JOURNAL OF FINANCIAL AND QUANTITATIVE ANALYSIS Vol. 58, No. 8, Dec. 2023, pp. 3305–3341

doi:10.1017/S0022109022001314

Is There a Trade-off Between Protecting Investors and Promoting Entrepreneurial Activity? Evidence from Angel Financing

Jiajie Xu
University of Iowa Tippie College of Business
jiajie-xu@uiowa.edu

Abstract

This article studies how changes in investor protection regulations affect local entrepreneurial activity, relying on the heterogeneous impact of a 2011 SEC regulation change on the definition of accredited investors across U.S. cities. Using a difference-in-differences approach, I show that cities more affected by the regulation change experienced a significantly larger decrease in local angel financing, entrepreneurial activity, innovation output, employment, and sales. I find that small business loans and second-lien mortgages became entrepreneurs' partial substitutes for angel investment. My cost-benefit analysis suggests that the costs of protecting angel investors through the 2011 regulation change outweigh its benefits.

I. Introduction

Small businesses, which account for two-thirds of new jobs created in the United States, are the basis for innovation and crucial for economic growth.[1] Raising capital for small businesses is important but not easy in a market with large information asymmetry and high search costs of potential investors.[2] Regulators like the U. S. Securities and Exchange Commission (SEC) have called lack of

I am grateful to Scott Bauguess (the referee) and Jarrad Harford (the editor) for their valuable input. This article is based on chapter 2 of my dissertation at Carroll School of Management of Boston College. I am indebted to the guidance and support from my dissertation committee, Thomas Chemmanur (Chair), Francesco D'Acunto, Ran Duchin, Hassan Tehranian, and Xuan Tian. For helpful suggestions and comments, I thank Chang Suk Bae (discussant), Vyacheslav Fos, Rawley Heimer, Adam Jorring, Nadya Malenko, Alan Marcus, Philip Strahan, Ting Xu (discussant), seminar participants at Boston College, University of Iowa, Iowa State University, Washington State University, Tulane University, University of Delaware, University of Arizona, and conference participants at 2021 AFA PhD Student Poster Session, 2021 Midwest Finance Association Annual Meeting, 2021 Student Workshop on Entrepreneurial Finance and Innovation, and 2021 Eastern Finance Association Annual Meeting. Special thanks to Walls & Associates for providing me the access to the National Establishment Time Series (NETS) Database. I am responsible for all remaining errors and omissions.

[1]President Barack Obama, Proclamation, National Small Business Week, 2014 (May 9, 2014), "Small businesses represent an ideal at the heart of our Nation's promise – that with ingenuity and hard work, anyone can build a better life. They are also the lifeblood of our economy, employing half of our country's workforce and creating nearly two out of every three new American jobs."

[2]There is a large strand of literature discussing these frictions, see examples in Leland and Pyle (1977), Grinblatt and Hwang (1989), and Conti, Thursby, and Rothaermel (2013)).

investor access to private companies a growing challenge.[3] However, there is often a trade-off between promoting entrepreneurial activity and protecting investors, especially for small investors who may lose a significant amount of money by investing in entrepreneurial firms that turn out to be unsuccessful.

The regulatory debate on this trade-off recently escalated when the accredited investor standard was amended by the SEC on Aug. 26, 2020. In addition to the existing tests for income or net worth, the amendment allows investors to qualify when they have certain professional knowledge, experience, or certifications. Immediately afterward, two SEC Commissioners issued a joint statement publicly criticizing that the Commission majority failed to protect vulnerable investors and the update was issued without "sufficient data or analysis."[4] In this article, I exploit a 2011 SEC regulation change to empirically analyze this trade-off in the context of angel financing.

Angel financing presents a good setting to study the above trade-off. Angel investors drive a large portion of the financing for entrepreneurial firms (Shane (2008), Kerr, Lerner, and Schoar (2014), and Denes, Howell, Mezzanotti, Wang, and Xu (2020)). Many firms were backed by angel investors at their early stage, with some famous examples including Google, Amazon, Facebook, Paypal, Costco, and The Home Depot. Yet, angel investors are individual investors, as distinguished from institutional investors like venture capital (VC) and private equity (PE) firms. They may be more vulnerable to investing in frauds and scams, have less risk-bearing ability, and are more likely to make irrational investment decisions compared to institutional investors (Collewaert and Fassin (2013), Drover, Busenitz, Matusik, Townsend, Anglin, and Dushnitsky (2017)).

The concerns about protecting individual investors increased rapidly after the 2008 financial crisis, in which many individuals went bankrupt and lost their home residence. On Dec. 21, 2011, the SEC adopted amendments to the definition of accredited investors, requiring that the value of a person's primary residence be excluded when determining whether the person qualifies as an "accredited investor" on the basis of having a net worth in excess of $1 million.[5] The new rule was enacted under the requirement of the 2010 Dodd-Frank Act with the main goal

[3]In an SEC press release on June 18, 2019, "The Securities and Exchange Commission today requested public comment on ways to simplify, harmonize, and improve the exempt offering framework to expand investment opportunities while maintaining appropriate investor protections and to promote capital formation."

[4]Specifically, the statement (Lee and Crenshaw (2020)) wrote, "With its actions today, the Commission continues a steady expansion of the private market, affording issuers of unregistered securities access to more and more investors without due regard for the risks they face, and without sufficient data or analysis to ensure that our policy choices are grounded in fact rather than supposition." The SEC press release on updating the accredited investor definition is available at https://www.sec.gov/news/press-release/2020-191.

[5]On Dec. 21, 2011, the SEC issued an announcement for immediate release (No. 2011-274), "the Securities and Exchange Commission has amended its rules to exclude the value of a person's home from net worth calculations used to determine whether an individual may invest in certain unregistered securities offerings. The changes were made to conform the SEC's definition of an 'accredited investor' to the requirements of the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act." The announcement can be found at https://www.sec.gov/news/press/2011/2011-274.htm. The final rule release can be found at https://www.sec.gov/rules/final/2011/33-9287.pdf.

of preventing unsophisticated investors from personal bankruptcies and loss of residency by investing in unsuccessful firms. The regulation change is estimated to eliminate more than 20% of previously eligible households in the United States (Hudson (2014)).

I use the regulatory change as a quasi-natural experiment. The new rule directly changed the investor protection environment in the private offering market by restricting the definition of accredited investors, which is considered as the "most important investor protection in the private market" (Lee and Crenshaw (2020)). Importantly, the implementation of this regulation change was not driven by local entrepreneurial activity, ruling out reverse causality. In addition, I am able to use the heterogeneity of home value to net worth across U.S. cities as a proxy for variation in the investor protection environment, which has traditionally been hard to observe and measure in the private market.

I apply a difference-in-difference (DiD) approach with a continuous treatment variable to examine its impact. To reflect the average extent of a city being affected by the regulation change, I construct a variable, home-value-to-net-worth (HV/NW henceforth), by dividing the average home value by the average net worth in a city at the end of 2011. The results of the DiD analysis show that the 2011 SEC regulation change had a significantly negative impact on local angel financing. Cities with a higher HV/NW ratio, experienced significantly larger decreases in both the number and amount of angel financing after the regulation change. Specifically, a 1-standard-deviation increase in the HV/NW ratio prior to the regulation change, on average, led to a 11.3% larger decrease in the amount and a 1.3% larger decrease in the number of angel investments after the regulation change. Translating the estimates into dollar amount, there would be a $2.75 billion larger decrease per year in angel financing across the United States if the HV/NW ratios increased 1-standard-deviation in all sample cities. I conduct a battery of robustness tests to support a causal interpretation of the results.

I find that the decrease in local angel financing had nonnegligible impact on the financing of some high-quality firms. I examine the impact of the 2011 SEC regulation change on local entrepreneurial activity measured by subsequent financing and successful exits (i.e., acquisitions or IPOs) generated by firms receiving angel financing (angel-backed firms). My results suggest that a 1-standard-deviation higher HV/NW ratio prior to the regulation change, on average, led to a 0.75% larger decrease in the number of angel-backed firms that later receive next-round financing and a 0.40% larger decrease in the number of angel-backed firms that later receive VC financing after the SEC regulation change. I also find that the number of angel-backed firms that later have successful exits decreased to a significantly greater extent in cities more affected by the SEC regulation change. The results confirm that distance-related frictions could hinder the matching between investors and firms in the early-stage financing market (Agrawal, Catalini, and Goldfarb (2015)): Some marginal angel investors who had local information to better select or monitor local firms lost the eligibility to participate in angel investing due to the regulation change, and some high-quality firms lost access to capital because of the restricted pool of local investors.

I also provide evidence that the SEC regulation change imposed a nonnegligible cost on the local economy. I examine the impact of the SEC regulation change

on the generation of innovation, employment, and sales by firms that received angel investments in the local area. I show that when a city had a 1-standard-deviation higher HV/NW ratio prior to the regulation change, it experienced a 0.99% larger decrease in the number of patents, 0.05% larger decrease in the number of patent citations generated by angel-backed firms in the city, on average. The same city also experienced a 11.24% greater decrease in sales generated and a 3.23% greater decrease in the number of jobs supported by angel-backed firms after the above regulation change.

I also find an indirect impact from reducing angel financing on two alternative financing sources for small firms: small business loans guaranteed by the Small Business Administration (SBA) and second-lien mortgages. The number and amount of small business loans and second-lien mortgages increased significantly more in cities that were more affected by the SEC regulation change. The results suggest that the SEC amendment indeed reduced the supply of angel financing and pushed some entrepreneurs to borrow from taxpayers or to mortgage their own home.

Finally, I provide suggestive evidence that the costs of the investor protection regulation change outweigh the benefits. The benefit is estimated by calculating the reduced amount of angel investment (due to the SEC regulation change) in entrepreneurial firms that would have turned out to be unsuccessful – investor protection through loss avoidance. The costs are measured by the present value of reduced sales generated by entrepreneurial firms that did not receive angel financing (i.e., the present value of lost sales). Assuming a discount rate is 30% and growth rate is 25% (when early investors require a high return and young firms have high sales growth) and the impact of the regulation change lasts for 5 years, the present value of total net benefits of the regulation change is negative 6.32 billion dollars at the end of 2011. I also show that the costs of reduced patents and employment generated by these firms are nonnegligible.

The rest of the article is organized as follows: Section II discusses the contribution of this article to the related literature. Section III introduces the institutional background of angel investors and private placements in the United States. Section IV describes data sources and variable construction in this study. Sections V–VII explain the empirical strategy and show how the SEC regulation change impacted local angel financing, entrepreneurial activity, and the local economy. Section VIII analyzes the substitution effects of reduction in angel financing on alternative financing sources. Section IX presents a cost-benefit analysis of the regulation change. Section X discusses the policy implications from this study. I conclude the article in Section XI.

II. Related Literature and Contribution

This article contributes to several strands of literature. First, it contributes to the literature on early-stage investors in entrepreneurial firms and their effects on firm performance. Previous studies have examined how angel groups (Kerr, Lerner, and Schoar (2014), Lerner, Schoar, Sokolinski, and Wilson (2018)), accelerators (Yu (2020)), and crowd-funding (Xu (2018)) impact firms' survival and performance. In terms of angel investors, studies have examined the relationship between

angel investors and venture capitalists both theoretically (Chemmanur and Chen (2014), Hellmann and Thiele (2015)) and empirically (Hellmann, Schure, and Vo (2021)). Venugopal and Yerramilli (2022) examine how seed-round successes of angel investors impact the evolution of investor network. Bernstein, Korteweg, and Laws (2017)) study which firm characteristics are more important to attract early-stage investors. There is a contemporaneous and independent paper by Lindsey and Stein (2020), which uses the same policy shock (the regulation change on the accreditation standard of angel investors) but differs in execution and findings. First, they focus mainly on the impact of the regulation change on aggregated small business employment. In contrast, the focus of my article analyzes the trade-off between investor protection regulations and the promotion of entrepreneurial activity by angel investors. Whereas they study the state-level aggregated business formation and employment for small firms (but not necessarily on angel-backed firms), I use different and more micro-level data sets to examine how the regulation change directly affected local angel financing, how it reduced the innovation, sales, and employment generated by angel-backed firms, and these firms' subsequent financing and successful exits.[6,7] Their paper suggests that angel financing is complementary to alternative financing sources. I find that the decreased angel financing has significant substitution effects on other financings such as small business loans and second-lien mortgages, even though these sources may not serve as perfect substitutes for angel financing.[8]

Second, my article contributes to the literature on the impact of investor protection regulations on firm performance and financial policies. Existing literature has studied how institutional features shape investor protection laws across countries and their impact on external financing, corporate governance, corporate valuation, and dividend payout policies (La Porta, Lopez-de Silanes, Shleifer, and Vishny (1997), Claessens, Djankov, and Lang (2000), La Porta, Lopez-de Silanes, Shleifer, and Vishny (2000), Claessens, Djankov, Fan, and Lang (2002), La Porta, Lopez-de Silanes, Shleifer, and Vishny (2002), and Shleifer and Wolfenzon (2002)). Agrawal (2013) shows that investor protection has a causal impact on

[6]I obtain firm-level angel financing data from SEC Form D filings, Crunchbase, and VentureXpert, patent data from the USPTO, annual sales and employment from the NETS, and their successful exits and financing histories from the VentureXpert and Crunchbase. I match these firm-level data sets and compile them at the city level. In Lindsey and Stein (2020), they mainly use the state-level aggregated data on the number of businesses and employment from Census's Business Dynamics Statistics and Quarterly Workforce Indicators. A discussion on the differences between their and my measurement of the treatment is in Appendix A of the Supplementary Material.

[7]My article is also related to the literature on the effect of VC-backing on corporate innovation, see, for example, Chemmanur, Loutskina, and Tian (2014) and Tian and Wang (2014).

[8]Potential explanations for the different findings on alternative financing sources between the two papers are as following: First, the two papers measure alternative financing sources differently: I use the number of applications and approvals of small business loans and home equity loans, while they use bank asset volumes and housing price growth. Second, the methodology is different in the two papers: I show substitution effects by directly testing changes in the usage of the small business loans and home equity loans, while they infer complementarity indirectly from a subsample test where the outcome variable is firm entry and divide states based on past housing price appreciation and bank asset volumes. Finally, the difference could also be due to the different geographic units used in the two papers (city in mine vs. state in theirs).

public firms' performance using the staggered passage of blue-sky laws in the United States. However, there has been no study analyzing effects of investor protection regulations on the private offering market. To my knowledge, this is the first article in the literature that empirically analyzes the impact of investor protection regulation in the private market on local entrepreneurial activity and on the local economy.

