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The Impact of Funding on Market Valuation in Technology Start-Up Firms: implication for open innovation

Amril Nazir
Zayed University

Dina Tbaishat
Zayed University; University of Jordan, dina.tbaishat@zu.ac.ae

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The impact of funding on market valuation in technology start-up firms: Implication for open innovation

Amril Nazir[a,*], Dina Tbaishat[b,c]

[a] College of Technological Innovation, Zayed University, Abu Dhabi, United Arab Emirates
[b] College of Technological Innovation, Zayed University, Dubai, United Arab Emirates
[c] University of Jordan, Jordan

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ABSTRACT

Do outside funds and increased access to capital have an effect on the market valuation of technology startup firms? Should entrepreneurs prioritize outside funding to increase the values of their firms? This research seeks to answer these important questions. Given the current lack of empirical-based assessment on this topic, a causal impact analysis was conducted to draw conclusions regarding the effect of different investment types and funding amounts on market valuation. Using the Crunchbase data platform, we conducted a study of 7481 early-stage technology startups in the United Arab Emirates (UAE) from 2000 to August 2022. To ensure an accurate and reliable evaluation of the impact of funding on market valuation in technology startups, we employed the Ordinary Least Squares (OLS) and various causal inference methods such as Shapley values analysis, Average Treatment Effect (ATE), and Conditional Average Treatment Effect (CATE). The findings suggest that there is a U-shaped relationship between the amount of capital raised and post-money valuation, indicating that while capital funding has an overall positive effect on market valuation, raising too much capital has a negative impact. Furthermore, we found evidence that private equity, Series B, and Series C rounds generate significant market valuation for early-stage technology companies. These results extend the current literature by highlighting the positive impact of capital funding and financing on market valuation. Policymakers can use these empirical results to make informed decisions about promoting higher investments into early-stage technology firms through venture capital financing from both the government and private sectors.

1. Introduction

As start-up economy continues to grow globally, the need for substantial funding is necessary for its sustainability and growth. Recently, innovative financial instruments have emerged, providing attractive funding opportunities in this rapid pace of technology revolution and spread of globalization. Startup valuations are becoming an increasingly interesting topic in the field of entrepreneurial finance and the startup ecosystem. Existing studies (Dushnitsky and Lenox, 2006; Guo and Jiang, 2013; Davis, 2021; Eldridge, 2021, Kim, 2022) provide empirical literature that investigates the impact of VC and private equity on firm performance in many countries, such as the UK, Europe, and China. Several studies have shown the significant impact of the investment types on market valuation (Engel, 2002; Davila, 2003; Bertoni, 2011; Hochberg, 2016; Eldridge, 2021; Davis, 2021); However, very little research has been published on how funding can drive market valuation of startups. In specific, a major research gap analysis is found in relation to investigating determinants and factors contributing to technology startups success, in UAE in specific. Other than Abdeldayem and Aldulaimi (2021) work, no evidence to-date has been traced.

The research question is articulated based on the research gap analysis conducted during literature review: Do outside funds and increased access to capital have an effect on the market valuation of technology startup firms? Given the current lack of empirical-based assessment on this topic, it is crucial to explore the impact of external funding and capital financing for technology startups. To answer this question, the authors attempt to address the following objectives: (1) conduct a causal impact analysis comparing the market valuation of technology startups that received external funding to those that did not, and (2) analyze the collected data to draw conclusions regarding the effect of investment types and funding amounts on market valuation.

* Corresponding author.
E-mail addresses: mohd.nazir@zu.ac.ae (A. Nazir), dina.tbaishat@zu.ac.ae (D. Tbaishat).

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As for the methodology used in this paper, we examine the impact of capital funding on market valuation using funding and post-money valuation information on high-tech early-stage companies founded in the UAE from the year 2000–2022 provided on the Crunchbase platform. Crunchbase is a platform that provides information on investments and funding, mergers and acquisitions, and industry trends. There are 7481 samples of startup companies across the UAE over the period 2001–2022. The dataset includes variables on the regions, the total number of investment rounds, the investment type, and the total amount invested per round in seven regions across the UAE. The Ordinary Least Squares (OLS) method (Gujarati, 2022) was employed, along with other methods such as the Shapley value, to rank the impact of specific variables on the model output. While OLS is a reliable statistical tool for estimating the impact of each variable on the outcome, it does not account for interactions between variables. Shapley values, on the other hand, provide a more detailed understanding of how each feature contributes to the outcome, taking into account the interactions between variables. Furthermore, the Average Treatment Effect (ATE) (Imbens and Rubin, 2015) of each variable is computed to determine whether the investment type and funding amount interventions have a causally significant effect. The Conditional Average Treatment Effect (CATE) analysis (Athey and Imbens, 2017) is also conducted to gain additional insight on the optimal amount of capital needed to achieve positive market valuation.

Our findings reveal the positive effects of capital investment in early-stage high-tech companies, contributing to market valuation growth. Measuring market valuation is somewhat difficult due to the many factors that must be considered. Here, we measure market valuation in terms of post-money valuation. Post-money valuation refers to the approximate market value given to a start-up after a round of financing from investment firms, such as venture capitalists and secondary markets (Moro-Visconti, 2021). To eliminate any potential temporal bias, we will consider a company's post-money valuation only one year after funding, as it usually experiences an immediate surge after a funding round. We will also consider only the most recent post-money valuation (or the most recent post-money valuation prior to receiving another funding round) of each startup company to assess the long-term impact of capital funding accurately. This approach acknowledges that although the market valuation typically increases on the day of funding reception, it may decline over time due to poor financial performance or user growth. By doing so, we can effectively eliminate any potential public market signals bias and ensure a more accurate analysis. Moreover, since this study is restricted to early-stage technology companies, established tech companies in all sectors, such as petroleum and manufacturing, are excluded from our studies.

Recently, the middle east has witnessed acceleration in investments and fintech startups growth. According to Wamda (2022), startups in the Middle East and North Africa region saw a 260% month-on-month increase in funding. This study makes theoretical and practical contributions to existing literature. Not only does this paper contribute to the understanding of the critical role of VC funding events on firm's market valuation highlighting four main investment types, but also referring to the secondary market negative impact on the market valuation for UAE firms. Another contribution is the examination of the startup financing landscape, at different funding stages, in the context of the UAE. Very little research has been published on financing technology startups and their economic impact in the UAE in specific. The empirically based results of this study can further contribute to the policymakers' assessments and decisions in relation to promoting higher investments into early-stage high-tech firms by venture capital financing from both the government and the private investment sectors.

The rest of the paper is organized as follows, Section 2 presents a review of related work highlighting the impact of capital funding on market valuation and innovation, followed by related work in the Middle East. Section 3 provides a description of the data and variables and the analytic methods used, Section 4 illustrates the results and discussion, before conclusions are drawn in Section 5.

