An Overview of the Capital Raising Activities Among Proptech Firms

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This article presents an overview of the capital raising activities among property/real estate technology (i.e. Proptech) firms. This overview highlights the strengths and weaknesses of the Proptech sector in recent years. This article provides a detailed summary and description of how the capital raising activities distribute across different Proptech categories and geographic locations in different market conditions. The authors find that the capital-raising activities in Proptech have cooled down despite the rising real estate prices last year. The authors hope that this review can present a more comprehensive picture of the Proptech development and attract more researchers to investigate the costs and benefits of Proptech to the real estate markets. This research contributes to the understanding of Proptech sector more comprehensively by utilizing a unique hand-collected dataset. The results present a different perspective on the recent trends of Proptech firms as they feature both the promising trends and concerning issues within the field.

Keywords: Proptech, real estate, raising capital, diversity

INTRODUCTION

The real estate industry has experienced quite an innovative and digital disruption in recent year that firms which engage in real estate/property-related technologies, defined as Proptech firms, have attracted more attention and media coverages in the real estate industry and capital markets as investors and consumers have noticed and hoped that technological innovations can ease or reduce the market frictions in the real estate markets. Fields (2019) suggests that the digital technological advancements after 2008 have enabled automation in many core real estate functions, such as rent collection and maintenance. Cajias and Wins (2021) show two applicable examples of data algorithms on real estate analytics and performance. However, it is also noted that we should not simply assume that the benefits of Proptech always outweigh the costs or unintended consequences from these technological applications (Porter, et al., 2019).

Tagliaro, Stefallo and Ciaramella (2021) document that the Proptech market has undergone a sudden acceleration in terms of funding in recent years. Increasingly, real estate industries have adopted more innovative technologies and platforms, such as crowdfunding, to increase investment accessibility and

diversification benefits (Gibilaro & Mattarocci, 2021). Starr, Saginor, and Worzala (2021) attract our attention to the technological disruptions and applications in commercial real estate in the upcoming wave of Real Estate 4.0. Chow and Tan (2022) show real-life cases of tokenized real estate markets in Asia-Pacific region and indicate the possibility of blockchain technology as a viable source of funding in real estate. Thus, a deeper and more comprehensive examination of the Proptech firms is warranted to understand how Proptech impact the real estate markets, such as pricing, demand, supply, and public policies (Shaw, 2020).

According to Baum (2017) and Baum et al., (2020), there have been two major waves in the development of the Proptech world. Using technology to improve the real estate industry is not a recent idea. The first wave of Proptech firms started around the 1980s. Well-known firms, such as CoStar, Yardi, and Autodesk, were founded during that decade and have become mega-billion-dollar companies. The first wave of Proptech focused on the software development of real estate industry. The Proptech survivors obecomefirst wave have thrived and became staples in the real estate industry. The second wave of Proptech firms began in early 2000s. The dot com bubble certainly facilitated the growth of technology firms focusing on real estate industry. The maturity of internet technology is tremendous in creating and developing online real estate spaces and technologies. Zillow and Trulia (later acquired by Zillow) were born during the mid-2000s. The most significant growth in the second wave occurred during and after the recent Global Financial Crisis around 2008. This wave also overlaps with the financial industry's significant growth in the FinTech industry as the global financial meltdowns have intrigued and inspired many entrepreneurs to enhance the inefficiencies in the mortgage and residential real estate markets.

The U.S. housing market has seen housing price rise since the pandemic in 2020. However, the number of deals and the amount of money raised in the Proptech sectors have fallen. Many believe that we are now at the end of the second wave of Proptech. Newer and developing technologies, such as Machine Learning and Blockchain, may lead to the next wave of Proptech.

As the big picture of Proptech is being analyzed more and more frequently the in real estate industry (Feth & Gruneberg, 2018) and academia (Baum, 2017; Starr, Saginor, & Worzala, 2021), in this research, we would like to focus on the overview of the capital raising activities among the U.S. Proptech firms for the past 20 years. We dig deeper into the capital raising information on the deal level and firm level to highlight the strengths and weaknesses of the growth in Proptech.

We show detailed descriptions on how the capital investments distribute across different Proptech categories, geographic locations, and throughout the years. We show an increasing trend among Proptech firms to raise more capital in recent years, but the activities have cooled down during the COVID pandemic year. The number of Proptech companies are disproportionally located in two primary states: CA and NY. Proptech firms specializing in Commercial Real Estate have raised much less capital than Residential Real Estate. This could be of concern as commercial real estate markets have shown to have more frictions and less liquidity.

Furthermore, we find an increasing trend of using debt/convertible notes in the capital-raising activities. Using a limited variable provided by Crunchbase, we suggest that improvement is needed for diverse representations among Proptech firms. We show that Proptech firms are top-heavy as the top 10% of the sample firms have raised over 65% of the total capital. The top-heavy situation in Proptech is certainly not unique to this sector per se, but the active and continuous consolidations in Proptech may reduce the competitiveness in the sector before Proptech can fully develop to improve the efficiency in the market. The overall capital raising activities are positively correlated with the real estate market conditions.

The remaining of the research article is organized as follows: Section 2 describes the data sources and data sample; Section 3 presents the main results; Section 4 concludes.

DATA SAMPLE

In this research, we obtained a list of real estate tech (Proptech) companies from RealEstateTech.co in late 2020. Using this list, we hand-collected a dataset on the capital raising activities and the company profiles of these real estate tech companies on Crunchbase from late 2020 to early 2021. Firms without

fundraising information are removed from the sample. In this research, we focus on firms based in U.S. only.

The dataset contains the amount of money raised in each round by each company (if available from Crunchbase), the year the firms is founded, the firm's location which the firm primarily serves in real estate, and a diversity spotlight variable. The diversity spotlight variable is interesting for the US firms on Crunchbase: it shows if the company is founded or led by traditionally underrepresented groups, such as Women, Black/African American, and Hispanic/Latinx. We believe this manually constructed dataset is a great start to analyze the trends and behaviors of the capital raising activities of the Proptech firms. After cleaning up the dataset, we have a total of 302 unique Proptech firms which spans from the year 2000 to early year 2021. These 302 unique firms assemble a data set of 948 deal-year or 815 firm-year samples.

