The Impact of Non-stop Flights to Silicon Valley on Raising Venture Capital in the U.S. and Abroad

Author: Kyle J. Waters

The Impact of Non-stop Flights to Silicon Valley on Raising Venture Capital in the U.S. and Abroad

Kyle J. Waters

Submitted in partial fulfillment of graduation requirements for the degree of Bachelor of Arts in Economics

Boston College
Department of Economics
May 2018

Advised by Donald Cox, Ph.D.

Abstract

Does being a non-stop flight away from Silicon Valley help entrepreneurs access venture capital? With its abundance of researchers and investors, Silicon Valley leads the world in entrepreneurship. In Silicon Valley, venture capital investors (VCs) and startups benefit from proximity, forming strong relationships and meeting frequently in person. VCs often choose to focus their operations locally, bringing down the costs of monitoring investments. Not all entrepreneurs can locate themselves in this global hub of course. Without a direct connection to Silicon Valley entrepreneurs may find it difficult to raise capital and tap into the extensive resources clustered in the region. There is emerging evidence that long-distance business relationships are viable, but only if travel is convenient enough. But we know little about how the benefit of non-stop flights might depend on whether international borders are crossed. I show that non-stop connections to Silicon Valley matter immensely for foreign startups in international cities but are less important domestically. A new daily flight from Silicon Valley to an international city leads to $23 million of additional venture capital raised by startups in the region. These results are intuitive considering that these cities are generally farther away, both geographically and culturally. As economic inequality between cities increases both in the U.S. and globally, these results demonstrate the importance of continued investments in infrastructure and suggest there are meaningful economic benefits to interconnectedness.

Acknowledgements

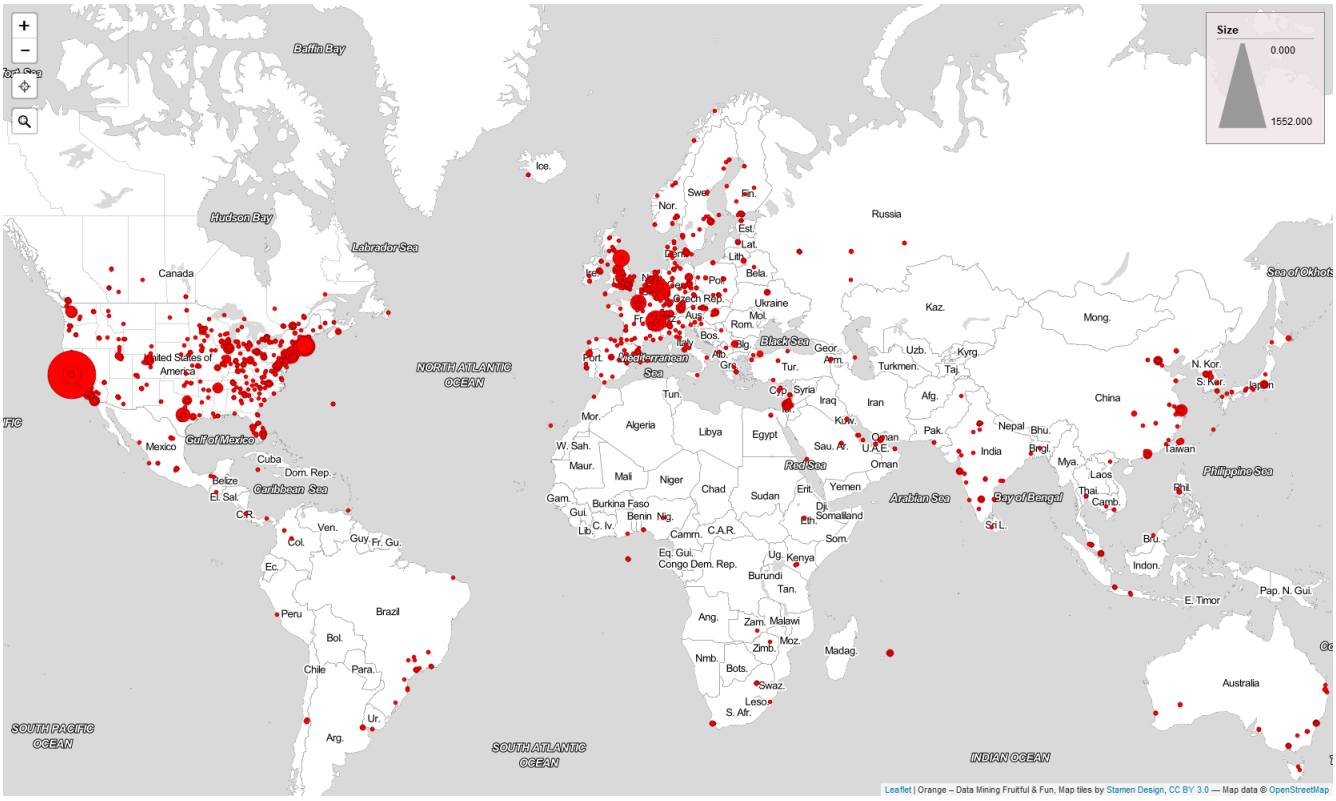
I want to thank the Economics Department for playing a large role in my personal development and growth over my four years at Boston College. I would like to especially thank Professor Don Cox for advising me throughout my senior year. Our weekly meetings were essential in refining and narrowing my topic. He helped me to navigate the process of independent research and I am very grateful for his guidance. I want to also thank Professor Robert Murphy for supporting me and providing many opportunities for involvement in the economics community at BC. I want to thank the team at Crunchbase for providing me with the data necessary to produce this finished paper. Finally, I want to thank my parents for their endless support and encouragement.

Contents

1 Introduction

Do non-stop flights to Silicon Valley help startups attract more venture capital? Around the globe, Silicon Valley is synonymous with innovating startups aspiring to build the next big thing. With access to universities, workers, and capital, Silicon Valley is unique in the world. Entrepreneurs hoping to pitch their grand idea are in close proximity to the largest and most influential investors. In fact, it may only take a drive down Sand Hill Road in Menlo Park - where some 40 venture capital firms are located. Mapping the headquarters of roughly 9,000 VC firms operating in the world in Figure 1 it is clear that Silicon Valley is the leading center for venture capital.

FIGURE 1. Headquarters of Venture Capital Firms operating in the world in 2017[1]



[1]Each firm is weighted by the number of companies they have invested in. Of the top 50 US VCs, 35 are headquartered in Silicon Valley and the greater San Francisco Bay Area.

Venture capital is unlike traditional forms of finance. It is more difficult to evaluate a startup pioneering transformative applications of A.I. than an established, publically traded company. VCs overcome this by evaluating the entrepreneurs - meeting with them in-person and hearing their pitches. VCs also do more than simply provide funds, and often sit on the startup's board and provide valuable mentorship and access to new markets. With greater information asymmetry and a generally more active relationship with their investments, it is not surprising that VCs tend to be biased toward local companies (Cumming, Dai, 2010).

There are many innovators all over the world looking for access to venture capital. While there are VCs operating in diverse places, ties to Silicon Valley are still important for growth opportunities given the breadth and depth of the market. Moving might not always be an option: rising costs of living in Silicon Valley and a decreased propensity to move may leave good ideas unfunded in disconnected geographies.[2]

Today, a global network of air routes brings cities closer together and changes the notion of a "local" company. In theory, this should decrease travel costs and allow Silicon Valley VCs to fund and form relationships with companies in cities connected to the region. Recent research by Campante and Yanagizawa-Drott (2016) suggest that adding non-stop connections between cities has a significant impact on the formation of business links and economic outcomes. This research confirms widespread anecdotal evidence that business travelers place a high value on travel convenience. Given their high sensitivity to proximity, it is reasonable to believe that non-stop flights matter even more for VCs, as surveys of VC partners confirm in Giroud, Bernstein, Townsend (2014).

We know that non-stop connections are important, but do these connections to Silicon Valley matter more for cities outside of the United States? This paper studies the impact of new direct connections to Silicon Valley on venture capital funding in cities both in and outside of the U.S. The main finding is that non-stop connections are less important for cities

[2]The median monthly rent in the San Francisco Bay Area was $3400/month as of Dec. 2017 per the Zillow Rent Index (See Appendix Figure 1). The percentage of Americans moving across state borders each year has been cut in half since the 1990's.

in the U.S. but are significant additions for foreign startups in cities across U.S. borders. I differ from past research by focusing on Silicon Valley as a hub point and exploring the interaction between new domestic and international non-stop flights. I divide my analysis and first estimate a distributed lag model that explains total monthly venture capital investment across American metro areas. While a new daily flight from Silicon Valley to a U.S. city has an insignificant impact on VC investment, I estimate a similar model for international cities and find that a new daily non-stop flight leads to $23 million more VC raised.[3]

How might we interpret these findings? Consider two cities - one domestic and one international - that have increased their connectedness to Silicon Valley in recent years: Copenhagen, Denmark and Columbus, Ohio. In 2015, Southwest Airlines introduced a new non-stop flight to Oakland International, one of the three major airports providing access to Silicon Valley.[4] Similarly, Scandinavian Airlines began operating a flight between Copenhagen and San Francisco International (SFO) in 2013. Putting aside some obvious differences between the two cities, a quick comparison in Figure 2 suggests that the new flights did not lead to much more VC investment in Columbus, but might have helped increase venture capital raised in Copenhagen, at least with a lagged effect.

FIGURE 2. VC Raised by startups in Columbus and Copenhagen and Total Number of Flights between Columbus and OAK and Copenhagen and SFO (2010-2017)

[3]In my paper, I use Silicon Valley to refer generally to the greater San Francisco Bay Area.

