

Homophily, Information Asymmetry and Performance in the Angels Market

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CIRANO, Montréal

- Information asymmetry is a feature of financial markets (Spence (2002)).

Motivation

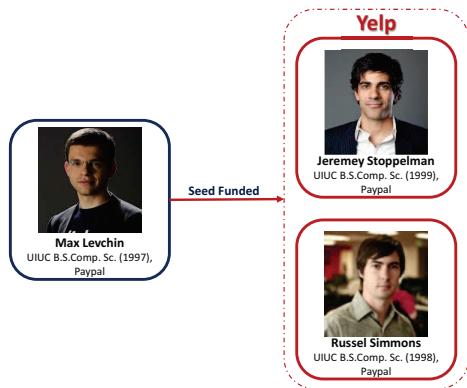
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- Entrepreneurial financing markets suffer from a high level of information asymmetry.
- *“When asymmetric information problems are large ... innovations associated with young start-up firms may never be commercialized”* -OECD (2015).

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 - *“When asymmetric information problems are large ... innovations associated with young start-up firms may never be commercialized”* -OECD (2015).
 - A growing finance literature argues that social connections can mitigate information asymmetry.
- Can social connections influence matching of investors and startups?
 - What is the effect of social connections on post-investment performance?
 - Is the effect positive or negative?

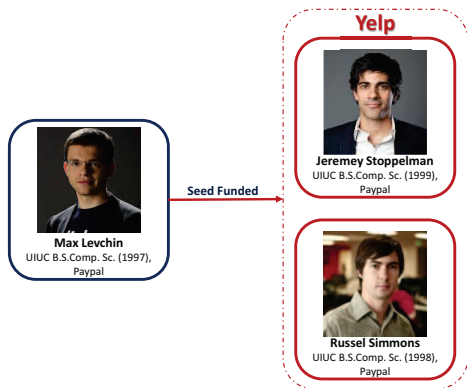
Motivation: Influence of Social Connections on Startup Financing

The case of Yelp



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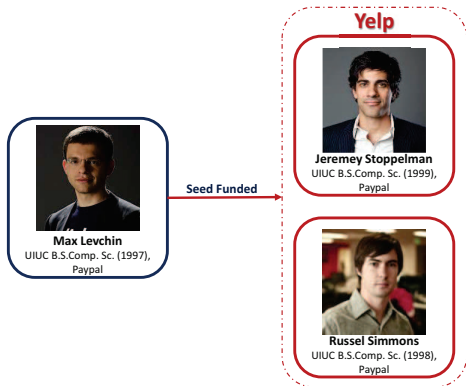
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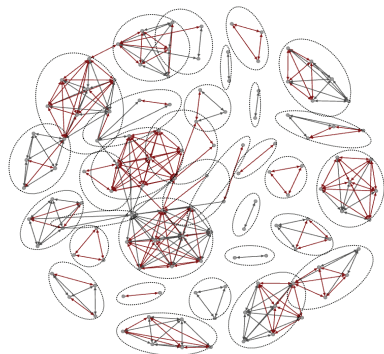
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2013's Big Data Investments:



Nodes = Investors;
Edges = Co-investment.
Red edge = at least one social connection with other investor.

I use **angel investor market** as the testing ground:

- Wealthy individuals who invest their own funds.
- Angels fund more than 95% of the early-stage startups (OECD (2011)).
- Angels invested \$24.6 billion in 2015 (Sohl (2015)).

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- Decision makers are **individual investors**.
 - Easier to see the effect of social connections on investments decisions.
- High uncertainty surrounding startups and angel investors.
- Angels invest in early-stages and have higher influence on startups.

Homophily hypothesis: Social connection between an angel and entrepreneur *should lead* to an **increase in the likelihood of matching**.

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Coordination hypothesis: Social connections **improve post-investment performance** of startups.