MAIN RESULTS

What About These Proptech Firms?

First, we would like to present some descriptions of the distributions of the Proptech firms in our sample. Table 1 shows the distribution of the firms and deals by year in our sample. Proptech companies in our sample raised a total of over 18 billion dollars for the past 21 years. We can see that Year 2014, 2015, and 2016 are the most active years of capital raising by Proptech firms. The interesting observation is that, even though the number of deals and firms involved have decreased in 2018 and 2019, the total amount of money raised in these two years is the largest in our sample. However, last year the capital raising activities declined sharply compared to 2019. The time trend of the deal numbers and the number of firms in Proptech industry are consistent with the findings in Baum et al., (2020). Such pattern corresponds with the immersion and the growth of Proptech firms in recent years.

TABLE 1
DISTRIBUTION OF CAPITAL IN THE PROPTECH SECTOR

Year	Number of Deals	Number of Firms	Capital Raised
2000	6	4	$83,800,000
2001	2	2	$23,400,000
2002	1	1	$10,000,000
2003	2	2	$38,300,000
2004	3	3	$36,300,000
2005	9	7	$79,600,000
2006	6	5	$196,000,000
2007	8	7	$48,800,000
2008	10	10	$334,250,000
2009	16	16	$86,191,700
2010	18	16	$66,507,700
2011	27	25	$101,686,200
2012	39	37	$118,190,000
2013	92	74	$787,307,200
2014	140	118	$1,355,645,000
2015	141	115	$1,693,387,200
2016	127	112	$1,703,321,271
2017	94	83	$1,878,833,300
2018	84	68	$3,659,834,900

Year	Number of Deals	Number of Firms	Capital Raised
2019	79	68	$3,938,570,000
2020	39	38	$1,796,210,000
2021	4	4	$281,600,000
Total	**947**	**815**	**$18,317,734,471**

Note: this table shows the distribution of capital throughout the past 21 years in the Proptech sector. The number of deals and number of firms involved each year are also shown.

Table 2 compasss the amount of capital raised by Proptech firms versus two popular sectors, Fintech and Biotech. We collected the overall Fintech and Biotech sector data from the Crunchbase database. This comparison is informative in that it shows the Proptech sector itself is still in its infancy compared to other technology-related firms to the Venture Capital (VC) industry. The number of firms involved and the number of deals completed are not nearly close to Fintech and Biotech sectors. We argue that our general overview of the Proptech firms is essential to develop and to deepen our understanding of the Proptech sector as it is such a new and fresh sector for the VC or other related funding/investment industries.

TABLE 2
THE COMPARISON OF PROTECH WITH OTHER SECTORS

	Proptech	Fintech	Biotech
Number of Firm-Year Obs	815	4,943	11,191
Number of Deals	947	21,281	5,100
Capital raised	$18,317,734,471	$151,647,518,707	$381,225,326,088

Note: this table shows the comparison of the recent Proptech funding deals with other popular sectors in our sample period, such as Fintech and Biotech. The number of firm-year observations and the number of deals is shown along with the total capital raised by the three sectors.

Table 3 presents the current operating status of the 302 firms in our sample. About 2/3 of the sample firms remain active independently, and 20% of the sample firms have been acquired as of 2021. A few samples have gone public, while the rest have closed shop.

TABLE 3
OPERATING STATUS IN THE SAMPLE

Operating Status	Number of Firms
Acquired	69
Active	207
Closed	15
Delisted	2
Public	9
Total	**302**

Note: this table shows the current operating status of the Proptech firms in our sample.

Table 4 exhibits the rounds of funding types[1] obtained by the sample Proptech firms by year. Proptech firms have been raising capital via various channels and capital types. Among all the rounds, Series B, C, D, and E have been raising the most significant amount of dollars for the Proptech sector, with each round having more than 2 billion dollars raised.

TABLE 4
FUDING TYPES IN THE SAMPE OF PROPTECH FIRMS BY YEAR

Year	Angel	Pre Seed	Seed	Series A
2003				$ 31,600,000
2005			$ 400,000	$ 47,100,000
2006				$ 10,500,000
2007				$ 5,200,000
2008	$ 450,000			$ 9,500,000
2009	$ 50,000	$ 18,000	$ 2,000,000	$ 3,148,700
2010	$ 800,000		$ 4,050,000	$ 12,751,000
2011	$ 290,000		$ 4,750,000	$ 31,287,000
2012	$ 550,000	$ 925,000	$ 28,330,000	$ 50,400,000
2013	$ 350,000	$ 820,000	$ 56,054,700	$ 111,850,000
2014	$ 5,789,000	$ 225,000	$ 74,097,000	$ 195,500,000
2015	$ 2,697,000	$ 350,000	$ 40,307,500	$ 308,800,000
2016	$ 4,325,000	$ 1,600,000	$ 52,324,471	$ 120,400,000
2017	$ 3,630,000	$ 190,000	$ 38,293,000	$ 206,200,000
2018		$ 1,900,000	$ 45,470,300	$ 142,800,000
2019			$ 29,500,000	$ 102,900,000
2020			$ 2,300,000	$ 20,000,000
Grand Total	**$ 18,931,000**	**$ 6,028,000**	**$ 377,876,971**	**$ 1,409,936,700**

Year	Series B	Series C	Series D	Series E
2000	$ 17,500,000			$ 42,000,000
2001		$ 13,400,000		
2002		$ 10,000,000		
2003				
2004		$ 4,100,000	$ 12,200,000	
2005	$ 12,200,000	$ 4,900,000		$ 5,000,000
2006	$ 180,000,000			
2007		$ 28,500,000		
2008	$ 17,000,000	$ 13,600,000	$ 265,000,000	
2009		$ 8,000,000	$ 10,000,000	
2010				
2011	$ 17,958,000			$ 14,800,000
2012				
2013	$ 148,700,000	$ 80,000,000	$ 40,000,000	
2014	$ 117,400,000	$ 69,000,000	$ 20,000,000	
2015	$ 355,700,000	$ 359,500,000	$ 143,000,000	$ 173,500,000
2016	$ 274,200,000	$ 125,000,000	$ 485,000,000	