[4]San Francisco International (SFO), Oakland International (OAK), Norman Y. Mineta San Jose International (SJC)

FIGURE 2a. Columbus, Ohio

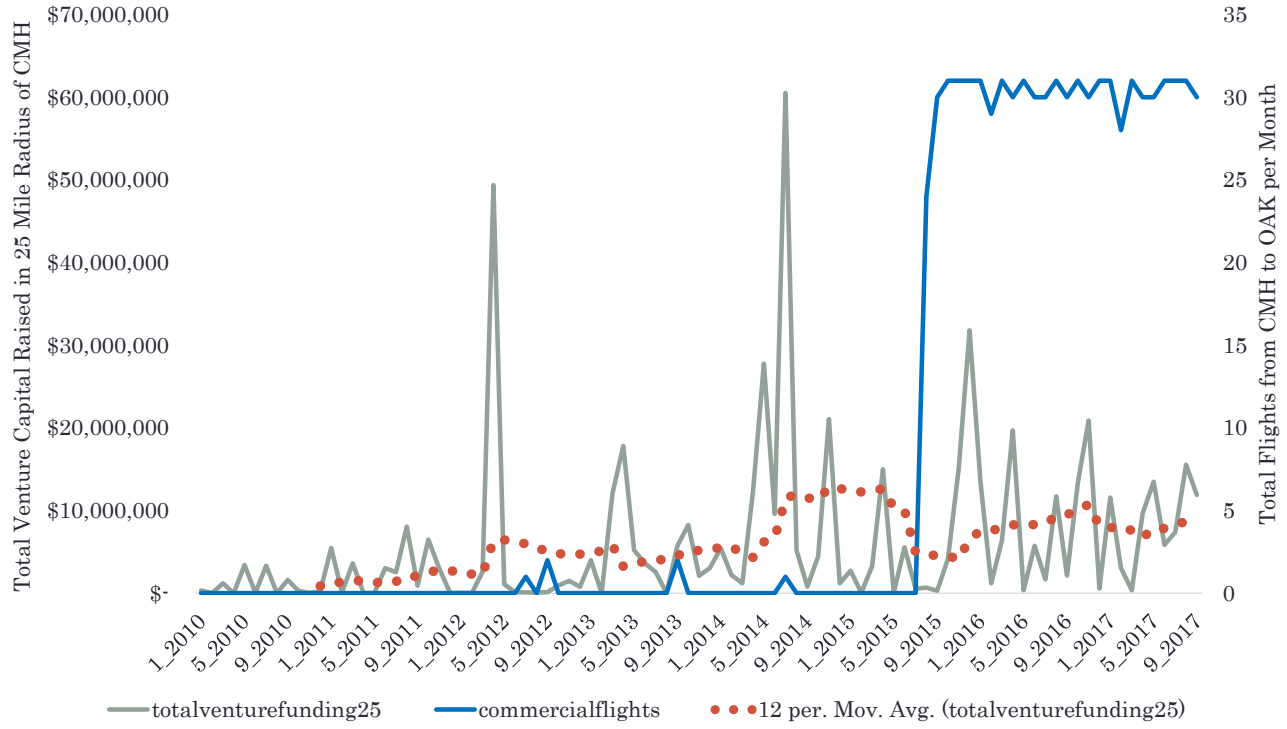
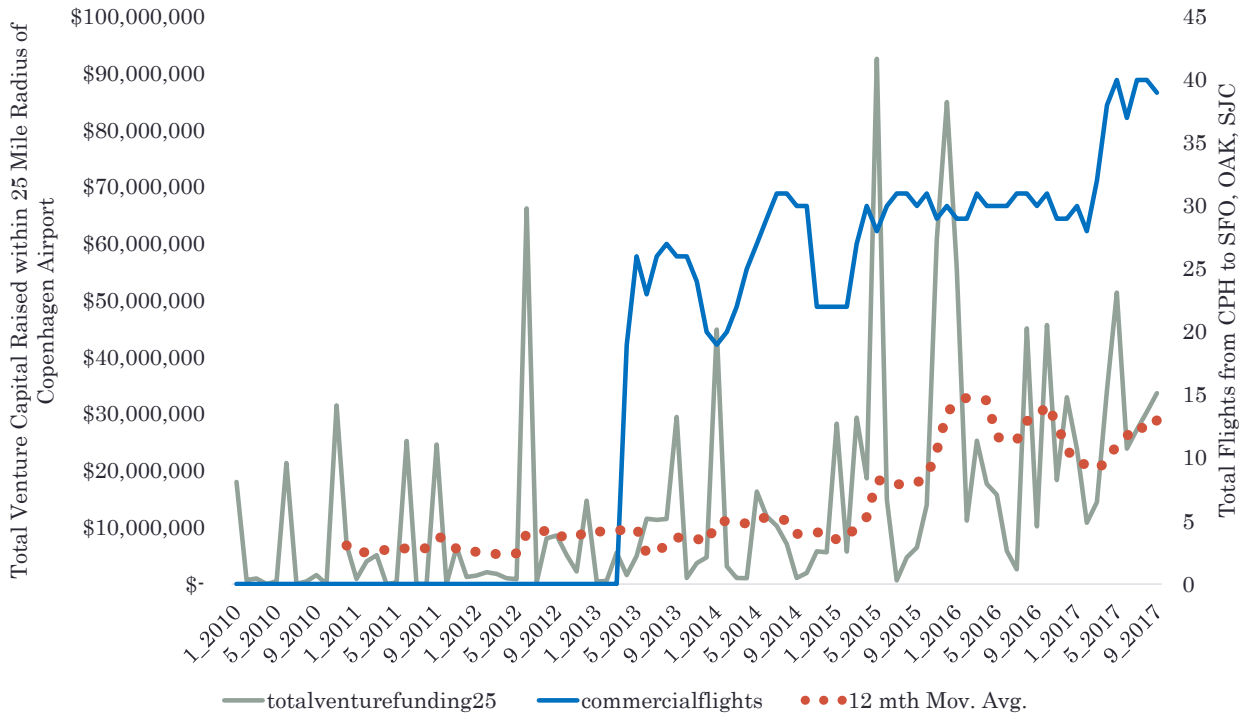
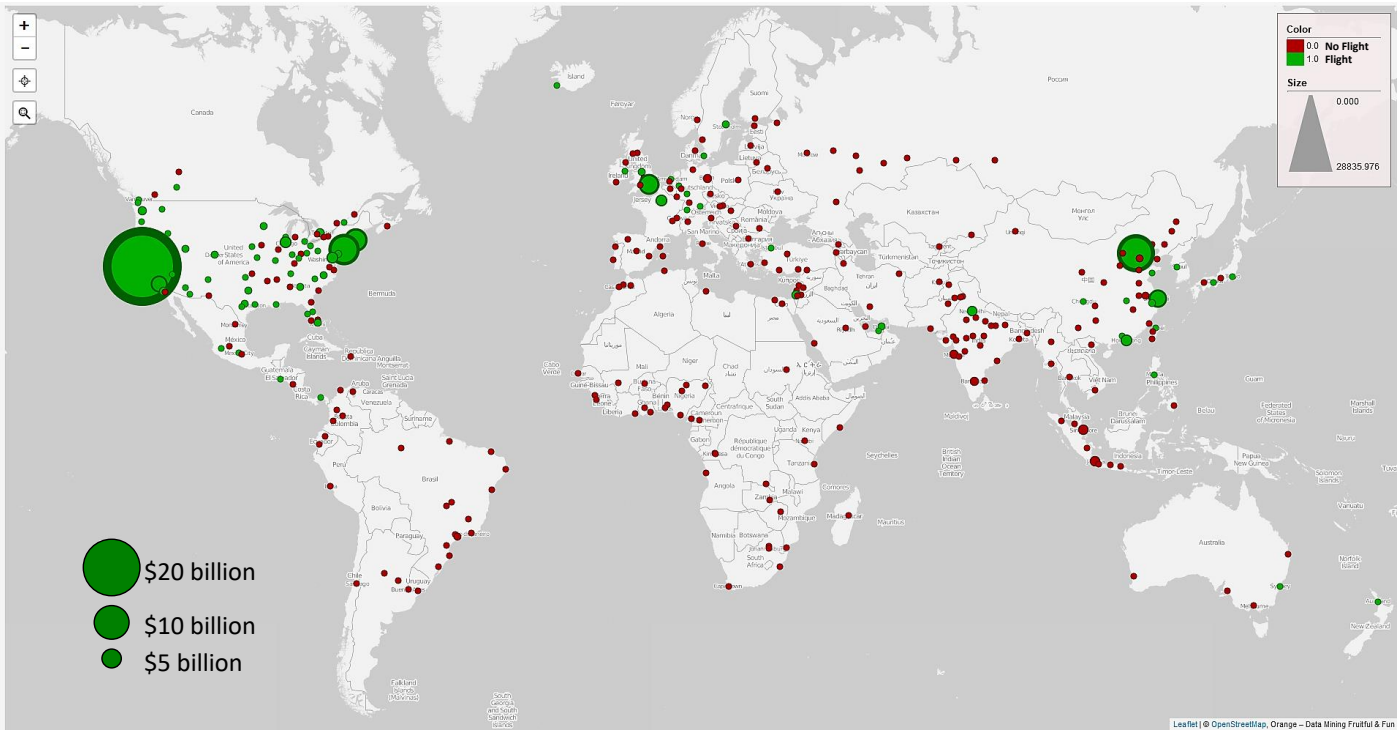


FIGURE 2b. Copenhagen, Denmark



There are two main reasons why this new flight was more beneficial for Copenhagen. Geographically, Columbus is much closer to Silicon Valley. The new direct flight eliminated a layover in Chicago or Denver but this only translates to 3 hours gained on average.[5] A long-haul flight like SFO to Copenhagen may save double that.[6] In Copenhagen, U.S. VCs and foreign startups may face possible barriers of culture and language making in-person meetings more necessary. Greg Sands, founder of Palo Alto-based Costanoa Ventures, provides support for this idea in a recent interview with Bloomberg Business: "I think for companies that are even farther away, so outside the U.S., it ends up being very important to have some sort of connection to Silicon Valley and the ability to do that."[7] Looking at aggregate VC investment across 332 cities in the world in Figure 3, non-stop flights connect the majority of the top international cities to Silicon Valley (cities with non-stop flights are in green).

FIGURE 3. Global Distribution of Venture Capital Investment (2017)



[5]In aviation, direct and non-stop flights have distinct meanings. However, in my paper I refer to them interchangeably.

[6]Queries from Google Flights show that the average non-stop flight was roughly 10hrs and 45min to Copenhagen but could be 15-20hrs with layovers.

[7]Greg Sands Discusses Technology and Investment. Bloomberg Masters in Business, November 16, 2017

It is important to note that I measure total VC investment flows to a region, not just those coming from Silicon Valley VCs. For example, the connection to Copenhagen may facilitate the movement of workers and ideas as well as capital. Startups in the region might improve in quality and receive more funding from other global VCs in addition to those based in Silicon Valley.

My research is relevant to a growing dialogue regarding the impacts of globalization and rising regional inequality. First, my findings suggest that distance, both geographically and culturally, is important for VC. As with Campante (2016), my findings imply broader economic benefits to a developed network of air links. A contribution of my research for policy makers is that new connections to Silicon Valley may foster growth in startups in places that are left behind in today's global economy.