- Social connections facilitate easier communication (Bhagwat (2013) and Hegde and Tumlinson (2014))
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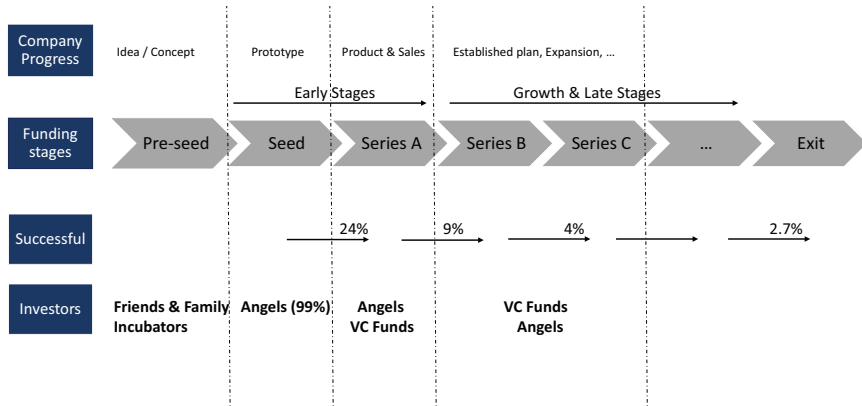
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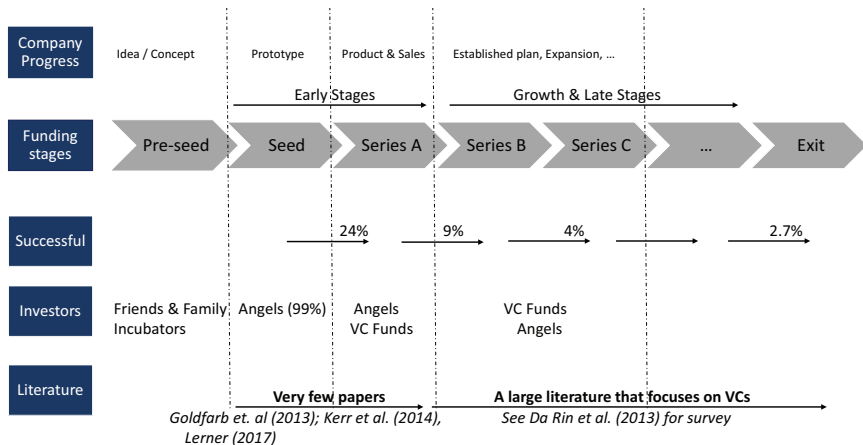
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Social connections can **also hurt performance** through inefficient monitoring (Ishii and Xuan (2014) and Gompers et al. (2016)).

Startup Life-cycle



Literature



Hand-collected data on Angel investors and early-stage.

- Investors and Startups: Crunchbase (crunchbase.com) and AngelList (angel.co)

▶ Alexis Ohanian

▶ UBER Inc

- Angel Investors: Location, Investment history, Employment and Education details.
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- Funds-raised: SEC Form D filings
 - Biography: LinkedIn, S&P Capital IQ
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 - Normalized measure of demand in a product demand.
 - Ethnicity: Yahoo! Research and Stony Brook Data Science Lab.
 - Identification algorithm based on first and last names.
 - Trained on a sample of 74 million names (Ye et al. (2017)).
 - Additional sources: CB Insights, Mattermark, Owler and News websites.

Selection Criteria:

- The angel should have invested in at least 3 different startups as of 2015.
- Startups should be seed-funded by angel investors.
- Full funding history and profiles of founders and investors should be available.

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- 9,396 startups founded by 15,951 entrepreneurs between 2005 to 2015.
- Seed-funded by 5,417 angel investors (2,655 lead angels).

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| Variable | Mean | SD | p25 | p50 | p75 | N |
|---|------|------|------|------|------|------|
| Pre-seed Startup Characteristics | | | | | | |
| Age at seed | 0.97 | 1.04 | 0.00 | 0.67 | 1.53 | 9396 |
| No. of Founders | 1.87 | 1.30 | 1.00 | 2.00 | 2.00 | 9396 |
| Serial Entrepreneur | 0.12 | 0.32 | 0.00 | 0.00 | 0.00 | 9396 |
| Traction | 2.97 | 2.99 | 0.60 | 1.55 | 5.23 | 9396 |
| Seed-stage Startup Characteristics | | | | | | |
| Seed Funds | 0.86 | 4.87 | 0.00 | 0.19 | 0.75 | 9396 |
| No. of seed investors | 1.99 | 1.78 | 1.00 | 1.00 | 2.00 | 9396 |
| Post-seed Outcomes | | | | | | |
| Seed Success | 0.20 | 0.40 | 0.00 | 0.00 | 0.00 | 9396 |
| Series A Funds | 4.24 | 8.77 | 0.20 | 2.00 | 5.00 | 1863 |

Social Connections Variables

Indicators capture social connections between angel and startup **before investment**.