Year	Series B	Series C	Series D	Series E
2017	$ 172,400,000	$ 319,600,000	$ 150,000,000	$ 625,000,000
2018	$ 283,500,000	$ 253,000,000	$ 1,006,900,000	$ 725,000,000
2019	$ 501,500,000	$ 501,000,000	$ 398,000,000	$ 1,132,500,000
2020	$ 115,000,000	$ 355,000,000	$ 237,500,000	$ 75,000,000
2021		$ 32,000,000		
Grand Total	**$ 2,213,058,000**	**$ 2,176,600,000**	**$ 2,767,600,000**	**$ 2,792,800,000**

Year	Series F	Series G	Series H	Series I
2006	$ 5,500,000			
2013	$ 50,000,000			
2014		$71,000,000		
2015	$ 80,000,000			
2016		$ 50,000,000		
2018	$ 400,000,000		$ 75,000,000	
2019	$ 170,000,000	$ 370,000,000	$ 97,900,000	$94,900,000
2020	$ 608,800,000			
Grand Total	**$ 1,314,300,000**	**$ 491,000,000**	**$ 172,900,000**	**$ 94,900,000**

Year	Venture	Private Equity	Equity	Equity Crowdfunding
2000	$ 12,300,000			
2001	$ 10,000,000			
2003	$ 6,700,000			
2004	$ 20,000,000			
2005	$ 10,000,000			
2007	$ 13,100,000			
2008	$ 4,800,000			
2009	$ 11,500,000			
2010	$ 18,906,700			
2011	$ 6,026,200			
2012	$ 28,077,000			
2013	$ 52,650,000			
2014	$ 415,241,500	$ 8,000,000	$ 1,985,000	
2015	$ 148,671,200		$ 2,000,000	
2016	$ 159,442,000	$ 151,300,000	$ 1,000,000	
2017	$ 175,485,000		$ 14,500,000	
2018	$ 134,700,000	$ 200,000,000		
2019	$ 145,200,000			$ 1,700,000
2020	$ 230,910,000	$ 25,000,000		$ 8,100,000
2021	$ 4,600,000	$ 95,000,000		
Grand Total	**$ 1,608,309,600**	**$ 479,300,000**	**$ 19,485,000**	**$ 9,800,000**

Year	Convertible Note	Debt Financing	Funding	Corporate	Grant
2007		$ 2,000,000			
2008					$23,900,000
2009		$475,000			$1,000,000
2010		$ 5,000,000			
2011		$ 475,000			$19,200,000
2012	$ 25,000	$ 833,000			$9,050,000
2013		$ 24,142,500	$300,000		$40,000
2014	$ 300,000	$ 369,550,000	$ 200,000		$257,500
2015	$2,925,000	$ 23,436,500		$30,000,000	
2016	$ 10,045,200	$ 203,556,400	$11,500,000		$13,500
2017	$ 785,000	$12,250,300			
2018		$ 362,564,600	$15,000,000	$10,000,000	
2019	$470,000	$385,000,000		$ 8,000,000	
2020	$8,600,000				
2021		$150,000,000			
Grand Total	**$ 23,150,200**	**$ 1,539,283,300**	**$ 27,000,000**	**$ 48,000,000**	**$ 53,461,000**

Year	Initial Coin Offering	Non-Equity Assistance	Post IPO Debt	Post IPO Equity	Secondary Market
2000				$12,000,000	
2009				$50,000,000	
2010					$25,000,000
2011				$ 6,900,000	
2013			$ 222,400,000		
2014		$1,100,000			$ 6,000,000
2015				$ 22,500,000	
2016				$ 23,000,000	$30,614,700
2017	$ 15,500,000			$ 45,000,000	$100,000,000
2018				$ 4,000,000	
2020				$ 110,000,000	
Grand Total	**$ 15,500,000**	**$ 1,100,000**	**$ 222,400,000**	**$ 273,400,000**	**$ 161,614,700**

Table 5 shows the geographic distribution of the 302 firms in our sample. 112 out of the 302 are based in CA, while 70 out of 302 are based in NY. Not surprisingly, the amount of capital raised by the firms in each state is highly positively correlated with the number of firms in each state with a correlation coefficient of 96.86%.

TABLE 5
GEOGRAPHIC DISTRIBUTION OF CAPITAL IN THE PROPTECH SECTOR

State	Number of Firms	Capital Raised
AZ	2	$155,827,900
CA	112	$9,353,572,900
CO	6	$179,299,800
CT	1	$4,310,000
DC	4	$110,607,500
FL	4	$18,772,000
GA	9	$729,325,000
IA	1	$25,000
IL	8	$300,397,500
IN	1	$396,000
MA	12	$252,576,671
MD	5	$36,355,000
MN	6	$9,755,000
MO	2	$17,890,000
NC	3	$11,800,000
NE	1	$2,900,000
NH	1	$300,000
NJ	4	$25,400,000
NV	1	$4,750,000
NY	70	$3,661,243,000
OH	4	$10,145,000
OR	5	$96,615,000
PA	3	$23,108,000
SC	2	$20,200,000
TN	1	$10,700,000
TX	16	$864,499,700
UT	5	$1,591,891,500
WA	12	$712,572,000
WI	1	$112,500,000
Total	**302**	**$18,317,734,471**

Note: this table shows the geographic distribution of capital in the Proptech sector. The number of firms located in each state is also shown.

What Do These Proptech Firms Do?

Generally, we classify the real estate markets into residential real estate and commercial real estate. The products and services offered in these two main types of real estate markets can be distinctive. Thus, we are interested in what type of real estate Proptech firms primarily focus on. Also, we are interested to know what types of products or services that Proptech firms mainly invest themselves in. Table 6 shows

the distributions. In our sample, there are slightly more Proptech firms focusing on residential real estate markets compared to commercial real estate markets.

In our dataset, we categorize the firms into five categories in real estate tech: Crowdfunding (firms, such as RealtyMogul and Fundrise, that provide platforms to raise capital from a large number of people to investment in real estate properties), Data Provider (firms , such as Compstak and RadPad, that provide specialized real estate related data and information, for example, transaction data, comps, rents, construction costs, and etc.), Property Portal (firms, such as Compass and Zumper, that provide an outlet for property listings or rental listings), Service Provider (firms, such as Redfin and Homelight, that provide services and platforms for buyers and sellers in the real estate markets), and Software Provider (firms, such as Matterport and Appfolio, that provide a specialized software/interface to facilitate with information flows and communications). Service Providers and Software Providers are the top two categories that recent Proptech firms have been concentrated on.