2. Background Literature

Start-up economy continues to grow globally. The Global Startup Ecosystem Report (Global Entrepreneurship Network, 2020) states that start-up business produced around 3 trillion USD from 2017 to the first half of 2019. Startup Blink (2022) issued the Global Startup Ecosystem Index 2022, which has been considered since 2017 a reference for policymakers in providing insights into their start-ups and a tool for founders to expose the best ecosystems. However, technology start-ups require substantial funding to kick off. They are risky in nature and therefore getting access to banking credit is difficult (Rédis, 2010). A study conducted by Lloyd-Ellis and Bernhardt (2000) revealed that start-up founders complain about lack of funds for the technical and managerial functions of their firms. However, other studies state that such financial constraints should not hinder the survival of the firm; Estrin et al. (2006) and Giraudo et al. (2019) found that technology-based start-ups needed funds the most at the scaling up stage rather than the creation stage.

With the current revolution in technology and the globalization of processes, not only did start-up activities spread geographically across the globe, but also innovative financial instruments have emerged, providing attractive funding opportunities. An interesting systematic review of 85 high-quality research articles was conducted by Klein et al. (2020) to explore the financing spectrum of start-ups in the digital age, between 1990 and 2019. The authors classified the articles into two main start-ups financing instruments: traditional (such as bootstrapping, equity from founder and closer environment, venture capital and credit financing) and novel (such as crowdfunding, governmental venture capital, and corporate venture capital). The authors noticed that the diversity of funding opportunities has increased, and new forms of venture capital have emerged. Venture capital is considered a finance solution for technology start-ups. Menon (2018) believes that venture capital industry is evolving rapidly and that traditional data sources are no longer sufficient. In France, venture capital investments reached 503 million Euros in the first half of 2009, a rise of 7% from the first half of 2008. During that period, the technology sector accounted for 44.4% of the venture capital at that time. Rowley (2020) report shows that there is substantial grow in private market investment, in which around 1.5 trillion USD was invested over the past decade in venture capital deals. Florida and Hathaway (2018) also refer to a noticeable increase in startup and venture capital activity since 2009. The availability of venture capital is an essential aspect in impacting the technology-based start-up competitiveness in the pre-growth stages (Audretsch and Lehmann, 2004).

Governments' framed policies and regulations can contribute to surging or restricting the spread of start-ups, and therefore deserve attention. Governments can take a positive front in supporting start-ups. An example is the government of India; Garg and Shivam (2017) states that Start-up India was launched to increase self-employment in India. In addition to offering various types of loans to promising start-ups, like the case of remarkable project CabMe. Government policies can affect all entrepreneurial components of the ecosystem including resource providers, entrepreneurial connectors within the ecosystem, and the entrepreneurial environment (Google, 2018).

2.1. The impact of capital funding on firm's market valuation and innovation

Startup-valuations is becoming an increasingly interesting topic in entrepreneurial-finance field and the startup-ecosystem. Several factors play a role in start-ups growth, this is not new, it was back in 1959 when the original 'theory of the growth of the firm' emerged (Penrose, 1959). Some of these factors are internal (such as capabilities, culture and strategic plans (Canals, 2000)), while others are external (such as market forces (Singh and Lumsden, 1990)). Much research has been conducted for evidence on whether corporate VC investment creates

value to investing firms or not. Many scholars proposed challenges associated. According to Davila et al. (2003), in the early stages of start-ups; VC is considered an important internal factor relevant to firm's growth. VC firms can contribute to the management of start-ups and overcome the obstacles start-ups face in terms of accessing financial sources. The authors examined the growth of 494 employees mainly Silicon Valley based startups around the time of financing, they found out that the number of employees increases in the months just before the venture capital funding round and furthermore increase during the months after the event. Dushnitsky and Lenox (2006) found that corporate VC increase value creation when pursued for strategic reasons. The author provided evidence that corporate VC investment creates greater firm value when exploited for novel technology. Colombo and Grilli (2010) examined and analyzed the joint effects of the human capital of founders and access to venture capital (VC) investments on the growth of 439 Italian new technology-based firms, as both factors are considered key drivers of firm's success.

Many other studies in the literature observed the positive relationship between VC finance and growth (Jain and Kini, 1995; Manigart and Van Hyfte, 1999; Alemany and Martì, 2005; Puri and Zarutskie, 2008). Bertoni et al. (2011) research resulted in a positive significant treatment impact of VC investments on the growth of employment and sales of new technology-based firms, over the effect attributable to selection, boosting employment growth of portfolio firms immediately after the first financing round. In studying the relationship between VC investment and the performance of entrepreneurial Firms in China, the authors found that VC-backed firms' performance is magnified after the venture capital investment is made (Guo and Jiang, 2013).

Drivers of start-ups valuation have changed as new digital financing channels emerged, and due to increased diversity in the sequence of financial milestones that ventures go through, therefore, Colombo et al. (2022) conducted a systematic literature review on entrepreneurial ventures' valuation drivers and their underlying theoretical lenses. The authors found several challenges arising from the fragmentation of the literature on entrepreneurial venture valuations, and that further improvement is needed to better understand the valuation phenomenon. Examples of research topics that need further investigation are new digital milestones, boundary conditions of the drivers' effects, and the path-dependency nature of venture valuations and their implications.

Similarly, Berre and Le Pendeven (2022) state that research on start-up valuation is fragmented, not thorough enough and less consistent. The authors conducted a systematic literature review analyzing 87 studies published between 1985 until 2020. 36 startup-valuation drivers were identified and grouped into five macro-themes: Entrepreneur Characteristics; Firm Characteristics; Investor Characteristics; Market Conditions; and Deal Conditions, and their valuation-impact on start-ups was described. In another study focusing on the technological factors, Hidayat et al. (2022) found that "financial information (revenues) and nonfinancial information (social media) as well as sectoral and technological differences influence startup equity valuation".

The region is recognized to be an influential factor on the success of startup companies due to the advantages of taxes, density of universities, research centers and incubators, and regional income level. Therefore, it is included as an independent variable because such factors may affect the growth of start-ups. Several studies have shown the significant impact of the investment types on market valuation. For example, (Hochberg, 2016) shows that the pre-seed funding can have a direct impact on startup growth, and subsequently leads to economic growth. (Eldridge, 2021) examines the impact of equity crowdfunding on innovation and growth opportunity within small- and medium-sized enterprises and discovered that crowdfunding funds have an impact on the growth opportunity of small firms, with a strong positive correlation. (Davis, 2021) provides scientific evidence that shows private equity and buyouts bring particularly important economic and social benefits. (Engel, 2002) analyzes the impact of venture capital finance on growth and innovation activities on early-stage German startup firms. They discovered that the venture funded firms generated significantly larger growth rates. (Davila, 2003) observes that startups increase their growth pace when they receive new funds. They also found a relationship between headcount growth and changes in the valuation of startups over successive rounds. (Bertoni, 2011) conducted empirical studies on the impact of venture capital financing on the growth of high-tech start-ups, and the empirical results strongly support the view that VC investments positively influence firm growth. Their results also show that the treatment effect of VC investments is of large economic magnitude, especially on growth of employment.

