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Cross-border Venture Capital investments and syndication: a study on Brexit and Covid-19

Abstract

"How did the Brexit policy uncertainty and the Covid-19 policy uncertainty affect cross-border and syndicated Venture Capital investments in the UK?" This paper finds evidence that Economic Policy Uncertainty (EPU) surrounding the period of the Brexit referendum adversely impacted VC investment activity in the UK. This is partly explained by cross-border VCs which tend to shy away from investing in foreign ventures during policy uncertainty. Furthermore, the paper shows that syndication in VC investments can mitigate the negative impact of Brexit. Lastly, no evidence has been found of an effect of EPU surrounding the Covid-19 pandemic on VC investment activity. The paper builds forth upon the scarce literature on the relationship between EPU driving events and VC investment activity.

Keywords: Venture Capital, Corporate Venture Capital, Innovation, Entrepreneurship, Start-ups, United Kingdom, Brexit, Covid-19
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I hereby declare and confirm that this thesis is entirely the result of my own work except where otherwise indicated. I acknowledge the supervision and guidance I have received from Professor Lela Mélon. This thesis is not used as part of any other examination and has not yet been published.

Tim Wegter, 09-08-2022

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Introduction

Venture Capital (VC) investments are becoming an increasingly important avenue for start-up companies to continue growing. Support of new businesses through VC investments stimulates innovation, creates more jobs, increases competition and eventually add to the economy (Carree & Thurik, 2005). In light of this, although the UK VC industry is growing at a significant rate (BVCA, 2021), academic studies show that a country's VC investments are affected by macroeconomic indicators (Gompers & Lerner, 1999; Jeng & Wells, 2000). For instance, the literature documents adverse effects of economic policy uncertainty (EPU) on corporate investments (Bernanke, 1983; Siegel & McDonald, 1986; Julio & Yook, 2012; Gulen & Ion, 2016) and VC investments (Tian & Ye, 2017; Sitorus, 2018). However, the literature on EPU and VC activity is scarce.

Economic uncertainty rose in the UK as the country voted with a majority of 52% to leave the European Union (EU) in 2016. This has consequences for economic factors such as fundraising, M&A activity, employment, domestic interest rates, foreign exchange rates, consumer confidence, customs union and many others. Furthermore, currently the world is still coping with the economic consequences of the Covid-19 pandemic. The withdrawal from the EU by the UK and the effects of the Covid-19 pandemic are very recent and relevant and also affect the VC industry. As the UK VC industry entails a significant part of the VC activity in continental Europe (BVCA, 2021) and VC embodies a significant driver of innovation, economic growth and employment (Kortum & Lerner, 2000; Popov & Roosenboom, 2012; Mason & Harrison, 2002), it is therefore an interesting field of research. However, the impact of the economic uncertainty surrounding the Brexit referendum and Covid-19 on VC investments still remains poorly understood, in particular on cross-border and syndicated VC investments in UK start-ups. Therefore, in this paper, the following research question will be examined:

"How did the Brexit policy uncertainty and the Covid-19 policy uncertainty affect cross-border and syndicated Venture Capital investments in the UK?"

There are various reasons why this is a relevant question. First, Brexit and Covid-19 are two modern-day topics. Although the Brexit referendum vote merely acted as a formal matter, consequences stemmed from the economic policy uncertainty might already be visible for UK's economy after the referendum in 2016. The Brexit uncertainty has raised concerns for companies that need capital to continue growing, in particular start-ups that benefit from funds received from VCs who invest in them, as a capital flight from the UK to the EU has occurred and is still occurring (Böttcher & Schmithausen, 2014; Morel et al., 2016). Uncertainty can lead to VC funds postponing their fundraising and investment decisions (Julio & Yook, 2012; Jens, 2017). The same could potentially hold for the economic policy uncertainty surrounding Covid-19. Also,

since the Brexit uncertainty is only present in the UK itself, it could scare off cross-border VC funds who seek to invest in the country. Second, the UK is a highly relevant country to examine, as it is estimated that it accounts for the largest part of fundraising (± 50%), investments (± 40%) and divestments (± 40%) in continental Europe during the period of 2007 to 2021 and it therefore has the largest Private Equity (PE) market in continental Europe (Invest Europe / EDC, 2021). Furthermore, the UK's relevance in the global VC landscape is growing continuously (Sitorus, 2018). Third, VC investments are essential drivers to innovation (Kortum & Lerner, 2000; Popov & Roosenboom; 2012), employment, economic growth and new business creation (Mason & Harrison, 2002; Popov & Roosenboom, 2013). They are essential in helping companies to continue growing, especially during times of economic uncertainty, as during the Brexit for instance it can be more difficult to raise capital (Wright, 2016).

