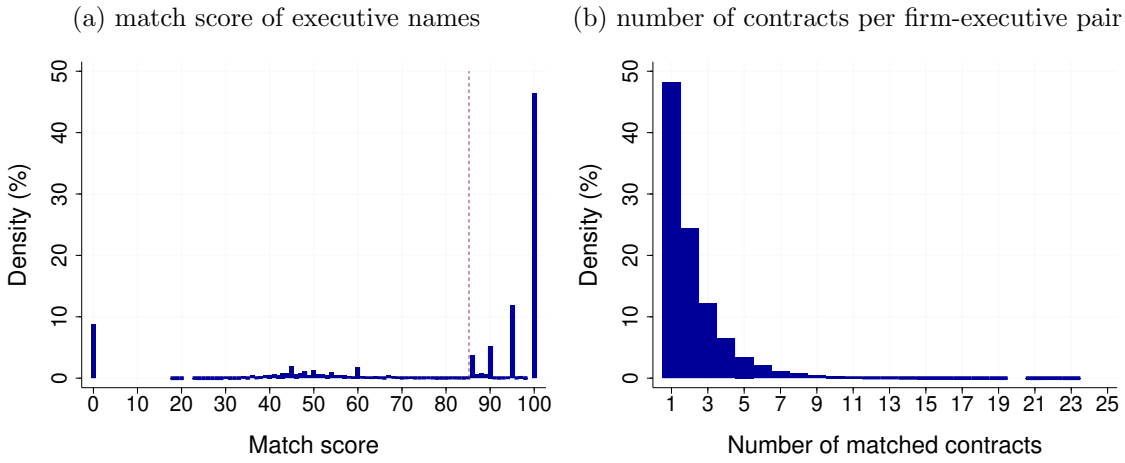
WHEREAS, pursuant to the Separation Agreement, the Executive agreed to be bound by a Confidentiality and Non-Competition Restrictive Covenants agreement (the "Non-Competition Agreement") provided for under the CIC Severance Plan, which includes a covenant to not compete with the Company for a minimum period of twelve months following the date of the Executive's separation from employment (the "First Non-Competition Period");

V. Potential Forfeiture of Payment

In addition to the remedies provided in Section IV of this Agreement, in the event that the Executive has breached the non-competition covenants contained in this Agreement or in the Separation Agreement (i) during the First Non-Competition Period, the Executive shall forfeit all right and interest to $3,000,000, or (ii) during the Second Non-Competition Period, $1,500,000. The Executive shall be required to pay to the Company the applicable forfeiture amount, in cash, within fifteen (15) days after demand is made therefore by the Company, as liquidated damages for the breach of such restrictive covenants. The provisions of this Section V shall constitute an amendment of Section I of the Separation Agreement and Exhibit A of the CIC Severance Plan.

Note: The figure displays snapshots of the contract. The full text of the contract can be found at https://www.sec.gov/Archives/edgar/data/1544229/000156459016021836/egl-ex103_275.htm.

Figure F.4: Matching executive names between the contracts and ExecuComp



the firm appearing alongside the one representing the employee.

Determining whether a contract includes a noncompete clause is straightforward. I define that a firm-executive pair signed a noncompete clause if at least one contract has one or more word counts of variations of "noncompete." I find that, if a contract includes a noncompete clause, it has on average 2.9 counts of such words.

It is slightly more difficult to determine the noncompete duration. I do so by extracting the time description in the noncompete terms. Key words such as "restriction period" and "noncompete period" help to improve accuracy. For example, the contract displayed in Figure F.2 has this feature.

Most contracts also specify the legal jurisdiction under which the contract is to be governed. This information is also reliably gathered. The legal jurisdiction largely coincides with the state where the company's headquarter is located, but it is a disproportionately biased towards the state of Delaware.

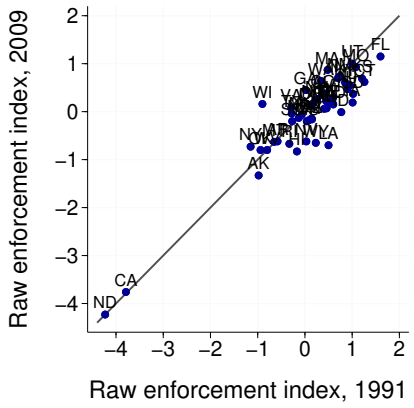
F.1.3 Matching Names

I match the executive names in the contracts to the ones in ExecuComp. Taking advantage of the fact that the company filings have a unique company identification, I match each contract to the set of executive names within the identified company in ExecuComp.[4] Panel (a) of Figure F.4 shows the distribution of match scores. Almost half of the contracts have match score of 100.

Of the 68,267 employment contracts gathered, I keep 45,446 of them with a score of 86

[4]I use the string matching package FuzzyWuzzy in python, which uses Levenshtein Distance to calculate the differences between sequences of strings.

Figure F.5: Enforcement index over time



and above. I keep the firm-executive matches in ExecuComp linked to at least one contract. The merged sample includes 17,928 executives employed at 2,916 firms, a total of 19,035 firm-executive matches. Many executives have multiple contracts. Panel (b) of Figure F.4 shows the distribution of the number of contracts for each firm-executive pair. The average number of contracts per employment relation is 2.3.

