The Effect of Non-Competes on Productivity Growth through Spinouts and R&D

Nicolas Fernandez-Arias

Student Macro Workshop, Dec 14, 2017

Introduction

- A **non-compete agreement** is a clause in an employment contract preventing the employee from working for a competitor (including founding a competing firm) during specified time span after leaving current employer
  - Often limited in geographic scope
  - Sometimes have attached a *buyout clause* that allows the employee to free himself, though rare except managers (Rauch 2015)
- A **spinout** of a firm is a new firm founded by an employee of the initial firm
  - E.g. Fairchild semiconductor spinouts form basis of SV detail
  - Note: NOT a *spinoff*, which is a subsidiary of a company which is sold off
- **Question this project seeks to answer**: What is the effect of non-competes on productivity growth and welfare?

Motivation

- Empirical importance of non-competes (survey data)
  - 20% of US labor force currently under a non-compete, higher for knowledge workers (Starr 2017) by industry and occupation
  - 88% of companies with less than $50 million in sales require non-competes (Leonard 2001)
  - VC firms require non-competes for 90% of founders of companies they finance (Kaplan & Stromberg 2000)
- Empirical importance of entry and employee spinouts in particular:
  - 25% of aggregate productivity growth due to entrants (Akcigit & Kerr 2017)
  - In Brazil, employee spinouts account for between 15-30% of entrants; larger, grow faster than other entrants (Muendler et al. 2012)

Motivation: current policy issue

- Differing enforcement across states map
- Literature has tentatively endorsed the view that Silicon Valley, CA displaced Rt. 128, MA as high-tech hub due to non-enforcement (starting with Saxenian 1994, Gilson 1999, etc.)
- Policymakers converging to belief that not enforcing is key to creating high-tech hub
  - 2015 - Hawaii passes law precluding enforcement of non-competes for "technology workers"
  - Several states considering weakening enforcement explicitly in an effort to imitate California (e.g. Massachusetts)

Theory: big picture

- Schumpeter 1942, Arrow 1962, etc.: if knowledge is not excludable, it will be underproduced in competitive equilibrium because no private benefit to agent incurring costs of production
- Intellectual property laws (e.g. patents) makes knowledge excludable
- Patent literature: optimal level of excludability? Dynamic efficiency vs. static monopoly distortion tradeoff (Nordhaus 1967, etc.)
- Similar economics here
- Why use non-competes instead of patents or non-disclosure agreements (NDAs) to protect intellectual property?
  - Some knowledge is difficult to patent (e.g., early stage knowledge, c.f. discussion in Hellmann-Perotti 2005)
  - NDAs are hard to enforce
  - Sometimes NDAs are de facto non-competes under "inevitable disclosure" doctrine (in enforcing states)
  - Suggestive survey evidence that non-competes are used to protect trade secrets detail

Existing theoretical work

- Advantages of non-competes:
  - more employer investment in R&D (e.g., Shankar-Ghosh 2013)
  - more employer investment in employee human capital (e.g., Shi 2017)
  - reduce socially inefficient creative destruction (Shi 2017)
- Disadvantages of non-competes:
  - less employee reallocation to better match (e.g. Shankar-Ghosh 2013, Shi 2017)
  - less employee investment in own human capital (Garmaise 2011)
  - static monopoly distortion of production (Rauch 2015)
- Note: in theory optimal contract would mitigate these disadvantages are avoided through buyouts / renegotiation, but empirically not used for average tech worker / researcher (Rauch 2015)

Existing empirical work

- Survey: Bishara-Starr 2016 "The Incomplete Noncompete Picture"
- In non-enforcing regimes:
  - Employment / payroll / business formation grows more in response to exogenous increases in the supply of VC funding (Samila-Sorenson 2011)
  - More workforce mobility (Fallick et al. 2006, Garmaise 2011, Marx et. al 2009)
  - Less market concentration (Kang-Fleming 2017)
  - Employees have higher wages (Chang et al. 2017)

Existing empirical work (cont.)