2 The Importance of Geography in Venture Capital

Despite advances in communication technology over the years - much of it, ironically, developed in Silicon Valley - physical proximity is still a very important factor in venture capital. Research suggests that virtual meetings are inadequate and face-to-face meetings are still necessary in building relationships and establishing trust in business (Storper, Venables, 2002). The high-risk nature of investing in startups requires frequent meetings in person. The average startup will meet with a venture capitalist 3-8 times before receiving funding (Cumming, Dai 2010). Within Silicon Valley, some have even suggested a "20-minute rule": a startup must be within a 20-minute drive of the venture firm's office to receive funding.[8] Although the data do not seem to support this exact "rule," - the median distance between an investor and startup is roughly 250 miles (Cumming, Dai 2010) - there is a growing body of literature supporting the importance of distance in VC investing.

[8]Stross, Randall, "It's not the people you know. It's where you are." *The New York Times*, Nov. 22, 2006.

Past research explains some of the reasons why geography matters for VCs in particular. In general, innovation and new technology are valuable, but this leads to high informational asymmetries for VCs evaluating startups. Unlike public equity markets, there is no SEC oversight or financial analysts covering private startup companies (Gompers and Lerner, 1999). This places more emphasis on the VC's own due diligence. In early-stage startups, these asymmetries are highest and VCs have limited financial data to work with (Gompers, 1995). A startup may simply be an idea in which case the VC must measure the opportunity based on a founder's vision and abilities.

VCs learn of new potential investments from submitted business plans, conferences, and personal networks - all of which become less effective with distance. Simply put, strong networks are easier to build in concentrated areas. It's not hard to imagine a scenario in which an entrepreneur is in line at Coupa Café in Palo Alto and hits it off with a VC while ordering their chai latte.

A notable finding is that VC partners are twice as likely to sit on the board of directors for a startup that is within 5 miles of the VC's headquarters (Lerner, 1995). Given the high moral hazard introduced after a funding decision, VCs choose to monitor their investments closely. The board of directors makes critical business decisions and involvement with the board is one way VCs can be active investors and closely follow a startup's development. The recent securities fraud surrounding Palo Alto-based startup Theranos Therapeutics emphasizes this last point. After receiving over $700 million from venture capitalists between 2013 and 2015, an independent investigation discovered that the company had ultimately lied to investors about its blood-analysis technology.[9] Prominent investors lost money after failing to monitor the developments at Theranos. For these reasons, it is not surprising that VCs tend to focus on local companies.

It is important to note that distance matters for both parties. From an entrepreneur's perspective, having a distant investor will mean fewer in-person meetings and opportunities

[9]Shubber, Kadhim "Theranos founder charged with 'massive' securities fraud" *Financial Times*, March 14, 2018.

to receive advice. Consistent with this intuition, Bernstein, Giroud and Townsend (2014) find that startups that interact more with their VC investors have a higher chance of going public. Mark Andreessen of Silicon Valley-based venture firm Andreessen-Horowitz provides anecdotal evidence that this is indeed how VCs think about investing in distant startups: "We do think venture capital is a craft, and a lot of it is the relationship with the board members, founders and team - so there is a local dynamic to it... we do fund companies outside the Valley but on an exception basis, like they have to be super special."[10] Finally, Chen et al. (2010) find that VCs are more likely to fund companies in distant regions if they already have an investment in that same region.

3 The Role of Non-stop Flights in Business and VC

Fast and efficient travel should help to mitigate the complications of long-distance VC investing. A large network of direct air links connects Silicon Valley to the world. In 2017, a traveler could reach 47 domestic and 47 international destinations from Silicon Valley (Appendix Figure 2). Many other places are in reach as well, but with a connecting flight. Almost all air travelers will agree that flying non-stop is preferable. Non-stop travelers not only save time but also reduce risk. An extra flight increases the risk of losing luggage or missing a connection - risks that may rise with international flights. Campante and Yanagizawa-Drott (2016) show that these circumstantial preferences are associated with real economic consequences. They find that the introduction of a non-stop connection between two cities leads to more cross-ownership of companies and general business deals. This is evidence that direct connections allow for more face-to-face meetings, which helps to foster business activity.

Bernstein, Giroud and Townsend (2014) provide evidence that VCs care immensely about non-stop connections and ease of travel when conducting business. After surveying 306 partners at VC firms, almost 90% agree that they would visit a portfolio startup more often if

[10]Interview with Mark Andreessen. Bloomberg Masters in Business, May 19, 2017.

a new non-stop flight were introduced between the VC and startup offices. In a regional analysis in the U.S., they find that new direct connections increase VC investment between two Metropolitan Statistical Areas (MSAs).

4 The Economic Effects of Crossing a Border

The key takeaway from past literature is that non-stop flights are important in business. However, do non-stop flights matter more when traveling internationally? Previous work exploring the prices of goods along the Canadian and U.S. border suggests they might. Engel and Rogers (1996) study differences in prices of similar goods between places along the border and find that distance alone does not explain price variability. For example, prices of footwear can vary greatly between relatively close places like Buffalo and Niagara Falls (Ontario), even after taking into account things like trade laws and taxes. These findings establish a "border effect": the act of leaving the country alone has economic consequences.

Thus, I depart from the literature by comparing the impact of non-stop flights on total VC investment in both international and domestic cities from a specific hub - Silicon Valley. Bernstein, Giroud and Townsend conduct a regional analysis but only domestically and without a focus on a single hub. Moreover, Campante and Yanagizawa-Drott look at cities globally, but do not focus on VC investment as a dependent variable and do not have a single focus region. Importantly, there is no comparison between the economic impact of a new non-stop flight that remains within a country's borders and one that connects two international cities. My research addresses this and adds to a growing literature analyzing the economic effects of a connected, globalized world.

5 Data and Descriptive Statistics

5.1 Venture Capital and Startup Data

My main data source for venture capital funding is Crunchbase, a leading database of startups, investors and entrepreneurs worldwide. I collect data from the period 2010 to 2017 on funded global startups and build two panel datasets for domestic and international startups. Each observation in the original dataset I build from is a startup funding round. An important feature of venture capital is that startups tend to receive funding in distinct rounds. These rounds reflect the stage of the firm in its development. A startup often begins with seed money and receives capital in subsequent venture rounds as it grows. Venture rounds generally range from series A to series H, in the order of the startup firm's development. Rounds in the series A-B range involve earlier-stage companies with a dollar amount generally in the $1-10 million range. Companies receiving funds in rounds ranged series C-H are more established, and usually raise above $10 million.[11]

Each funding round in my data has relevant information such as the date of the deal, the investor or investors involved in the deal, the dollar amount received by the company and the city and country of its headquarters.[12] Figure 4 provides a breakdown of an average funding round. The average dollar amounts raised are in line with the expected round sizes detailed above. I merge latitude and longitude data to each HQ city for geographic analysis. Consistent with the discussions of geography and VC investing, I find that over half of the companies Silicon Valley-based VCs invested in are local (Appendix Figure 3). One limiting factor is that I have the size of the deal for 81% of U.S. funding rounds and 70% of international rounds, although there is no obvious reason to believe this is a biased sample.

[11] Crunchbase Glossary of Funding Types

[12] The data provide the most recent HQ and do not account for satellite offices or second HQs. International deals are converted to USD amounts based on the exchange rate on the day the round was announced.

FIGURE 4a.

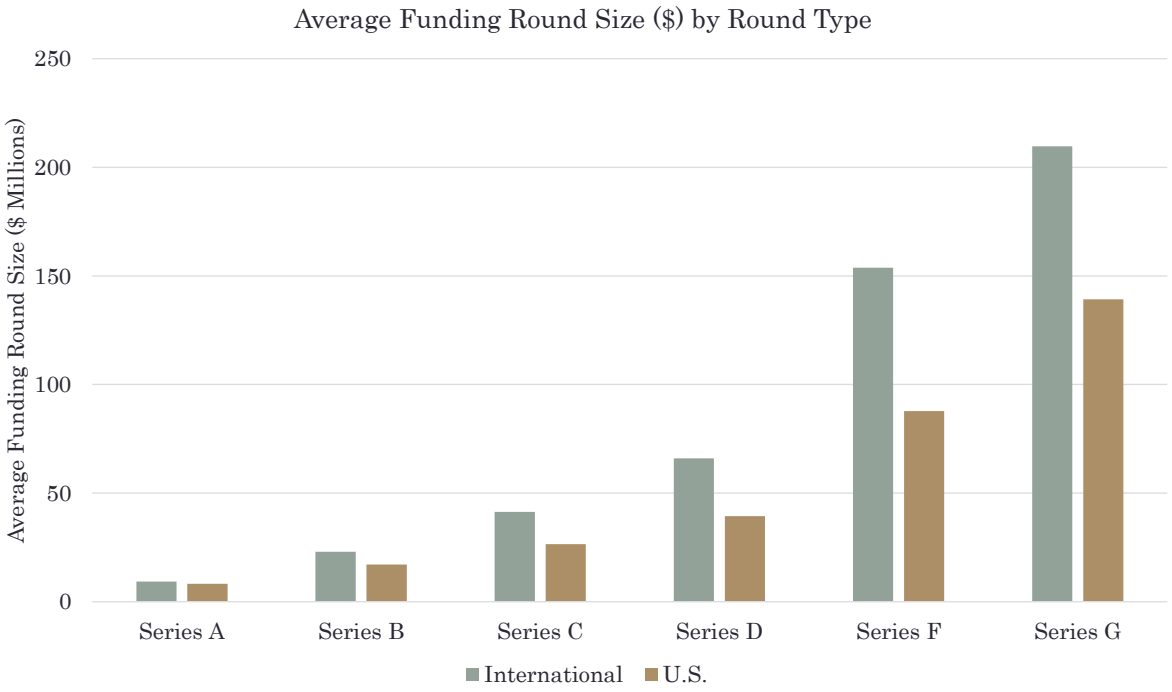
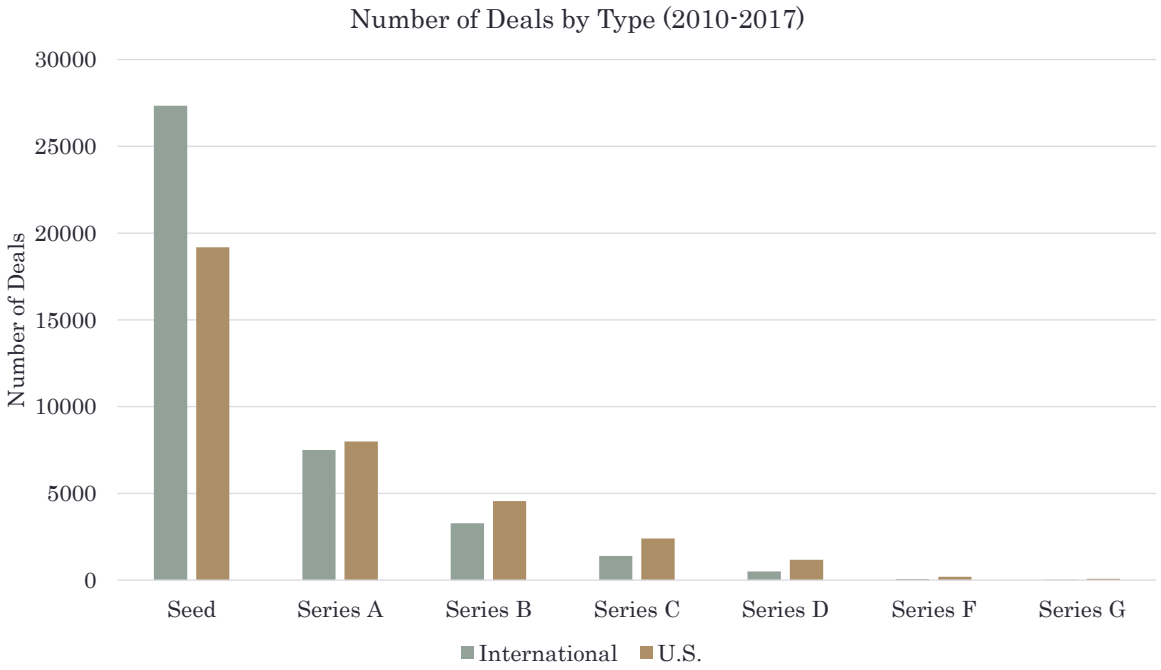