Third, my article is related to the literature on the role of government in promoting entrepreneurship and innovation. Lerner (2000) and Audretsch, Link, and Scott (2002) show that the U.S. Small Business Innovation Research (SBIR) positively impacts firms' R&D investment, commercialization, and subsequent firm growth. Howell (2017) causally estimates that an award from the U.S. Department of Energy's SBIR program approximately doubles the probability of receiving subsequent VC financing and has a positive impact on firms' innovation output and revenue growth. Da Rin, Nicodano, and Sembenelli (2006), however, find no evidence that public R&D spending has a positive effect on innovation using European data. Babina, He, Howell, Perlman, and Staudt (2023) compare government funding with private funding and find industry grants lead to greater appropriation of intellectual property. Brander, Du, and Hellmann (2015) and Denes (2017) study the impact of government-sponsored VC funding on the performance of entrepreneurial firms and its relationship with private VCs. Tian and Xu (2022) show that a place-based policy in China, the implementation of national high-tech zones, had a significant positive effect on local innovation and entrepreneurship. Denes et al. (2020) show that, although investor tax credits increase angel financing, they do not have a significant effect in promoting high-growth entrepreneurship. However, existing literature has not examined the impact of investor protection regulations on entrepreneurial activity. In this study, I provide evidence that these regulations can negatively affect entrepreneurship and the real economy.

Fourth, my article contributes to the recent debate about the effects of the JOBS Act on the funding of small businesses and entrepreneurship in the United States. Most of the existing studies have focused only on the impact of the JOBS Act on the initial public offerings (IPO). While the JOBS Act boosted IPO volume in subsequent years (Dambra, Field, and Gustafson (2015)), it also has brought unintended costs including higher IPO underpricing (Chaplinsky, Hanley, and Moon (2017)) and larger information uncertainty (Barth, Landsman, and Taylor (2017)) for emerging growth companies. These studies, however, have not looked into the crucial trade-off between protecting investors and promoting capital raising by small businesses, which is one of the main objectives of the JOBS Act. My article empirically analyzes the above trade-off and provides policy implications for regulators.

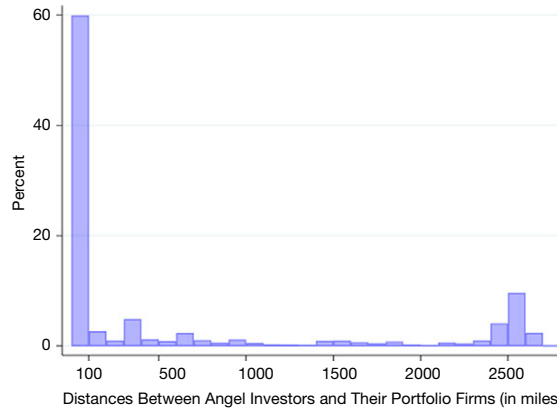
III. Institutional Background

The financing of early-stage firms relies largely on investment from noninstitutional investors. Angel investors, who are also known as accredited investors, provide about 90% of the first outside equity raised by entrepreneurial firms

FIGURE 1

Distances Between Angel Investors and Their Portfolio Firms

Figure 1 shows the distribution of distances in miles between angel investors and their portfolio firms. Data are collected from Crunchbase. I include all U.S. firms that are available in the Crunchbase data set and have received investments from angel investors in the United States prior to 2014. The sample contains 8,832 investor-firm pairs in total.



("first-money-in" after friends and family).[9] Angel investors invested $24.8 billion in 70,730 deals in 2013, compared to venture capital, which invested $29.6 billion in 4,050 deals in 2013.[10] Angel investors usually invest at an earlier stage with a smaller amount of investment per firm than institutional investors like VCs. Many successful firms, like Google, Facebook, Amazon, and Costco, received angel investment at an early stage.

Unlike VC investors, the geographical distribution of angel investors is more diverse. 63% of angel investors are located outside of San Francisco, Boston, and New York City, with 16.2% in the Great Lakes region, 15.4% in the Southeast, and 10.7% in the Mid-Atlantic (Huang, Wu, Lee, Bao, Hudson, and Bolle (2017)). Like other types of early-stage investment which tend to be distance sensitive (Stuart and Sorenson (2005), Michelacci and Silva (2007), and Agrawal et al. (2015)), most angel investors invest locally. As illustrated in Figure 1, 60% of 8,832 angel investments in the United States have a distance of fewer than 100 miles between the angel and the funded company.

To receive money from investors, companies can sell securities either through a public offering or a private placement. To conduct a public offering, firms need to register with the SEC to make sure that all investors have enough information about what they are buying. Private placements, which are governed by SEC registration rules collectively known as Regulation D, are offerings of unregistered securities

[9]This statistic is from Marianne Hudson, Executive Director, Angel Capital Association, Presentation to SEC Advisory Committee on Small and Emerging Companies, Washington, DC (Dec. 17, 2014) and The 2017 Halo Report, available at https://angelresourceinstitute.org/reports/halo-report-full-version-ye-2017.pdf.

[10]The statistics on angel investors are from the annual angel report produced by the Center for Venture Research at the University of New Hampshire, which is available at https://paulcollege.unh.edu/sites/default/files/resource/files/2013-analysis-report.pdf. The statistics on VC are from NVCA 2014 Yearbook, which is available at https://nvca.org/research/nvca-yearbook/.

to a limited pool of investors. Under Regulation D, companies may issue varying amounts of securities based on the type of investor they are selling them to (accredited or nonaccredited investors) without registering those securities with the SEC.[11] Firms conducting private placements need to file a notice of an exemption to the SEC by using Form D within 15 days after the first sale of securities in the offering (Appendix C of the Supplementary Material shows the first two pages of the Form D). Although there are three rules under Regulation D, Rule 504, Rule 505, and Rule 506, 99% of the Form D filings file under SEC Rule 506. Rule 506 requires that most of the offering to be given only to accredited investors and can be given to at most 35 nonaccredited investors. Even though Rule 506 permits up to 35 nonaccredited investors to participate, these investors need to receive "an extensive disclosure document with almost as much detail as is required for an initial public offering."[12] These additional disclosure requirements mean high accounting and legal costs for early-stage firms. Therefore, start-up firms rarely include nonaccredited investors in early private offerings (especially for angel financing when the total amount is relatively small compared to later rounds of financing). In fact, more than 90% of private placements were sold only to accredited investors (Ivanov and Bauguess (2013)), which underscores the importance of defining who can become accredited investors.

As discussed above, investors in private placements consist mainly of accredited investors. Thus, the definition of accredited investors is crucial for capital access to the private market. According to the SEC, an accredited investor is a person (or a married couple) with a net worth of at least $1 million, or an individual who earned an income of at least $200,000, or more than a combined income of $300,000 in the case of a married couple, for each of the last 2 years, and reasonably expects the same for the current year.

On Dec. 21, 2011, the SEC amended its rules under the Securities Act of 1933 as required by the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act to exclude the value of a person's home from net worth calculations, which are used to determine whether an individual may invest in certain unregistered securities offerings. The amendment became effective on Feb. 27, 2012.[13] The regulation change is estimated to eliminate more than 20% of eligible households in the U.S., according to the survey conducted by the Angel Capital Association (Hudson (2014)).[14]

[11]More information is available on the website of Financial Industry Regulatory Authority (FINRA), https://www.finra.org/rules-guidance/key-topics/private-placements.

[12]Matthew W. Bower, "Reasons to Include Only Accredited Investors in Your Rule 506(b) Private Offering," https://www.varnumlaw.com/newsroom-publications-reasons-to-include-only-accredited-investors-in-your-rule-506b-private-offering.

[13]More information about the SEC regulation change is available on the website of the SEC, https://www.sec.gov/news/press/2011/2011-274.htm. Even though the Dodd Frank Act required the change to the net worth standard to be effective upon passage on July 21, 2010, and required the SEC to revise the definition of accredited investors, it was not until the late 2011 when the SEC officially adopted amendment to the rules under the Securities Act of 1933, which governs the security issuance. After the SEC amendment, the detailed definitions of net worth and primary home value became clear to the public.

[14]In the unreported analysis, I observe that there was no significant increase in the usage of placement agents in angel financing after the regulation change. However, the definition of accredited investors can still be binding due to the search friction between entrepreneurs and investors. Rubinstein and Wolinsky

In this article, I study how the above SEC regulation change to the definition of accredited investors impacted local angel financing and subsequently affected firms' entrepreneurial activity and the local economy by exploiting the heterogeneity in the ratio of home value to net worth across U.S. cities. I also analyze the economic costs and benefits of the above regulation change.

IV. Data

A. Data Sources

I compile data from various sources. Among them, angel investments are the most difficult to observe and previous studies had to rely mainly on estimations from surveys (Shane (2008)). Following Denes et al. (2020), I combine data from SEC Form D filings, Crunchbase, and Thomson Reuters VentureXpert to overcome this data challenge.

A Form D is used to file a notice of an exempt offering of securities with the SEC when firms do private placements.[15] Form D filings provide information such as the name, location, industry, incorporation year of filing firms, and the date and total offering amount of each filing. I include only the first-time Form D filing of each firm to capture the "entrepreneurial" property of economic activity and to avoid the potential bias driven by the differences in the frequency of firms doing private placements. Filings from firms in the industries of financial services or energy are excluded. I exclude SEC Form D amendments and only allow one filing per day for one firm to avoid duplicate filings.

I supplement Form D observations with angel investments from Crunchbase and VentureXpert.[16] Crunchbase is a leading open-source database collecting information on start-ups and their round-by-round financing (Wang (2018), Yu (2020)). VentureXpert provided by Thomson Reuters is a commercial database that has a better coverage on deals made by institutional investors such as VC and PE firms (Ozmel, Robinson, and Stuart (2013), Chemmanur et al. (2014)). I identify angel investments based on the round type and investor identity.[17] These identified angel investments from Crunchbase and VentureXpert are then matched with identified angel investments from Form D filings based on firm name, location,

(1987) suggest that the value of a buy-side middleman will decrease when the ratio of the number of sellers to the number of buyers becomes smaller. In the context of angel financing, the network of placement agents mainly helps entrepreneurs reach out to marginal angel investors who were hard to be contacted by the entrepreneurs themselves. Once the number of marginal investors decreased due to the regulation change, entrepreneurs' necessity to use placement agents to find angel investors may not change or even decrease.

[15]The federal securities laws require the notice to be filed by companies that have sold securities without registration under the Securities Act of 1933 in an offering made under Rule 504 or 506 of Regulation D or Section 4(a)(5) of the Securities Act.

[16]This procedure is to address the issue that some firms may not file a Form D to the SEC even though they may face legal troubles. Ewens and Malenko (2020) show that some early-stage investments have never filed Form D.

[17]I include round types specified as "pre-seed," "seed," and "angel" in Crunchbase and investor type identified as "angel," "individual," and "angel group" in VentureXpert. This procedure is similar as in Denes et al. (2020) with the only difference that I do not include round type "equity crowdfunding" or investor type "accelerator," "incubator," or "micro VC" as angel investments.

and the announcement date within three months of the filing date of the Form D. Nonmatched observations are then added with the first-time Form D filings to form a comprehensive angel-investment database. As part of the matching procedure, I exclude first-time Form D filings if they are regarded as VC/PE rounds using information from Crunchbase and VentureXpert. Finally, I aggregate the angel investments at the city level semiannually.[18]

To measure the extent of a city being affected by the SEC regulation change, I construct the mean home-value-to-net-worth ratio. Higher ratios indicate greater potential impact. Home value data are from Zillow.[19] The household net worth is estimated by combining data from the Survey of Income and Program Participation (SIPP) and Internal Revenue Service (IRS) following the procedure suggested by Chenevert, Gottschalck, Klee, and Zhang (2017).

To examine the impact on local entrepreneurial activity, I look at the subsequent financing and successful exits (i.e., IPO or acquisition) of angel-backed firms. Data on firms' subsequent financing, investor identity, and successful exits are collected from SEC Form D filings, Crunchbase and VentureXpert. I match firms in these databases based on firm name and location. I then aggregate the entrepreneurial activity generated by angel-backed firms to the city level.

To examine the impact on local economic activity, I look at the generation of innovation, employment, and sales. For innovation output, I use data from the United States Patent and Trademark Office (USPTO) and calculate the number of patents and the number of patent citations. Data on the employment and sales are obtained from the National Establishment Time Series (NETS). I match firms in the USPTO database, the NETS database, and the SEC Form D filings based on their name and location.[20]

Finally, to examine the potential substitution effects of reduced angel financing on entrepreneurs' demand for alternative financing sources, I use data on small

[18]I set the unit of the analysis to be a city instead of other geographic units for several reasons. First, I did not choose ZIP codes because they are set up for the postal services and sometimes can be too small to be counted as a complete economic cluster. For example, ZIP code 02203 only covers a block in Downtown Boston in Massachusetts. Second, I did not choose counties because they can be too large to include many economic clusters like the County of Los Angeles and their boundaries can cut through an economic cluster as in many cases listed here: https://en.wikipedia.org/wiki/List_of_U.S._municipalities_in_multiple_counties. Regarding choosing semester as the main time unit, there are mainly two reasons. First, choosing semesters over years would increase the number of units in the analysis, which enables me to show more specific dynamics of the coefficient estimates (providing evidence for the parallel trend assumption) and perform the placebo test using more specific pseudo-event times. Second, I did not use quarterly time units because much more cities would have zero filings and zero firms having successful exits and subsequent financings in a quarter. The main results are robust under different time units (see Table B10 of the Supplementary Material).

[19]Zillow home value data have been used in many studies (e.g., Mian, Suff, and Trebbi (2015), Di Maggio et al. (2017), Giroud and Mueller (2017), (2019), Bailey, Cao, Kuchler, and Stroebel (2018), and Kaplan, Mitman, and Violante (2020)).

[20]In total, 29,808 out of 43,123 angel-backed sample firms have matched information in the NETS database. The matching rate of 69% is similar as in Denes et al. (2020). I observe 13,459 sample firms that have at least one patent during the sample period and treat the unmatched firms as having zero patents. The matching between the angel-backed firms and other data sets is separated from the aggregation of the angel financing records to city level, and therefore, does not affect the main result of how the regulation change impacted local angel financing.

business loans guaranteed by the Small Business Administration (including both 7(a) and 504 loans) and data on second-lien mortgages collected under the Home Mortgage Disclosure Act (HMDA).