- In addition to shortcomings cited in Bishara-Starr 2016...
- ...empirical work based on comparing outcomes depending on enforcement regime (even that based on exogenous variation) cannot identify aggregate effect if there are **cross-regime spillovers**
- Direct evidence of brain drain from Michigan to non-enforcing regions after accidental policy change in late 1985 (Marx 2015)
  - After Michigan began enforcing, hazard rate of migration from patent holders to non-enforcing regimes *doubled*
  - More pronounced for those with more patents & more valuable patents

This paper

- Model quantifies a specific tradeoff (closest to Shankar-Ghosh 2013)
- Advantages of non-competes
  - more employee investment in knowledge capital
  - prevent employees from spinning out and engaging in socially inefficient creative destruction
  - prevent entrants from engaging in socially inefficient arms race (entrants are small, incumbent is large)
- Disadvantages of non-competes
  - prevent more productive employee spinouts from forming
  - monopoly distortion on R&D

Data

- Have:
  - Crunchbase full dataset: free dataset, 100,000+ startups (mostly founded in the last 20 years chart), information on founders and funding rounds. Some missing data, but more coverage of early stage startups than competing (expensive) datasets
  - Moments from empirical work: e.g. brain drain in Marx 2015
  - Survey data from Starr 2017 on prevalence of non-competes
  - Data on strength of non-compete enforcement from Bishara 2011
- Need / want:
  - Previous employment / occupation of founders in Crunchbase dataset. VentureOne has this, but it is not free.
  - Better industry / product information classification – need to merge with Crunchbase by firm name
  - LEHD data would be great for comparing outcomes across different enforcement regions...but hard to come by.

Model overview

- Quality ladders model (ultimately based on Grossman-Helpman 1991)
- Endogenous productivity growth through improved quality of intermediate goods
- Quality improvements result from labor allocated to R&D
- R&D workers at incumbent form spinouts to compete in R&D race
- Creative destruction

Model: Intermediate goods production

- Continuum of intermediate goods, indexed by $j \in J = [0, 1]$
- Denote frontier quality of good j by q_j, amount produced by c_j
- Each good produced with technology

$$c_j = \overline{q} l_j$$

  where $\overline{q} = \int_0^1 q_j dj$ is the average quality level of the economy
- At a given point in time, each good has a monopoly producer
- Across goods, monopolistic competition

Model: Final good production

- Final good is produced using labor and a continuum of intermediate goods $j \in [0, 1]$ with production technology

$$C(t) = L(t)^{\beta} \left(\left(\int_0^1 q_j(t)^{\beta} c_j^{1-\beta}(t) dj \right)^{1/(1-\beta)} \right)^{1-\beta}$$
$$= L(t)^{\beta} \int_0^1 q_j(t)^{\beta} c_j^{1-\beta}(t) dj$$

  where q_j is quality, c_j is quantity
- Restricts labor share to be related to markup $\mu = 1/(1-\beta)$
- Can relax this using Grossman et. al 2016
- CRS implies zero profits so no need to consider ownership

Model: R&D race timing

Participant in the R&D race for good j begins with monopoly on good j R&D

$\downarrow$

Hires R&D labor; at rate ν per unit of R&D labor hired, an employee acquires ability to open rival R&D lab (but not to compete directly on product market).

$\downarrow$

This worker becomes part of mass n_j and leaves the lab (replaced by someone who values the chance of learning the R&D process)

$\downarrow$

At rate τ, agents' non-competes expire, adding to the mass m_j

$\downarrow$

At some point, either incumbent or entrant wins patent race, restarting the process

Model: R&D race (cont.)

- Laws of motion for m_j, n_j

$$\dot{n}_j = \nu l_j^{RD} - \tau n_j$$
$$\dot{m}_j = \tau n_j$$

- Note that (q_j, m_j, n_j) is the state of product j

Model: R&D technology

- z_I,z_E units of labor yields innovations at Poisson rate (for incumbents and entrants, respectively)

$$R_I(z_I;\bar{z}) = \chi_I z_I \phi(\bar{z})$$
$$R_E(z_E;\bar{z}) = \chi_E z_E \phi(\bar{z})$$

where

$$\bar{z}^j = \int_0^{m_j} z^j(\ell)d\ell + z_I^j$$

is total innovation effort on j, with (endogenous) mass m of entrants indexed by ℓ.