FIGURE 4b.



[12]Note: Later-stage international rounds are higher than in the U.S. but there is also less data as displayed by the total counts by round type. The average seed round was roughly $650,000 internationally and $925,000 in the U.S.

5.2 Non-stop Flight Data and Region Selection

Air route data comes from the U.S. Bureau of Transportation Statistics T-100 Segment (All Carriers). This database includes the total number of non-stop flights performed monthly from airports in the U.S. to both domestic and international destinations, reported by airlines.[13] I isolate only those flights departing from either SFO, OAK or SJC. The dataset includes the operating airline, and I remove any non-commercial operators including freight and private charters.[14]

I select U.S. regions to include in the analysis based on FAA designated airports that are "primary-large" and "primary-medium" in addition to airports designated primary-small with greater than one million enplanements in 2017. This criterion leaves me with 83 U.S. airports that I then group into 68 regions, accounting for the fact that some cities have multiple airports.[15] Internationally, I start with all cities with populations greater than one million and merge an airport using BTS data on world airports. Like in the U.S., I create region groups if there are multiple airports in a city and emerge with 263 international regions.

I construct my dependent variable, VC funding by region, by first locating the largest airport in each region. I then draw a 50-mile radius circle around each airport. In each month and region, I count the total number of funding rounds within this 50-mile radius and aggregate the dollar size of each deal.[16] I am left with two panel datasets from 2010 to 2017 for International and U.S. regions. I present summary statistics for each panel in Appendix Table 1. Appendix Figure 4 exhibits the recent trends in VC for the U.S. and

[13] Data are collected from Form 41 of the US Department of Transportation (DOT). Airlines are required by law to file form 41 and face fines for misreporting.

[14] A potential complication is the usage of private jets, but this is not widespread in VC (Bernstein, Giroud, Townsend, 2014).

[15] I refer to regions and cities interchangeably

[16] I construct a similar variable with a 25-mile radius circle; I make no distinction between the stage of the deal in my baseline model.

internationally, giving the total investment and deal count by year.

6 Methodology

6.1 Baseline Model

If a connection to Silicon Valley matters more for international cities, we would expect flights to have a larger impact on total VC funding on the international level. To test this hypothesis, I estimate two distributed lag models for international and domestic regions explaining total VC investment over time. I estimate the following baseline specifications for both the international and domestic panels:

$$VCFunding50_{i,t} = \beta_0 + \beta_1 Flights_{i,t} + X_{i,t}\gamma + \alpha + \phi + \omega_i + \epsilon_{i,t} \tag{1}$$

The dependent variable, $VCFunding50$, measures total venture capital raised within a 50-mile radius of the primary airport in region i in month t. $Flights$ is a continuous variable capturing the total number of flights from Silicon Valley in each month to region i. The coefficient of interest is β_1, which captures the contemporaneous effect of an increase in flights on VC funding. I explore lagged effects of flights but opt for the concurrent effect in the baseline model because airlines announce new flights months in advance. In effect, this creates a lag of the impact of the new flight. X is a vector of controls including the number of venture capital firms operating in each region across time, business conferences and events held in the region each month, and the size of the startup community - as measured by the total number of profiles in Crunchbase in each region and month. These are active VC partners, entrepreneurs, and general leaders in the business world.[17] For the U.S. I experiment with additional control variables including the median value of a home in a city, the number of homes for sale, and the unemployment rate by city. Finally, α and ϕ are yearly

[17] A sample business event in my dataset would be something like the upcoming "Big Data Innovation Summit" being held in Boston in September, 2018.

and monthly controls to deal with trends and seasonality while ω_i captures fixed effects by region.

6.2 One-year Lag Model

It is reasonable to believe that the effects of a new flight continue through time. To this end, I estimate an additional model with a one-year lag of flights as below,

$$VCFunding50_{i,t} = \beta_0 + \sum_{k=1}^{12} \beta_k Flights_{i,t-(k-1)} + X_{i,t}\gamma + \alpha + \phi + \omega_i + \epsilon_{i,t} \tag{2}$$

Where as before the dependent variable $VCFunding50$ is the aggregate VC raised by startups in region i in month t. $Flights$ is the total number of non-stop flights from Silicon Valley to region i in month t while X captures the same controls as before and α, ϕ, and ω_i are year, month and region fixed effects, respectively. The purpose of this model is to see if there is any difference between the cumulative effects on VC investment of a new domestic flight beginning one year ago and a new international flight also introduced one year prior. This is simply the addition of each of the monthly effects $\beta_1 + \beta_2 + ... + \beta_{12}$. If the hypothesis is correct that non-stop flights to Silicon Valley matter more for international cities, we should expect this sum to be larger when estimated on international regions.

6.3 Model Assumptions

This model is appropriate to capture the impact of a connection to Silicon Valley if there is exogenous variation in the number of flights. This is in turn dependent upon the process of route selection by airlines. Airlines optimize the use of their fleet by selecting routes with the highest forecasted demand. This may be problematic if this general demand is correlated with VC funding. However, young startup companies are just one segment of a city's economy and might not be the primary driver of a new flight. The case for exogeneity is best made for international flights. Advances in aircraft technology and a decrease in the

price of oil are making long-distance flights more viable.[18]

Furthermore, I make an assumption that regions do not simultaneously connect with other cities when they connect to Silicon Valley. For example, if Copenhagen adds new non-stop flights to both San Francisco and New York at the same time, I will capture the effect of the New York flight in addition to the new connection to Silicon Valley.

7 Results

7.1 Baseline Results

Table 1 presents my estimates for the U.S. and International datasets. In the U.S., I find limited statistical evidence that non-stop flights to Silicon Valley help startups attract more capital. Regressions in columns 3-4 estimate the baseline specification in the U.S. and find economically and statistically insignificant effects of more flights. Appendix Table 2 presents results from models with additional controls, and explore a nonlinear effect but have similar results. It is important to note that the addition of more controls leads to a similar conclusion for the value of new flights. This suggests that the baseline controls are effective in controlling for the underlying strength of a city's startup environment.

Internationally, I find that non-stop flights to Silicon Valley have a statistically significant impact on VC funding in a region. Specifically, the baseline model in column 1 suggests that new daily flight (30 flights/month) is associated with $\sim$ \$23 million of additional VC raised in a region. These results are economically significant as well. With the average seed round near \$600,000 and series A round at $\sim$ \$9 million, this value is equivalent to $\sim$35 more seed rounds and roughly 2 more series A rounds.

[18] "The Rise of the Ultra-Long-Haul Flight," *The Economist*. March 27, 2018.

Table 1: Baseline Model Results: International and U.S. Regions

	International	*International*	*U.S.*	*U.S.*
	(1)	(2)	(3)	(4)
	VC Funding 50	VC Funding 25	VC Funding 50	VC Funding 25
Flights_t	761581***	754357***	8482	11997
	(157453)	(157090)	(35375)	(35478)
$\text{CrunchbaseProfiles}_t$	12834**	13008***	6486	6316
	(5041)	(4983)	(3975)	(3887)
OperatingVCs_t	962684***	869209***	1233612***	1251759***
	(243660)	(233531)	(260146)	(259026)
Events_t	1300264	959032	2139786	642788
	(1244216)	(1217891)	(1755574)	(1811475)
Observations	24459	24459	6324	6324
R^2	0.252	0.247	0.716	0.710
Region Fixed Effects	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes
Month Controls	Yes	Yes	Yes	Yes

Robust Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: VC Funding 50 counts fundings rounds within a 50-mile radius. VC Funding 25 uses a 25-mile minimum.

7.2 Effects Across Time and Checks for Robustness

Appendix Table 3 presents my findings from the one-year lag model. I find that the cumulative effect of a new flight is flat in the U.S. but positive and significant internationally. After one year, a new daily non-stop connection to Silicon Valley is associated with an additional $\sim$ \$61 million of VC raised by startups in a city outside the U.S.

For a robustness check, I redefine my dependent variable to only capture early stage VC investment (seed, series A, series B). I find similar, but smaller overall results. An additional daily non-stop flight to a city outside the U.S. is associated with roughly \$7 million of additional VC raised. However, this simply reflects the fact that younger startups raise less money in earlier rounds. This also alleviates any fears that outliers are driving my results, as late stage rounds are infrequent but also have the largest dollar value (see figure 4). Additionally, focusing on a 25-mile radius does not influence my findings in any material way.

A potential limitation to my analysis arises from the fact that when a city adds a new direct flight to Silicon Valley, they may simultaneously add new non-stop flights elsewhere. If a city has a non-stop flight to San Francisco they may also have a non-stop flight to New York City, for example. In this case, omitting New York flights would lead to an upward bias of the coefficient estimating the impact of a connection to Silicon Valley.