- *Same School*: =1, if the lead angel and founder attended the same school during an *overlapping time period*.
- *Same Employer*: =1, if the lead angel and founder worked for the same employer during an *overlapping time period*.
- *Same Ethnic Minority*: = 1, if the lead angel and founder belong to the same ethnic minority.

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| Variable | Mean | SD | p25 | p50 | p75 | N |
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| Same School | 0.13 | 0.33 | 0.00 | 0.00 | 0.00 | 9396 |
| Same Employer | 0.21 | 0.41 | 0.00 | 0.00 | 0.00 | 9396 |
| Same Ethnic Minority | 0.30 | 0.46 | 0.00 | 0.00 | 1.00 | 9396 |
| Connected Angel-Founder | 0.46 | 0.50 | 0.00 | 0.00 | 1.00 | 9396 |

Effect of Social Connections on Matching

For each actual lead angel-startup pair, create hypothetical pairs as follows:

- Each startup is matched with “control” angels who have been active in the past 3 years and who are interested in the same state.
- Each angel is matched with “control” startups located in the angel's preferred locations.
- $Investment = 1$ for actual lead angel-startup pairs.
- $Investment = 0$ for hypothetical lead angel-startup pairs.

Effect of Social Connections on Matching

| | Investment | | | | | |
|----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| Same School | 0.061*** (0.001) | | | | | 0.027*** (0.001) |
| Same Top School | | 0.059*** (0.001) | | | | |
| Same Bottom School | | 0.066*** (0.004) | | | | |
| Same Employer | | | 0.283*** (0.001) | | | 0.282*** (0.001) |
| Same Top Employer | | | | 0.225*** (0.001) | | |
| Same Bottom Employer | | | | 0.314*** (0.002) | | |
| Same Ethnic Minority | | | | | 0.007*** (0.000) | 0.005*** (0.000) |
| Obs. | 2395651 | 2395651 | 2395651 | 2395651 | 2395651 | 2395651 |
| Adj. R^2 | 0.122 | 0.129 | 0.215 | 0.227 | 0.121 | 0.215 |

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Effect of Social Connection Strength on Matching

| | Investment | |
|--|---------------------|---------------------|
| | (1) | (2) |
| Same School | 0.018*** (0.001) | |
| Same Employer | 0.162*** (0.002) | |
| Same Ethnic Minority | 0.002*** (0.000) | |
| Same School × Employer | 0.091*** (0.005) | |
| Same School × Ethnic Minority | 0.006** (0.003) | |
| Same Employer × Ethnic Minority | 0.048*** (0.003) | |
| Same School × Employer × Ethnic Minority | 0.072*** (0.009) | |
| Connection Depth=1 | | 0.023*** (0.000) |
| Connection Depth=2 | | 0.188*** (0.001) |
| Connection Depth=3 | | 0.291*** (0.006) |
| Obs. | 2395651 | 2395651 |
| Adj. R ² | 0.227 | 0.110 |

Likelihood of matching increases with the strength of social connections.

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Effect of Social Connection on New vs. Established Markets

Information asymmetry is higher in new product markets

- *New Market* = 1, if startup is one of the first 25% formed in a product market.

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| | (1) | (2) | (3) |
| Connected Angel-Startup | 0.234*** (0.005) | 0.182*** (0.006) | |
| Same School | | | 0.023*** (0.001) |
| Same Employer | | | 0.215*** (0.001) |
| Same Ethnic Minority | | | 0.004*** (0.000) |
| New Market | | -0.068*** (0.013) | -0.063*** (0.010) |
| Connected Angel-Startup × New Market | | 0.087*** (0.008) | |
| Same School × New Market | | | 0.043* (0.022) |
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Social connections are more important for matching in new product markets.