TABLE 6
REITS MARKET TYPES AND PROPTECH FIRM SERVICES

Type of RE Market	Crowd-funding	Data Provider	Property Portal	Service Provider	Software Provider	Total
Both	4	6		4	11	25
Commercial	18	16		36	56	126
Not Applicable		4		1	4	9
Residential	4	15	13	71	39	142
Total	**26**	**41**	**13**	**112**	**110**	**302**

Note: this table shows the sample distribution of real estate market types and main categories of the product or service that a Proptech firm engages in.

Table 7 and Table 8 show where the capital have been going based on the real estate market types and product/service categories. Table 7 presents some interesting results. More than 12 billion dollars have been raised in residential real estate Proptech sector, which is overwhelmingly the number one market type for Proptech firms. Proptech firms in the commercial real estate markets only raised less than half of the amount raised by those in the residential real estate market. The dominance of residential Proptech firms exhibit itself throughout the years in our sample. It would be interesting to explore the reasons behind such disparity in the capital raising activities.

TABLE 7
ANNUAL ALLOCATION OF CAPITAL RASIED BY PROPTECT FIMRS IN EACH TYPE OF REAL ESTATE MARKET

Year	Both	Commercial	Not Applicable	Residential	Total
2000	$11,300,000	$29,500,000		$43,000,000	$83,800,000
2001	$13,400,000	$10,000,000			$23,400,000
2002		$10,000,000			$10,000,000
2003	$31,600,000	$6,700,000			$38,300,000
2004	$20,000,000	$12,200,000	$4,100,000		$36,300,000
2005	$11,400,000	$15,000,000		$53,200,000	$79,600,000

Year					Total
2006		$5,500,000		$190,500,000	$196,000,000
2007	$200,000	$1,600,000		$47,000,000	$48,800,000
2008	$18,400,000	$3,000,000	$6,500,000	$306,350,000	$334,250,000
2009	$10,500,000	$52,000,000		$23,691,700	$86,191,700
2010	$6,557,700	$6,800,000		$53,150,000	$66,507,700
2011	$16,587,000	$28,223,000		$56,876,200	$101,686,200
2012		$23,928,000	$2,125,000	$92,137,000	$118,190,000
2013	$16,150,000	$130,556,300	$84,068,000	$556,532,900	$787,307,200
2014	$70,150,000	$176,817,500	$44,000,000	$1,064,677,500	$1,355,645,000
2015	$125,467,000	$609,167,700	$154,455,000	$804,297,500	$1,693,387,200
2016	$70,125,000	$725,468,571	$1,650,000	$906,077,700	$1,703,321,271
2017	$42,300,000	$532,405,000		$1,304,128,300	$1,878,833,300
2018	$82,100,000	$1,313,316,000	$9,000,000	$2,255,418,900	$3,659,834,900
2019	$11,325,000	$924,270,000		$3,002,975,000	$3,938,570,000
2020	$7,500,000	$306,510,000		$1,482,200,000	$1,796,210,000
2021	$4,600,000			$277,000,000	$281,600,000
Total	**$569,661,700**	**$4,922,962,071**	**$305,898,000**	**$12,519,212,700**	**$18,317,734,471**

Note: this table presents the annual allocation of capital raised by Proptech firms in each type of real estate market.

Table 8 shows consistent results with Table 6. As there are more Proptech firms in Service or Software Provider categories, the amounts of capital raised by these firms are also the highest. Service providers rank at top by raising almost 8 billion dollars while software providers come in as close 2nd by raising more than 6.5 billion dollars. It is intriguing to see how such pattern or trend would continue as the Proptech sector going through consolidation period.

TABLE 8
ANNUAL ALLOCATION OF CAPITAL RAISED BY PROPTECH FIRM IN EACH PRODUCT OR SERVICE CATEGORGY

Year	Crowd funding	Data +Provider	Proptech Category Property Portal	Service Provider	Software Provider	Total
2000		$23,300,000	$43,000,000		$17,500,000	$83,800,000
2001		$13,400,000			$10,000,000	$23,400,000
2002					$10,000,000	$10,000,000
2003					$38,300,000	$38,300,000
2004					$36,300,000	$36,300,000
2005		$400,000	$7,800,000	$45,000,000	$26,400,000	$79,600,000
2006		$2,500,000	$20,000,000	$168,000,000	$5,500,000	$196,000,000
2007			$10,000,000	$32,000,000	$6,800,000	$48,800,000
2008			$15,450,000	$276,700,000	$42,100,000	$334,250,000
2009		$6,800,000	$2,198,700	$64,193,000	$13,000,000	$86,191,700
2010		$2,000,000	$800,000	$56,001,000	$7,706,700	$66,507,700

2011	$2,000,000	$9,770,000		$73,837,000	$16,079,200	$101,686,200
2012		$9,660,000	$26,550,000	$61,402,000	$20,578,000	$118,190,000
2013	$4,570,000	$40,100,000	$247,627,900	$357,688,800	$137,320,500	$787,307,200
2014	$62,785,000	$45,325,000	$53,000,000	$989,106,000	$205,429,000	$1,355,645,000
2015	$148,660,000	$82,227,000	$37,000,000	$758,632,700	$666,867,500	$1,693,387,200
2016	$121,410,000	$183,190,200	$123,535,000	$760,369,671	$514,816,400	$1,703,321,271
2017	$126,240,000	$54,500,000	$664,400,000	$428,910,900	$604,782,400	$1,878,833,300
2018	$29,700,000	$122,500,000	$510,000,000	$1,424,325,300	$1,573,309,600	$3,659,834,900
2019	$35,700,000	$290,100,000	$370,000,000	$1,573,275,000	$1,669,495,000	$3,938,570,000
2020	$8,100,000		$178,000,000	$667,210,000	$942,900,000	$1,796,210,000
2021				$245,000,000	$36,600,000	$281,600,000
Total	**$539,165,000**	**$885,772,200**	**$2,309,361,600**	**$7,981,651,371**	**$6,601,784,300**	**$18,317,734,471**

Note: this table presents the annual allocation of capital raised by Proptech firms in each main category of product/service by the Proptech sample firms.