To address this, I collect data on non-stop flights from New York City to international cities and reestimate the baseline model with flight data from both Silicon Valley and New York. I find that flights to New York City are significant and lower the impact of a daily non-stop flight to Silicon Valley, but by only \$3 million to around \$20 million. Appendix Table 4 presents these results. This result does suggest a potential limitation but I still find that the impact of a non-stop flight to Silicon Valley is more important for VC than a non-stop flight to New York City, despite New York City also being a large hub for VC activity.

7.3 Summary of Results

In sum, these results suggest the importance of a non-stop connection to Silicon Valley is dependent upon whether these flights are international or domestic. My findings imply a "border effect" in which VCs place more weight on non-stop flights that are international. This may be because aggregate travel costs (including money, time, and convenience) are higher for travelers when flying internationally. For example, the risks of missing the connecting flight may also be associated with larger costs.

Additionally, when a VC crosses the U.S. border, geographic and cultural distance increases. We know that physical distance is a hindrance to the craft of VC but might this other "distance" introduce an additional constraint? My research suggests it does. Entrepreneurs abroad may speak a different language and have different business conventions and etiquette. Virtual business meetings could be even less effective in this case for establishing trust and conducting due diligence. In-person meetings help to overcome this. In-person meetings between VCs in Silicon Valley and a startup in Copenhagen, for example, are easier to plan with a non-stop flight.

8 Extension: Ultra-Long-Haul Flights are Taking Off

Under the framework of my baseline model, the key assumption is that new connections to Silicon Valley are exogenously determined. There may be limitations to this model if airlines evaluate and select routes from Silicon Valley to a region based mainly on the strength of the local startup community. Here, I present a supplementary finding that may motivate the focus of future work analyzing the impact of a connection to Silicon Valley.

A key insight from Campante and Yanagizawa-Drott (2016) is that prior to 2014, regulations on maximum flight time and requirements for crew accommodations made non-stop flights of more than 12 hours in duration (6000 miles) unlikely (but not impossible). Modern wide-body aircraft make these long-distance connections possible but there needs to be suf-

ficient infrastructure. For example, the Airbus A380 may need 10,000 feet of runway space to safely land and take off on an average day and payload.[19] If these requirements are not met, this could present an additional hurdle for a distant city to gain a connection. Runway expansion is not always straightforward though and this may constitute an exogenous variable determining a city's connectedness. Debates over the addition of a third runway at London Heathrow confirm this.[20] Large projects like building a new runway take time and can be disruptive given the amount of space airports occupy.

How do these two variables, distance from Silicon Valley and number of runways greater than 10,000 feet, do at predicting whether an international city has a non-stop connection to Silicon Valley? I estimate the following logit model for whether or not a city outside the U.S. has a weekly connection in 2010 and find they are good predictors.

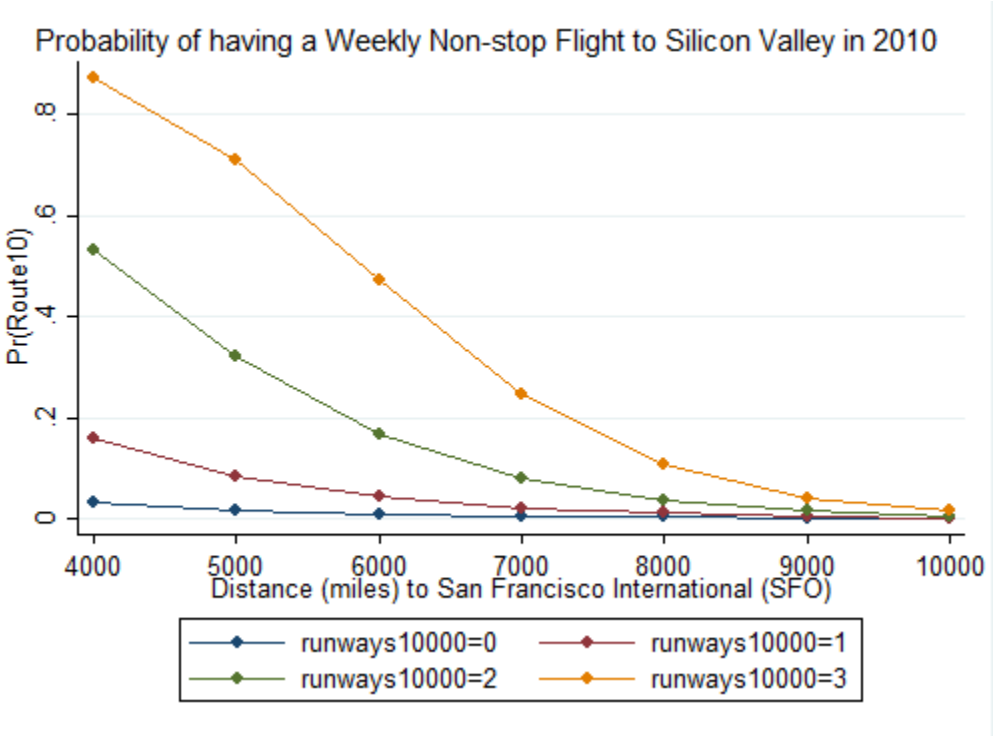
$$\mathbb{P}(Route_i) = \beta_0 + \beta_1 DistanceSF_i + \beta_2 Runways_i + \beta_3 DistanceSF_i * Runways_i + \epsilon_i \quad (3)$$

Where $Route_i$ is an indicator variable equal to one if the city has at least a weekly connection in 2010 to Silicon Valley. $DistanceSF_i$ is the distance in miles from region i's main airport to San Francisco International Airport. Finally, $Runways_i$ captures the number of runways greater than 10,000 feet in length in region i while the interaction term between the two accounts the fact that distant airports without long runways are less likely to have a non-stop connection. Figure 5a shows the predicted probability of having a flight. Even with a well-developed airport, the model predicts that distant places like Cape Town, South Africa (10,244 miles away) will almost certainly lack a direct connection to Silicon Valley.

[19] Airbus A380 Aircraft Characteristics, Airport and Maintenance Planning

[20] "Final Call: The long debate over where to put London's first full-sized runway for 70 years is drawing to a close." *The Economist*, October 13, 2016.

FIGURE 5a.

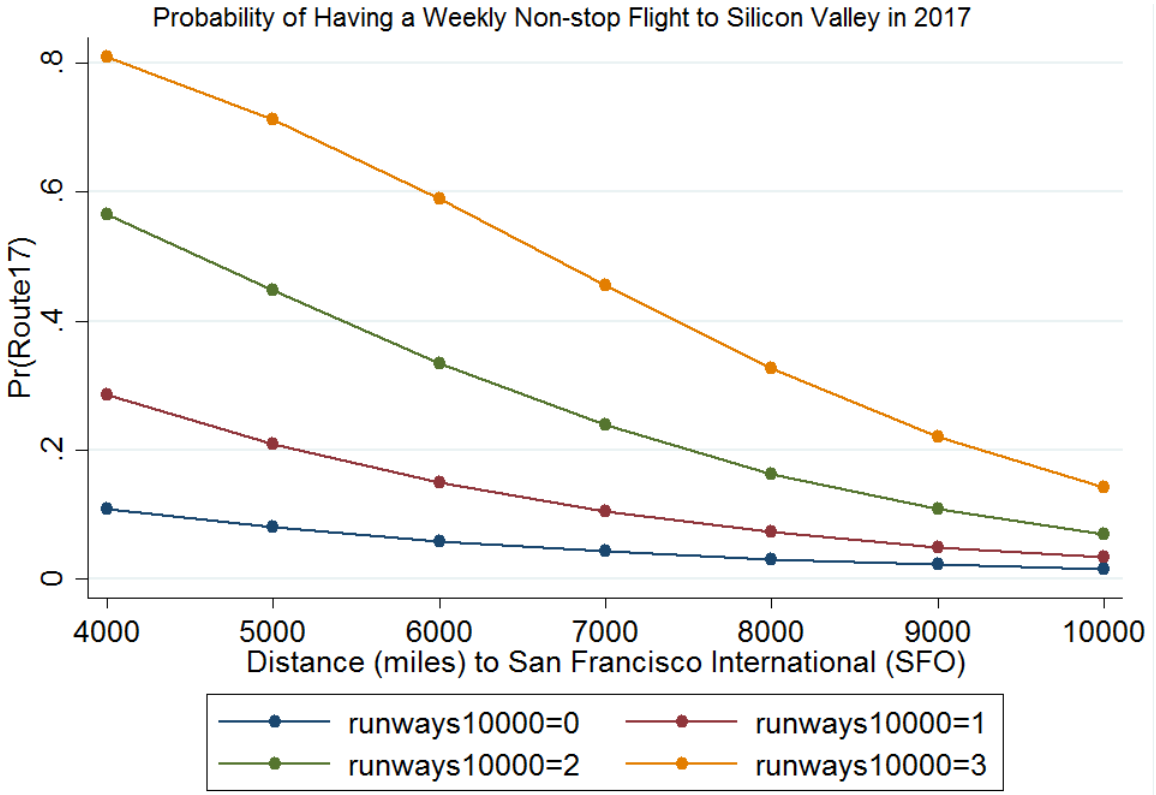


Are places like Cape Town out of luck? Not exactly. I discover a significant change since 2010 in the relationship between distance from Silicon Valley and the odds of having a non-stop flight. I reestimate the model with 2017 data and find that a place like Cape Town (1 runway greater than 10,000 feet) has a small, but higher chance of connecting to Silicon Valley.[21]

FIGURE 5b.[22]

[21] In 2018, Capetown International Airport (CPT) embarked on a 3.8 bn rand ($305 million) runway expansion to accommodate larger planes.

[22] Logit Estimates in Appendix



There are reasons to believe these odds may only rise. The proliferation of new aircraft technology like Boeing's 787 Dreamliner are largely behind this rise in ultra-long-haul routes.[23] Moreover, like Campante and Yanagizawa-Drott point out, changes in the regulatory environment in 2014 removed constraints on longer non-stop flights. With a range of 10,300 miles, Airbus' new A350 could plausibly operate routes like San Francisco to Cape Town.[24] If Cape Town were to gain a daily non-stop flight, my model suggests an increase of about $23 million in VC. Considering that startups in Cape Town raised $100 million in all of 2016, this would be a significant boost. This recent change in aviation is important in determining connectivity to Silicon Valley and may present an opportunity for further research.