- Total arrival rate of innovations at j is $\zeta_j = (\chi_I z_I^j + \chi_E \int_0^{m_j} z^j(\ell)d\ell)\phi(\bar{z}^j)$
- Entrant productivity of R&D χ_E weakly greater than incumbent productivity χ_I
- $\phi(z)$ decreasing, $z\phi(z)$ increasing
- Entrant ℓ can hire $z \leq \xi$ units of R&D labor (in equilibrium $z(\ell) = \xi$)

Model: Workers

- Unit mass continuum of risk-neutral individuals indexed by $i \in I = [0, 1]$, with objective

$$U = \int_0^\infty \exp(-\rho t) c(t) dt$$

where $c(t)$ is final goods consumption at t.

- Individuals can supply labor to final goods production (l^F), intermediate good production (l^I) and R&D (l^{RD}) such that

$$l_t^F + l_t^I + l_t^{RD} = 1$$

- Aggregate labor market satisfies (where $L_t^k = \int_I l_t^k(i) di$)

$$L_t^F + L_t^I + L_t^{RD} = 1$$

Worker optimization timeline

Allocates labor to R&D and final and intermediate good production (indifferent)

$\downarrow$

While performing R&D for good j hit by knowledge shock with intensity ν per unit of R&D labor supplied to j

$\downarrow$

No longer works for good j until next step on ladder (because already has knowledge)

$\downarrow$

At rate τ, hit by non-compete expiry shock

$\downarrow$

Provided $m_j < M_t(q, n)$ ("free entry" mass of entrants), enters R&D race

Worker optimization

- Workers indifferent between occupations (Final goods, intermediate goods, R&D)
- From assumptions on intermediate and final goods production, get closed form for final goods wage $\overline{w}_t = \Gamma(\beta)\overline{q}_t$
- Indifference condition implies intermediate goods wage $w_t^I = \overline{w}_t$
- R&D wage at product j depends on state of the product, which is (q, m, n)
- Indifference condition

$$w_t(q, m, n) + \nu W_t^{NC}(q, m, n) = \overline{w}_t$$

  where $W_t^{NC}(q, m, n)$ is the value of the knowledge (bound by a non-compete)
- Since $w_t(q, m, n) < \overline{w}_t$, in equilibrium workers immediately leave employer once knowledge is attained
- Note: this indifference condition implies that value functions A, W^F, W^{NC} do not scale with q

Intermediate goods firms optimization

- Let $\tilde{q}$ denote qe^{-gt} where g is growth rate on BGP
- Value function of **incumbent** is $A_t(q,m,n) = e^{gt}A(\tilde{q},m,n)$
- Flow profits: $\pi(\tilde{q}) = \tilde{\pi}\tilde{q}$ in eq.
- HJB equation:

$$(\rho - g)A(\tilde{q},m,n) = \pi(\tilde{q}) - g\tilde{q}A_{\tilde{q}}(\tilde{q},m,n) - \tau n A_n(\tilde{q},m,n) + \tau n A_m(\tilde{q},m,n)$$

$$+ \max_z \Big\{ \chi_I z \phi(z + \overline{z}_E(\tilde{q},m,n)) \overbrace{\Big(A((1+\lambda)\tilde{q},0,0) - A(\tilde{q},m,n)\Big)}^{\text{NPV of successful innovation}}$$

$$- w(\tilde{q},m,n)z + \nu(z + \overline{z}_E(\tilde{q},m,n))A_n(\tilde{q},m,n)$$

$$- \chi_E \overline{z}_E(\tilde{q},m,n)\phi(z + \overline{z}_E(\tilde{q},m,n))A(\tilde{q},m,n)\Big\}$$

- $A_m, A_n < 0$ and $A_{\tilde{q}} > 0$ in equilibrium

Intermediate goods firms optimization (cont.)