Normally, a company's revenue and profitability are positively correlated to its post-money valuation (i.e., market value). However, this rule does not necessarily apply to early-stage high-growth companies, as these firms may temporarily experience financial losses due to their significant investment in accelerating growth. For example, Uber has a market capitalization of over USD 60 billion despite reporting a net loss. However, Uber generated USD 17.45 billion in revenue in 2021, and a percentage of this revenue is channeled to the government via income tax. Therefore, the amount of taxes paid contributes positively to economic growth.

Startup companies act as a powerful engine of open innovation processes and knowledge creation (Spender et al., 2017). Through this spread of knowledge, ecosystem is promoted. Although innovation plays a crucial role in organizational growth, it is not easily accomplished. It is both complex and risky and it also requires funding (Hall, and Lerner, 2021). According to the literature, funding is considered an important driver of innovation performance (Aerts and Schmidt, 2008; Cerulli, 2010; Costa, 2021). Czarnitzki and Ebersberger (2007) and Aerts and Schmidt (2008) argue that public support funding along with the private funding will further reinforce the open innovation strategies, leading to enhanced organizational performance (Dai et al., 2020). An interesting study on coupling between financing and innovation (Wang and Schøtt, 2022) states that networking with venture capitalists encourages the risk-taking and innovative behavior of the entrepreneur, not only by the financial capital, but also through market knowledge, technical expertise and strategic advice. Brown et al. (2018) found that entrepreneurs who use equity crowdfunding are willing to innovate and combine various financial resources to overcome their internal constraints. These results are in line with (Kortum and Lerner, 2000), in which the authors believe that venture capitalists encourage innovation with financial support.

2.2. Related Work in Middle East

Despite the high engagement of the Middle East and North Africa (MENA) region countries in the digital world and social media, entrepreneurship potential and landscape are yet limited. According to Alkasmi et al. (2018), only 8% of small and medium enterprises (SMEs) have an online presence across MENA, that's ten times less than in the United States. In addition, only 1.5% of MENA's retail sales are online, that's five times less than in the United States (McKenna, 2017). The authors believe that start-ups can be unlocked as private and public investors take serious actions regarding investments, allowing networking, governance and performance management. On a similar track, a study commissioned by Google (2018) explored how policies and regulations can be improved to further support tech entrepreneurship in the UAE, in addition to five more countries under investigation; Turkey, Russian Federation, South Africa, Nigeria and the Kingdom of Saudi Arabia. Outram Cullinan & Company (OC&C) Strategy Consultants outlined the inputs necessary to promote and generate thriving tech entrepreneurship; financial capital, skilled talent, networks, culture, regulations, ICT infrastructure and market potential (Google, 2018). Alkhaaleh (2021) study also calls for investigating the opportunities and challenges by the decision makers in the Arab countries.

Limited research work exists in the literature on determinants and factors contributing to technology startups success, in UAE in specific.

Some of the work done include, Abdeldayem and Aldulaimi (2021) analysis of crowdfunding (CF) as new entrepreneurial finance. The study was conducted in seven Middle Eastern countries including UAE. The results revealed that CF's presence positively impacts fundraising success and considered an effective FinTech tool for financing entrepreneurs in the Middle East. In another work as explained in Section 2.2, Zarrouk et al. (2021) examined the factors influencing the success of UAE-based FinTech ventures.

Recently, the middle east has witnessed acceleration in investments and fintech startups growth. UAE government has been committed to support startups and entrepreneurs; "Digital Dubai and our partners in the UAE government are committed to transforming the UAE into the new testbed for startups and entrepreneurs to innovate and scale emerging technologies" (Digital Dubai, 2022). According to Wamda (2022), startups in the Middle East and North Africa region saw a 260% month-on-month increase in funding.

This study makes theoretical and practical contributions to existing literature. Very little research has been published on financing technology startups and their economic impact in the UAE in specific. The empirically based results of this study can further contribute to the policymakers' assessments and decisions in relation to promoting higher investments into early-stage high-tech firms by venture capital financing from both the government and the private investment sectors.

3. Materials and methods

3.1. Data and variables

The Crunchbase data platform was used to extract funding and post-money valuation information on high-tech early-stage companies founded in the UAE from the year 2000–2022. There are 7481 samples of startup companies across the UAE over the period 2001–2022. The data is incomplete for the year 2022, as only data up to August 2022 was extracted. The dataset includes variables on the regions, the total number of investment rounds, the investment type, and the total amount invested per round. The seven regions across the UAE are Abu Dhabi, Ajman, Dubai, Fujairah, Ras Al Khaimah, Sharjah, and Umm Al Quwain. The investment type variable is the type of investment in startup companies: convertible note, debt financing, crowdfunding, pre-seed, seed, angel, private equity, secondary market, and series A to C. The raised amount is the amount of investment (in US dollars) raised during each fundraising round. The total number of investments represents the number of times a company receives an investment. This is important because not every company passes the traditional investment round from pre-seed, seed, and so forth. We find several instances where a firm skipped the seed funding round before receiving funds at Series B and Series C rounds. This is due to the fact that firms that are registered at Series B and C funds were already very successful in terms of revenue and/or user growth. Based on the Crunchbase data, it is observed that the investment type is largely determined by the amount of capital raised.

3.2. Analytic method

In our initial analysis, the following Ordinary Least Squares (OLS) model was formulated, in which the model minimizes the residual sum of squares between the observed targets in the dataset, and the targets predicted by the linear approximation:

$$MV_i = \beta_0 + \beta_1 RA + \beta_2 FR + \beta_3 NT + \xi_i \quad (1)$$

where i = 1,2,…,n, β0 is the intercept term, β1 to β1 are the coefficients, and $\xi_i$is the random error, and the variables are MV which refers to the post-valuation-money variable, RA refers to the raised amount, FR refers to the number of funding rounds, and NT refers to the investment type.

While coefficients are useful to examine what will happen when we change the value of an input variable, it is not sufficient to measure the overall importance of a variable. This is because the value of each coefficient depends on the scale of the input variables, which indicates that the magnitude of a coefficient is not necessarily a good measure of a variable's importance in a linear model. To overcome this limitation, we use the Shapley value (Lundberg, S. M., and Lee, S. I, 2017) to rank the impact of specific variable on the model output (i.e., variable importance). The main idea behind Shapley value is to use fair allocation results from cooperative game theory to allocate credit for a model's MV_i output among its input variables. Given a set of variables S, we first compute the conditional expected value:

$$E\left[MV_i |\ set\left(I_S = i_S\right)\right] \quad (2)$$

where variable i is the investment type. Next, a linear model is used to extract the values right off a partial dependence plot:

$$PDP_i = E\left[MV_i |\ set\left(I_S = i_S\right)\right] - E\left[MV_i\right] \quad (3)$$

The Shapley value SPV for variable i is then computed additively:

$$SPV\left(i\right) = \sum_{i \in S} PDP_i \quad (4)$$

Shapley values are useful to measure the importance of variables relative to other input variables. However, the values cannot explain whether manipulating the investment types and the capital amount raised would cause a change to the firm's market valuation. Therefore, there is a need to compute the Average Treatment Effect (ATE) of each variable to determine whether the variables are also causally significant. The region and the number of funding are used as independent variables, the investment type is used as the treatment variable, the amount raised (in usd) is used as the heterogeneity variable, and the post money valuation is the outcome of interest. The heterogenous treatment effects of investment type t_0 to t_1 (e.g., pre-seed, secondary market, private equity, Series A, Series B etc.) is quantified as follows:

$$T\left(t_0, t_1, x\right) = \mathrm{E}[MV\left(t_1\right) - MV\left(t_0\right) | I = i] \quad (5)$$

where t ∈ T, x is the capital raised amount, and MV(t) is a random vector of potential post money valuation outcomes. The Average Treatment Effect (ATE) is then computed as follows:

$$\partial T\left(t, x\right) = E\left[\nabla_t MV\left(t\right) | I = i\right] \quad (6)$$

where the gradient ∇_t is computed on a treatment vector of post money valuation.