Non-Equity Financing

Conventionally speaking, when we mention a technology firm raises capital, the most likely capital type is equity. Because our dataset has deal-level information, we are able to show that equity remains as the most likely choices for capital raising among Proptech firms. Table 9 shows that, out of 947 deals, 846 deals are financed with equity, 87 deals are financed with debt or convertible notes, and the remaining 14 deals are financed with grant. Table 10 shows the dollar distribution based on the financing capital types. We find that there is an increasing dollar volume of debt/note financing since 2013.

TABLE 9
FUNDING CAPITAL CHOICES BY PROPTECH FIRMS EACH YEAR

Year	Equity	Debt	Grant	Total
2000	6			6
2001	2			2
2002	1			1
2003	2			2
2004	3			3
2005	9			9
2006	6			6
2007	7	1		8
2008	9		1	10
2009	12	3	1	16
2010	17	1		18
2011	22	3	2	27
2012	34	3	2	39
2013	83	7	2	92
2014	128	8	4	140
2015	123	18		141

Year				
2016	106	19	2	127
2017	89	5		94
2018	75	9		84
2019	72	7		79
2020	37	2		39
2021	3	1		4
Total	**846**	**87**	**14**	**947**

Note: this table shows the funding capital choices by Proptech firms each year. Debt type includes both debt financing and convertible notes. If the deal does not include "debt," "notes" or "grant" in the information, we assume the round is equity.

TABLE 10
THE ANNUAL DOLLAR DISTRIBUTION OF CAPITAL RAISED BASED ON THE CAPITAL TYPES

Year	Equity	Debt	Grant	Total
2000	$83,800,000			$83,800,000
2001	$23,400,000			$23,400,000
2002	$10,000,000			$10,000,000
2003	$38,300,000			$38,300,000
2004	$36,300,000			$36,300,000
2005	$79,600,000			$79,600,000
2006	$196,000,000			$196,000,000
2007	$46,800,000	$2,000,000		$48,800,000
2008	$310,350,000		$23,900,000	$334,250,000
2009	$84,716,700	$475,000	$1,000,000	$86,191,700
2010	$61,507,700	$5,000,000		$66,507,700
2011	$82,011,200	$475,000	$19,200,000	$101,686,200
2012	$108,282,000	$858,000	$9,050,000	$118,190,000
2013	$500,274,700	$286,542,500	$490,000	$787,307,200
2014	$1,330,037,500	$21,850,000	$3,757,500	$1,355,645,000
2015	$1,640,250,700	$53,136,500		$1,693,387,200
2016	$1,513,610,771	$189,677,000	$33,500	$1,703,321,271
2017	$1,837,798,000	$41,035,300		$1,878,833,300
2018	$2,789,570,300	$870,264,600		$3,659,834,900
2019	$3,551,000,000	$387,570,000		$3,938,570,000
2020	$1,787,610,000	$8,600,000		$1,796,210,000
2021	$131,600,000	$150,000,000		$281,600,000
Total	**$16,242,819,571**	**$2,017,483,900**	**$57,431,000**	**$18,317,734,471**

Note: this table presents the annual dollar distribution of capital raised based on the capital types: equity, debt, or grant. Debt type includes both debt financing and convertible notes. If the deal does not include "debt," "notes" or "grant" in the information, we assume the round is equity.

Diversity Spotlight

Crunchbase has a unique variable for U.S. firms in their database: Diversity Spotlight[2]. It is an indicator to show if a firm has diversity in its leadership team. This information is self-reported by the firm itself on Crunchbase. Thus, it may provide a partial picture on the diversity profile of our sample Proptech firms. As diversity has been increasingly valued in both real estate and technology industries, we investigate the current status of diversity in Proptech sector. Table 11 presents the general profile, and Table 12 shows the dollar distribution for Proptech firms with Diversity Spotlight.

Table 11 suggests that only 64 out of 302 firms in our sample have diversity representations in their leadership teams. Self-reported racial and ethnicity data is scarce and limited in our sample. The majority of the diversity spotlight reporting concentrates on female representations. Table 12 provides a more detailed picture on how the capital has been distributed throughout the past 21 years to firms with diversity representations. Even though it is promising to see that the amount of capital raised by women-led or women-found Proptech firms has increased since 2013, the increase still lags behind the overall growth in the Proptech sector.

TABLE 11
DIVERSITY SPOTLIGHT

Diversity Spotlight	Number of Firms
Asian	1
Black/African American	3
Hispanic/Latinx/women	1
Women	59
N/A	238
Grand Total	**302**

Note: this table shows the distribution of the "Diversity Spotlight" information on Crunchbase website.

TABLE 12
DISTRIBUTION OF CAPITAL RAISED BY PROPTECHFIRMS DIVERSITY SPOTLIGHT

Year	Asian	Women	Black/African American	Hispanic/Latinx/women
2000		$54,300,000		
2001		$13,400,000		
2002				
2003				
2004				
2005		$7,800,000		
2006		$8,000,000		
2007		$22,000,000		
2008		$21,500,000		
2009		$12,950,000		
2010		$8,500,000		
2011		$23,950,000		
2012		$27,800,000	$8,000,000	
2013		$408,821,300		

2014		$218,110,000	$40,000,000	
2015		$289,933,700	$25,000,000	$1,300,000
2016		$211,330,500	$77,000,000	$1,100,000
2017	$1,000,000	$246,450,000	$600,000,000	$1,000,000
2018		$148,620,000	$431,000,000	
2019		$824,225,000	$485,000,000	
2020		$264,110,000		
2021		$186,600,000		
Grand Total	**$1,000,000**	**$2,998,400,500**	**$1,666,000,000**	**$3,400,000**

Note: this table exhibits the annual dollar distribution of capital raised by Proptech firms with "Diversity Spotlight" information on Crunchbase.

The Top Proptech Firms

In venture capital markets, it seems that a handful of firms in every industry would grab the attention and resources from all the investors. Our sample seems no exception as the average amount of capital raised in our entire sample is a little over 60 million dollars with a median of 8.3 million dollars. It shows high skewness in the sample.