- Value function of **entrant no longer bound by non-compete** is $W^F(\tilde{q}, m, n)$
- HJB equation:

$$\begin{aligned}(\rho + \zeta(\tilde{q}, m, n) - g)W^F(\tilde{q}, m, n) &= -g\tilde{q}W^F_{\tilde{q}}(\tilde{q}, m, n) \\ &+ (\nu\bar{z}(\tilde{q}, m, n) - \tau n)W^F_n(\tilde{q}, m, n) \\ &+ \tau n W^F_m(\tilde{q}, m, n) \\ + \max_z \Big\{ \chi_E z \phi(\bar{z}(\tilde{q}, m, n)) &\overbrace{\Big(A((1+\lambda)\tilde{q}, 0, 0) - W^F(\tilde{q}, m, n)\Big)}^{\text{NPV of successful innovation}} \\ &- w(\tilde{q}, m, n) z \Big\}\end{aligned}$$

where $\zeta(\tilde{q}, m, n)$ is the total arrival rate of innovations

- $W^F_m, W^F_n < 0$ and $W^F_{\tilde{q}} > 0$
- Entrants continue to enter until mass $M(\tilde{q}, n)$, where $M(\tilde{q}, n) = M_t(q, n)$
- Hence total entrant R&D will be $\bar{z}_E(\tilde{q}, m, n) = \xi \min(M(\tilde{q}, n), m)$

Intermediate goods firms optimization (cont.)

- Value function of **entrant bound by non-compete** is $W^{NC}(\tilde{q}, m, n)$
- HJB equation:

$$\begin{aligned}(\rho + \zeta(\tilde{q}, m, n) + \tau - g)W^{NC}(\tilde{q}, m, n) = & -g\tilde{q}W^{NC}_{\tilde{q}}(\tilde{q}, m, n) \\ & + (\nu\bar{z}(\tilde{q}, m, n) - \tau n)W^{NC}_n \\ & + \tau n W^{NC}_m + \tau W^F(\tilde{q}, m, n)\end{aligned}$$

- $W^F_m, W^F_n < 0$ and $W^F_{\tilde{q}} > 0$
- Entrants continue to enter until a mass $m = M(\tilde{q}, n)$, where $M(\tilde{q}, n) = M_t(q, n)$
- Hence aggregate entrant R&D will be $\bar{z}_E(\tilde{q}, m, n) = \xi \min(M(\tilde{q}, n), m)$

Recursive BGP Equilibrium

- Growth rate g, value functions $A(\tilde{q}, m, n)$, $W^F(\tilde{q}, m, n)$, and $W^{NC}(\tilde{q}, m, n)$, ergodic distribution $dP(\tilde{q}, m, n)$, R&D wages $w(\tilde{q}, m, n)$, production wage $\overline{w}$, prices and quantities of intermediate goods, free entry mass $M(\tilde{q}, n)$, individual R&D policies $z_I(\tilde{q}, m, n)$ and $z_E(\tilde{q}, m, n)$, total entrant R&D $\overline{z}_E(\tilde{q}, m, n) = \xi \min(M(\tilde{q}, n), m)$, total R&D $\overline{z}(\tilde{q}, m, n) = z_I(\tilde{q}, m, n) + \overline{z}_E(\tilde{q}, m, n)$, production labor allocations L^F and $L^I(j)$ such that:
  - Value functions A, W^F, W^{NC} solve HJB eqs, individual policy functions optimal given value functions
  - Ergodic distribution $dP(\tilde{q}, m, n)$ satisfies KF equation
  - Final and intermediate goods wage satisfy $\overline{w} = \Gamma(\beta)$
  - R&D wages satisfy indifference condition $w(\tilde{q}, m, n) + \nu W^{NC}(\tilde{q}, m, n) = \overline{w}$
  - $M(\tilde{q}, n)$ is smallest m satisfying free entry condition $w(\tilde{q}, m, n) = A(\tilde{q}, 0, 0) - W^F(\tilde{q}, m, n)$
  - Labor resource constraint: $L^F + L^I + L^{RD} = 1$
  - Growth g is consistent with research policy functions: $g = \lambda \int \tilde{q}\zeta(\tilde{q}, m, n) dP(\tilde{q}, m, n)$