The ATE analysis is useful to learn the direct treatment of each variable from a global average level. However, we are also interested to analyze the impact of certain range of investment amount on post money valuation. We will therefore conduct the Conditional Average Treatment Effect (CATE) analysis to gain additional insight on the optimal amount of capital needed to achieve positive market valuation. The Conditional Average Treatment Effect (CATE) is computed as follows:

$$T\left(t_0, t_1, x\right) = \mathrm{E}[g\left(t_1, I, \xi\right) - g\left(t_0, I, \xi\right) | I = i] \quad (7)$$

where MV(t) = $g\left(t, I, \xi\right)$, and ξ is drawn from the i.i.d samples $\{MV_i, T_i, I_i\}$.

4. Results and discussion

4.1. Descriptive statistics and exploratory analysis

Table 1 presents descriptive statistics and correlations among the variables in our model for the multicollinearity check. We conducted a variance inflation factor (VIF) test for all variables, and we present coefficients and robust standard errors. We can see that the average value of VIF is 1.030825, and the highest value is 1.0468. If the VIF value is lower than 10.0, we can conclude that there is no multicollinearity issue in the results. Therefore, this sample is appropriate for analysis (Chatterjee et al., 2000; Neter et al., 1996).

Table 1
Descriptive statistics and correlations.

	VIF	mean	s.d	1	2	3	4	5
Post money		25289286	529092391	1				
Region	1.0309	2.877888	0.8059322	0.0253	1	-0.034		
Investment type	1.0468	12.83993	5.405457	0.0865	-0.167	1	-0.028	
Raised amount (usd)	1.0184	11710223	64997003	0.2643	0.049	-0.067	1	-0.041
Number of funding rounds	1.0272	1.731023	1.02462	0.0058	0.066	0.000	0.024	1

Regional entrepreneurship activity is measured by new firm establishment and the investment made in each region. However, not all startup firms are successful after establishment. Hence, the amount money raised by these startups as well as their market worth would give a better indicator of their success in the regions. There are 7 regions in the UAE, but Abu Dhabi and Dubai are the predominant regions of high investment landscape (Fig. 1). In fact, Abu Dhabi and Dubai constitute 98% of the total investment in the UAE, with the remaining 2% followed by Sharjah and Ajman. Dubai has a consistent track record of tech startup investments across 2010–2018. Since 2019, the Abu Dhabi region has overtaken Dubai in terms of investment due to its aggressive move in tech startup investments.

From Fig. 2, the secondary market is clearly seen as the main source of financing channel where startup companies obtain their fundings, followed by debt financing. The secondary market in the UAE features active participation from government sovereign funds, such as Abu Dhabi Developmental Holding Company (ADQ), Abu Dhabi Investment Authority (ADIA), Abu Dhabi Investment Council (ADIC), Emirates Investment Authority (EIA), Mubadala Investment Company PJSC (Mubadala), and others. This market provides startup companies with the opportunity to secure additional funding from these sovereign funds without waiting for a final exit, enabling them to focus on value creation and growth without the burden of generating short-term profits. This trend underscores the significant role played by the government in supporting the growth of early-stage startup companies in the UAE. Interestingly, debt-financing is the second top source of capital injections for technology companies, with startup companies preferring to raise additional money from bonds and loans instead of venture capital fundings. This highlights the attractiveness of the debt-financing facilities offered by UAE banks and suggests that these commercial banks are willing to accept high-risk loans and raise high-risk bonds.

4.2. Do capital funding and financing impact firms' market valuation?

Table 2 presents the results of an OLS regression where the dependent variable is the post-money valuation. There are two independent variables: the raised amount and the investment type. The investment type consists of dummy variables. For example, a convertible note is a dummy variable that equals one when the investment type is a convertible note and zero otherwise. All the investment type variables should be read in the same way. The table reports the regression coefficient estimates and their statistical significances, as well as the standard errors, the t-statistic, the p-value, and the confidence intervals for each variable.

We can see that private equity, series B, and series C investment types/rounds are significant determinants of the post-money valuation. The coefficients for series B and series C are positive, implying that an increase in the amount raised through these rounds results in higher post-money valuation, making them the most effective rounds to increase market valuation. Quite surprisingly, private equity has a negative coefficient, implying a decrease in the post-money valuation. This suggests that private equity funds, on average, exhibit poor returns from investment in the UAE. These results are not consistent with the most recent study in the USA, which demonstrates that, on average, private equity funds are able to add value by timing the markets (Jenkinson, T., Morkoetter, S., Schori, T., & Wetzer, T, 2022).

However, in the case of the UAE, our result is consistent with earlier findings that private equity firms often exhibit poor operating performance due to weak board oversight, as previously documented by RW Masulis and RS Thomas (2009). In terms of post-money valuation, we find that firms on the Series C investment round are, on average, four times higher than firms backed by Series B round. This implies that firms that have already passed Series A and Series B are more likely to gain market traction. Therefore, when they reach the Series C round, they have a higher likelihood of generating high growth and/or profitability, which in turn increases the firms' post-money valuation.

Fig. 3 shows that both series C and series B investment rounds are the top two most important predictors for the post-money valuation. It is worth noting that the ordering of these predictor variables is the same with our initial OLS analysis, but not in SHAP values. For SHAP values, the secondary market investment is considered more significant when compared to the private equity investment type. Series A investment round is not statistically significant in the OLS analysis, but it has positive SHAP value with some explanatory power. Therefore, it is worth examining the causal effect of this variable on the post-money valuation. Grant investment type is also not statistically significant in the OLS

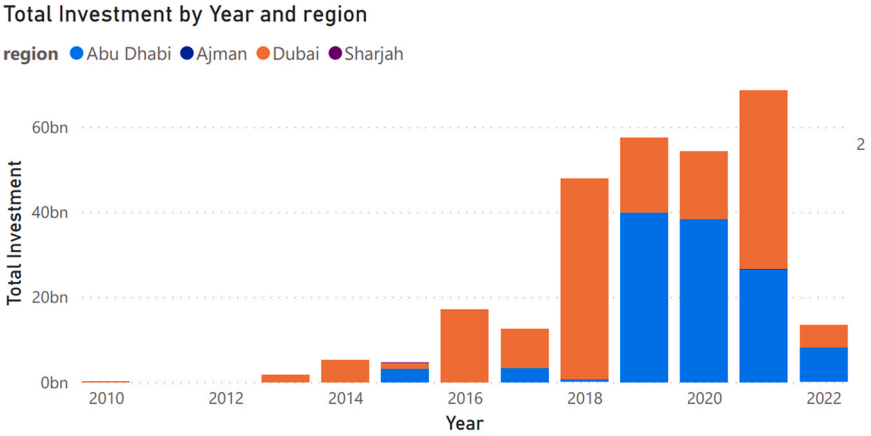


Fig. 1. Total Investment in UAE by year and region. Some regions were excluded because their total investment is insignificant.