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- Positive side: Better communication and coordination
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| | (1) | (2) | (3) | (4) | (5) | (6) |
| Same School | 0.091*** (0.028) | | | | | 0.076** (0.034) |
| Same Top School | | 0.096** (0.041) | | | | |
| Same Bottom School | | 0.083** (0.036) | | | | |
| Same Employer | | | 0.102*** (0.021) | | | 0.127*** (0.022) |
| Same Top Employer | | | | 0.119*** (0.033) | | |
| Same Bottom Employer | | | | 0.084*** (0.029) | | |
| Same Ethnic Minority | | | | | 0.039** (0.019) | 0.037* (0.019) |
| Obs. | 9396 | 9396 | 9396 | 9396 | 9396 | 9396 |
| Adj. R ² | 0.172 | 0.170 | 0.169 | 0.171 | 0.169 | 0.172 |

Connected startups are more likely to move from seed to series A stage:

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- Is better performance due to selection or treatment?

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- I use adopt a Heckman (1979) model:

$$1^{st} \text{ stage : } Investment_{i,j} = \alpha_0 + \alpha_1 \text{Connected Angel Startup}_{i,j} + \alpha_2 \text{Angel Profile On CB}_i \\ + \alpha_3 \text{Startup Profile On CB}_j + \alpha_A A_i + \alpha_S S_j + \mu_t + \mu_{ind} + \mu_{loc} + \epsilon_{ij}$$

$$2^{nd} \text{ stage : } Outcome_j = \beta_0 + \beta_1 \text{Connected Angel Startup}_{i,j} + \beta_2 IMR_{ij} \\ + \beta_A A_i + \beta_S S_j + \eta_i + \eta_t + \eta_{ind} + \eta_{loc} + u_j$$

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- *Startup Profile On CB_j*: indicates if the startup had a Crunchbase profile before the seed-funding date
- β_1 is the estimate of post-investment influence of the angel investor on the startup.

Effect of Social Connection on Seed-stage Success

| | OLS | Heckman: 1 st stage | Heckman: 2 nd stage |
|---------------------------|---------------------|--------------------------------|--------------------------------|
| | (1) Seed Success | (2) Investment | (3) Seed Success |
| Connected Angel-Startup | 0.087*** (0.020) | 0.112*** (0.016) | 0.136*** (0.024) |
| Ln(Traction) | 0.037*** (0.010) | 0.002*** (0.000) | 0.020* (0.011) |
| Ln(Seed Funds) | 0.052*** (0.015) | | 0.093*** (0.020) |
| Ln(Degree) | 0.014** (0.006) | 0.000 (0.001) | 0.019** (0.007) |
| Seed Success Ratio | 0.201*** (0.031) | 0.003*** (0.001) | 0.166*** (0.036) |
| Inverse Mills Ratio | | | -0.082*** (0.010) |
| Angel on CB Before Seed | | 0.076*** (0.014) | |
| Startup on CB Before Seed | | 0.051*** (0.010) | |
| Obs. | 5793 | 1942292 | 5793 |
| R ² | 0.161 | 0.397 | 0.152 |

Social connection has a significant effect on Seed Success even after controlling for selection.

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| Inverse Mills Ratio | | | -0.082*** (0.010) |
| Angel on CB Before Seed | | 0.076*** (0.014) | |
| Startup on CB Before Seed | | 0.051*** (0.010) | |
| Obs. | 5793 | 1942292 | 5793 |
| R ² | 0.161 | 0.397 | 0.152 |

Social connection has a significant effect on Seed Success even after controlling for selection.