This contract data is much larger than the hand-collected data in previous studies. For example, Gillan et al. (2009) and Bishara et al. (2015) respectively hand-collected around 500 and 1000 executive employment contracts. In the later, they find that 78.7% of the CEOs they study have signed a noncompete contract. The corresponding number in my sample is 67.8%.

F.2 Noncompete Law Data

To measure noncompete laws, I borrow the Bishara enforcement indices for the years 1991 and 2009 at the state level from Starr (2019). This time range roughly coincides with the one for the contract data. Figure F.5 plots the index in 1991 against the index. The dots roughly fall along the 45-degree line, which suggests that, while there is substantial cross-state variation, the noncompete law has been very stable over the time period.

I normalized the Bishara enforcement index for the year 2009 to California at 0 and Florida at 1. Although North Dakota has a lower enforcement index than California, there are very few observations located in North Dakota.[5]

[5]One exceptional situation to the statutory ban on noncompete contracts in California is sale of business ownership.

F.3 Additional Data

Employment history. The ExecuComp data reports the dates the executive joined the company (joined_co, rejoin) and left the company (leftco, releft). However, the employment data is less than ideal due to many missing information. Hence, I supplement it with BoardEx, which includes the complete employment history.

I use the following procedure the combine the two sources of information. First, I use the reported date in ExecuComp (joined_co, rejoin) to define the starting date. Second, if the firm started disclosing the executive as a top executive in ExecuComp before the reported joining date, I use the first year of disclosure as the starting year instead. Third, in the case that the starting date is missing in ExecuComp or if the executive holds a managerial role in the firm according to BoardEx before the reported starting date in ExecuComp, I use the starting time in BoardEx instead.

Compensation. Due to the SEC regulation, public-listed firms are required to disclose compensation for their top executives. I explain some relevant details of compensation definition. First, two types of total compensation measure—awarded compensation and realized compensation—are reported. A large part of awarded compensation are in the form of restricted equity deferred to future dates contingent on the executive staying with the firm. Therefore, realized compensation is the proper wage measure in the model.

Second, the disclosure requirement has gone through regulatory changes. Prior to 2006, the two measures are tdc1 for awarded compensation and tdc2 for realized compensation. Starting in 2006, two alternative compensation measures, total_alt1 for awarded and total_alt2 for realized, are reported in compliance with the 2006 financial accounting standard for equity compensation (FAS 123R). The main distinction between the pre- and post- 2006 measures is that, for the latter, stock and option awards reflect the estimated fair value at grant date and exercise or vest date rather than book value. In order to use a longer panel consistently, I use the pre-2006 measure.[6]

F.4 Variable Definition

I provide details on how the key variables are defined. All nominal values are deflated to year 2010 prices using the CPI. I define an industry at three-digit SIC industry code level.

[6]For realized compensation, one obtains a higher wage growth using the post-2006 definition compared to using the pre-206 definition.

Noncompete (Y/N). An executive is subject to a noncompete clause if at least one noncompete clause is found among his contracts with the employing firm.

Noncompete (Duration). In instances when an executive has multiple contracts with differing information on the noncompete duration, I define the noncompete duration to be equal to the maximum level found.

Tenure. Tenure is defined as one for the first year of employment.

Separation. The dummy for the separation event is defined as 1 for the last year of employment and 0 otherwise.

Job-to-job transition. The dummy for the job-to-job transition event is defined as 1 for the last year of employment if the executive is subsequently employed at another firm in the sample and 0 otherwise. The within- and between-industry job-to-job transition events are defined using industry classification at two-digit SIC codes. The job-job-transition events are biased downward as the executives may move out of the sample.

Awarded compensation. It includes salary, bonus, valued of shares awarded, value of options awarded, non-equity incentive, change in pension, and other compensation. The variable name in ExecuComp is tdc1.

Realized compensation. It includes salary, bonus, value of shares vested, value of options exercised, non-equity incentives, change in pension, and other compensation. The variable name in ExecuComp is tdc2.

Cash compensation. It is the sum of salary, bonus, and non-equity incentives.

Deferred equity compensation, It is the sum of value of shares vested and value of options exercised.

F.5 Sample Selection

I filter the merged data sample in four steps following the standard procedures in the literature. First, I exclude firms operating in regulated industries (SIC codes 4900-4999), financial industries (6000-6999), and firms categorized as public service, international affairs, or non-operating establishments (9000 and above). Finally, I restrict the observations to executives