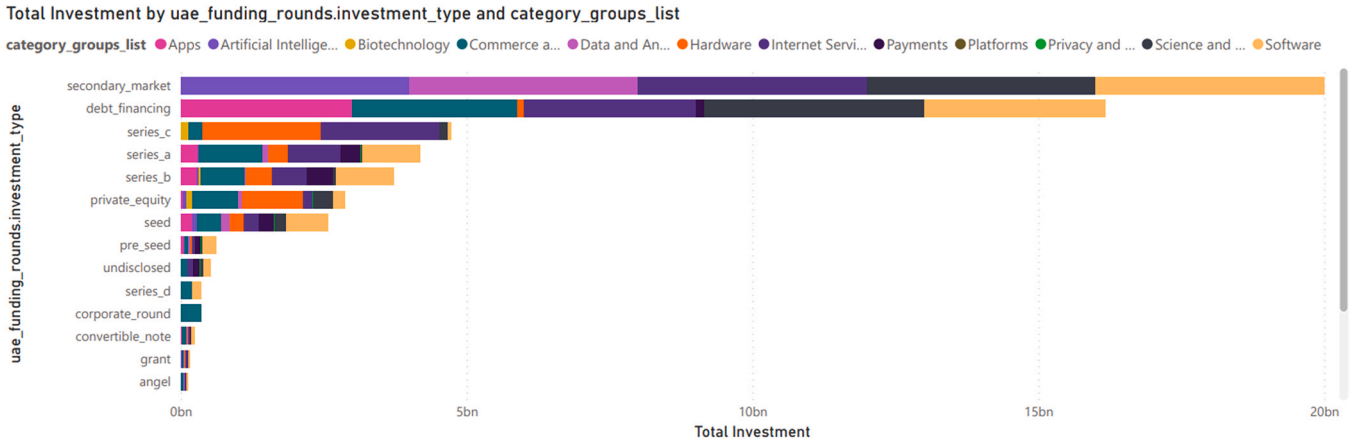


Fig. 2. Total Investment raised by different investment types.

Table 2
results for an OLS regression for the whole datasets.

	coef	std err	T	p-value	ci lower	ci upper
const	4.43E+ 06	2.05E+ 07	0.216	0.83	-3.61E+ 07	4.50E+ 07
raised_amount_usd	1.0149	0.31	3.277	0.001	0.403	1.626
convertible_note	-3.13E+ 06	4.36E+ 07	-0.072	0.943	-8.91E+ 07	8.29E+ 07
debt_financing	-1.93E+ 06	5.81E+ 07	-0.033	0.973	-1.17E+ 08	1.13E+ 08
equity_crowdfunding	9.33E+ 05	5.81E+ 07	0.016	0.987	-1.14E+ 08	1.16E+ 08
grant	8.56E+ 06	4.36E+ 07	0.196	0.845	-7.75E+ 07	9.47E+ 07
pre_seed	-8828.9358	2.15E+ 07	0	1.000	-4.24E+ 07	4.24E+ 07
private_equity	1.05E+ 08 * **	3.31E+ 07	3.155	0.002	3.91E+ 07	1.70E+ 08
secondary_market	1.84E+ 08	2.54E+ 08	0.722	0.471	-3.18E+ 08	6.86E+ 08
seed	1.98E+ 06	2.16E+ 07	0.092	0.927	-4.06E+ 07	4.46E+ 07
series_a	5.59E+ 07	2.84E+ 07	1.964	0.051	-2.89E+ 05	1.12E+ 08
series_b	2.23E+ 08 * **	3.56E+ 07	6.251	0.000	1.52E+ 08	2.93E+ 08
series_c	9.19E+ 08 * **	1.06E+ 08	8.648	0.000	7.09E+ 08	1.13E+ 09

* P < .10; * * P < .05; * ** P < .01

analysis, but the SHAP value indicates that the variable is close to being important for impacting the post-money valuation. From the OLS analysis, it is evident that the capital raised from funding has significant effect to increasing the companies' post money valuation. This implies that capital investment raised is positively correlated with the firms' market valuation.

However, does raising capital always create sustainable positive market valuation? To investigate this, we conducted panels of OLS

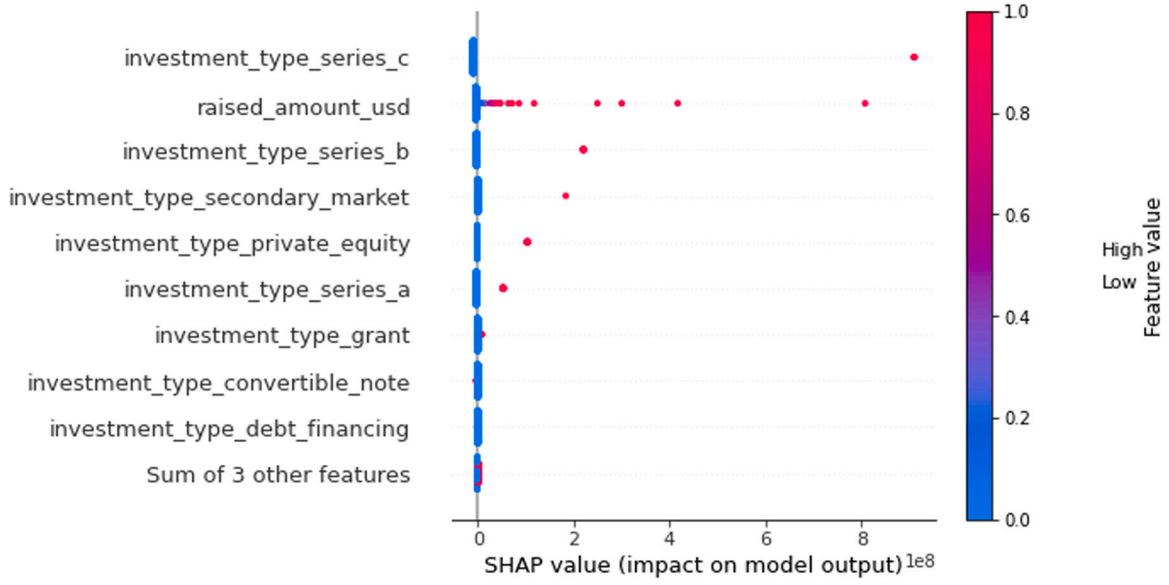


Fig. 3. The essence of the SHAP value is to measure the contributions to the outcome from each player separately among the coalition while preserving the sum of contributions being equal to the outcome. The variables are ordered by how much they influenced the model's prediction. The x-axis stands for SHAP value, and the y-axis lists all relevant variables. The red color means a higher value of a feature. Blue means the lower value of a feature. We can get a general sense of the features' directionality impact based on the distribution of the red and blue dots. Higher values (red color) indicate best predictors for post-money valuation.