Hence, we examine the top Proptech firms in raising capital. Table 13 shows the list of the top 30 firms (equivalent to top 10-percentile) ranked by the amount of capital raised during our sample period. An average Proptech firm in the top-30 sub-sample have raised over 440 million dollars. The top 30 firms in our sample have raised a total of over 12.8 billion dollars which counts more than 65% of the entire 18 billion dollars raised in our whole sample. The uneven distribution is particularly interesting when we consider the overall health and growth of the Proptech sector. Moreover, such uneven distribution may have contributed to the increasing volume of mergers and acquisitions in the Proptech sector. The median age of the Proptech firms in our sample is 10 years old with only 3 firms younger than 5 years old. As 69 of our sample firms and 15 of them are either acquired or closed as of now, the state of competitiveness in the Proptech sector could be of concerns for many.

TABLE 13
CAPITAL RAISED FROM THE TOP 10% OF OUR SAMPLE FIRMS

Firm Name	Total Capital Raised
Chime	$1,542,600,000
Compass	$1,518,000,000
Opendoor	$1,480,000,000
Katerra	$1,253,200,000
Procore	$627,800,000
GreenSky	$610,000,000
HomeAway	$506,300,000
Nextdoor	$455,200,000
States Title	$379,600,000
Blend	$365,000,000
Privlo	$355,900,000
EasyKnock	$332,700,000

Redfin	$317,600,000
Trulia	$255,100,000
SMS Assist	$255,000,000
LendingHome	$240,900,000
Real Matters	$232,151,700
Accela	$215,600,000
Updater	$192,500,000
View The Space/VTS	$187,300,000
loanDepot	$182,000,000
Divvy Homes	$180,000,000
Bitfury	$170,000,000
Apto	$166,822,000
Homelight	$164,500,000
Qualia	$160,000,000
Flyhomes	$160,000,000
OfferPad	$155,000,000
Zumper	$143,100,000
Total	$12,803,873,700

Note: this table shows the top 10% of our sample firms (approximate to 30 firms) based on total capital raised during the past 21 years.

Capital Raising and Market Conditions

In this section, we explore if the capital raising activities in the Proptech sector are correlated with the capital market conditions. We use the following market indices to proxy for the capital market conditions: Case & Shiller Home Price Index[3], Commercial Property Price Index[4] by Green Street, Tech Pulse Index[5], NAHB Housing Market Index (HMI)[6], and US Stock Market Valuation Confidence Index[7]. We believe these indices can be appropriate proxies for different aspects of our capital markets, including real estate and stock markets. The Federal Reserve has discontinued the Tech Pulse index in April 2020. All indices are available on a monthly basis, and we use the simple average method to aggregate the monthly index values to an annual basis. Figures 1-5 present visual examinations of the relations between capital raised by Proptech firms and each individual market index.
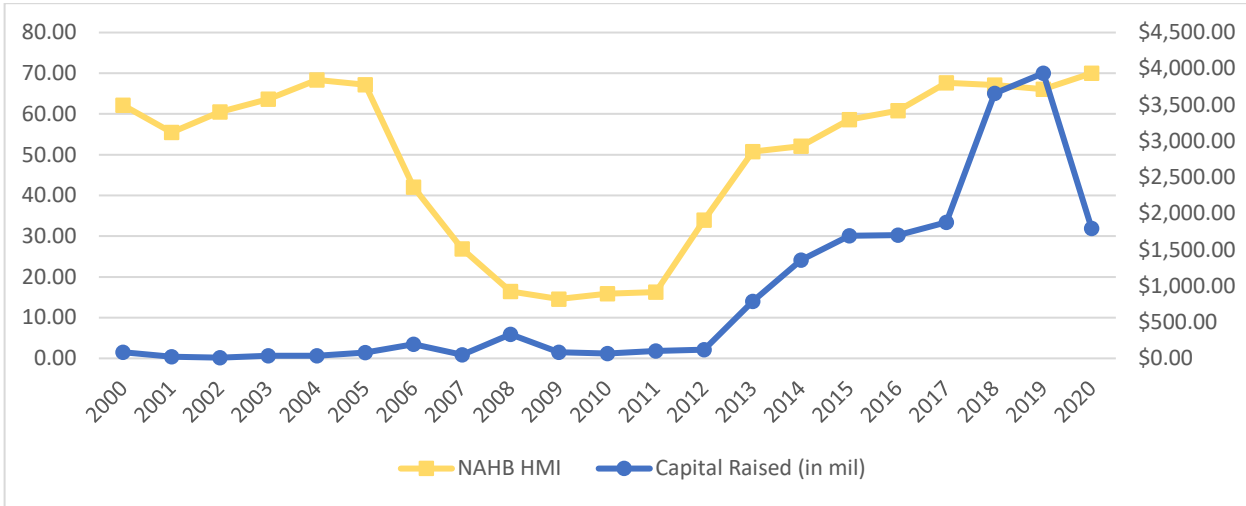
FIGURE 1
CAPITAL RAISED VS. CASE & SHILLER HOME PRICE INDEX
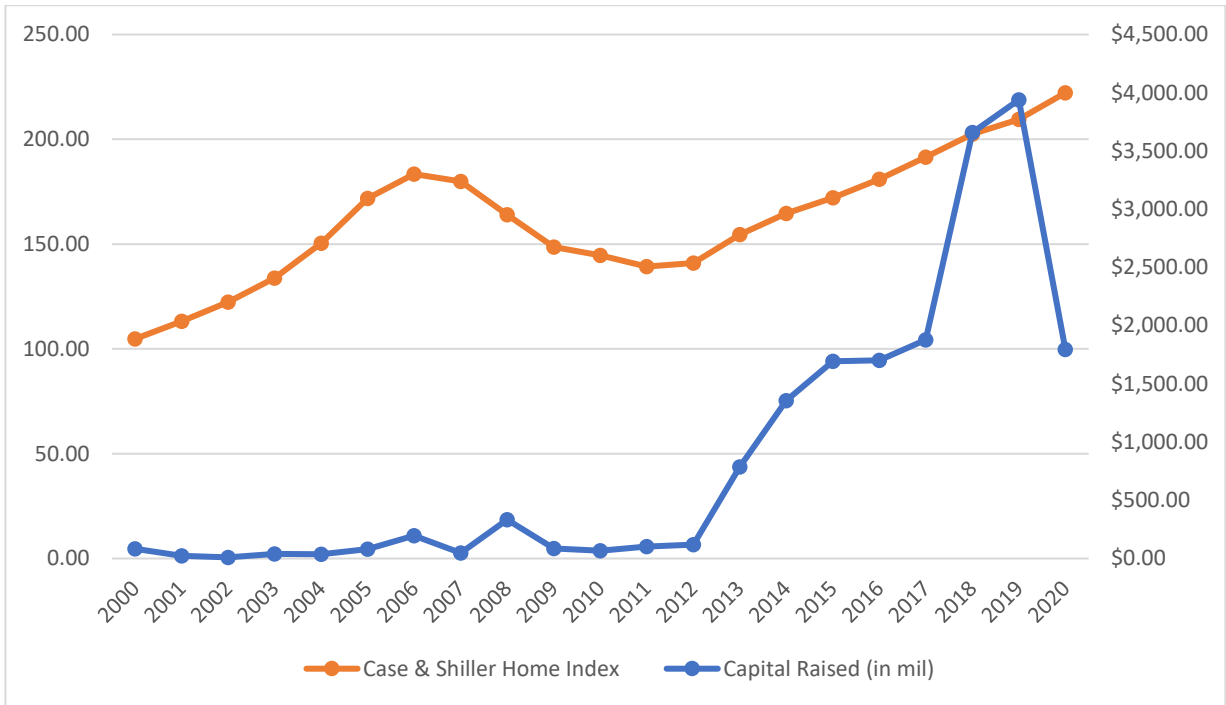
FIGURE 2
CAPITAL RAISED VS CPPI
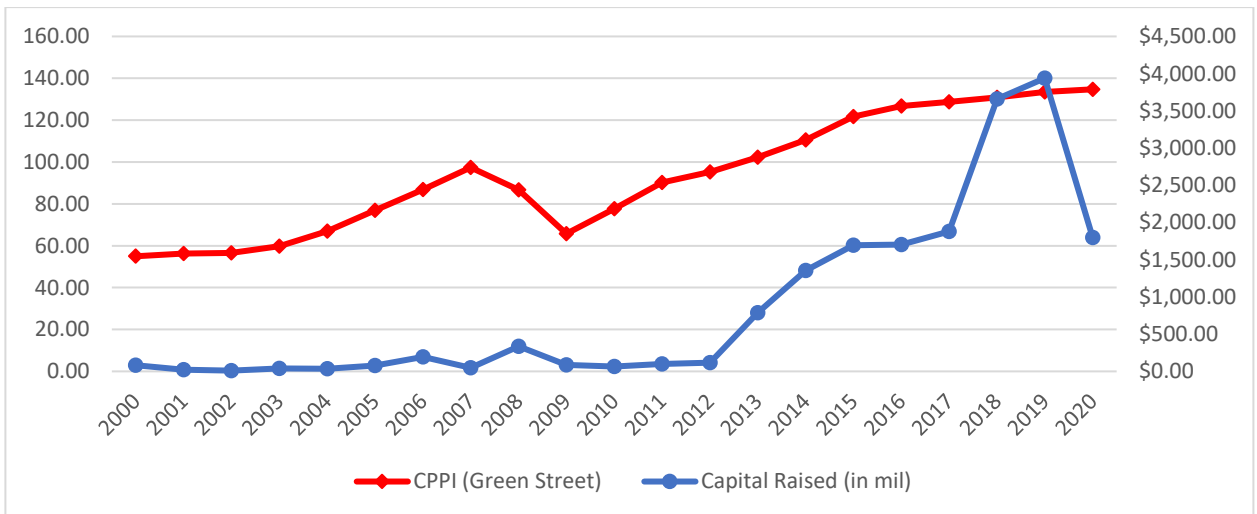
FIGURE 3
CAPITL RAISED VS NAHB HMI