[23]Recently, Qantas airlines began operating one of the longest non-stop routes in the world between Perth and London (9010 miles) with a 787.

[24]Powley, Tanya. "A new era of ultra-long-haul aviation", *Financial Times*, November 6, 2015.

9 Conclusion

This paper studies the effects of being connected to Silicon Valley via a non-stop flight on venture capital funding in the U.S. and abroad. Complementing the trade literature, I find that startups outside the United States benefit greatly from a direct connection to Silicon Valley, though there is little evidence of this domestically. Startups in an international city raise $23 million of additional venture capital with the introduction of a new non-stop flight. With an increase in geographic distance and expected cultural differences between countries, this result is not surprising.

Further work may explore the benefits of connectedness to Silicon Valley in greater detail. How important might a connection be in predicting startup success? Are other means of connections like establishing satellite offices in Silicon Valley beneficial? Are there additional ways to measure the benefits of connectedness like growth in a technology-focused labor force? These are potential questions for future research.

My findings are relevant in the discussion of rising regional inequality in the world. In 2016, the OECD found that the difference in labor productivity between the top 10% most productive regions and bottom 75% widened by close to 60% between 1995 and 2013.[25] Startups introduce new solutions, and this innovation can help raise productivity in a region. Yet, my research suggests areas disconnected from the flow of capital and ideas emanating from the superstar cluster of Silicon Valley may be left behind. My analysis implies initiatives to improve connectedness, such as investments in air infrastructure, can help these places catch the VC tailwind.

[25] OECD Regional Outlook 2016

References

Bernstein, Shai, Xavier Giroud, and Richard R. Townsend (2014). "The Impact of Venture Capital Monitoring: Evidence from a Natural Experiment" *Journal of Finance.*

Campante, Filipe, Yanagizawa-Drott, David (2016). "Long-Range Growth: Economic Development in the Global Network of Air Links". *National Bureau of Economic Research.*

Chen, Henry, Gompers, Paul, Kovner, Anna, Lerner, Josh (2010). "Buy Local? The Geography of Successful and Unsuccessful Venture Capital Expansion." *Harvard Business School.*

Cumming, Douglas, Dai, Na (2010). "Local Bias in Venture Capital Investments." *Journal of Empirical Finance.*

Engels, Charles, Rogers, John (1996). "Optimal Investment, Monitoring, and the Staging of Venture Capital." *The Journal of Finance.*

Gompers, Paul, Lerner, Josh (1999). "What Drives Venture Capital Fundraising." *National Bureau of Economic Research.*

Gompers, Paul, Kovner, Anna, Lerner, Josh (2009). "Specialization and Success: Evidence from Venture Capital." *Journal of Economics and Management Strategy.*

Gompers, Paul (1995). "Optimal Investment, Monitoring, and the Staging of Venture Capital." *The Journal of Finance.*

Lerner, Josh (1995). "Venture Capitalists and the Oversight of Private Firms." *The Journal of Finance.*

Powley, Tanya. "A new era of ultra-long-haul aviation", *Financial Times*, November 6, 2015.

Shubber, Kadhim "Theranos Founder charged with 'massive' securities fraud." *The Financial Times*. May 19, 2017.

Storper, Michael, Anthony, Venables (2004). "Buzz: Face-To-Face Contact and the Urban Economy." *Journal of Economic Geography*.

Stross, Randall. "It's Not the People You Know. It's Where You Are." *The New York Times*, November 22, 2006.

The Economist. "Final Call: The Long Debate over Where to put London's First Full-Sized Runway for 70 years is Drawing to a Close.".
October 13, 2016.

The Economist. "Left in the lurch: Globalisation has marginalised many regions in the rich world.". October, 21, 2017.

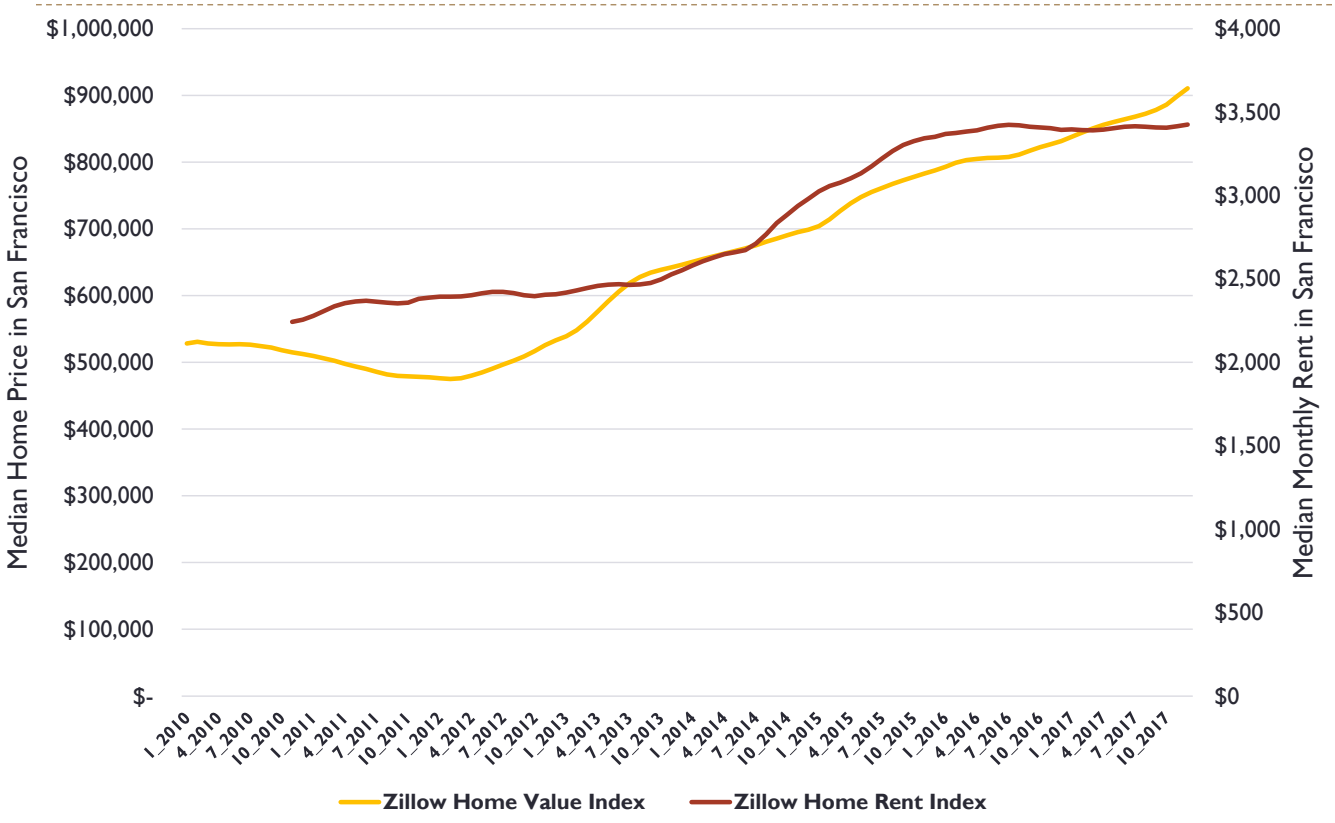
The Economist. "The Rise of the Ultra-Long-Haul Flight.". March, 27, 2018.

Appendix

9.1 Appendix Figures

Figure 1: Median Home Prices and Monthly Rent in the San Francisco Bay Area (2010-2017)

This figure presents the median value of a home and monthly rent in the San Francisco region, as geographically defined by Zillow. Leverages Zillow Research's Home Value and Rental Indices.[26]

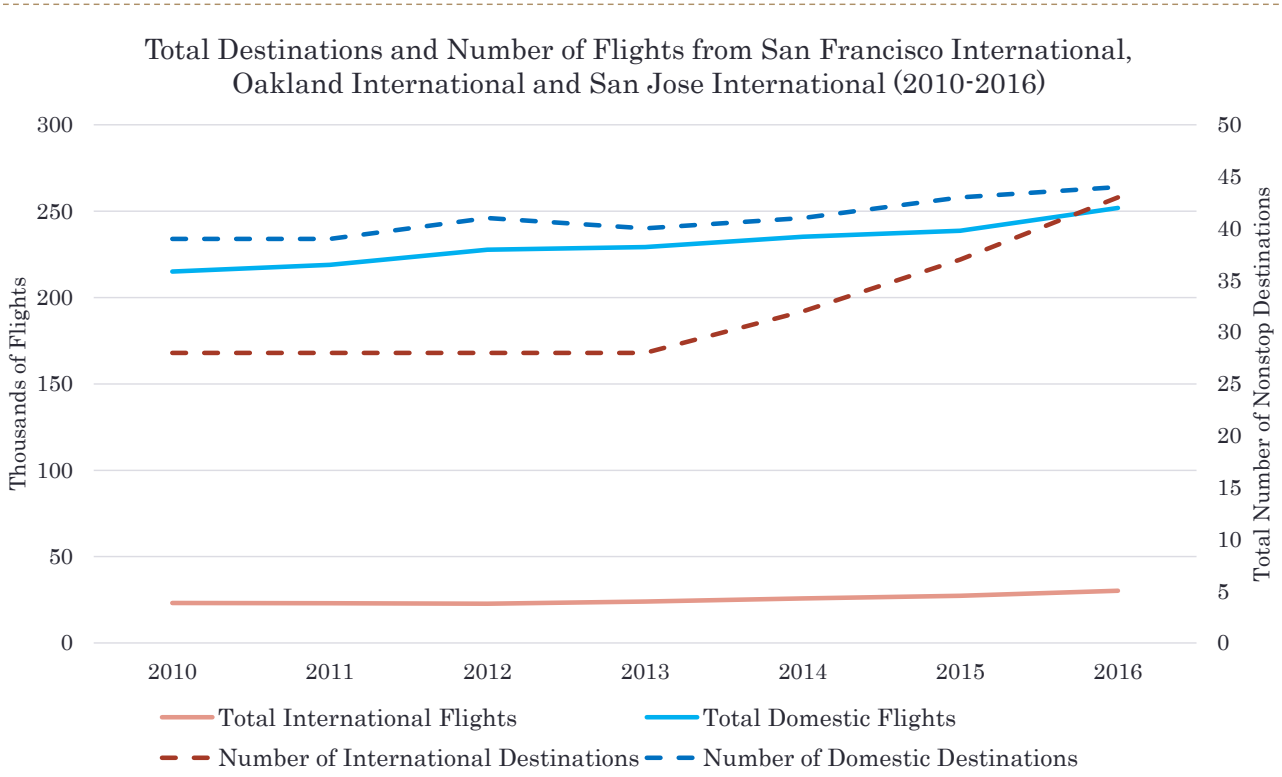


Source: *Zillow Research*

[26] Zillow describes their methodology for these indices here https://www.zillow.com/research/zhvi-methodology-6032/