Using pooled OLS regressions with a sample of 11,548 VC investments encompassing 2,868 unique firms in the UK over the period 2011 to 2021, the paper shows evidence that EPU surrounding Brexit negatively impacted VC investment activity in the UK overall. Part of this is explained by the fact that cross-border VCs postpone and shy away from investing in uncertain periods due to their increased focus on portfolio companies and due to higher monitoring and transaction costs. Furthermore, the lower VC investment activity during Brexit is mitigated by syndication of VC investments as syndication decreases the liability of being foreign and it entails higher returns. Finally, no significant impact of EPU surrounding the Covid-19 pandemic on VC investment activity has been found.

The paper contributes to the existing literature in the sense that it sheds new light on the relationship between Brexit and Covid-19 and VC investment activity for the UK market. Also, it is the first paper that provides evidence that EPU negatively impacted VC investment activity in the UK during the Brexit period and that cross-border VCs are less robust in coping with this EPU compared to local VCs. Finally, up until now the research on the relation between EPU events and VC investment activity received limited attention and this study elaborates further on the theory of understanding macro-level events such as Brexit and Covid-19.

The paper is structured as follows. Section 2 reviews the literature on VC, VC in the UK, micro- and macro-effects on VC funding, cross-border and syndicated VC investments and Economic Policy Uncertainty (EPU) of corporate investment and VC. Section 3 describes the data and construction of the used variables. Section 4 discusses the methodological procedure and section 5 analyses the results and reviews the findings, limitations and next steps for future research. Finally, section 6 concludes.

2. Literature review

2.1 Venture capital in general

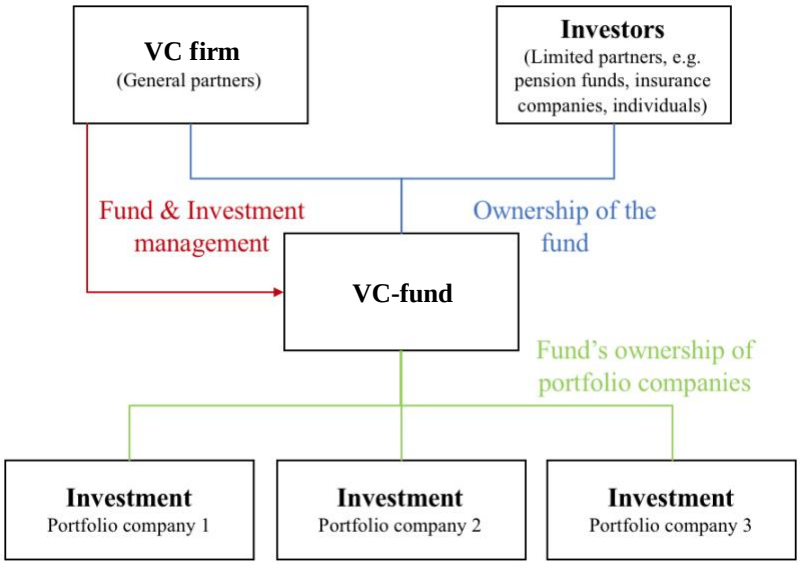
In this section all the relevant literature regarding VC investments during times of economic policy uncertainty will be discussed. Before this, it is necessary to understand the VC firm and the organizational structure of its committed fund. The VC firm itself is managed by natural persons, so called 'general partners' (GPs), and the firm receives capital from its self-created VC fund. The VC fund is a close-ended fund, meaning that it holds money provided by various (institutional) investors, such as pension funds, insurance companies, sovereign wealth funds or wealthy individuals. These investors are called 'limited partners' (LPs). The three main activities of a VC firm are raising capital from LPs; investing the capital in entrepreneurial ventures; and monitoring the start-up and giving advice on business decisions (Sahlman, 1990). In general, the GPs manage the fund and make all the decisions regarding the potential investment opportunities and therefore the LPs do not have an active role in the decision-making process of investing in start-up firms. A VC funds' lifetime typically spans from seven to ten years and after this period the capital provided to the fund by the LPs usually flows back to the LPs. This means that an exit of a VC investment within this time frame is likely. The two ways a VC firm can exit the VC investment is either by an Initial Public Offering (IPO) or through selling to another company (Gilson & Black, 1999). The trick for the GPs of the VC firm is to identify high growth ventures that have potential to become a large and financially sound company, as an exit of such a company could lead to high returns for the VC firm (Sahlman, 1990). VC firms mainly invests in start-up or early-stage companies with minority stakes, often by partnering up with other VC firms, and they are an important avenue for growth for small companies: they cannot bear the financial risk themselves since they do not have enough collateral to use to borrow money against favorable terms (Gompers & Lerner, 1999; Cumming, Fleming, & Schwienbacher, 2005). In figure 1, the typical VC fund structure is shown.