Table 3
Results of the panel OLS regression models that demonstrate the U-shaped relationship.

	Model 1	Model 2
investment_type	3.102e+ 06(0.000841)* **	2.684e+ 06(0.003133)* *
raised_amount_usd	4.052e01(3.56e-10)* **	8.068e-01(< 2e-16)* **
raised_amount_usd ^2	-5.051e11(9.54e10)* **	-1.462e-09(9.20e-09)* **
R squared	0.0756	0.1203
P-value	9.54E-09	2.83E-14

* **P < .01,* *P < .05,*P < .1

Table 4
Global causal effects by causal importance (p-value).

	point	stderr	zstat	p_value	ci_lower	ci_upper
secondary_market	-1.73E+ 09	1.26E+ 07	-136.92	0.00	-1.75E+ 09	-1.70E+ 09
series_c	7.07E+ 08	2.55E+ 07	27.75	0.00	6.57E+ 08	7.57E+ 08
private_equity	4.44E+ 07	9.97E+ 06	4.45	0.00	2.48E+ 07	6.39E+ 07
series_b	1.45E+ 08	3.43E+ 07	4.23	0.00	7.80E+ 07	2.12E+ 08
seed	-7.59E+ 07	5.33E+ 07	-1.42	0.15	-1.80E+ 08	2.85E+ 07
series_a	2.68E+ 07	2.70E+ 07	0.99	0.32	-2.63E+ 07	7.98E+ 07
pre_seed	1.28E+ 07	1.98E+ 07	0.64	0.52	-2.60E+ 07	5.16E+ 07
debt_financing	4.80E+ 07	1.37E+ 08	0.35	0.72	-2.20E+ 08	3.16E+ 08
convertible_note	1.20E+ 08	3.51E+ 08	0.34	0.73	-5.69E+ 08	8.08E+ 08
equity_crowdfunding	9.61E+ 07	3.57E+ 08	0.27	0.79	-6.04E+ 08	7.96E+ 08
grant	3.29E+ 07	1.36E+ 08	0.24	0.81	-2.34E+ 08	3.00E+ 08
raised_amount_usd	-5.19E-02	1.10E+ 00	-0.05	0.96	-2.21E+ 00	2.10E+ 00

regression model that includes the raised amount as an independent variable to predict the post money valuation. Model 1 includes the raised amount as the independent variable. To consider the effects of both the raised amount and the different investment types, Model 2 includes the raised amount and the investment type as input variables.

Table 3 presents the results of the panel data regression. Interestingly, the results show that the raised amount and post money valuation have a U-shaped relationship. In model 1, the coefficient of the ratio of raised amount is statistically significant and positive ($\beta = 0.4052$, $p < .01$), and the coefficient of its squared of the raised amount is also statistically significant and negative ($\beta = -5.051e\text{-}11$, $p < .01$). In model 2, the coefficient of the ratio of raised amount is also statistically significant and positive ($\beta = 0.8068$, $p < .01$), and the coefficient of its squared of the raised amount are also statistically significant and negative ($\beta = -1.462e\text{-}09$, $p < .01$). The negative coefficient on the squared of the raised amount implies a U-shaped relationship. This result indicates that as the proportion of raised amount increases, the post money valuation increases, but after some point, further increase in capital investment leads to decline of post money valuation. The decline of post money valuation is most likely to be attributed to the trade-off between cashflow efficiency/productivity and profitability/customer growth.

Next, we are interested in further examining the association between hard capital investment and market valuation by investigating their causal effects. In our causal analysis, we shall include heterogeneity features to make the appropriate endogeneity correction for the treatment effects. These features include the industry category and the number of years the company has been operational. Without correcting the endogeneity problem, the effect on the amount of capital raised on post-money valuation will be overestimated. Table 4 shows the global causal effects by causal significance (p value) for each investment type, and Fig. 4 further graphically illustrates Average Treatment Effect that examines the direct causal effect of the variables by causal significance