The unit of analysis in my study is at the city level. I match all the variables using city names and manually check for matching accuracy.[21] To make sure that the results of my study reflect changes in local angel financing, I require sample cities to have at least one angel investment during the sample period. The final sample of this study has 3,896 cities during the time period of 2009 to 2013.

B. Variable Construction

1. Construction of Outcome Variables

The first set of outcome variables in the analysis is related to local angel financing. I construct two variables, the natural logarithm of 1 plus the number of angel investments in city i and time t (ln(NUM+1)) and the natural logarithm of 1 plus the amount of angel investments in city i and time t (ln(AMOUNT+1)).

To examine the impact of the SEC regulation on local entrepreneurial activity, I use the natural logarithm of 1 plus the number of firms who received angel-backing in city i and time t and later receive next-round financing (ln(NUM_NEXT_FINANCING+1)) and the number of angel-backed firms that later receive VC financing (ln(NUM_LATER_VC+1)) as the outcome variables for subsequent financing (t is the time when a firm receives the angel investment not the time when the firm receives next-round financing). Similarly, I use the natural logarithm of 1 plus the number of angel-backed firms that are acquired later (ln(NUM_ACQ+1)) later, the natural logarithm of 1 plus the number of angel-backed firms that have an IPO (ln(NUM_IPO+1)), and the natural logarithm of 1 plus the number of angel-backed firms that have either an acquisition or an IPO (ln(NUM_ACQ_OR_IPO+1)) as the outcome variables for successful exits. To account for the potential bias that may be created by the truncation problem in the data, I restrict all the above subsequent financing events or successful exits to be observed within 5 years after the angel investment.

To study the real economic impact of the SEC regulation change on the local economy, I examine the innovation, employment, and sales generated by angel-backed firms. For innovation output, I use the natural logarithm of 1 plus the number of patents (ln(NUM_PATENTS+1)), the natural logarithm of 1 plus the number of citations (ln(NUM_CITES+1)), and the natural logarithm of 1 plus the number of citations per patent (ln(NUM_CITES_PER_PAT+1)) generated by firms who 1 their angel investments in city i and time t (t is the time when a firm receive the angel investment not the time of the generation of patent, sales, or employment). The above three variables related to patents are adjusted for truncation biases following Hall, Jaffe, and Trajtenberg (2001). For employment and sales, I use the natural logarithm of 1 plus the number of jobs supported by angel-backed firms who received their investments in city i and time t in the next year

[21] When both ZIP code and city names are provided in a data set, I adjust city names based on the ZIP code-city link table (available at https://simplemaps.com/data/us-cities) to make sure that the territory a city name refers to, remains the same during the sample period.

(ln(EMPLOYMENT+1)) and the natural logarithm of 1 plus the amount of sales generated by these firms in the next year (ln(SALES+1)).

To evaluate the impact of the SEC regulation change on small business loans, I construct ln(NUM_SBL+1), the natural logarithm of 1 plus the number of small business loans approved by the SBA, ln(AMNT_SBL+1), the natural logarithm of 1 plus the amount of small business loans approved by the SBA, and ln(GUARANTEED_AMNT_SBL+1), the natural logarithm of 1 plus the amount of small business loans guaranteed by the SBA in city i and time t (i is the city where borrower firms locate in and t is the loan application time). To examine the impact on home equity loans, I use the number and the amount of second-lien mortgages (ln(2NDLIEN_NUM+1) and ln(2NDLIEN_AMNT+1)) in city i annually (i is the city where mortgage borrows locate in and t is the mortgage application time).

2. Construction of the Treatment Variables and Control Variables

I examine how the SEC regulation change in 2011 of removing primary residence from the net worth qualification standard of accredited investors impacted local entrepreneurial activity and the local economy. The key explaining variable, which measures the extent of a city being affected by the above SEC regulation change, is a city's home-value-to-net-worth ratio (the HV/NW ratio). The HV/NW ratio is calculated by dividing the weighted-average home value by the weighted-average household net worth in a city. The weighted average of home value in city i is calculated by taking the mean of the Zillow home value index across all ZIP codes in city i using ZIP-code population as the weights. The construction of the weighted average net worth in city i is estimated through the following steps: i) the total net worth and the net worth of five categories of assets of an average household in a state in 2011 are collected using data from the SIPP; ii) using data from the IRS, state-level net-worth-to-income ratios, $\left(\frac{\text{NW}}{\text{INCOME}}\right)_{\text{STATE,CATEGORY}}$, are calculated by dividing the average net worth of each asset category to the average household gross income of that category in 2011; iii) multiplying the net-worth-to-income ratio at the state-level by the income from each asset category using the ZIP-code level income ($\text{INCOME}_{\text{ZIP,CATEGORY}}$) data from the IRS, I obtain the household net worth of each asset category at the ZIP-code level ($\text{NW}_{\text{ZIP,CATEGORY}} = \left(\frac{\text{NW}}{\text{INCOME}}\right)_{\text{STATE,CATEGORY}} \times \text{INCOME}_{\text{ZIP,CATEGORY}}$) and add them up to get the household total net worth at the ZIP-code level[22]; iv) the city-level household net worth is estimated by taking the weighted average of the net worth of all ZIP codes in the city using ZIP code-level population as the weights.[23] I discuss more on the details of constructing the net worth in Appendix A of the Supplementary Material.

Following the existing literature, I control for a vector of city characteristics that would affect a city's angel financing and economic activity. Control variables

[22]Net worth statistics are not available for geographic units lower than the state level. To conduct this research at a finer geographic level and employ more variation in the treatment variable across the United States, an assumption is made in the estimation that the net-worth-income ratio is constant within a state.

[23]Note that the estimated net worth does not include home value even though it may include the net worth of real estate assets.

include the natural logarithm of a city's population (POPULATION), the natural logarithm of a city's average income per person (INCOME_PER_PERSON), and the natural logarithm of a city's average home value (HOME_VALUE). Data on population and income are collected from the IRS and data on home value are collected from Zillow.[24]

C. Summary Statistics

Summary statistics are reported in Table 1. To alleviate the concern that the results may be driven by outliers, I winsorize all city-level aggregated variables at the 1st and 99th percentiles in the regressions.[25]

As shown in Panel A of Table 1, the median of the HV/NW ratio, which reflects the extent of a city being affected by the above SEC regulation change, is 1.029. This statistic suggests that for a median city in the sample, the average home value is about the same as the average household net worth. Figure 2 shows the geographic variance of the HV/NW ratio across the United States in 2011.[26] The darkness of the color in the figure reflects the HV/NW ratio, with darker colors indicating higher values and reflecting the larger extent of being affect by the regulation change. One can observe from Figure 2 that there is a large variation in the HV/NW ratio across U.S. cities: The HV/NW ratio is quite high along the west coast (especially in the Bay Area and around Los Angeles) and in cities like Boston and the New York City, but is relatively low in other places like many cities around the Great Lakes. Furthermore, the impact of the regulation change does not seem to be merely a metropolitan phenomenon.[27]

Panel B of Table 1 reports the summary statistics on the outcome variables related to local angel financing. On average, a sample city has 1.2 (=0.616 $\times$ 2) angel investments per year totaling \$6.2 (=3.110 $\times$ 2) million. Panel C of Table 1 reports statistics on variables related to the subsequent financing and the successful exits of the firms that received angel investments. Panel D shows statistics related to the innovation generated, employment supported, and sales generated by the

[24]I calculate the income per person by dividing the gross income by the total number of personal exemptions, which approximates the population in the ZIP code according to IRS. I then obtain the city-level income per person by averaging the income per person at the ZIP code level and aggregate the ZIP code-level population to the city level.

[25]The statistics reported in Table 1 are not winsorized. The main results are similar if using nonwinsorized variables in the regressions.

[26]Note that the figure is used to illustrate the geographic variation of HV/NW ratio across the United States and not all cities that have a HV/NW ratio in the figure enter the sample for the later analysis. As stated in Section IV.A, I require all cities in the sample to have at least one angel investment during the 4-year sample period to address the concern that cities never had any angel investments may contaminate the results. This step excludes many cities with low net worth from the sample.

[27]In Figure B1 of the Supplementary Material, I show the HV/NW ratio of cities that are within top-30 metropolitan statistical areas (MSA). Top-30 MSAs are chosen based on the total populations in 2011. We observe that even for these large cities located within MSAs, they have great variation in terms of the extent impacted by the regulation change: Cities in MSAs such as Minneapolis-St. Paul-Bloomington, Chicago-Naperville-Joliet, and Detroit-Warren-Livonia have relatively low HV/NW ratios while the ratio is much higher for cities located in MSAs such as Los Angeles-Long Beach-Santa Ana, Orlando-Kissimmee, and New York-Northern New Jersey-Long Island.

TABLE 1

Summary Statistics

Table 1 displays the summary statistics for the data used in this study. Panel A reports statistics on the treatment variable. Panel B reports statistics on the outcome variables related to local angel investments. Panel C reports statistics on the subsequent financing received by and the successful exits of firms obtained angel investments. Panel D shows statistics on the innovation generated, employment supported, and sales generated by firms obtained angel investments. Panel E shows statistics related to small business loans and second-lien mortgages. Panel F reports statistics on control variables. Data sources are introduced in Section IV.A. Observations are at the city-semiannual level within the period from 2009 to 2013. Panel G reports statistics of firm-level data (Panels A–F show statistics of the city-level data which are aggregated from the firm-level data semiannually).

	N	Mean	Std. Dev.	Min	Median	Max
Panel A. Treatment Variable						
HV/NW	38,960	1.154	0.574	0.119	1.029	4.514
Panel B. Angel Investments						
NUM	38,960	0.616	2.125	0.000	0.000	20.000
AMOUNT ($MILLION)	38,960	3.110	14.699	0.000	0.000	130.000
Panel C. Entrepreneurial Activity (Subsequent Financing and Successful Exits)						
NUM NEXT FINANCING	38,960	0.196	0.776	0.000	0.000	7.000
NUM LATER VC	38,960	0.050	0.299	0.000	0.000	3.000
NUM IPO	38,960	0.005	0.090	0.000	0.000	5.000
NUM ACQ	38,960	0.018	0.219	0.000	0.000	13.000
NUM ACQ OR IPO	38,960	0.023	0.267	0.000	0.000	13.000
Panel D. Economic Activity (Innovation, Employment, and Sales)						
NUM PATENTS	38,960	0.088	0.559	0.000	0.000	5.894
NUM TOTAL CITES	38,960	0.002	0.017	0.000	0.000	0.202
NUM CITES PER PATENT	38,960	0.001	0.007	0.000	0.000	0.068
EMPLOYMENT	38,960	6.907	50.408	0.000	0.000	3,306.044
SALES ($MILLION)	38,960	0.662	6.067	0.000	0.000	494.742
Panel E. Small Business Loans and Second-Lien Mortgages						
NUM SBL (MILLION)	38,960	0.076	0.178	0.000	0.019	1.630
AMOUNT SBL ($MILLION)	38,960	1.554	3.828	0.000	0.135	32.764
GUARANTEED AMOUNT SBL ($MILLION)	38,960	0.870	2.231	0.000	0.032	18.944
2NDLIEN NUM (THOUSAND)	19,375	0.063	0.170	0.000	0.023	5.660
2NDLIEN AMNT ($MILLION)	19,375	3.499	10.545	0.000	1.217	447.397
Panel F. Control Variables						
POPULATION (MILLION)	38,214	0.0500.127	0.000	0.022	2.923	
INCOME PER PERSON ($MILLION)	38,214	0.038	0.031	0.009	0.030	0.786
HOME VALUE ($MILLION)	38,960	0.251	0.206	0.022	0.189	3.106
Panel G. Firm-Level Statistics						
AMOUNT ($MILLION)	43,123	2.414	3.355	0.004	0.750	12.000
1(NEXT FINANCING)	43,123	0.214	0.410	0.000	0.000	1.000
1(LATER VC)	43,123	0.060	0.238	0.000	0.000	1.000
1(IPO)	43,123	0.004	0.066	0.000	0.000	1.000
1(ACQ)	43,123	0.016	0.126	0.0000.000	1.000	
1(EXIT)	43,123	0.020	0.139	0.000	0.000	1.000
PATENTS	43,123	0.094	0.495	0.000	0.000	5.433
TOTAL CITES	43,123	0.005	0.068	0.000	0.000	5.218
SALES ($MILLION)	43,123	0.216	0.541	0.000	0.002	2.138
EMPLOYMENT 43,123	5.141	12.675	0.000	1.060	89.000	

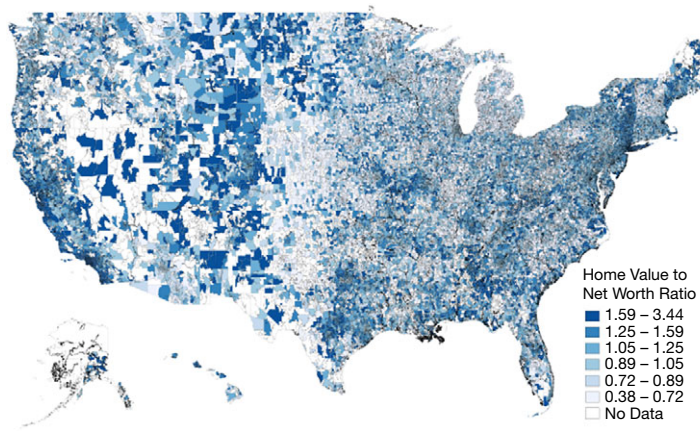
firms that received angel investments. Panel E of Table 1 shows statistics related to small business loans and second-lien mortgages. As reported in Panel F of Table 1, sample cities on average, has a population of 50,000 per year with $38,000 annual income per person and a housing value of $251,000.

Panel G of Table 1 presents the summary statistics of the sample firms. There are 43,123 firms that received angel financing in the sample (i.e., 43,123 angel financing deals). On average, the amount raised is about $2.4 million per deal with

FIGURE 2

Geographical Variation of the Home-Value-To-Net-Worth Ratio in 2011

Figure 2 shows the geographical variance of the HV/NW ratio across the United States in 2011. The darker the color represents a higher HV/NW ratio. The HV/NW ratio is calculated by diving the average home value in a city by the average household net worth in the city. The average home value in city i is calculated by averaging the Zillow home value index across all ZIP codes in city *i*. The average net worth in city *i* is estimated by combining data from SIPP and IRS following the procedure specified in Appendix A of the Supplementary Material.