Efficiency

- Worker indifference condition implies firm compensated (in expectation) for profits of future spinouts
- Franco-Filson 2006 logic suggests this may imply Pareto efficiency without non-competes
- However, equilibrium may still be inefficient as spinouts reduce monopoly power, shifting equilibrium along dynamic efficiency / static monopoly distortion tradeoff
- This introduces role for non-competes
- Could introduce further role by making R&D labor supply less elastic (infinitely elastic here due to indifference condition)

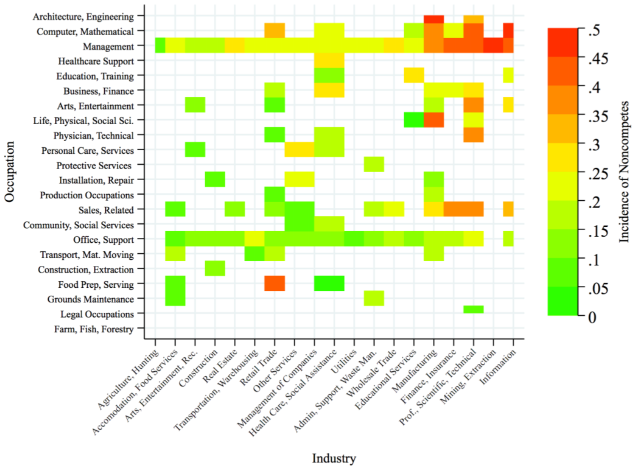
Next steps

- Solve model numerically – challenging due to 3 state variables (expect equilibrium to exist, but have not proven)
- Add enforcing and non-enforcing regions, which requires answering...
  - How does migration map into differential outcomes?
  - How does observed migration map into relevant unobserved migration?
- Calibration
  - How to map migration in the data to migration in the model? Data not a BGP
- Welfare analysis and optimal non-compete length

Incidence of Non-competes

back

Figure A5: Incidence of noncompetes by industry and occupation

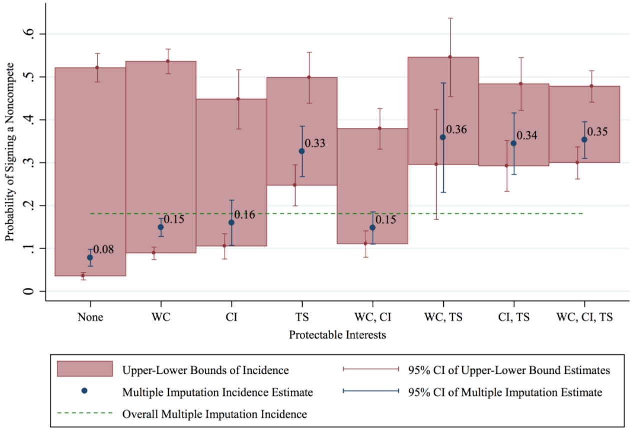


Source: Starr et al. 2017 (survey data)

Incidence of Non-competes

back

Figure A6: Incidence of noncompetes by legitimate business interest



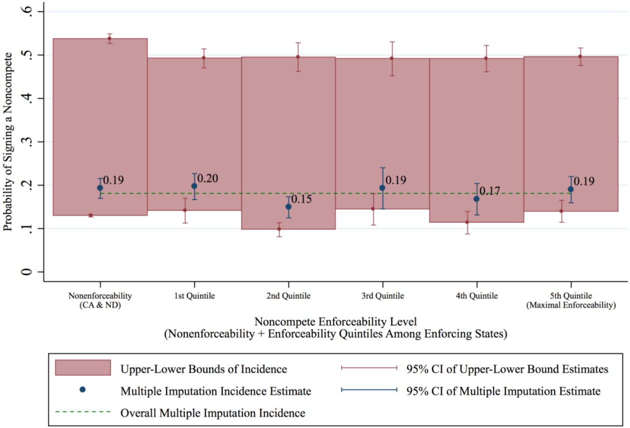
The upper-lower bounds of the incidence of noncompetes assume that those who don't know if they have signed a noncompete did and did not sign, respectively.
WC stands for 'Works directly with clients', CI stands for 'Access to client lists or information', TS stands for 'Knowledge of Trade Secrets.'