Table F.1: Summary statistics

	N. Obs.	All	Noncompete		t-stat.
			No	Yes	(diff.)
Fraction (%)	13,535	100	36	64	
Duration (year)	7,187			1.6	
Executive Characteristics					
Age joined	13,531	44.9	45.2	44.8	2.95
Tenure	13,531	10.2	10.1	10.2	-0.54
Separation rate (%)	108,589	8.14	8.50	7.95	3.15
Job-to-job transition rate (%)	108,589	2.58	2.66	2.53	1.23
– within industry	108,589	0.32	0.35	0.30	1.42
– between industry	108,589	2.26	2.31	2.23	0.78
Firm Characteristics					
Asset (mn)	77,848	5,388	5,579	5,283	2.44
Emploment (thousands)	77,022	21	17	22	-9.18
Sales (mn)	77,848	5,237	4,894	5,428	-4.22
Phyiscal investment	77,545	0.063	0.061	0.065	-6.45
Intangible investment	77,545	0.112	0.118	0.109	11.90
Tobin's Q	70,633	1.43	1.45	1.42	4.54
Cash flow	77,441	0.29	0.27	0.30	-2.81
ROA	77,764	0.024	0.020	0.027	-4.12
Compensation					
Awarded compensation (mn)	71,686	3.09	3.04	3.12	-1.45
Realized compensation (mn)	76,925	3.00	2.90	3.05	-2.40
– cash	78,298	0.77	0.76	0.77	-0.40
– deferred equity	70,775	1.87	1.86	1.87	-0.18

Note: Physical capital investment is defined as capital expenditure (capx) normalized by lagged total capital (ppegt+k_int). Intangible capital investment is defined as R&D expense (xrd) plus 30% of selling, general and administrative expenses (xsga) normalized by lagged total capital (ppegt+k_int). R&D expense is set to zero whenever missing. Tobin's Q is defined as book assets (at) plus market value of equity (prcc_f×csho) minus common equity (ceq) and deferred taxes (txdb) normalized by property, plant and equipment (ppegt). Cash flow is defined as income before extraordinary items (ib) plus depreciation and amortization (dp) normalized by lagged property, plant and equipment (ppegt). Return on asset (ROA) is defined as net income (ni) normalized by book assets (at). Nominal values are deflated to year 2010 prices using the CPI.

Table F.2: Effect of noncompete contracts on wage dynamics

	Realized		Awarded	
	(1)	(2)	(3)	(4)
(Noncompete × Enforce)	0.148**	0.128**	0.084*	0.083
	(0.057)	(0.057)	(0.048)	(0.052)
Tenure/10	1.106***	1.001***	0.035	-0.057
	(0.095)	(0.089)	(0.066)	(0.069)
Tenure/10 × (Noncompete × Enforce)	-0.246	-0.180	0.048	0.076
	(0.147)	(0.151)	(0.100)	(0.105)
$(\text{Tenure}/10)^2$	-0.570***	-0.500***	0.002	0.068*
	(0.062)	(0.062)	(0.041)	(0.040)
$(\text{Tenure}/10)^2$ × (Noncompete × Enforce)	0.159	0.127	-0.049	-0.065
	(0.096)	(0.097)	(0.065)	(0.059)
$(\text{Tenure}/10)^3$	0.088***	0.078***	-0.001	-0.012
	(0.011)	(0.011)	(0.008)	(0.007)
$(\text{Tenure}/10)^3$ × (Noncompete × Enforce)	-0.030*	-0.026	0.007	0.010
	(0.017)	(0.017)	(0.012)	(0.011)
Year FEs	√	√	√	√
State FEs	√		√	
Industry FEs	√		√	
Firm FEs		√		√
Observations	76,737	76,737	71,513	71,513
Adjusted R^2	0.49	0.33	0.52	0.30

Note: Tenure is rescaled, dividing by 10, for the purpose of displaying coefficient scale properly. Enforce variable refers to the state-level enforcement index. Standard errors clustered by state are in parentheses.

in the age range between 25 and 65. The final sample includes 12,679 executives employed at 2,157 firms, a total of 13,363 firm-executive matches, from 1992 to 2015.

For the firm-level panel, to avoid bias due to merger and acquisition activities on investment, I first exclude firm-year observations flagged as "AA","AB","AR","AS", or "AT". Further, I exclude firm-year observations with annual asset or sales growth over 100%. Finally, I exclude firm-year observations with missing or non-positive book value of assets or sales, as well as firm observations with less than $5 million in physical capital.

F.6 Empirical Evidence on Wage Dynamics

Table F.2 shows the tenure effect and its interaction effect with the noncompete contract choice. Column 1 reports the regression result, using realized compensation as the wage

measure and controlling for year, state, and industry fixed effects. It confirms the model prediction on wage dynamics over tenure. The positive coefficient for tenure and the negative coefficient for tenure squared imply that wage increases non-linearly with tenure. Further, the positive coefficient for the contract choice and negative coefficient for the interaction between tenure and the contract choice imply that noncompete clauses increase the starting wage and lowers wage growth over tenure. In column 2, after controlling for firm fixed effects, the interaction coefficients become less significant.

In columns 3 and 4, when looking at awarded compensation, the overall tenure effect is small. The executives in the sample have an average age of around 50 and standard deviation of 7. This range is the part of life cycle where earnings tend to be flat, which is reassuring that the age effect is not mixed with the tenure effect. Moreover, the differential effect due to noncompete contract choice almost disappears completely.

The discrepancy between the awarded compensation and realized compensation is due to firms using restricted equity—"golden handcuffs'—to backload wage for retention. The percentage of compensation realized through stock vesting and options exercised is over 60% on average in the data.

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