$750,000 as the sample median.[28] Among these firms, 21.4% of them received the next round of financing within 5 years and 6% of them received VC financing later, 0.4% of the sample firms have gone public, and 1.6% have been acquired. In Table B1 of the Supplementary Material, I report more details on the age and geographical distributions of the sample firms.

V. Impact on Local Angel Financing

A. Main Specification and Baseline Results

To examine whether the 2011 regulation change of removing primary residence from net wealth in the qualification standard for accredited investors has generated any impact on local angel financing, I use a DiD approach with a continuous treatment.

The 2011 regulation change appears to be a good candidate to generate exogenous variation in investor protection strength given that the heterogeneity in housing values and net worths could lead to differences in the fraction of accredited investors being affected across U.S cities. The reverse causality concern is low given that the regulation change was mainly enacted to prevent unsophisticated investors from loss of primary residency and personal bankruptcies, and not in anticipation of future entrepreneurial activity. This exogenous variation in investor protection strength is captured by the treatment variable, $\ln(HV/NW)_i$, for each city

[28]These statistics are comparable to other data sets. For example, Pitchbook reports that "the median deal size for angel rounds is $600,000 compared to $2.1 million for seed rounds." The Pitchbook report is available at https://pitchbook.com/news/reports/3q-2019-2019-venture-capital-outlook-1h-follow-up.

i at the end of 2011.[29] I more fully discuss on the causal interpretation and the validity of the treatment variable after showing the results on local angel financing.

The DiD analysis is performed by estimating the following equation:

$$(1) \qquad Y_{i,t} = \alpha + \beta \ln(\mathrm{HV/NW})_i \times \mathrm{POST}_t + \mathrm{CONTROLS}_{i,t} + \delta_t + \eta_i + \varepsilon_{i,t},$$

where *i* represents a city and *t* represents a semiannual time period. $Y_{i,t}$ are the two dependent variables, $\ln(\mathrm{NUM}+1)_{i,t}$, the natural logarithm of 1 plus the number of angel investments, and $\ln(\mathrm{AMOUNT}+1)_{i,t}$, the natural logarithm of 1 plus the amount of angel investments in city *i* and time *t*. POST_t is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise.[30] $\mathrm{CONTROLS}_{i,t}$ include $\mathrm{POPULATION}_{i,t}$, the natural logarithm of population in city *i* and time *t*, $\mathrm{INCOME\_PER\_PERSON}_{i,t}$, the natural logarithm of average income per person in city *i* and time *t*, and $\mathrm{HOME\_VALUE}_{i,t}$, the natural logarithm of the average home value in city *i* and time *t*. To account for time-specific shocks and time-invariant city unobservable characteristics that may affect the estimation, I include city-fixed effects and time-fixed effects (and therefore, ln(HV/NW) and POST are omitted in the regressions). In all regressions, I cluster standard errors both at the city level and at the time level.[31]

Table 2 shows the results. In columns 1 and 3, the dependent variable is the quantity variable of angel financing, ln(NUM+1). In columns 2 and 4, the dependent variable is replaced with the amount variable of angel financing, ln(AMOUNT+1). Columns 1 and 2 show the results when controlling for city-fixed effects and time-fixed effects. Columns 3 and 4 show results with additional demographic control variables. The coefficient estimates on ln(HV/NW) × POST in Table 2 are all negative and significant at least at the 5% level. The magnitude of these estimates suggests that when the HV/NW ratio of a city increases 10% higher than the mean in 2011, it on average would experience 0.26% greater decrease in the number of angel investments and a 2.28% greater decrease in the amount of angel investments after the regulation change. To put it in another way, when the HV/NW ratio increases 1-standard-deviation (49.7% = 0.574/1.154) for all the cities in the sample, there would be a $2.75 billion-larger decrease in the amount of angel financing per year.[32]

[29]To account for the right skewness of the variables and to facilitate the interpretation of the estimation magnitude, I take log transformation for both the treatment variable and dependent variables.

[30]As discussed in footnote 13, there are two important dates regarding the regulation change: July 21, 2010, when the Dodd-Frank Act was passed and Dec. 21, 2011, when the SEC officially announced the amendment to its rules under Securities Act of 1933 as required by the Dodd-Frank Act. I chose the latter date for the following reason. Even though the Dodd-Frank Act could have aroused immediate attention from law firms and institutional investors, the Act requires time for individual investors to learn all the provisions (most of which are not relevant for individuals but on regulating banking and financial institutions), especially for the marginal small angel investors in my study. Also, it was not until late 2011 that detailed definition on net worth and primary home value became clear to the public.

[31]The significances of coefficient estimates with standard errors clustered only at city level are similar to those double-clustered at city and time level, with some estimates become more statistically significant and some become less but still significant at the 10% level. The results of estimation with standard errors clustered only at the city level are available from the authors.

[32]From the coefficient estimate, an average city would experience a 11.33% (=0.228% × 0.497) larger decrease in the amount, that is, 11.33% × 3,110,000 = 352,363 per semester. Hence, all the sample

TABLE 2

Impact on Local Angel Financing

Table 2 shows the results of the DiD analysis by estimating the following model:

$$Y_{i,t} = \alpha + \beta \ln(\text{HV/NW})_i \times \text{POST}_t + \text{CONTROLS}_{i,t} + \delta_t + \eta_i + \varepsilon_{i,t},$$

where i represents a city and t represents a semiannual time period. $Y_{i,t}$ are the two dependent variables that represent local angel financing, the natural logarithm of 1 plus the number of angel investments (ln(NUM + 1)) and the natural logarithm of 1 plus the amount of angel investments (ln(AMOUNT + 1)) in city i and time t. ln(HV/NW) is the natural logarithm of city i's home-value-to-net-worth ratio in 2011. Post is a dummy that equals 1 if period t is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for time and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(NUM + 1)	ln(AMOUNT + 1)	ln(NUM + 1)	ln(AMOUNT + 1)
	1	2	3	4
ln(HV/NW) × POST	−0.027***	−0.245**	−0.026***	−0.228**
	(0.006)	(0.096)	(0.006)	(0.099)
POPULATION			0.009	0.280
			(0.057)	(0.967)
INCOME_PER_PERSON			0.038	0.613
			(0.060)	(0.835)
HOME_VALUE			−0.016	0.328
			(0.040)	(0.533)
Constant	0.242***	3.471***	−0.039	−9.651
	(0.000)	(0.001)	(1.198)	(17.290)
No. of obs.	38,960	38,960	38,214	38,214
R^2	0.667	0.432	0.668	0.433
City FE	Yes	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes	Yes
No. of cities	3,896	3,896	3,822	3,822

B. Identification Assumptions and Challenges: Additional Tests

The causal interpretation of the results relies on three main identifying assumptions. I take several steps to provide supporting evidence for these assumptions.

First, to ensure that my results satisfy the parallel trend assumption required by the DiD approach, I examine the dynamics of the impact of the SEC regulation by replacing the time dummy (POST_t) in equation (1) with a set of dummies that represent each semiannual period (PERIOD_t). The dummy for the event period (i.e., the second-half year of 2011) is dropped to avoid the multicollinearity problem. I control for the same set of variables as in equation (1) with city-fixed effects and time-fixed effects included.

Figure 3 plots the coefficient estimates on PERIOD_t. The dependent variable in the regression is ln(NUM+1) in Graph A of Figure 3 and ln(AMOUNT+1) in Graph B. Graphs A and B of Figure 3 show that there is no significant trend prior to the regulation change: all of the coefficient estimates on PERIOD_t are not statistically less than 0 at the 10% significance level. After the regulation change, there is a downward trend in Graphs A and B, indicating that the change indeed had a negative effect on angel financing. Figure 3 provides supporting evidence for the parallel trend assumption not being violated.

Second, my empirical approach will be most effective when angel investments (especially from those marginal investors) are local. Previous research has

cities across the United States would experience a $352{,}363 \times 2 \times 3{,}896 = 2.75$ billion larger decrease per year if all sample cities had a 1-standard-deviation increase in the HV/NW ratio in 2011.

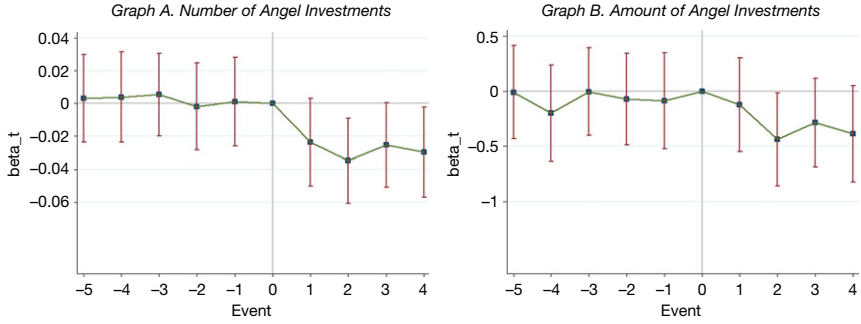
FIGURE 3

Plot of Coefficients Around the Event Time

Figure 3 shows the coefficients plot around the SEC regulation change in 2011 by estimating the following model:

$$Y_{i,t} = \alpha + \sum_{t=-5, t\neq 0}^{4} \beta_t \ln(\text{HV/NW})_i \times \text{PERIOD}_t + \text{CONTROLS}_{i,t} + \delta_t + \eta_i + \varepsilon_{i,t},$$

where PERIOD_t is a set of dummy variables that equals 1 if a city-half-year observation is from the time unit t. For example, PERIOD_1 equals 1 if observations are from the first half year of 2012. The benchmark group comprises of observations from the event period (the second half of 2011, $t = 0$). Graph A shows the plot of estimates of β_t when the outcome variable is the natural logarithm of 1 plus the number of angel investments. Graph B shows the plot of estimates of β_t when the outcome variable is the natural logarithm of 1 plus the amount of angel investments. The center points show the point estimates of β_t and the vertical lines denote the 90% confidence intervals of β_t estimates.



shown that entrepreneurial investments tend to be distance-sensitive (Stuart and Sorenson (2005), Michelacci and Silva (2007), and Agrawal et al. (2015)), which is consistent with the assumption. Furthermore, Figure 1 shows that around 60% of the angel-firm pairs in the Crunchbase database have a distance of less than 100 miles, suggesting that most angel investors in the United States invest locally. Next, to address the concern that the previous results might disappear when considering spillover effects, I run the baseline regressions controlling for these effects from nearby cities in regressions. The results are shown in Panel A of Table 3. In addition to ln(HV/NW) × POST, I add the interaction terms of the time dummy with the natural logarithm of the average HV/NW ratio in other cities within a 25, 50, and 100 mile radius around city i, $\ln(\text{HV/NW})_{25(50,100)\text{Miles}}$ × POST. The results suggest that the SEC regulation change had negative spillover effects on the angel financing in nearby regions and that after controlling for the spillover effects, the main effect of the regulation change on local angel financing is still significant.[33]

Third, readers may worry that the treatment variable, the HV/NW ratio, may not reflect the extent of a city being affected by the SEC regulation change, but indicate other contemporaneous factors. One specific concern is that the 2011 SEC regulation change was implemented during the recovery of housing market after the Great Recession. Regions hit the most during the recession may experience a greater recovery afterward, and therefore, the decline in angel financing in these

[33]For the succinctness of the paper, I report the results of the additional identification tests in Table 3 when the dependent variable is the number of angel investments, ln(NUM + 1) as the number of firms receiving angel financing is more relevant than the total dollar amount of financing received in a city. The results and conclusions are similar when using the amount variable, ln(AMOUNT + 1).

TABLE 3
Additional Identification Tests

Table 3 presents the results of additional identification tests. Panel A shows the results of the robustness test by controlling for spillover effects from nearby regions. $\ln(HV/NW)_{25(50,100)MILES}$ is the natural logarithm of the average home-value-to-net-worth ratio in cities within 25 (50, 100) miles to city *i*. Panel B shows the results of the robustness test by controlling for short-term housing price changes. HOME VALUE GROWTH 6M is the change in the natural logarithm of the housing price in a city in the last six months, and the HOME VALUE GROWTH 12M is the change in the natural logarithm of the housing price in a city in the last year. Panel C shows the results of the robustness test by excluding entrepreneurship cluster cities. In column 1, I exclude San Francisco, New York, and Boston ("the three" cities) in the analysis; In column 2, I exclude "the three" cities and cities within 100 miles in the analysis. Panel D shows the impact of the SEC regulation change on nonangel investments. The dependent variable in column 1 is the natural logarithm of 1 plus the number of investments made by venture capitalists or private equity firms in city *i* and time *t* (ln(NUM VC + 1)). In column 2, the dependent variable is ln(NUM LATER + 1), the natural logarithm of 1 plus the number of nonfirst-time SEC Form D filings in city *i* and time *t*. Panel E presents the results of the placebo test using pseudo-event time prior to the actual event time (i.e., the second half of 2011). POST_09H2 (POST_10H2) is a dummy that equals 1 if period *t* is after the second half year of 2009 (2010) and equals 0 otherwise. Similarly, POST_10H1 (POST_11H1) is a dummy that equals 1 if period *t* is after the first half year of 2010 (2011) and equals 0 otherwise. The dependent variable in Panels A, B, C, and E is ln(NUM+1), the natural logarithm of 1 plus the number of angel investments in city *i* and time *t*. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011, POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. In all the panels, I include control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE. I also control for time- and city-fixed effects. In all regressions, I double-cluster standard errors at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A. Controlling for Spillover Effects From Nearby Regions

	ln(NUM+1)	ln(NUM+1)	ln(NUM+1)
	1	2	3
ln(HV/NW) × POST	−0.015*	−0.016*	−0.014*
	(0.007)	(0.008)	(0.007)
ln(HV/NW)25 × POST	−0.023*		
	(0.011)		
ln(HV/NW)50 × POST		−0.027**	
		(0.012)	
$\ln(HV/NW)_{100}$ × POST			−0.041**
			(0.015)
No. of obs.	38,064	38,194	38,204
R^2	0.669	0.668	0.669
Controls	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes

Panel B. Controlling for Short-Term Housing Price Changes

	ln(NUM+1)	ln(NUM+1)	ln(NUM+1)	ln(NUM+1)
	1	2	3	4
ln(HV/NW) × POST	−0.027***	−0.027***	−0.027***	−0.027***
	(0.006)	(0.006)	(0.006)	(0.006)
HOME_VALUE_GROWTH_6M	0.064	0.071		
	(0.064)	(0.061)		
HOME_VALUE_GROWTH_12M			0.026	0.032
			(0.034)	(0.031)
No. of obs.	38,214	38,214	38,214	38,214
R^2	0.668	0.668	0.668	0.668
Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes	Yes

Panel C. Excluding Top-Three Entrepreneurship Cities and Cities Nearby

	ln(NUM+1)	ln(NUM+1)
	1	2
ln(HV/NW) × POST	−0.026***	−0.024***
	(0.006)	(0.006)
No. of obs.	38,184	37,174
R^2	0.663	0.658
Exclude cities	"The three cities"	<100 miles to "the three cities"
Controls	Yes	Yes
City FE	Yes	Yes
Semiannual FE	Yes	Yes

(continued on next page)

TABLE 3 (continued)
Additional Identification Tests

Panel D. Placebo Test: Impact on Nonangel Investments

	ln(NUM_VC+1)	ln(NUM_LATER+1)
	1	2
ln(HV/NW) × POST	−0.002	0.001
	(0.002)	(0.012)
No. of obs.	38,214	38,214
R^2	0.638	0.636
Controls	Yes	Yes
City FE	Yes	Yes
Semiannual FE	Yes	Yes

Panel E. Placebo Test: Using Pseudo Event Time

	ln(NUM + 1)	ln(NUM + 1)	ln(NUM + 1)	ln(NUM + 1)
	1	2	3	4
ln(HV/NW) × POST_09H2	−0.007			
	(0.006)			
ln(HV/NW) × POST_10H1		−0.006		
		(0.006)		
ln(HV/NW) × POST_10H2			−0.009	
			(0.006)	
ln(HV/NW) × POST_11H1				−0.005
				(0.005)
No. of obs.	38,214	38,214	38,214	38,214
R^2	0.499	0.499	0.499	0.385
Pseudo event-time	2009H2	2010H1	2010H2	2011H1
Controls	Yes	Yes	Yes	Yes
City FE	Yes	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes	Yes

regions may not be driven by the 2011 regulation change but by potential entrepreneurs switching from angel financing to mortgaging housing equity to relax their financial constraints (Corradin and Popov (2015), Kerr, Kerr, and Nanda (2015), and Schmalz, Sraer, and Thesmar (2017)). In Panel B of Table 3, I control for short-term housing price changes (past 6-month or 1 year) in addition to the level of housing price (HOME_VALUE) and find that the previous findings stay robust. In Table B2 of the Supplementary Material, I split all the sample cities into two groups based on their housing market growths from the end of 2008 to the end of 2011 and run a subsample test. If the alternative explanation was true, the baseline results should be stronger in cities with a higher housing price growth because entrepreneurs could borrow more against their housing equity. The results are contrary to the explanation of housing market recovery.

One may also question whether the SEC regulation change, which in theory should only affect marginal angel investors, would have an impact on local angel financing when the large angel clusters are excluded from the sample.[34] Panel C of Table 3 suggests that the negative impact on local angel investments was particularly strong in regions that are not within the radius of San Francisco, New York,

[34]Angel investments are prevalent across the United States, partly thanks to the angel tax credit program put forward by several state governments over the past decades (Denes et al. (2020)). In fact, Huang et al. (2017) show that 63% of angel investors reside outside the three cities, San Francisco, New York, and Boston ("the three" cities) where most VCs are located in.

and Boston, confirming that marginal angel investors were the ones that drove the results.

I perform two placebo tests to further substantiate the causal interpretation of the results. In the first test shown in Panel D of Table 3, I show that the SEC regulation change had no significant impact on nonangel or later-stage investments (the 2011 SEC regulation change which mainly affected marginal angel investors should not have a significant impact on these investments). Pane E of Table 3 shows the results of the second test where I replace the actual event time with different pseudo-event times to address the concern that other contemporaneous events may contaminate the previous findings. I do not observe significant results using pseudo-event times.

I conduct several other tests to show the robustness of the main results in Appendix B of the Supplementary Material. In Table B3 and Figure B2 of the Supplementary Material, I show that the results are similar when using a classic DiD approach, where the continuous treatment variable (ln(HV/NW)) is replaced by a dummy variable, which equals 1 if city *i*'s HV/NW ratio is larger than the sample median of the HV/NW ratio in 2011. Tables B4 and B5 of the Supplementary Material show that the results are robust when excluding cities with the top and/or bottom deciles of net worths or housing values. Table B6 of the Supplementary Material shows that the results are similar to those in the baseline regressions both statistically and economically when using an alternative treatment variable, the ratio of top-tier home value to the average net worth of individuals with top-bracket income in a city (the HV_TOP/NW_TOP ratio).[35] Table B7 of the Supplementary Material shows that the negative impact of the regulation change on angel financing appeared across firms of all age groups.

VI. Impact on Local Entrepreneurial Activity

Even though the last section shows that the SEC regulation change limited the participation of marginal angel investors and reduced local angel financing, it is unclear if it would affect the financing for high-quality firms and have real impact on the local economy. In a perfect market where marginal investors match with marginal firms, reduced supply of capital by restricting the participating of investors with marginal wealth should not affect the fund raising of high-quality firms, such as those who would have an IPO or receiving next-round financing. However, if there are market frictions that hinder the matching between investors and firms, then high-quality firms would also face challenges in raising angel capital when the pool of local investors shrank. In this section, I examine the impact of the 2011 SEC regulation change on local entrepreneurial activity measured by the number of angel-backed firms receiving subsequent financing or successful exits (i.e., IPO or Acquisition). I then examine the rate of the above entrepreneurial activity of angel-backed firms. I use the same empirical specification as illustrated by equation (1).

[35]The HV/NW ratio and the HV_TOP/NW_TOP ratio are highly correlated (a correlation coefficient of 0.8).

TABLE 4

Impact on Local Entrepreneurial Activity: Subsequent Financing of Firms Received Angel Investments

Table 4 shows how the SEC regulation change impacted local entrepreneurial activity measured by subsequent financing of firms received angel investments. I use the same empirical specification as described in Table 2. The dependent variable in column 1, ln(NUM_NEXT_FINANCING + 1), is the natural logarithm of 1 plus the number of firms that received an angel investment in city *i* and time *t* and receive next round financing in the future. The dependent variable in column 2, ln(NUM_LATER_VC + 1), is the natural logarithm of 1 plus the number of firms that received an angel investment in city *i* time *t* and later receive investments from venture capitals. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011. POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for time- and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(NUM_NEXT_FINANCING+1)	ln(NUM_LATER_VC+1)
	1	2
ln(HV/NW) × POST	−0.015**	−0.008*
	(0.005)	(0.004)
POPULATION	0.024	−0.012
	(0.034)	(0.014)
INCOME_PER_PERSON	0.016	−0.008
	(0.033)	(0.015)
HOME_VALUE	−0.066**	−0.046***
	(0.021)	(0.011)
Constant	0.502	0.792**
	(0.611)	(0.315)
No. of obs.	38,214	38,214
R^2	0.581	0.490
City FE	Yes	Yes
Semiannual FE	Yes	Yes

Table 4 examines whether the SEC regulation impacted on local entrepreneurial activity in terms of the subsequent financing of angel-backed firms. The dependent variable in column 1 is ln(NUM_NEXT_FINANCING+1), the natural logarithm of 1 plus the number of firms that received their angel investments in city *i* and time *t*, and received next-round financing within 5 years. The dependent variable in column 2 is ln(NUM_LATER_VC+1), the natural logarithm of 1 plus the number of firms that received their angel investments in city *i* and time *t*, and received at least one investment from VC within 5 years after. The coefficient estimates on ln(HV/NW) × POST in both columns are significantly negative at the 5% significance level and at the 10% significance level, respectively. The magnitude of the above coefficient estimates suggests that 1-standard-deviation increase (i.e., a 49.7% increase) in the HV/NW ratio is associated with a 0.75% greater decrease in the number of angel-backed firms that received next-round financing and 0.40% greater decrease in the number of angel-backed firms that later received VC financing.

Table 5 shows the results of how the SEC regulation has affected local entrepreneurial activity in terms of successful exits of firms that received an angel investment. The dependent variable in column 1, ln(NUM_ACQ+1), is the natural logarithm of 1 plus the number of firms that received their angel investments in city *i* and time *t* and have an acquisition within 5 years after. The dependent variable in column 2 is ln(NUM_IPO+1), the natural logarithm of 1 plus the number of firms that received their angel investments in *i* and time *t* and have an IPO within 5 years

TABLE 5

Impact on Local Entrepreneurial Activity: Successful Exits of Firms Received Angel Investments

Table 5 shows how the SEC regulation change impacted local entrepreneurial activity measured by investors' successful exits of firms received angel investments. I use the same empirical specification as described in Table 2. The dependent variable in column 1, ln(NUM_ACQ + 1), is the natural logarithm of 1 plus the number of firms that received angel investments in city *i* and time *t* and have an acquisition later. The dependent variable in column 2, ln(NUM_IPO + 1), is the natural logarithm of 1 plus the number of firms that received angel investments in city *i* and time *t* and have an IPO later. The dependent variable in column 3, ln(NUM_ACQ_IPO + 1), is the natural logarithm of 1 plus the number of firms received angel investments in city *i* and time *t* and have an acquisition or an IPO later. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011. POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for time- and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(NUM_ACQ + 1)	ln(NUM_IPO + 1)	ln(NUM_ACQ_IPO + 1)
	1	2	3
ln(HV/NW) × POST	−0.006**	−0.005**	−0.008**
	(0.002)	(0.002)	(0.002)
POPULATION	−0.014	−0.014	−0.017
	(0.009)	(0.008)	(0.012)
INCOME_PER_PERSON	−0.035**	−0.031**	−0.037**
	(0.011)	(0.014)	(0.011)
HOME_VALUE	−0.039***	−0.022**	−0.045***
	(0.011)	(0.008)	(0.012)
CONSTANT	0.980***	0.738**	1.117***
	(0.228)	(0.270)	(0.276)
No of obs.	38,214	38,214	38,214
R^2	0.351	0.261	0.362
City FE	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes

after. The dependent variable in column 3 is ln(NUM_ACQ_IPO+1), the natural logarithm of 1 plus the number of firms that received their angel investments in city *i* and time *t* and have an acquisition or an IPO within 5 years after. The coefficient estimates on ln(HV/NW) × POST in all columns are significantly negative at the 5% significance level. The magnitude of the above coefficient estimates suggests that a 1-standard-deviation increase in the HV/NW ratio, led to a 0.30% greater decrease in the number of angel-backed firms that have an acquisition, a 0.25% greater decrease in the number of angel-backed firms have an IPO, and a 0.40% greater decrease in the number of angel-backed firms having an acquisition or an IPO after the regulation change.

In addition to the aggregated variables, I also examine how the SEC regulation change has affected the rate of receiving subsequent financing and the rate of having a successful exit conditional on firms having received angel financing. Table B8 of the Supplementary Material shows the results. The coefficient estimates on ln(HV/NW) × POST are all negative, providing suggestive evidence that the SEC regulation change did not successfully select firms based on their potential for future successful exit for their investors. The results are consistent with the discussion in Hall and Lerner (2010) that the prospects of start-up firms are highly uncertain and thus hard to screen at their early stages.[36]

[36]There can be two explanations for the above findings on the nonpositive impact on the aggregated number and the rate of entrepreneurial activity. One is due to the distance-related frictions (Agrawal et al. (2015)) in the angel financing market that some marginal investors who had better local information to

The above results show that the regulation change of restricting the definition of accredited investors had negative impact on local entrepreneurial activity generated by angel-backed firms. The results also suggest that due to certain frictions in the angel financing market, the regulation change affected the funding raising even for some high-quality firms.

VII. Real Economic Impact

I then examine how the 2011 regulation change has impacted the local economy in terms of innovation, employment, and sales generated by the local firms that received angel financing.

Table 6 presents the results of examining whether the SEC regulation change has impacted the innovation generated by local angel-backed firms. In column 1, the dependent variable is the natural logarithm of 1 plus the number of patents generated by firms that received their angel investments in city *i* and time *t*, ln(NUM_PATENTS+1). The coefficient estimate on ln(HV/NW) × POST in column 1 is significantly negative at the 1% significance level. In column 2, I replace the dependent variable with the natural logarithm of 1 plus the number of

TABLE 6

Impact on the Local Economy: Innovation Generated by Firms Received Angel Investments

Table 6 shows the impact of SEC regulation change on the local economy in terms of innovation generated by the filing firms. The dependent variable in column 1, ln(NUM_PATENTS + 1), is the natural logarithm of 1 plus the number of patents generated by firms that received angel investments in city *i* and time *t*. The dependent variable in column 2, ln(NUM_CITES + 1), is the natural logarithm of 1 plus the number of patent citations received by firms who obtained their angel investments in city *i* and time *t*. The dependent variable in column 3, ln(NUM_CITES_PER_PATENT + 1), is the natural logarithm of 1 plus the average number of citations per patent received by firms who obtained angel investments in city *i* and time *t*. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011. POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for time- and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(NUM_PATENTS + 1)	ln(NUM_CITES + 1)	ln(NUM_CITES_PER_PATENT + 1)
	1	2	3
ln(HV/NW) × POST	−0.020***	−0.001**	−0.0004**
	(0.005)	(0.000)	(0.0002)
POPULATION	−0.038	−0.002	−0.0013*
	(0.025)	(0.001)	(0.0007)
INCOME_PER_PERSON	−0.051	−0.004**	−0.0014*
	(0.029)	(0.001)	(0.0007)
HOME_VALUE	−0.086**	−0.003**	−0.0017*
	(0.030)	(0.001)	(0.0008)
Constant	1.999***	0.099***	0.0498**
	(0.598)	(0.027)	(0.0157)
No. of obs.	38,214	38,214	38,214
R^2	0.427	0.375	0.3158
City FE	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes

select or monitor firms were not able to invest after the regulation change, which also led to some high-quality firms lost the access to angel capital. Another explanation is that some high-quality firms switched from angel financing to debt financing as Section VIII shows that the aggregated small business lending and mortgage lending increased.