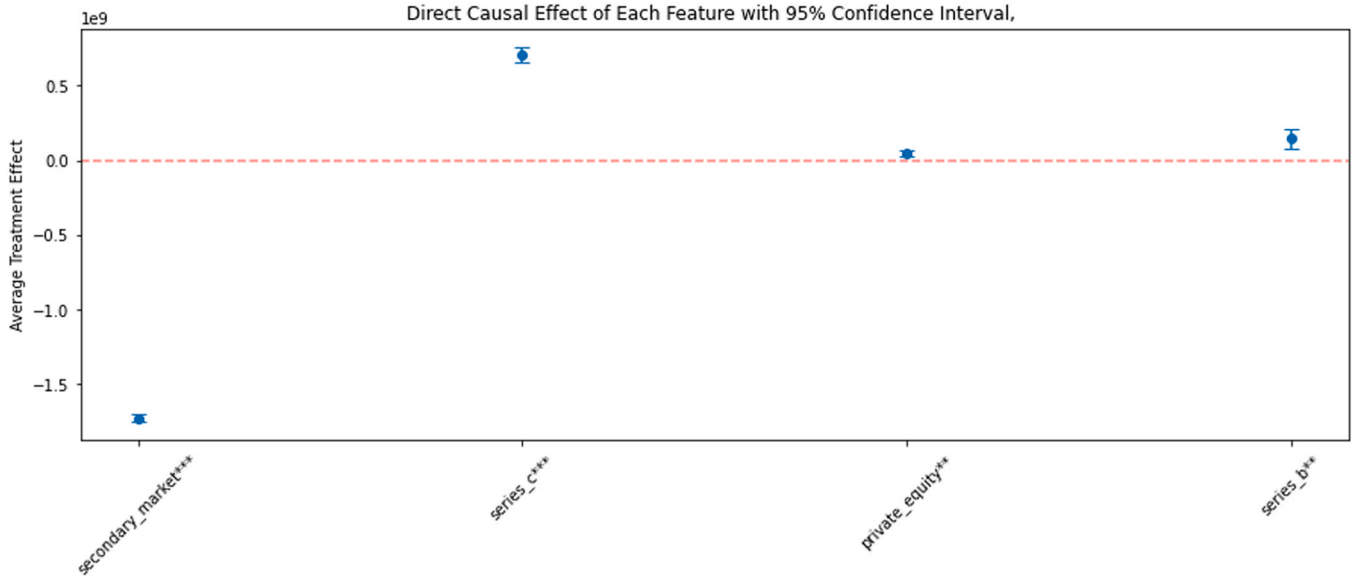
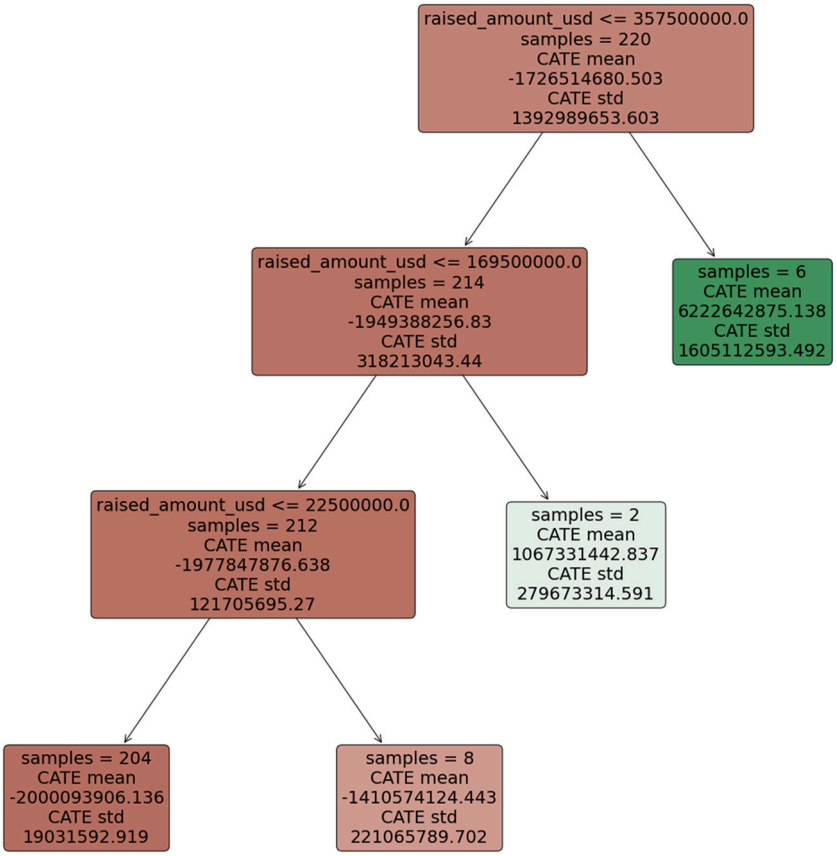
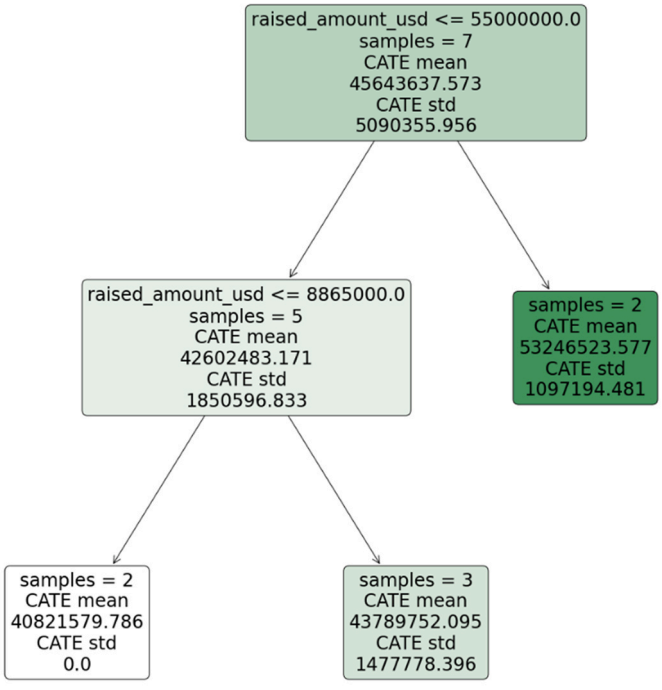


Fig. 4. Direct Causal Effect for each significant variable.



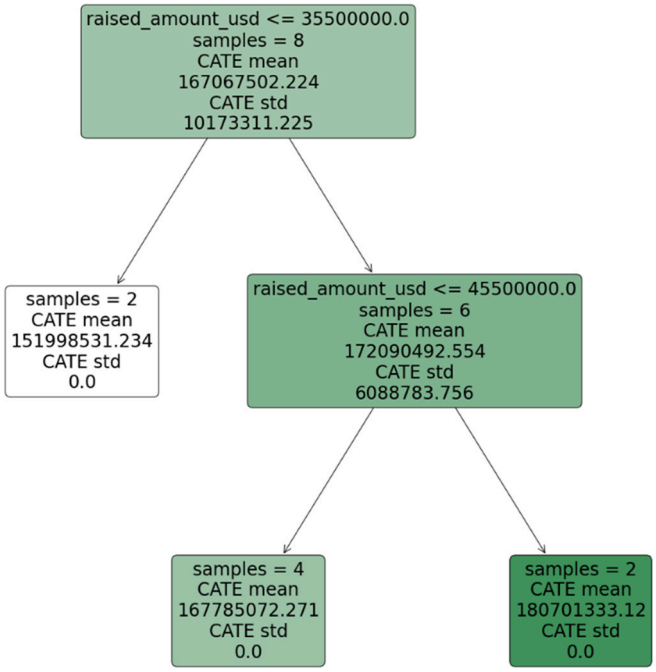
(a) Secondary Market



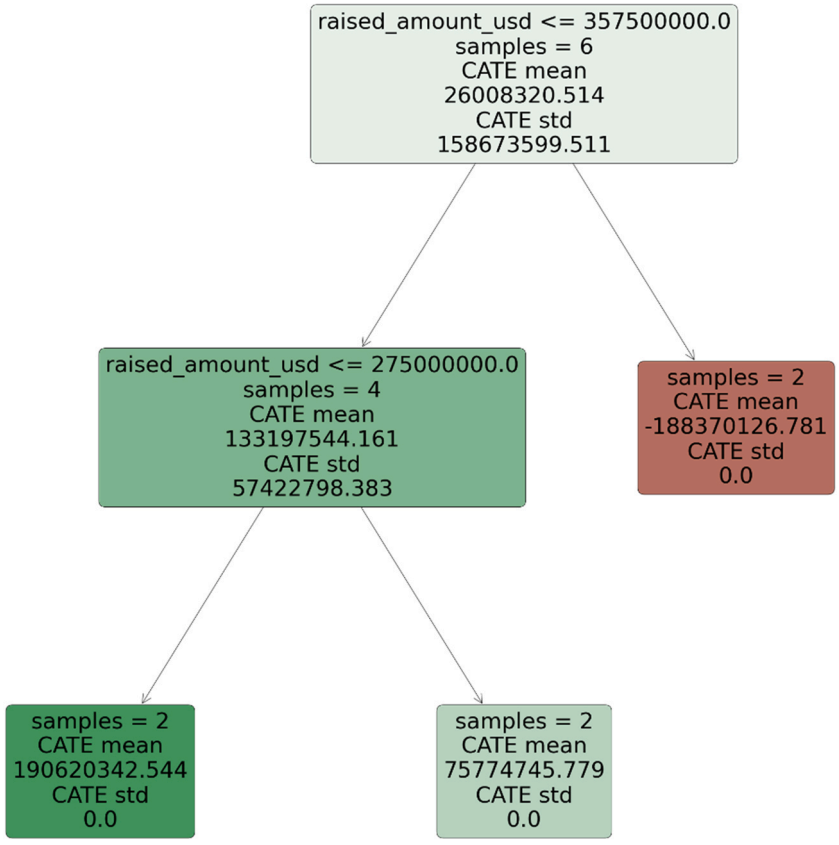
(b) Private Equity

Fig. 5. Conditional Average Treatment Effect (CATE) Segmentation Analysis.