Figure 2: Non-stop Destinations from Silicon Valley (2010-2016)

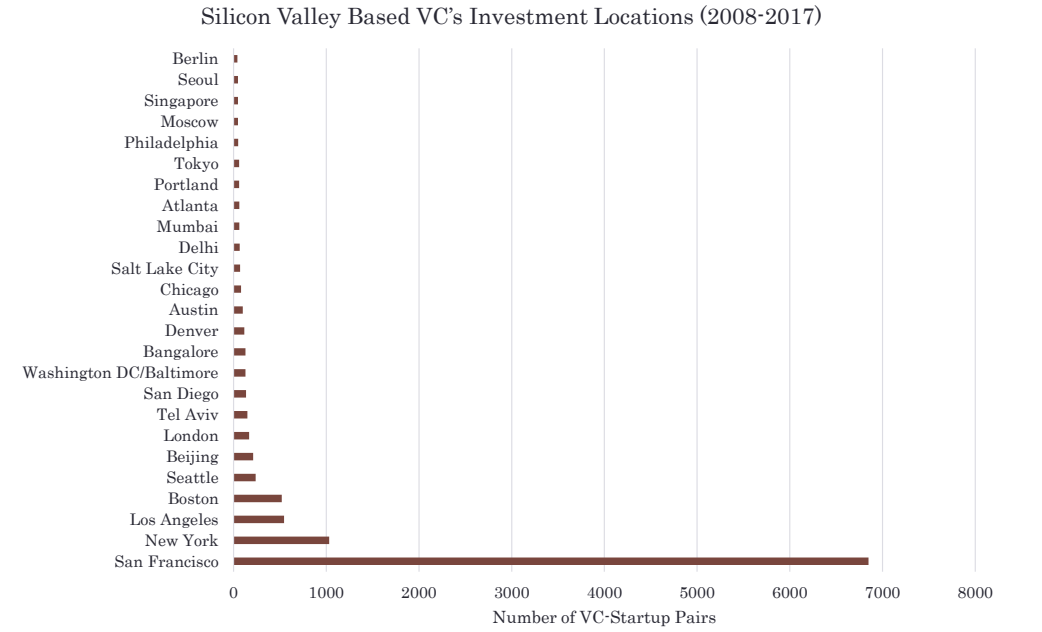
This figure shows the number of direct destinations departing from the three main airports in the Greater San Francisco Bay Area. I define a connection to be at least weekly - or at least 52 flights in a year. There is a noticeable increase in international destinations since 2013, which may be attributed to a combination of lower oil prices and more fuel-efficient planes, as well as a general proliferation of long-haul routes.



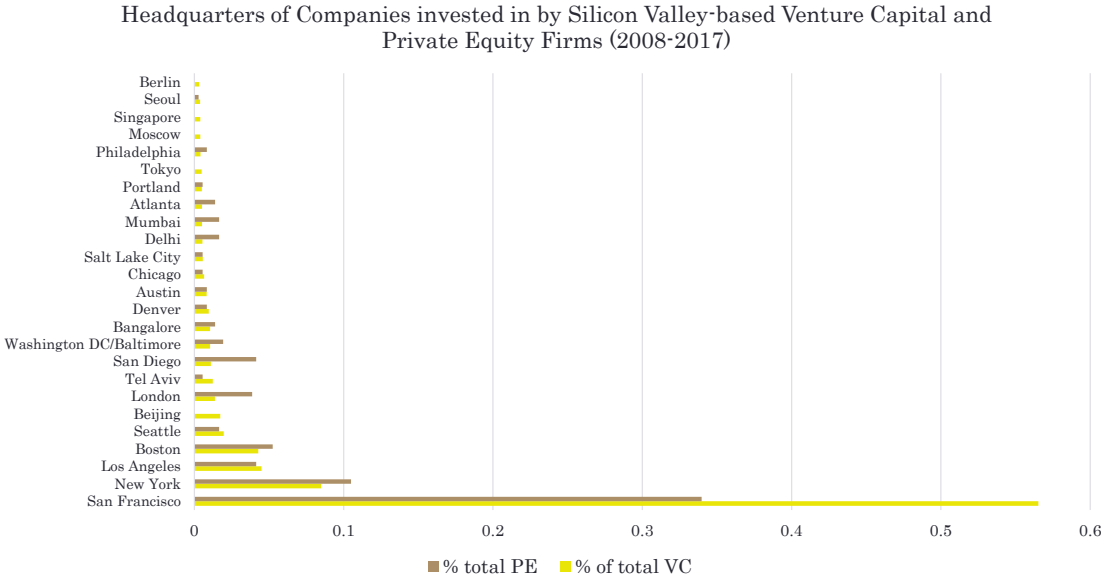
***Source**: U.S. Bureau of Transportation Statistics T-100 Form for all Carriers*

Figure 3: Investment Locations of Silicon Valley VCs (2008-2017)

This figure presents the cities where VCs based in Silicon Valley invested in most. Of 12,117 VC-Startup pairs, $\sim 57\%$ are local and located in or around Silicon Valley. A valuable comparison is with Private Equity Firms based in Silicon Valley. Of 362 investments over the same period, only 34 percent are located in Silicon Valley. This data is consistent with the hypothesis of more local bias in VC investing.



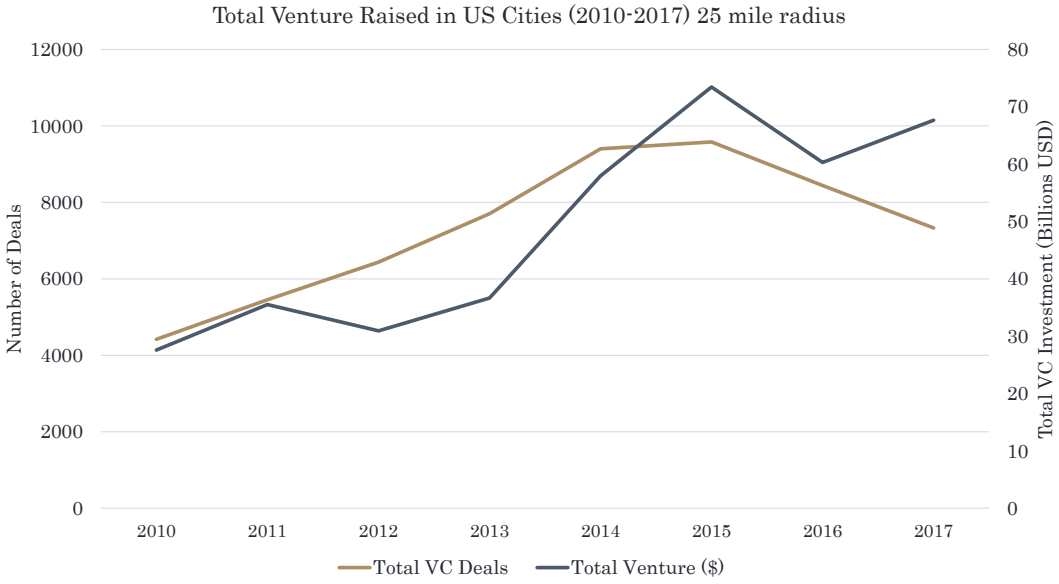
***Source**: Crunchbase*



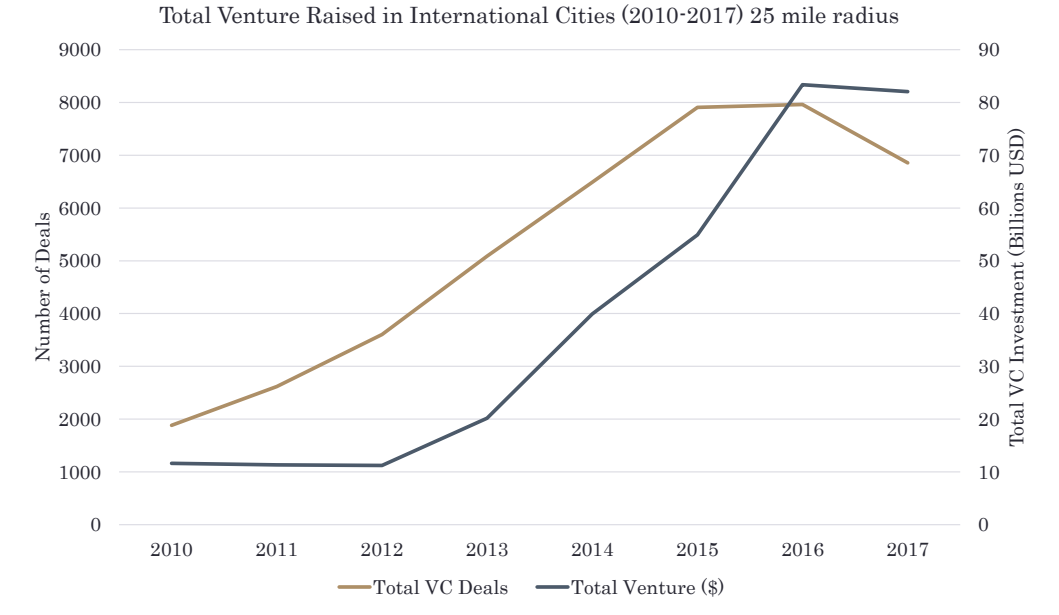
***Source**: Crunchbase*

Figure 4: Total VC raised by companies in the U.S. and Abroad (2010-2017)

These figures present the total VC investment and total number of deals with companies headquartered across the 332 regions in my sample, 68 in the United States and 263 international. To be counted, the company HQ must be within 25 miles of the largest airport in the region.