TABLE 7

Impact on the Local Economy: Employment and Sales Generated by Firms Received Angel Investments

Table 7 shows the impact of SEC regulation change on the local economy in terms of employment supported and sales generated by the filing firms. The dependent variable in column 1, ln(EMPLOYMENT + 1), is the natural logarithm of 1 plus the number of jobs supported in the next year by firms who received angel investments in city *i* and time *t*. The dependent variable in column 2, ln(SALES + 1), is the natural logarithm of 1 plus the amount of sales generated in the next year by firms who received angel investments in city *i* and time *t*. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011. POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for time- and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(EMPLOYMENT + 1)	ln(SALES + 1)
	1	2
ln(HV/NW) × POST	−0.065***	−0.226**
	(0.016)	(0.088)
POPULATION	−0.066	0.202
	(0.162)	(0.813)
INCOME_PER_PERSON	0.012	0.426
	(0.077)	(0.453)
HOME_VALUE	−0.064	0.258
	(0.052)	(0.368)
Constant	1.797	−7.023
	(2.239)	(12.374)
No. of obs.	38,214	38,214
R^2	0.540	0.452
City FE	Yes	Yes
Semiannual FE	Yes	Yes

patent citations received by angel-backed firms in city *i* and time *t*, ln(NUM_CITES+1). In column 3, the dependent variable is the natural logarithm of 1 plus the average number of citations per patent received by firms that received their angel investments in city *i* and time *t*, ln(NUM_CITES_PER_PATENT+1).[37] The coefficient estimates on ln(HV/NW) × POST in columns 2 and 3 are both negative and significant at the 5% level. The magnitudes of the coefficient estimates suggest that a 1-standard-deviation increase from the mean of a city's HV/NW ratio, on average, led to a 0.99% greater decrease in the total number of patents, a 0.05% greater decrease in the total number of patent citations, and a 0.02% greater decrease in the number of citations per patent by firms that received angel financing after the 2011 regulation change than those received angel financing prior to the regulation change.

Table 7 presents the results of examining whether the SEC regulation change has affected the total employment supported and total sales generated by local angel-backed firms. The dependent variable in column 1 is ln(EMPLOYMENT + 1), the natural logarithm of 1 plus the number of jobs supported in the next year by firms that received angel financing in city *i* and time *t*. The coefficient estimate in column 1 is significantly negative at the 1% significance level. The magnitude of the estimate in column 1 suggests that a 1-standard-deviation increase in a city's HV/NW ratio, led to a 3.23% greater decrease in the number of jobs supported in the next year by local angel-backed firms after the regulation change. In column 2, I replace the dependent variable with ln(SALES + 1), the natural logarithm of 1

[37] All variables related to patents have been adjusted for truncation bias following Hall et al. (2001), as discussed in Section IV.

plus the amount of sales in the next year generated by angel-backed firms in city *i* and time *t*. The coefficient estimate on ln(HV/NW) × POST in column 2 is both negative and significant at the 5% level. The magnitude of the estimate suggests that a 1-standard-deviation increase in a city's HV/NW ratio, led to a 11.24% greater decrease in the amount of sales generated in the next year by local angel-backed firms after the regulation change.

The above results provide evidence that the SEC regulation change imposed a real economic cost on the local economy in terms of innovation, employment, and sales generated by firms that received angel financing.

VIII. Impact on Demands for Alternative Financing Sources

After showing that the 2011 regulation change has indeed generated negative impact on angel financing, a natural question would be whether there are any substitution effects of the reduction in angel financing on entrepreneurs' demand for other financing sources, among which I specifically focus on small business loans and second-lien mortgages. Addressing this question has two purposes: First, it could validate the prediction based on the previous findings that entrepreneurs would search for alternatives when the availability of angel financing declined; second, it may show potential unintended consequences of the regulation change on the other sectors of the economy through these alternative financing channels.

A. Small Business Loans

When the supply of angel financing is reduced, one important alternative financing source for entrepreneurs is the small business loans guaranteed by the Small Business Administration. In this section, I test whether the 2011 SEC regulation change on the definition of accredited investors had any impact on small business loans. I collect small business loan data from Small Business Administration during the sample period of 2009 to 2013. I identify the location of borrowers and aggregate the loan observations at the city-semiannual level using the application date. I use the same empirical specification as illustrated by equation (1).

Table 8 shows the results. The dependent variable in column 1 is the natural logarithm of 1 plus the number of approved small business loans applied in city *i* and time *t*, ln(NUM_SBL + 1). The coefficient estimate on ln(HV/NW) × POST is both positive and significant at the 5% significance level. The magnitude suggests that a 1-standard-deviation increase in a city's HV/NW ratio prior to the SEC regulation change, would lead to a 26.67% increase in the number of small business loans after the SEC regulation change. In columns 2 and 3, I replace the dependent variables with the natural logarithm of 1 plus the amount of small business loans, ln(AMNT_SBL + 1), and the natural logarithm of 1 plus the amount of small business loans guaranteed by the Small Business Administration, ln(GUARANTEED_AMNT_SBL + 1), respectively. The coefficient estimates on ln(HV/NW) × POST in both columns are positive and significant at least at the 5% significance level, suggesting that cities more affected by the SEC regulation change experienced larger increases in both the total amount of small business loans and the amount of these loans guaranteed by the government after the regulation change.

TABLE 8

The Substitution Effect Between Angel Financing and Small Business Loans

Table 8 shows the substitution effect between reduced angel financing and the demand for small business loans. The dependent variable in column 1, ln(NUM_SBL + 1), is the natural logarithm of 1 plus the number of approved small business loans applied in city *i* and time *t*. The dependent variable in column 2, ln(AMNT_SBL + 1), is the natural logarithm of 1 plus the approved amount of small business loans applied in city *i* and time *t*. The dependent variable in column 3, ln(GUARANTEED_AMNT_SBL + 1), is the natural logarithm of 1 plus the amount of small business loans applied in city *i* and time *t* guaranteed by the Small Business Administration. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011. POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for time- and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(NUM_SBL + 1)	ln(AMNT_SBL + 1)	ln(GUARANTEED_AMNT_SBL + 1)
	1	2	3
ln(HV/NW) × POST	0.424**	0.536***	0.496**
	(0.134)	(0.162)	(0.184)
POPULATION	0.596	0.931	0.127
	(0.611)	(0.891)	(0.835)
INCOME_PER_PERSON	0.438	0.718	0.708
	(0.496)	(0.581)	(0.639)
HOME_VALUE	0.104	−0.239	−0.079
	(0.642)	(0.801)	(0.776)
CONSTANT	−3.781	−4.037	1.185
	(14.738)	(18.875)	(15.124)
No. of obs.	38,784	38,784	38,784
R^2	0.591	0.591	0.573
City FE	Yes	Yes	Yes
Semiannual FE	Yes	Yes	Yes

B. Second-Lien Mortgages

Previous literature has shown the importance of housing mortgages as a funding source for entrepreneurship (Adelino, Schoar, and Severino (2015), Corradin and Popov (2015), Kerr, Kerr, and Nanda (2015), and Schmalz, Sraer, and Thesmar (2017)). Entrepreneurs can seek a second mortgage (or a second-lien mortgage) provided by local financial institutions as an alternative financing source when it is hard to obtain angel financing. Second-lien mortgages tap into the equity of a house, which is the market value of a home minus loan balances. In this section, I examine whether the 2011 regulation change, which reduced local angel financing, had any impact on the demand for second-lien mortgages. The mortgage data are collected under the Home Mortgage Disclosure Act (HMDA). I aggregate mortgage applications with a lien status specified as "subordinate lien" in the HMDA data to the city-year level from 2009 to 2013.[38] Specifically, I construct two variables using the HMDA data: ln(2NDLIEN_NUM + 1), the natural logarithm of 1 plus the number of second-lien mortgages applied in city *i* and time *t*, and ln(2NDLIEN_AMNT + 1), the natural logarithm of 1 plus the amount of second-lien mortgages applied in city *i* and time *t*.

Results are reported in Table 9. The dependent variable is ln(2NDLIEN_NUM + 1) in column 1 and is ln(2NDLIEN_AMNT + 1) in column 2. The coefficient estimate on ln(HV/NW) × POST is positive and significant at the 1%

[38]HMDA only reports the year of the mortgage application during my sample period and therefore, I had to switch from aggregating semiannually to annually for this specific test.

TABLE 9

The Substitution Effect Between Angel Financing and Second-Lien Mortgages

Table 9 shows the substitution effect between reduced angel financing and the demand for second-lien mortgages. The dependent variable in column 1, ln(2NDLIEN_NUM + 1), is the natural logarithm of 1 plus the number of second-lien mortgages applied in city *i* and time *t*. The dependent variable in column 2, ln(2NDLIEN_AMNT + 1), is the natural logarithm of 1 plus the amount of second-lien mortgages applied in city *i* and time *t*. ln(HV/NW) is the natural logarithm of city *i*'s home-value-to-net-worth ratio in 2011. POST is a dummy that equals 1 if period *t* is after 2011 and equals 0 otherwise. Control variables, POPULATION, INCOME_PER_PERSON, and HOME_VALUE, are described in Section IV.B. I also control for year- and city-fixed effects. Standard errors are double-clustered at the city level and at the time level. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

	ln(2NDLIEN_NUM + 1)	ln(2NDLIEN_AMNT + 1)
	1	2
ln(HV/NW) × POST	0.184***	0.264**
	(0.037)	(0.064)
POPULATION	0.282	0.523
	(0.273)	(0.577)
INCOME_PER_PERSON	0.183	0.451
	(0.116)	(0.281)
HOME_VALUE	0.401	0.653*
	(0.197)	(0.268)
CONSTANT	−6.715	−11.811
	(4.109)	(5.695)
No. of obs.	19,002	19,002
R^2	0.947	0.927
City FE	Yes	Yes
Semiannual FE	Yes	Yes
No. of cities	3,801	3,801

significance level in column 1. The magnitude suggests that a 1-standard-deviation increase in the HV/NW ratio of a city, led to a 9.15% increase in the number of second-lien mortgage applications after the SEC regulation change in restricting the definition of accredited investors. In column 2, the coefficient estimates on ln(HV/NW) × POST is positive and significant at the 5% significance level, suggesting that a 1-standard-deviation increase in the HV/NW ratio, led to a 13.13% increase in the amount of second-lien mortgage applications after the SEC regulation change.

C. Discussion on the Alternative Financing Sources

The above results provide suggestive evidence that the 2011 SEC regulation change had an impact on alternative financing sources such as small business loans and second-lien mortgages. These results, however, need to be carefully interpreted mainly for the two reasons discussed below.

First, given the differences between debt and equity financing, borrowing either from government-sponsored loans or home equity loans is not the same as financing through angel capital (Schwienbacher (2007), Winton and Yerramilli (2008)). One difference is that creditors usually require a firm or an entrepreneur to have good credit, clear ability to repay, and an operating history.[39] In other words, firms with higher risks such as those in the technology sector could have a hard time finding a substitute for angel financing. Additionally, previous literature has

[39]One example illustrating what the lenders of Small Business Admission Loan Program seek can be found at https://www.sba7a.loans/downloads/SBA-7a-Loan-Terms-Fact-Sheet.pdf.

shown that early-stage investors such as VC and angels differentiate themselves from creditors as they provide value-added services and perform monitoring on their portfolio firms (Hellmann and Puri (2002), Kerr, Lerner, and Schoar (2014)). Hence, more than just providing funds to a firm, angel investors can also influence the growth and outcome of a firm. The above reasons explain why the two alternative financing sources may not perfectly substitute angel investments.

Second, even though credit provided from alternative financing sources can help entrepreneurs partially loosen financial constraints, these loans also present potential concerns. One concern relates to the efficient usage of government funding (Babina, He, Howell, Perlman, and Staudt (2023)). Taxpayers pay for the cost if firms borrowing from the government-sponsored loans turn out to be unsuccessful. Even these firms succeed, their successes are subsidized by taxpayers' money: Brown and Earle (2017) estimate that the taxpayer cost per job created from small business loans is at least $21,000. In addition, shifting from equity financing to debt financing may incur underinvestment among risk-averse entrepreneurs (Myers (1977)).

IX. Costs and Benefits of the 2011 SEC Regulation Change

The previous results in this article suggest that increasing investor protection induced by a 2011 regulation change led to a reduction in angel financing and entrepreneurial activity, which, in turn, imposed real costs on the economy. In this section, I evaluate the trade-off between investor protection and the promotion of entrepreneurial activity. Specifically, I estimate the benefits of the above regulation change in terms of avoiding losses of angel investors through investment in unsuccessful entrepreneurial firms. I estimate the costs of the above SEC regulation change in terms of lost sales, innovation, and employment generated by entrepreneurial firms that did not receive angel financing. I then perform a cost-benefit analysis under different assumptions and discuss the results.

A. Estimation of Benefits of the 2011 Regulation Change

The main pecuniary benefit of the 2011 SEC regulation change is that it can prevent the later-unqualified angel investors from investing in firms that would have turned out to be unsuccessful. I estimate this benefit for each city by calculating a city's reduced amount of investment due to the 2011 regulation change multiplied by the average failure rate of angel-backed firms in the city as follows:

$$\text{BENEFIT}_{i,t} = \Delta(\text{AMOUNT})_{i,t} \times \text{FAILURE\_RATE}_{i,t}. \tag{2}$$

The average failure rate in city i and time t, $\text{FAILURE\_RATE}_{i,t}$, is calculated by dividing the number of angel investments in city i and time t that did not receive next-round financing within next 5 years by the total number of angel investments in city i and time t.[40] The reduced amount of angel investment of city i in time t,

[40]Although a firm could still be operating without receiving next-round financing within the next 5 years, it is considered as a failure for angel investors because they cannot successfully exit the investment.