Effect of Social Connection on Other Seed-stage Outcomes

| | Heckman: 2 nd stage | | | |
|-------------------------|--------------------------------|-----------------------------|-----------------------|---------------------------|
| | (1) Ln(Series A Funds) | (2) Ln(Time to Series A) | (3) VC in Series A | (4) Connected Investor |
| Connected Angel-Startup | 0.126** (0.055) | 0.141** (0.067) | 0.146* (0.083) | 0.153* (0.078) |
| Ln(Traction) | -0.074 (0.070) | 0.025 (0.031) | 0.021 (0.038) | 0.019 (0.064) |
| Ln(Seed Funds) | 0.502*** (0.114) | 0.074 (0.050) | -0.044 (0.062) | -0.035 (0.104) |
| Ln(Degree) | 0.068 (0.044) | 0.010 (0.019) | 0.052** (0.024) | 0.146*** (0.040) |
| Seed Success Ratio | -0.052 (0.186) | -0.425*** (0.082) | 0.008 (0.102) | -0.047 (0.171) |
| Inverse Mills Ratio | -0.131* (0.067) | 0.055* (0.029) | -0.018 (0.036) | -0.057 (0.061) |
| Obs. | 1167 | 1167 | 1167 | 1167 |
| R ² | 0.151 | 0.294 | 0.098 | 0.015 |

Connected startups perform better than unconnected startups:

Effect of Social Connection on Other Seed-stage Outcomes

| | Heckman: 2 nd stage | | | |
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| | (1) Ln(Series A Funds) | (2) Ln(Time to Series A) | (3) VC in Series A | (4) Connected Investor |
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Connected startups perform better than unconnected startups:

- Raise \$0.26 million more in series A stage.

Effect of Social Connection on Other Seed-stage Outcomes

| | Heckman: 2 nd stage | | | |
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| R ² | 0.151 | 0.294 | 0.098 | 0.015 |

Connected startups perform better than unconnected startups:

- Raise \$0.26 million more in series A stage.
- Take about 4 months more to reach series A stage.

Effect of Social Connection on Other Seed-stage Outcomes

| | Heckman: 2 nd stage | | | |
|-------------------------|--------------------------------|-----------------------------|-----------------------|---------------------------|
| | (1) Ln(Series A Funds) | (2) Ln(Time to Series A) | (3) VC in Series A | (4) Connected Investor |
| Connected Angel-Startup | 0.126** (0.055) | 0.141** (0.067) | 0.146* (0.083) | 0.153* (0.078) |
| Ln(Traction) | -0.074 (0.070) | 0.025 (0.031) | 0.021 (0.038) | 0.019 (0.064) |
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| Obs. | 1167 | 1167 | 1167 | 1167 |
| R ² | 0.151 | 0.294 | 0.098 | 0.015 |

Connected startups perform better than unconnected startups:

- Raise \$0.26 million more in series A stage.
- Take about 4 months more to reach series A stage.
- 14.6% more likely to attract a VC in series A stage.

Conclusion

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- This paper is the first to study the effect of social connections on partnership decisions and post-investment performance in individual angels market.

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Conclusion

- I assemble a unique dataset on 9,393 startups seed funded by angel investors.
- This paper is the first to study the effect of social connections on partnership decisions and post-investment performance in individual angels market.
- Connected angels and entrepreneurs are more likely to work together.
- School (employer) connections at top and lower ranked schools (companies) affect investment decisions.
- Connected startups perform better compared to unconnected startups:
 - More likely to move from seed to series A stage.
 - But, take longer to reach series A.
 - Raise more series A funds.
 - Attract VC investment in series A stage.

Contributes to the growing literature in finance that investigates the effect of social connections on performance:

- By showing that social connections improve performance in early-stage startup financing markets.

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Contributes to the small but growing literature on angels investors:

- By describing the characteristics and performance of the firms funded by angels.
- By focusing on individual angels rather than large angel groups.

Thank you!