FIGURE 4
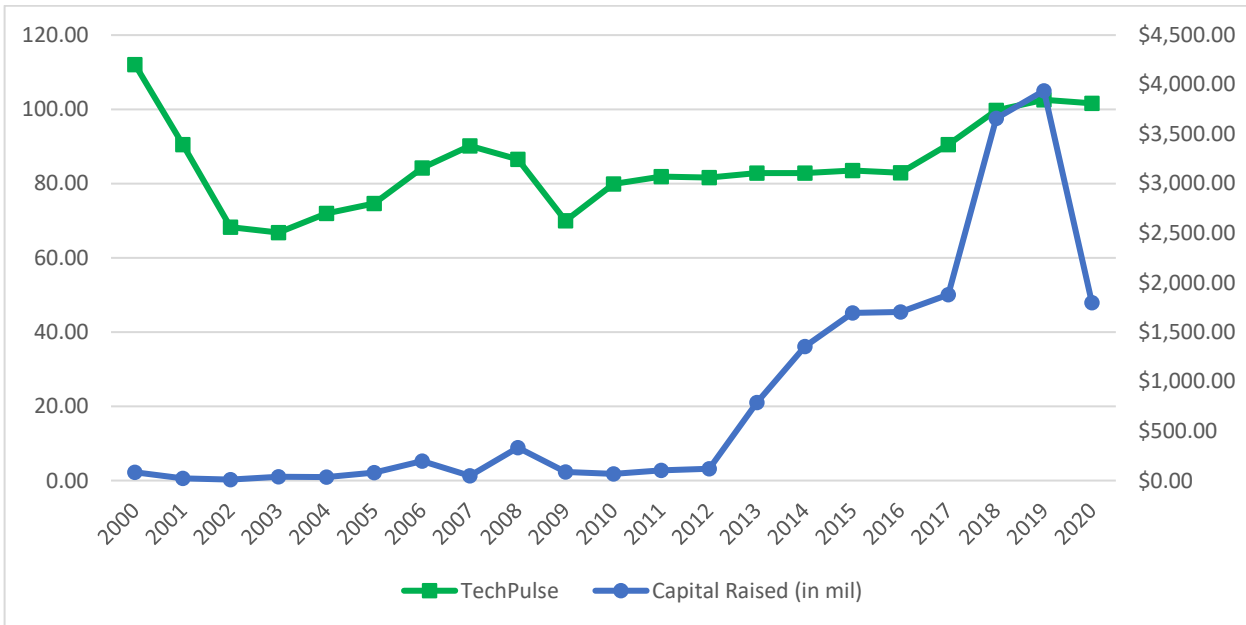**CAPITAL RAISED VS TECH PULSE INDEX**