Source: Starr et al. 2017 (survey data)

Incidence of Non-competes

back

Figure A8: Incidence of noncompetes by noncompete enforceability

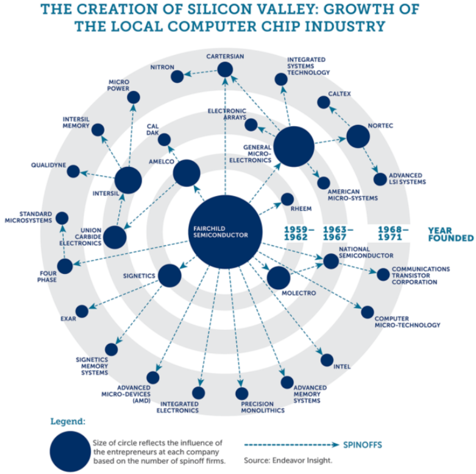


The upper-lower bounds of the incidence of noncompetes assume that those who don't know if they have signed a noncompete did and did not sign, respectively.
The noncompete enforceability measure from Starr (2015) is divided into nonenforcing states, and quintiles among enforcing states.

Source: Starr et al. 2017 (survey data)

Spinouts of Fairchild Semiconductor

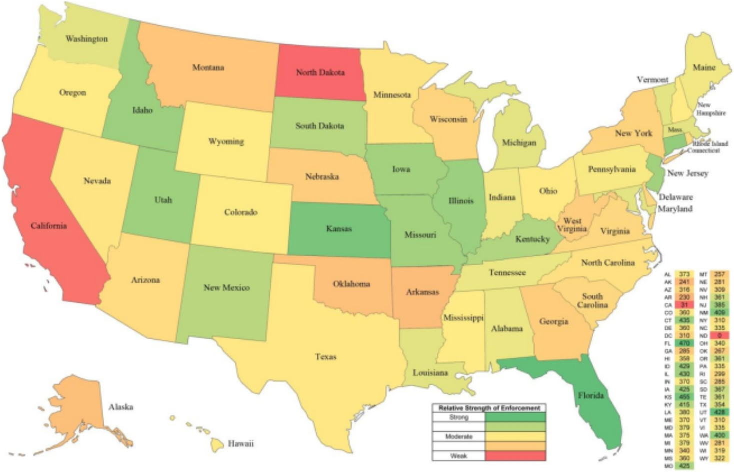
back



Source: Endeavor Insights

Motivation: differing enforcement

back



Source: Bishara 2011

Crunchbase data coverage

back

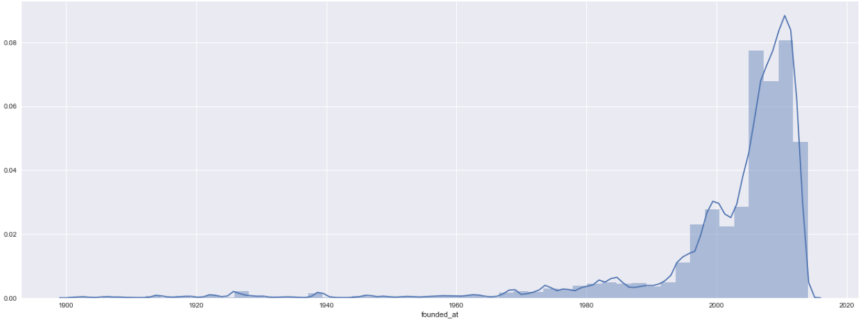


Figure: Histogram of founding dates for firms in Crunchbase dataset