(p-value) with 95% confidence intervals. Consistent with our previous analysis, we can see that there are only 4 significant variables namely the secondary market, series C, private equity, and series B. Interestingly, unlike our previous OLS analysis, we find evidence of a significant negative post-evaluation for the secondary market investment round. In our previous OLS analysis, the coefficient of the ratio of



(c) Series B



(d) Series C

Fig. 5. (*continued*)

the raised amount is positive and not significant. However, the Average Treatment Effect shows that there is a negative causal effect from the secondary market, which indicates that the secondary market stage round overall generates negative market value to startup companies. On the other hand, series B, series C, and private equity investment rounds have overall positive effect on the post-money valuation.

The next question that arises is: how much capital investment is necessary to generate a positive impact on the post-money valuation? To examine this question further, we conducted a segmentation analysis to explore the cutoff point of the raised amount-market valuation. Since the raised amount is a continuous variable, we conducted the Conditional Average Treatment Effects (CATE) of the raised amount and investment types on the post-money valuation. Figure 7 shows the CATE of secondary market, private equity, series B, and series C investments. For the secondary market investment type (Fig. 5a), we can see that, on average, a company receiving a secondary market investment has a negative impact on the market value, unless the raised amount is greater than USD 357.5 million. However, for an investment higher than USD 357.5 million, the CATE of secondary market investment is USD 6,222,642,875. This indicates that, on average, a secondary market investment generates an additional market value of USD 6,222,642,875, which represents an incredible 17.4x return on investment (ROI). However, note that the number of investors who have the financial capacity to invest over USD 357 million in a startup firm is relatively small.

In the UAE, these kinds of funds are generally provided by the Sovereign Wealth Fund of the Federal and/or State governments, or by one of the world's largest technology-focused investment funds, such as the Softbank Vision Fund. At the global level, the CATE of private equity investment is USD 45,643,637, indicating that on average, a private equity investment will generate an additional market value of USD 45,643,637 (Fig. 5b). Overall, we can observe that a private equity investment has a positive effect on the market value, but the effect is even more dramatic for investments of USD 55 million or more. As observed, the CATE of Series B investment is USD167,067,502, which indicates on average, a series B investment will generate an additional market value of USD167,067,502 (Fig. 5c).

We can see that the average market value increases by 3.66 times than that of Private Investment. Moreover, the market value increases by 3.77 times when the amount of investment is USD355.5 million or more. Moreover, the CATE of Series C investment is USD26,008,320, which shows that on average, a series C investment only generates additional market value of USD26,008,320 (Fig. 5d). Interestingly, the average market value is significantly lower than that of Series B by 6.42X times. This seems to be contradictory to our initial direct causal effect analysis shown in Fig. 4. However, this can be explained by the increased of CATE when the amount of investment is USD275 million or more. It can be observed that the additional market value increases up to USD190,620,342, which is 1.14 times higher than that of Series B.

This demonstrates the importance of our segmentation analysis, as the causal effect between the amount of capital raises and the market valuation is not straightforward. Interestingly, we can see that the Series C investment has negative net effect of USD188,370,126 on the market valuation when the amount of investment is USD357.5 million. This indicates that raising too much money at Series C stage can hurt the firm's market valuation. However, this effect was not observed at Series B as we did not have any historical sample of any investors that invested more than USD357 million.

5. Conclusions

Our findings are summarized as follows, the amount of capital raised, and post money valuation have a U-shaped relationship, which indicates that the capital raised overall has a positive effect on the market valuation. This result is in line with many studies in the literature that demonstrated the positive relationship between VC finance and growth (Jain and Kini, 1995; Manigart and Van Hyfte, 1999; Alemany and Martì, 2005; Puri and Zarutskie, 2008). However, raising too much capital has the opposite degradation effect to the market valuation, which is in line with the study conducted by Cumming and Dai (2011).

This paper contributes to academic understanding of the critical role of VC funding events on firm's market valuation and highlights four main investment types namely, secondary market, private equity, series b, and series C that have significant direct cause effect on the firms' market valuations. Out of all these investment rounds, the secondary market has a negative impact on the market valuation for UAE firms. An interesting finding as a lot of work has been done investigating private equity and its impact on valuation for example (Davis, 2021) but we are not aware of such secondary market negative impact in the literature. The results however show that only firms that receive investments USD357.5 million or higher generate significant positive effect to the firms' market valuation. This goes in line with a study on the size effect in the VC and private equity, in which Cumming and Dai (2011) found that large VC funds may provide larger investment and accept higher prices for start-ups.

However, investors that can afford such large investments are severely limited; only accessible from government-funded sovereign funds or from one of the world's largest technology-focused investment funds (i.e., Softbank Vision Fund). As can be seen in the literature, VCs succeeded in filling the gap in the innovation and commercialization process. However, to ensure viability, returns on investments remains a significant challenge given the risky nature of start-ups (Ang et al., 2022). Goldfarb et al. (2007) show that venture capitalists' limited ability could result in over-investments leading to undesirable return. Our study adds another contribution as it examines the startup financing landscape, at different funding stages, in the context of the UAE. Reflecting on the start-up valuation and different rounds of funding, we found significant evidence that capital injections and financing from Series B and Series C investment have overall positive impact on the market valuation of UAE firms. The probability of negative returns is relatively low at Series B and C rounds.

The practical implications of this work are of interest to the founders of start-ups and professional VC investors. VC can be an important tool in firm valuation by providing window on innovative technologies (Dushnitsky and Lenox, 2006). The empirically based results of this study can also be of interest to the policymakers' assessments and decisions in relation to promoting higher investments into early-stage high-tech firms by venture capital financing from both the government and the private investment sectors.

The present study has certain limitations that should be considered. Firstly, the study's scope is confined to the United Arab Emirates, and the sample size is restricted to 7481 companies. As such, the generalizability of the findings to other global regions may be limited. Secondly, the distribution of investment types in the sample is imbalanced, with the pre-seed and seed stages comprising the majority (84%) of investment types, while only a small proportion (7%) of investment types pertain to Series A-C. This imbalance may affect the overall generalizability of the study findings.

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