$\Delta(\text{AMOUNT})_{i,t}$, is the difference between the estimated amount of angel investments if there was no regulation change and the actual amount of angel investments with the above regulation change. Specifically, the reduced amount of angel financing is estimated as below:

$$(3)\quad \Delta(\text{AMOUNT})_{i,t} = \exp\left[|\widehat{\beta}| \times \frac{\text{HV}}{\text{NW}_i} + \ln(\text{AMOUNT}+1)_{i,t}\right] - \exp\left[\ln(\text{AMOUNT}+1)_{i,t}\right],$$

and $\widehat{\beta}$ in equation (3) is obtained from the estimation of the following equation[41]:

$$(4)\quad \ln(\text{AMOUNT}+1)_{i,t} = \alpha + \beta \frac{\text{HV}}{\text{NW}_i} \times \text{POST}_t + \text{CONTROLS}_{i,t} + \delta_t + \eta_i + \varepsilon_{i,t},$$

where the dependent variable is the natural logarithm of 1 plus the amount of angel investments in city i and in time t ($\ln(\text{AMOUNT}+1)_{i,t}$) with other variables defined in Section IV. The estimated β in equation (4) is shown in column 1 in Table B9 of the Supplementary Material. After obtaining the estimated benefits for each city in each time period, I aggregated these benefits to the national level annually.

Following the above procedure, the estimated benefits of preventing marginal angel investors from investing in firms that would have turned out to be unsuccessful are \$3.19 billion in 2012 and \$3.08 billion in 2013 nationally. The estimated benefits account for 8.2%(=\$3.19 billion/\$38.9 billion) of the total amount of angel investments in 2012 and 4.4%(=\$3.08 billion/\$69.8 billion) of the total amount of angel investments in 2013. It is worth-noting that the above estimate is likely to be the upper bound of the actual benefit because the failure rate of firms that received angel financing (i.e., observable firms) is used for firms that did not receive angel financing (i.e., unobservable firms) in the estimation. However, the unobserved failure rate of firms that did not get angel financing due to the regulation is likely to be lower: According to Table B8 of the Supplementary Material, the rate of successful exits (one minus the failure rate) for firms that received angel financing decreased due to the regulation change, thus a higher failure rate was used in the estimation.

Next, I calculate the present value of the benefits of the SEC regulation change in the following years at the end of 2011. I use the previously estimated benefits in 2012 and 2013 and assume the impact of the regulation change will last for 10 years, 5 years, or 3 years. The estimation of the present value of benefits is shown in Panel A of Table 10 with different assumptions on the discount rate ranging from 5% to 30%. The estimated present value of benefits takes a value from \$5.68 billion (in the lower right corner of Panel A, assuming the discount rate is 30% and the impact of the regulation change lasts for 3 years), to \$23.89 billion (in the upper left corner of Panel A, assuming the discount rate is 5% and the impact of the regulation change lasts for 10 years).

[41] I use the HV/NW ratio instead of the natural logarithm of the ratio (ln(HV/NW)) as in (1) simply for illustration purpose: When the HV/NW ratio is less than 1, ln(HV/NW) is negative and hard to interpret in (3). The estimated amount of reduced angel investment, however, is very similar when I use ln(HV/NW) and it does not affect the conclusion of the cost-benefit analysis.

TABLE 10

Cost-Benefit Analysis of the 2011 SEC Regulation Change

Table 10 shows the estimation of the benefits and costs of the 2011 SEC regulation change under different assumptions. Panel A shows the estimation of the present value (in billion dollars) of the benefits of the above regulation change at the end of 2011 with assumptions on the length of the policy impact will last (n years) and on the discount rate (r). Panel B shows the estimated present value (in billion dollars) of the cost of the above regulation change at the end of 2011 under different assumptions on the growth rate (g), the discount rate (r), and the length of the policy impact will last (n). For example, given that the estimated benefit is \$3.19 billion for 2012 and \$3.08 billion in 2013 (according to Section IX.A) and assuming the estimated benefit after 2013 is the same as in 2013, the present value of the total benefits at the end of 2011 can be calculated as $\$3{:}19\frac{3.19}{1+r+\sum_{t=2}^{n-1}\frac{3.08}{(1+r)^t}}$. When $r = 15\%$ and $n = 10$, the present value of benefit is \$15.55 billion. Section IX.B shows that the estimated reduced amount of annual sales of affected firms is \$0.73 billion in 2012 and \$1.05 billion in 2013, when assuming that firms operate for 10 years, $g = 5\%$ and $r = 15\%$, then the discounted value of reduced sales for affected firms in 2012 is \$4.36 billion $\left(4.36 = \frac{0.73}{0.15-0.05\times\left(1-\frac{(1+0.05)^{10}}{(1+0.15)^{10}}\right)}\right)$ and \$6.27 billion in 2013. I can obtain the present value of the total costs in terms of reduced sales at the end of 2011 by calculating $\frac{4.36}{1+r+\sum_{t=2}^{n-1}\frac{6.27}{(1+r)^t}=29.81}$ billion. Panel C of the table shows the estimated net benefits (i.e., benefits minus costs) under different assumptions. The details of the estimation are described in Section IX.

Panel A. Estimation of Benefits

r = Assumption	5%	10%	15%	20%	25%	30%
Assuming the impact of SEC regulation change lasts for 10 years	23.89	19.03	15.55	13.00	11.09	9.61
Assuming the impact of SEC regulation change lasts for 5 years	13.44	11.78	10.42	9.30	8.37	7.59
Assuming the impact of SEC regulation change lasts for 3 years	8.49	7.76	7.13	6.58	6.10	5.68

Panel B. Estimation of Costs

Assuming the impact of SEC regulation change lasts for 10 years	$r = g$ =	5%	10%	15%	20%	25%	30%
	0%	60.25	37.85	25.05	17.33	12.47	9.27
	5%		45.83	29.81	20.31	14.41	10.58
	10%			35.82	24.03	16.80	12.17
	15%				28.66	19.75	14.13
	20%					23.41	16.52
	25%						19.46
Assuming the impact of SEC regulation change lasts for 5 years	$r = g$ =	5%	10%	15%	20%	25%	30%
	0%	32.74	22.66	16.26	12.04	9.17	7.14
	5%		27.44	19.36	14.11	10.59	8.15
	10%			23.26	16.69	12.35	9.38
	15%				19.91	14.52	10.88
	20%					17.21	12.73
	25%						14.99
Assuming the impact of SEC regulation change lasts for 3 years	$r = g$ =	5%	10%	15%	20%	25%	30%
	0%	19.72	14.25	10.63	8.15	6.40	5.13
	5%		17.26	12.65	9.55	7.40	5.86
	10%			15.20	11.30	8.62	6.74
	15%				13.48	10.14	7.82
	20%					12.02	9.14
	25%						10.77

Panel C. Estimation of Net Benefits

Assuming the impact of SEC regulation change lasts for 10 years	$r = g$ =	5%	10%	15%	20%	25%	30%
	0%	−36.36	−18.83	−9.49	−4.33	−1.38	0.33
	5%		−26.80	−14.26	−7.31	−3.32	−0.97
	10%			−20.27	−11.02	−5.71	−2.57
	15%				−15.66	−8.67	−4.52
	20%					−12.32	−6.91
	25%						−9.85
Assuming the impact of SEC regulation change lasts for 5 years	$r = g$ =	5%	10%	15%	20%	25%	30%
	0%	−14.42	−7.88	−3.78	−1.15	0.56	1.69
	5%		−12.13	−6.64	−3.13	−0.85	0.66
	10%			−10.25	−5.61	−2.59	−0.59
	15%				−8.69	−4.74	−2.12
	20%					−7.40	−4.01
	25%						−6.32
Assuming the impact of SEC regulation change lasts for 3 years	$r = g$ =	5%	10%	15%	20%	25%	30%
	0%	−11.23	−6.49	−3.50	−1.57	−0.30	0.55
	5%		−9.50	−5.53	−2.97	−1.30	−0.18
	10%			−8.08	−4.72	−2.52	−1.06
	15%				−6.90	−4.04	−2.14
	20%					−5.92	−3.47
	25%						−5.09

B. Estimation of Costs of the 2011 Regulation Change

Following the same strategy, I estimate the costs of the SEC regulation change in terms of reduced sales generated by firms that did not receive angel financing due to the regulation change. Specifically, I estimate equations (3) and (4) with replacements of the variable $AMOUNT_{i,t}$ with $SALES_{i,t}$.[42] The estimated reduced sales due to the SEC regulation change are \$0.73 billion for angel-backed firms in 2012 and \$1.05 billion in 2013.[43]

If assuming these affected firms would operate for 10 years without the regulation change, I can obtain the present value of the reduced sales in each year. For example, with additional assumptions of a discount rate of 15% and a growth rate of sales of 5% per year, the present value of forgone future sales is \$4.36 billion in 2012.[44] The estimated costs are likely to be a lower bound of the actual costs of the regulation change. The reason is similar to what has been discussed in Section IX.A: The quality of firms received angel financing after the regulation change is assumed to be the same as the quality before the change in the estimation, while the quality of firms actually declined according to Table B8 of the Supplementary Material. Therefore, the actual foregone sales, innovation, and employment of firms that did not receive angel financing could be larger than what above estimation suggests.

Similar as the estimation of benefits, I then calculate the present value of costs of the SEC regulation change in terms of reduced sales at the end of 2011. I use the previously estimated costs in 2012 and 2013 and assume that annual reduced sales in years after 2013 are the same as in 2013 to simplify the analysis. Panel B of Table 10 shows the estimation results with different assumptions on the discount rate (ranges from 5% to 30%), growth rate (ranges from 0% to 25%), and the length of the regulation change lasts (3, 5, or 10 years).

Using the above strategy with a replacement of the variable $AMOUNT_{i,t}$ with $NUM\_PATENTS_{i,t}$ and $EMPLOYMENT_{i,t}$, I also estimate the reduced innovation output and employment generated by angel-backed firms.[45] The estimation suggests that the SEC regulation change reduced 292 patents generated by angel-backed firms in 2012 and 289 patents in 2013, 3,770 jobs supported by angel-backed firms in 2012 and 4,392 jobs in 2013. These reduced patents and employment are the additional costs brought by the 2011 regulation change.

C. Cost-Benefit Analysis and Discussion

I then perform an analysis using the above estimated present values of the costs of reduced sales and the benefits of preventing angel investment in unsuccessful firms for the 2011 SEC regulation change under different assumptions.

[42]The results of the estimation of (4) are shown in column 2 in Table B9 of the Supplementary Material.

[43]\$1.05 billions are the amount of the reduced sales that would have been generated by affected firms that did not receive angel financing in 2013, but not include the sales generated by firms who were affected in 2012. Therefore, when calculating the total present value of reduced sales, all years of reduced sales need to be discounted and aggregated (not only the last year).

[44]The \$4.36 billion is calculated from the formula: $\frac{P}{r-g} \times \left(1 - \frac{(1+g)^n}{(1+r)^n}\right) = \frac{1.05}{0.15-0.05} \times \left(1 - \frac{(1+0.05)^{10}}{(1+0.15)^{10}}\right)$.

[45]The estimates of β in (4) are shown in columns 3 and 4 in Table B9 of the Supplementary Material.

The estimated net benefits of the SEC regulation change are shown in Panel C of Table 10. To ensure that the conclusion of the analysis is not driven by a specific set of assumptions, I show results under various combinations of discount rates (5%, 10%, 15%, 20%, 25%, 30%) and growth rates (0%, 5%, 10%, 15%, 20%, 25%) for entrepreneurial firms with different lengths of the impact (10 years, 5 years, and 3 years). One can observe from Panel C of Table 10 that the estimated net benefits of the SEC regulation change are negative in 58 out of 63 scenarios. Among all the scenarios, the closest case to the real world is where the discount rate is 30% and the growth rate is 25% (when early investors require a high return and young firms enjoy high sales growth).[46] Under these two assumptions and assuming that the impact of the regulation change lasts for 5 years, the present value of total net benefits of the regulation change is negative 6.32 billion dollars at the end of 2011.

As mentioned in the previous two subsections, the estimated benefits of the 2011 SEC regulation change are likely to be the upper bound of the actual benefits while the estimated costs tend to be the lower bound of the actual costs. Therefore, the costs of the SEC regulation change are likely to exceed its benefits in most cases from a pecuniary viewpoint, not to mention the costs in terms of the reduced innovation output and employment generated by entrepreneurial firms that would have received angel financing without the regulation change. It is important, however, for readers to notice two major limitations of the above analysis and carefully interpret its results. First, the above cost-benefit analysis mainly focuses on the pecuniary aspect due to data and measurement limitations. There can be other costs and benefits of investor protection regulations that are not included in the analysis but also important to take into consideration when making policies. For example, other benefits of the 2011 SEC regulation change may include the prevention of bad social consequences for small investors when they lose their primary residence due to investing in unsuccessful firms. Other costs may include the loss of technological spillovers from high-tech start-ups to ordinary firms because there are less start-ups being funded by angel investors. Second, the above analysis is a partial-equilibrium analysis and it ignores the feedback effects from other players in the market that might also affect the performance and failure rate of entrepreneurial firms.[47]

X. Policy Implications

This article adds to the debate about the trade-off between investor protection in the private market and promotion of entrepreneurial activity. How can the

[46]One study, sponsored by the Ewing Marion Kauffman Foundation (Wiltbank and Boeker (2007)) looking at 3,097 angel investments, shows that the average IRR of these investments is 27%. Other studies provide estimates of returns of angel investors around this number (for a summary, see http://www.rightsidecapital.com/assets/documents/HistoricalAngelReturn.pdf). Regarding the growth rate, Kabbage Small Business Revenue Index shows that the median revenue growth of all small businesses across the United States is 16% in 2019, while angel-backed firms usually enjoy a higher growth rate than the median small business.

[47]Even though a cost-benefit analysis can be tentative as it relies on many assumptions, it is still important for providing policy evaluations and implications. Other studies have conducted cost-benefit analyses similar to mine (but in very different contexts): see, for example, Hombert, Schoar, Sraer, and Thesmar (2020).

government potentially encourage entrepreneurship? What are the important aspects that need to be considered when making policies and regulations related to entrepreneurs and early-stage investors? The policy implications of this article are as follows:

First, the government could encourage more private investment into entrepreneurial firms by allowing more angel investors to invest in these firms. However, there is always a cost arising from potential losses of angel investors through the failure of their portfolio firms. The results in this study show that the 2011 SEC regulation change reduced local angel financing received by entrepreneurial firms, and, in turn, led to reductions in the innovation, sales, and employment generated by entrepreneurial firms.

Second, the government could provide more funding to small businesses through government-led VCs or direct lending through agencies like the Small Business Administration (SBA). This study shows that the 2011 SEC regulation change has a substitution effect on small business loans guaranteed by the SBA. The government should be aware of these potential substitution effects when developing policies regarding protecting investors or promoting entrepreneurial activity. Also, promoting debt financing and equity financing may have different compositional effect on the industries and riskiness of firms being funded.