***Source**: Crunchbase*



***Source**: Crunchbase*

9.2 Appendix Tables

Table 1:

TABLE 1a: Summary Statistics, All U.S. Regions (2010-2017), Monthly

Variable	Mean	Median	Std	Max	Min
VC Funding ($'s, 25 Miles)	33,459,111	2,200,000	103,526,256	2,326,408,541	0
VC Funding ($'s, 50 Miles)	36,090,768	3,075,454	107,040,266	2,327,077,541	0
Private Equity, VC Funding ($'s, 50 Miles)	49,052,643	3,600,000	166,248,030	5,532,410,164	0
Commercial Flights from Silicon Valley	290.7	33.0	679.5	6199.0	0.0
Venture Capitalists Operating (50 Miles)	65.7	26.0	141.7	1239.0	2.0
Seasonally-Adjusted Housing Inventory	12919	7607	15708	135655	976
Zillow Home Value Index ($'s)	189,415	158,800	93,049	667,000	75,900
Unemployment Rate (%)	6.51	6.20	2.18	15.30	2.10
Business Conferences and Events	0.56	0.00	2.60	52.00	0.00
People in Crunchbase Database (50 Miles)	632	100	2069	31535	0
Private/Chartered Flights from Silicon Valley	0.29	0.00	1.76	56.00	0.00
Deal Count (50 Miles)	6.9	2.00	14.68	158.00	0.00

TABLE 1b: Summary Statistics, All Intenational Regions (2010-2017), Monthly

Variable	Mean	Median	Std	Max	Min
VC Funding ($'s, 25 Miles)	11,709,416	0	110,617,030	7,843,319,980	0
VC Funding ($'s, 50 Miles)	12,433,437	0	111,241,408	7,843,319,980	0
Private Equity, VC Funding ($'s, 50 Miles)	16,727,042	0	201,735,940	23,092,539,862	0
Commercial Flights from Silicon Valley	8.3	0.0	30.4	424.0	0.0
Venture Capitalists Operating (50 Miles)	24	4	63	946	0
Business Conferences and Events	0.13	0.00	1.17	94.00	0.00
People in Crunchbase Database (50 Miles)	154	7	726	23377	0
Private/Chartered Flights from Silicon Valley	0.32	0.00	4.51	117.00	0.00
Deal Count (50 Miles)	1.84	0.00	5.90	126.00	0.00

Table 2: US Regions with additional controls

	(1) VC Funding 50	(2) VC Funding 25	(3) VC Funding 50	(4) VC Funding 25
Flights_t	8481.6	11997.4	31904.7	33962.6
	(35375)	(35477.9)	(31469.2)	(31219.9)
$\text{Flights}_t \times \text{Flights}_t$			-23.52**	-21.55*
			(11.39)	(11.22)
$\text{Flights}_t \times \text{NumberofVCs}_t$			285.7*	261.3*
			(148.4)	(146.5)
OperatingVCs_t	1233612***	1251759***	538624.8	601586.0
	(260146)	(259025.7)	(399102.8)	(401527.1)
$\text{CrunchbaseProfiles}_t$	6486.4	6316.3	6149.0	5921.6
	(3975)	(3886.9)	(4050.0)	(3962.9)
$\text{HousingInventory}_t$			588.7*	556.7*
			(327.1)	(325.8)
$\text{ZillowHomeValueIndex}_t$			33.70	34.48
			(66.33)	(65.30)
$\text{UnemploymentRate}_t$			-557337.2	-354734.2
			(954800.0)	(942742.4)
Events_t	2139786.0	642788.1	763836.9	517542.8
	(1755574)	(1811475.2)	(1935792.4)	(1831039.7)
Events_{t-1}			3963649.3**	3963759.0**
			(1943946.4)	(1883289.4)
Observations	6324	6324	6161	6161
R^2	0.716	0.710	0.722	0.716
Region Fixed Effects	Yes	Yes	Yes	Yes
Year Controls	Yes	Yes	Yes	Yes
Month Controls	Yes	Yes	Yes	Yes
Joint F-Test Flights (p-val)			0.12	0.15

Robust Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Impact of a Non-stop Flight to Silicon Valley after One Year

	U.S.	*International*
	(1)	(2)
	VCFunding50	VCFunding50
Flights_t	9558	-55559
	(56162)	(255789)
Flights_{t-1}	50975	171083
	(80855)	(289814)
Flights_{t-2}	151975*	34207
	(78705.7)	(303544)
Flights_{t-3}	-31695	455584
	(105242)	(280247)
Flights_{t-4}	-176131***	-279329
	(66956)	(323055)
Flights_{t-5}	-77210	565907
	(105974)	(369790)
Flights_{t-6}	46433	288270
	(98999)	(278795)
Flights_{t-7}	42572	-181307
	(101889)	(284312)
Flights_{t-8}	14350	-13281
	(99842)	(306808)
Flights_{t-9}	49093	318117
	(67349)	(288146)
Flights_{t-10}	-7676	123531
	(104091)	(294269)
Flights_{t-11}	-132109	601134
	(109350)	(296865)
Observations	5576	21566
R^2	0.723	0.277
Cumulative Effect	-102,430	2,028,357
Joint F-Test Flights (p-val)	0.040	0.0001

Standard errors in parentheses

Note: Control variables included but estimates are omitted from table

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Early Stage

	(1) VC Funding 50	(2) VC Funding 25	(3) Early Stage VC 50	(4) Early Stage VC 50
Silicon Valley Flights$_t$	676127.4***	676717.1***	235124.7***	204943.8***
	(151848.5)	(151551.7)	(59335.5)	(56661.1)
New York Flights$_t$	147298.0***	133828.8**		55515.8***
	(54433.4)	(53850.7)		(19675.4)
CrunchbaseProfiles$_t$	13788.5***	13875.4***	3026.1	2705.2
	(5101.5)	(5036.2)	(2576.4)	(2816.8)
OperatingVCs$_t$	884591.7***	798257.4***	429510.4***	379753.5***
	(241969.0)	(231406.7)	(109703.8)	(102250.0)
Events$_t$	1207237.4	874512.0	330714.8	34576.4
	(1251708.9)	(1226890.0)	(585860.9)	(508489.2)
Events$_{t-1}$				1182883.8*
				(626120.8)
Observations	24459	24459	24459	24196
R^2	0.252	0.247	0.152	0.153

Standard errors in parentheses

Region Fixed Effects Month Controls Year Controls

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5: Logit results: Predicting if an international city has a direct route to Silicon Valley

This table presents estimates from logit models run with monthly flight data from 2010, 2013, 2014, and 2017. These results suggest that distant cities now have a higher chance of connecting to Silicon Valley via a non-stop flight. $Runways10000$ is the total number of runways greater than 10,000 feet in length in each city's airport(s) and $DistanceSF$ is the distance in miles from Silicon Valley to each city (calculated via Haversine forumla). I include an interaction term between the two variables based on the intuition that larger planes fly long-distance routes, and that these planes also require longer runways. I capture the overall trend that ultra-long-haul non-stop routes (greater than 12 hours in duration) are becoming more common. The model does a better job predicting whether a city has a flight to Silicon Valley in 2010 than in 2017. As previously mentioned, advances in aviation like the proliferation of the Boeing 787 Dreamliner and regulatory changes in 2014 are behind this recent trend.

	2010	*2013*	*2014*	*2017*
	(1)	(2)	(3)	(4)
	route	route	route	route
Runways10000	2.161***	2.463***	2.273***	1.454***
	(0.272)	(0.286)	(0.267)	(0.245)
DistanceSF	-0.000591***	-0.000588***	-0.000577***	-0.000367***
	(0.0000679)	(0.0000700)	(0.0000614)	(0.0000543)
Runways10000 × DistanceSF	-0.000120**	-0.000150***	-0.000143***	-0.0000501
	(0.0000475)	(0.0000494)	(0.0000458)	(0.0000402)
Constant	-1.038***	-1.166***	-0.753**	-0.857***
	(0.338)	(0.350)	(0.311)	(0.311)
Observations	3156	3156	3156	2367
Pseudo R^2	0.432	0.459	0.419	0.261

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: $Route = 1$ if city i has at least 4 flights to Silicon Valley during the month.

Runway data are collected from an open data source OurAirports, http://ourairports.com

2017 data are through November.

TABLE 5a: Top 10 U.S. Regions in 2017, Ranked by Total VC Funding

Region	VC Funding* (total, 50 miles)	CommercialFlights (monthly average)	VCsOperating (2017 average)	HousingInventory (2017 average)
San Francisco	28.79		1,425	3,677
New York	10.16	1,272	1,235	70,541
Boston	7.01	426	360	8,935
Los Angeles	4.15	5,764	433	16,402
Chicago	2.33	903	248	34,824
Wash. DC/Baltimore	2.11	473	257	15,974
Seattle	1.55	1,499	126	5,957
San Diego	1.27	1,334	101	5,136
Denver	0.99	947	139	6,085

**Notes: VC Funding Total in Billions of Dollars*

TABLE 5b: Top 10 U.S. Regions in 2017, Ranked by Total VC Funding

Region	ZillowHomeVal (2017 average)	UnemploymentRate (% 2017 average)	Events (total, 50 miles	People (2017 avg.)	Company Receving Most VC
San Francisco	859,056	3.47	342	39264	GRAIL
New York	416,222	4.34	238	27687	WeWork
Boston	424,333	3.53	84	10476	Ginkgo Bioworks
Los Angeles	607,156	4.42	64	13028	Compass
Chicago	209,811	4.70	33	7915	Outcome Health
Wash. DC/Baltimore	382,478	3.68	41	8339	Eco Service Partners
Seattle	438,656	3.86	26	5164	Rover.com
San Diego	541,122	4.20	19	2919	Progenity
Denver	366,167	2.41	14	3106	MycoTechnology

TABLE 6a: Top 10 International Regions in 2017, Total VC Funding

Region	VC Funding* (total, 50 miles)	CommercialFlights (monthly average)	VCsOperating (2017, average)	Events (total, 50 miles)
Beijing	18.47	85	106	6
Shanghai	11.53	103	113	4
London	8.71	231	944	243
Hong Kong	4.20	131	228	13
Paris	2.55	77	300	23
Singapore	2.48	60	208	25
Delhi	2.00	26	84	11
Dublin	1.95	28	60	9
Tel Aviv	1.87	30	240	6

**Notes: VC Funding Total in Billions of Dollars*

TABLE 6b: Top 10 International Regions in 2017, Total VC Funding

Region	People (2017 avg.)	Runways (2017) Greater than 10000 f	DistanceSF* (miles)
Beijing	1,039	3	5895
Shanghai	861	4	6134
London	22,505	4	5350
Hong Kong	1,578	3	6897
Paris	5,269	4	5565
Singapore	2,410	2	8437
Delhi	4,889	2	7687
Dublin	1,567	0	5081
Tel Aviv	2,639	2	7402

**Notes: Distances Calculated by Haversine Formula between a pair of latitudes/longitudes (Great Circle)*