FIGURE 5
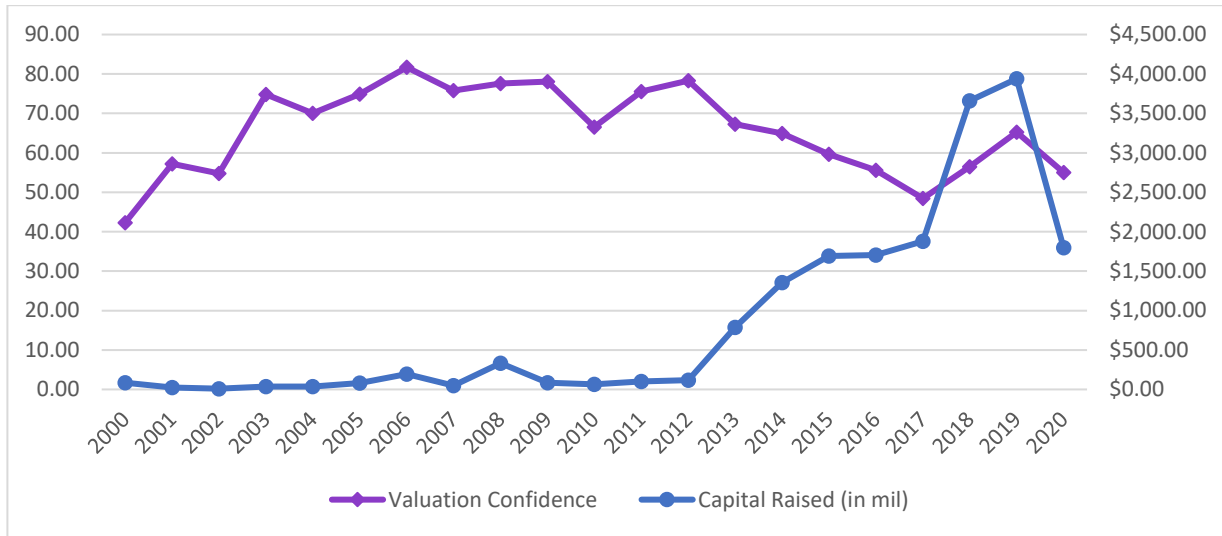**CAPITAL RAISED VS. STOCK MARKET VALUATION CONFIDENCE INDEXS**

Table 14 shows the correlation matrix. We can see that the amount of capital raised by Proptech firms is significantly positively correlated with all three market indices that capture real estate market conditions: The case & Shiller Home Index, the Commercial Property Price Index, and NAHB Housing Market Index. Capital raised by Proptech firms is also positively correlated with the Tech Pulse Index, which measures the health of the technology sector of U.S. The amount of capital raised by Proptech firms is negatively, though insignificantly, correlated with the Stock Market Valuation Confidence Index. When we examine Figure 5, it is fascinating to see in 2018 and 2019, when the Valuation Confidence Index dipped (an indicator of more investors considering the stock marketing to be overvalued), the activities in the Proptech sector skyrocketed.

TABLE 14
ANNUAL CAPITAL RAISED BH PROPTECH FIRMS AND FIVE MARKET CONDITION INDICES

	Capital Raised (in mil)	Case & Shiller Home Index	TechPulse	CPPI	NAHB HMI	Valuation Confidence
Capital Raised (in mil)	1					
Case & Shiller Home Index	0.7298***	1				
TechPulse	0.5334**	0.3352	1			
CPPI	0.8308***	0.8601***	0.4498**	1		
NAHB HMI	0.4619**	0.2535	0.2398	0.2555	1	
Valuation Confidence	-0.3933	0.0054	0.5342**	0.2228	-0.6011**	1

Note: this table presents the correlation matrix among annual capital raised by Proptech firms and five market condition indices. All market indices are aggregated to annual level. *** indicates 1%-level significance; ** indicates 5%-level; * indicates 10%-level. The definitions and descriptions of these five market indices are provided in the footnotes in the main text of the article.

CONCLUDING REMARKS

In this research, we conduct an overview f the capital raising activities among Proptech firms to shed light on a more thorough and comprehensive picture of the current stage of Proptech development. On the one hand, we find many promising results regarding the Proptech sector: an increasing amount of annual capital raised from 2008 to 2019; comparable numbers of Proptech firms in commercial real estate and residential real estate; various types of products and services provided, and engaged by Proptech firms; a positive correlation between the capital raising activities and real estate market conditions. On the other hand, we also find some concerning results regarding the future of Proptech development: cooling capital raising in 2020 despite the extraordinary performances in real estate markets; geographic concentration of Proptech firms; top 10% of the Proptech firms raised over 65% of the total capital; overwhelmingly more capital invested in residential real estate compared to commercial real estate; lack of younger firms in the sector; lack of the diverse representations in the leadership teams. We hope our review results may intrigue or encourage many more academic scholars to investigate the Proptech sector and how it impacts the real estate markets.

ENDNOTES

1. Please see the Crunchbase page here for the brief description of the funding types: https://support.crunchbase.com/hc/en-us/articles/115010458467-Glossary-of-Funding-Types
2. https://support.crunchbase.com/hc/en-us/articles/360049855154-What-is-Diversity-Spotlight-
3. https://fred.stlouisfed.org/series/CSUSHPINSA
4. https://www.greenstreet.com/insights/CPPI
5. https://www.frbsf.org/economic-research/indicators-data/tech-pulse/
6. https://www.nahb.org/news-and-economics/housing-economics/indices/housing-market-index
7. https://som.yale.edu/faculty-research-centers/centers-initiatives/international-center-for-finance/data/stock-market-confidence-indices/united-states-stock-market-confidence-indices

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