Third, the government needs to be aware of the potential underinvestment problem generated from the shift from equity financing to debt financing when angel investment decreases. Due to the risk aversion of entrepreneurs, they may choose to invest in less risky projects under debt financing even though these projects may bring lower growth to the firm.

XI. Conclusion

This article studies how an SEC investor protection regulation change in 2011 required by the Dodd-Frank Act affected local angel financing and its real economic consequences in the local economy. Relying on the heterogeneous impact of the SEC regulation change of removing the primary residence from net wealth standard for accredited investors, I use a DiD approach and find that cities more affected by the SEC regulation change, experienced a significantly larger decrease in local angel financing and local entrepreneurial activity generated by angel-backed firms. I further show that the SEC regulation change imposed a real cost on the local economy in terms of the innovation, employment, and sales generated by angel-backed firms. A number of additional tests suggest that the results are likely to be causal. I also show substitution effects between reduced angel financing and alternative financing sources such as small business loans guaranteed by the SBA and second-lien mortgages. Additionally, I provide an estimation of the pecuniary benefits of the regulation change by avoiding angel investors' losses through investing in unsuccessful firms and an estimation of the costs in terms of the reduced sales, patents, and employment generated by angel-backed firms. The cost-benefit analysis provides suggestive evidence that the monetary costs of protecting angel investors outweigh its benefits in most scenarios. My article contributes to the literature on early-stage investors, investor protection in the private market, and governments' role in promoting entrepreneurial activity. It provides new evidence to the debate about the trade-off between protecting investors and promoting entrepreneurial activity.

Supplementary Material

To view supplementary material for this article, please visit http://doi.org/10.1017/S0022109022001314.

References

Adelino, M.; A. Schoar; and F. Severino. "House Prices, Collateral, and Self-Employment." *Journal of Financial Economics*, 117 (2015), 288–306.

Agrawal, A. K. "The Impact of Investor Protection Law on Corporate Policy and Performance: Evidence from the Blue Sky Laws." *Journal of Financial Economics*, 107 (2013), 417–435.

Agrawal, A.; C. Catalini; and A. Goldfarb. "Crowdfunding: Geography, Social Networks, and the Timing of Investment Decisions." *Journal of Economics & Management Strategy*, 24 (2015), 253–274.

Audretsch, D. B.; A. N. Link; and J. T. Scott. "Public/Private Technology Partnerships: Evaluating SBIR-Supported Research." *Research Policy*, 31 (2002), 145–158.

Babina, T.; A. X. He; S. Howell; E. Perlman; and J. Staudt. "Cutting the Innovation Engine: How Federal Funding Shocks Affect University Patenting, Entrepreneurship, and Publications." *Quarterly Journal of Economics*, forthcoming (2023).

Bailey, M.; R. Cao; T. Kuchler; and J. Stroebel. "The Economic Effects of Social Networks: Evidence from the Housing Market." *Journal of Political Economy*, 126 (2018), 2224–2276.

Barth, M. E.; W. R. Landsman; and D. J. Taylor. "The JOBS ACT and Information Uncertainty in IPO Firms." *Accounting Review*, 92 (2017), 25–47.

Bernstein, S.; A. Korteweg; and K. Laws. "Attracting Early-Stage Investors: Evidence from a Randomized Field Experiment." *Journal of Finance*, 72 (2017), 509–538.

Brander, J. A.; Q. Du; and T. Hellmann. "The Effects of Government-Sponsored Venture Capital: International Evidence." *Review of Finance*, 19 (2015), 571–618.

Brown, D. J., and J. S. Earle. "Finance and Growth at the Firm Level: Evidence from SBA Loans." *Journal of Finance*, 72 (2017), 1039–1080.

Chaplinsky, S.; K. W. Hanley; and S. K. Moon. "The JOBS ACT and the Costs of Going Public." *Journal of Accounting Research*, 55 (2017), 795–836.

Chemmanur, T. J., and Z. Chen. "Venture Capitalists Versus Angels: The Dynamics of Private Firm Financing Contracts." *Review of Corporate Finance Studies*, 3 (2014), 39–86.

Chemmanur, T. J.; E. Loutskina; and X. Tian. "Corporate Venture Capital, Value Creation, and Innovation." *Review of Financial Studies*, 27 (2014), 2434–2473.

Chenevert, R.; A. Gottschalck; M. Klee; and X. Zhang, *Where the Wealth is: The Geographic Distribution of Wealth in the United States*. Washington, DC: U.S. Census Bureau (2017).

Claessens, S.; S. Djankov; J. P. Fan; and L. H. Lang. "Disentangling the Incentive and Entrenchment Effects of Large Shareholdings." *Journal of Finance*, 57 (2002), 2741–2771.

Claessens, S.; S. Djankov; and L. H. Lang. "The Separation of Ownership and Control in East Asian Corporations." *Journal of Financial Economics*, 58 (2000), 81–112.

Collewaert, V., and Y. Fassin. "Conicts between Entrepreneurs and Investors: The Impact of Perceived Unethical Behavior." *Small Business Economics*, 40 (2013), 635–649.

Conti, A.; M. Thursby; and F. T. Rothaermel. "Show Me the Right Stuff: Signals for High-Tech Startups." *Journal of Economics & Management Strategy*, 22 (2013), 341–364.

Corradin, S., and A. Popov. "House Prices, Home Equity Borrowing, and Entrepreneurship." *Review of Financial Studies*, 28 (2015), 2399–2428.

Da Rin, M.; G. Nicodano; and A. Sembenelli. "Public Policy and the Creation of Active Venture Capital Markets." *Journal of Public Economics*, 90 (2006), 1699–1723.

Dambra, M.; L. C. Field; and M. T. Gustafson. "The JOBS ACT and IPO Volume: Evidence that Disclosure Costs Affect the IPO Decision." *Journal of Financial Economics*, 116 (2015), 121–143.

Denes, M. "When Do Firms Risk Shift? Evidence from Venture Capital." Available at SSRN 2875882 (2017).

Denes, M.; S. Howell; F. Mezzanotti; X. Wang; and T. Xu. "Investor Tax Credits and Entrepreneurship: Evidence from US States." Available at SSRN 3596342 (2020).

Di Maggio, M.; A. Kermani; B. J. Keys; T. Piskorski; R. Ramcharan; A. Seru; and V. Yao. "Interest Rate Pass-through: Mortgage Rates, Household Consumption, and Voluntary Deleveraging." *American Economic Review*, 107 (2017), 3550–3588.

Drover, W.; L. Busenitz; S. Matusik; D. Townsend; A. Anglin; and G. Dushnitsky. "A Review and Road Map of Entrepreneurial Equity Financing Research: Venture Capital, Corporate Venture Capital,

Angel Investment, Crowdfunding, and Accelerators." *Journal of Management*, 43 (2017), 1820–1853.
Ewens, M., and N. Malenko. "Board Dynamics Over the Startup Lifecycle." Available at SSRN 3640898 (2020).
Giroud, X., and H. M. Mueller. "Firm Leverage, Consumer Demand, and Employment Losses during the Great Recession." *Quarterly Journal of Economics*, 132 (2017), 271–316.
Giroud, X., and H. M. Mueller. "Firms' Internal Networks and Local Economic Shocks." *American Economic Review*, 109 (2019), 3617–3649.
Grinblatt, M., and C. Y. Hwang. "Signalling and the Pricing of New Issues." *Journal of Finance*, 44 (1989), 393–420.
Hall, B. H.; A. B. Jaffe; and M. Trajtenberg. "The NBER Patent Citation Data File: Lessons, Insights and Methodological Tools." NBER Working Paper No. 8498 (2001).
Hall, B. H., and J. Lerner. "The Financing of R&D and Innovation." In *Handbook of the Economics of Innovation*, Vol. 1. North-Holland, Netherlands: Elsevier (2010), 609–639.
Hellmann, T., and M. Puri. "Venture Capital and the Professionalization of Start-up Firms: Empirical Evidence." *Journal of Finance*, 57 (2002), 169–197.
Hellmann, T.; P. Schure; and D. H. Vo. "Angels and Venture Capitalists: Substitutes or Complements?" *Journal of Financial Economics*, 141 (2021), 454–478.
Hellmann, T., and V. Thiele. "Friends or Foes? The Interrelationship between Angel and Venture Capital Markets." *Journal of Financial Economics*, 115 (2015), 639–653.
Hombert, J.; A. Schoar; D. Sraer; and D. Thesmar. "Can Unemployment Insurance Spur Entrepreneurial Activity? Evidence from France." *Journal of Finance*, 75 (2020), 1247–1285.
Howell, S. T. "Financing Innovation: Evidence from R&D Grants." *American Economic Review*, 107 (2017), 1136–1164.
Huang, L.; A. Wu; M. J. Lee; J. Bao; M. Hudson; and E. Bolle. "*The American Angel*." Washington, DC: Angel Capital Association (2017).
Hudson, M. "Angel Investors, Innovative Startups and the Accredited Investor Definition. SEC Advisory Committee on Small and Emerging Companies." (2014). Retrieved from https://www.angelcapitalassociation.org/data/Documents/Press%20Center/SECSmallBizCommitteeACA12-17-14Final.pdf?rev=B13D.
Ivanov, V., and S. Bauguess. "Capital Raising in the US: An Analysis of Unregistered Offerings Using the Regulation D Exemption, 2009–2012." U.S. Securities and Exchange Commission White Paper (2013).
Kaplan, G.; K. Mitman; and G. L. Violante. "Non-Durable Consumption and Housing Net Worth in the Great Recession: Evidence from Easily Accessible Data." *Journal of Public Economics*, 189 (2020), 104176.
Kerr, S. P.; W. Kerr; and R. Nanda. "House Money and Entrepreneurship." NBER Working Paper No. 21458 (2015).
Kerr, W. R.; J. Lerner; and A. Schoar. "The Consequences of Entrepreneurial Finance: Evidence from Angel Financings." *Review of Financial Studies*, 27 (2014), 20–55.
La Porta, R.; F. Lopez-de Silanes; A. Shleifer; and R. W. Vishny. "Legal Determinants of External Finance." *Journal of Finance*, 52 (1997), 1131–1150.
La Porta, R.; F. Lopez-de Silanes; A. Shleifer; and R. Vishny. "Investor Protection and Corporate Governance." *Journal of Financial Economics*, 58 (2000), 3–27.
La Porta, R.; F. Lopez-de Silanes; A. Shleifer; and R. Vishny. "Investor Protection and Corporate Valuation." *Journal of Finance*, 57 (2002), 1147–1170.
Lee, A. H., and C. Crenshaw. "Joint Statement on the Failure to Modernize the Accredited Investor Definition." Retrieved from https://www.sec.gov/news/public-statement/lee-crenshaw-accredited-investor-2020-08-26 (2020).
Leland, H. E., and D. H. Pyle. "Informational Asymmetries, Financial Structure, and Financial Intermediation." *Journal of Finance*, 32 (1977), 371–387.
Lerner, J. "The Government as Venture Capitalist: The Long-Run Impact of the SBIR Program." *Journal of Private Equity*, 3 (2000), 55–78.
Lerner, J.; A. Schoar; S. Sokolinski; and K. Wilson. "The Globalization of Angel Investments: Evidence Across Countries." *Journal of Financial Economics*, 127 (2018), 1–20.
Lindsey, L. A., & L. C. Stein. "Angels, Entrepreneurship, and Employment Dynamics: Evidence from Investor Accreditation Rules." Available at SSRN 2939994 (2020).
Mian, A.; A. Suff; and F. Trebbi. "Foreclosures, House Prices, and the Real Economy." *Journal of Finance*, 70 (2015), 2587–634.
Michelacci, C., and O. Silva. "Why So Many Local Entrepreneurs?" *Review of Economics and Statistics*, 89 (2007), 615–633.

Myers, S. C. "Determinants of Corporate Borrowing." *Journal of Financial Economics*, 5 (1977), 147–175.
Ozmel, U.; D. T. Robinson; and T. E. Stuart. "Strategic Alliances, Venture Capital, and Exit Decisions in Early Stage High-Tech Firms." *Journal of Financial Economics*, 107 (2013), 655–670.
Rubinstein, A., and A. Wolinsky. "Middlemen." *Quarterly Journal of Economics*, 102 (1987), 581–593.
Schmalz, M. C.; D. A. Sraer; and D. Thesmar. "Housing Collateral and Entrepreneurship." *Journal of Finance*, 72 (2017), 99–132.
Schwienbacher, A. "A Theoretical Analysis of Optimal Financing Strategies for Different Types of Capital-Constrained Entrepreneurs." *Journal of Business Venturing*, 22 (2007), 753–781.
Shane, S. *Fool's Gold?: The Truth behind Angel Investing in AMERICA*. New York, NY: Oxford University Press (2008).
Shleifer, A., and D. Wolfenzon. "Investor Protection and Equity Markets." *Journal of Financial Economics*, 66 (2002), 3–27.
Stuart, T. E., and O. Sorenson. "Social Networks and Entrepreneurship." In *Handbook of Entrepreneurship Research*. S. A. Alvarez, R. Agarwal, and O. Sorenson, eds. New York, NY: Springer (2005), 233–252.
Tian, X., and T. Y. Wang. "Tolerance for Failure and Corporate Innovation." *Review of Financial Studies*, 27 (2014), 211–255.
Tian, X., and J. Xu. "Do Place-Based Policies Promote Local Innovation and Entrepreneurship?" *Review of Finance*, 26 (2022), 595–635.
Venugopal, B., and V. Yerramilli. "Seed-Stage Success and Growth of Angel Co-Investment Networks." *Review of Corporate Finance Studies*, 11 (2022), 169–210.
Wang, X. "Catering Innovation: Entrepreneurship and the Acquisition Market." Working Paper, UCLA Anderson School of Management (2018).
Wiltbank, R., and W. Boeker. "Returns to Angel Investors in Groups." Available at SSRN 1028592 (2007).
Winton, A., and V. Yerramilli. "Entrepreneurial Finance: Banks Versus Venture Capital." *Journal of Financial Economics*, 88 (2008), 51–79.
Xu, T. "Learning from the Crowd: The Feedback Value of Crowdfunding." Available at SSRN 2637699 (2018).
Yu, S. "How Do Accelerators Impact the Performance of High-Technology Ventures?" *Management Science*, 66 (2020), 530–552.