Appendix

Effect of Social Connection on Matching - Base

| | Investment | | | |
|---------------------------------------|----------------------|----------------------|----------------------|----------------------|
| | (1) | (2) | (3) | (4) |
| <i>Startup Characteristics</i> | | | | |
| Ln(Age at Seed) | -0.002*** (0.000) | -0.002*** (0.000) | -0.001*** (0.000) | -0.001*** (0.000) |
| Serial Founder | 0.001*** (0.000) | 0.001*** (0.000) | 0.000*** (0.000) | 0.000* (0.000) |
| Ln(Traction) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) |
| Top School: Founder | | | 0.001*** (0.000) | 0.000*** (0.000) |
| Top Employer: Founder | | | | 0.001*** (0.000) |
| <i>Angel Investor Characteristics</i> | | | | |
| Ln(Degree Centrality) | | 0.000 (0.000) | 0.000 (0.000) | 0.000 (0.000) |
| Entrepreneur-Investor | | 0.001*** (0.000) | 0.001*** (0.000) | 0.001*** (0.000) |
| Success Ratio | | 0.001 (0.001) | 0.002** (0.001) | 0.002** (0.001) |
| Top School: Angel | | | 0.001*** (0.000) | 0.000*** (0.000) |
| Top Employer: Angel | | | | 0.001*** (0.000) |
| Obs. | 2395651 | 2395651 | 2395651 | 2395651 |
| Adj. R ² | 0.040 | 0.040 | 0.040 | 0.040 |
| Location, Prod. Market, Yr. F.E. | Yes | Yes | Yes | Yes |

Effect of Social Connection on Success - Base

| | Seed-stage Success | | | |
|---------------------------------------|---------------------|-----------------------|---------------------|---------------------|
| | (1) | (2) | (3) | (4) |
| <i>Startup Characteristics</i> | | | | |
| Ln(Age at Seed) | -0.024 (0.016) | -0.043 *** (0.016) | -0.025 (0.016) | -0.023 (0.017) |
| Serial Entrepreneur | 0.009 (0.016) | 0.006 (0.015) | 0.007 (0.015) | 0.009 (0.016) |
| Ln(Traction) | 0.024*** (0.008) | 0.027*** (0.008) | 0.024*** (0.008) | 0.021*** (0.008) |
| Top School: Founder | | | 0.058*** (0.020) | 0.056*** (0.022) |
| Top Employer: Founder | | | | 0.083*** (0.020) |
| <i>Angel Investor Characteristics</i> | | | | |
| Ln(Degree) | | 0.018*** (0.005) | 0.012** (0.005) | 0.013** (0.006) |
| Entrepreneur-Investor | | 0.017 (0.015) | 0.012 (0.015) | 0.003 (0.015) |
| Seed Success Ratio | | 0.107*** (0.026) | 0.109*** (0.026) | 0.106*** (0.026) |
| Top School: Angel | | | -0.003 (0.024) | 0.013 (0.026) |
| Top Employer: Angel | | | | -0.016 (0.023) |
| Obs. | 9396 | 9396 | 9396 | 9396 |
| Adj. R ² | 0.058 | 0.099 | 0.109 | 0.114 |
| Location, Prod. Market, Yr. F.E. | Yes | Yes | Yes | Yes |

Effect of Social Connection Strength on Seed Success

| | Seed-stage Success | | | | |
|--|---------------------|---------------------|---------------------|---------------------|---------------------|
| | (1) | (2) | (3) | (4) | (5) |
| Same School | 0.071** (0.031) | | | | |
| Same Employer | 0.088*** (0.027) | | | | |
| Same Ethnic Minority | 0.027* (0.016) | | 0.029* (0.017) | 0.028 (0.018) | 0.028 (0.018) |
| Same School × Employer | 0.069** (0.034) | | | | |
| Same School × Ethnic Minority | 0.028 (0.018) | | | | |
| Same Employer × Ethnic Minority | 0.013** (0.006) | | | | |
| Same School × Employer × Ethnic Minority | 0.112** (0.053) | | | | |
| Connection Depth=1 | | 0.044*** (0.018) | | | |
| Connection Depth=2 | | 0.079*** (0.030) | | | |
| Connection Depth=3 | | 0.123** (0.062) | | | |
| Same Top School | | | 0.080* (0.042) | 0.067 (0.043) | 0.066 (0.043) |
| Same Bottom School | | | 0.065* (0.037) | 0.055 (0.038) | 0.055 (0.038) |
| Same Top Employer | | | 0.131*** (0.038) | 0.119*** (0.041) | 0.119*** (0.040) |
| Same Bottom Employer | | | 0.101*** (0.036) | 0.098*** (0.039) | 0.098*** (0.039) |

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