When VC firms invest, they need to focus actively on improving governance mechanisms, as there exist asymmetric information and agency problems when dealing with start-ups (Sahlman, 1990; Gompers, 1995). Therefore, the VC investment process entails a detailed screening of the start-up, with value-sensitive incentivisation of the portfolio company's management and further monitoring after the investment in the start-up has been made. Areas of interest during this process range from strategic aspects such as market size, nature of technology or product, customer adoption and industry competition, to more operational factors such as relationship with portfolio company management (Kaplan & Strömberg, 2001). Evidence shows that VC managers use 50% of their time to oversee the portfolio company, which makes room to align interests between VC managers and founders of the start-up, reducing agency costs. Also, if capital commitments are staged, VCs have the opportunity to discontinue investment if this is desired (Gompers,

1995). Moreover, VC investments are done in different stages, starting at the seed stage, followed by consecutive phases such as early stage, expansion stage or later stage phases. Investments in these stages are made when the start-up has succesfully proven its development, for instance by having a functioning prototype or specific type of technology, or by obtaining revenues and profitability (Sahlman, 1990). Subsequently, Gompers (1995) shows that these different investment phases are dependent on asset tangibility, growth potential and asset specificity.

VC activity is beneficial for portfolio companies to continue growing and also, it adds to the wider economy of a country. On the one hand, from a firm-level perspective, VCs serve as traditional investors as they help start-ups in becoming more professional leading success in the long-term and they often increase innovation-driven growth by providing business competencies and knowledge the founders of the start-up may lack (Gorman & Sahlman, 1989; Hellmann & Puri, 2002; Engel & Keilbach, 2007). Also, there is evidence that ventures that are backed by VCs outperform their peers after an IPO (Brav & Gompers, 1997). On the other hand, from a macro-economic perspective, VC is a key driver of new business creation in Europe (Popov & Roosenboom, 2013). Furthermore, other literature shows that VC spurs innovation (measured by patented inventions) both in the US and in Europe (Kortum & Lerner, 2000; Popov & Roosenboom, 2012; Faria & Barbosa, 2014).

Figure 1: VC fund structure



2.2 The UK VC market

A well-known and trusted source of data on PE firms[1] is Invest Europe / EDC, which is the world's largest association of private capital providers (Invest Europe / EDC, 2022). The association keeps track of all fundraising, investments and divestments of Buyout funds, VC funds and Infrastructure funds in Europe and the UK. To illustrate the size of the part VC fundraising plays in the UK private capital landscape, UK VC funds have raised €5.2 billion in the UK in 2021, which is approximately 15% of total private funds raised in the UK in that year (€34.8 billion). Furthermore, after the financial crisis of 2008, UK VC firms experienced a slight decline in the amount and number of funds raised, while during the Brexit referendum (2016 Q2) and the Covid-19 crisis (2019 Q4), they experienced a significant increase (figure B.1 of the appendix). As can be seen in figure B.2 of the appendix, this can be partly explained by an increase in domestic UK funds and funds outside Europe and it could indicate that investors tend to trust VC firms with their money in times of economic uncertainty. With regards to VC investments, VC firms have invested €4.4 billion in UK ventures in 2021, which acount for 12% of total PE investments in UK companies in 2021 (€37.6 billion). In figure B.3, it can be seen that from 2016 and onwards, the total value and number of VC investments made in UK companies significantly increased, which could be a consequence of the amount of funds that was raised and was ready to be invested ('dry powder'). The total value and number of VC divestments of UK ventures stayed relatively constant during the same period, suggesting longer holding periods of UK ventures by VC firms during Brexit and Covid-19. Another explanation could be that venture owners are more reluctant to sell when asset prices are reduced during times of economic uncertainty (Wright et al., 2017). Lastly, although not shown in graphs, ventures active in the ICT (communications, computers and electronics), Biotech & Healthcare and Consumer Goods & Services were among the most favored industries to invest in, accounting for respectively 47%, 20% and 19%[2] of total VC investments in 2021 (Invest Europe / EDC, 2022).

2.3 Effects on Venture Capital funding

2.3.1 Micro-economic effects

There are numerous firm-level factors that affect VC funding according to previously written literature. In their study on VC investment patterns, Bertoni et al. (2015) distinguished between four types of VC investors in Europe: independent (IVC), corporate (CVC), bank-affiliated (BVC) and governmental (GVC) and they find that GVCs are the most distinct type of VC investor. Furthermore, they recently extended their study by showing IVCs focus more on internet, software and business support service venture that already

[1] 'PE firms' entails Private Equity, Venture Capital and Infrastructure investment firms.
[2] Measured in percentage of total UK venture investment amount in 2021.

have developed a proven idea, so that they invest in later stages. They do this often by syndicating their investments with other VC firms, both local and cross-border located (Bertoni et al., 2019). This is similar for CVCs and they favour to invest in more developed venture (older than five years) and they tend to diversify their portfolio across industries. In contrast, GVCs concentrate on engineering activities, R&D, biotech pharmaceutical and high-tech ventures and they invest mainly in the seed or early stage phase (less than a year existence) while showing the highest degree of single investments. Naturally, they make less cross-border investment relative to other types of VC investors. Lastly, BVCs engage in syndicated investments of venture that are more mature (older than five years) and invest mainly in finance and real estate venture that are domestically located. The most important factors that affect VC activity on a firm-level are thus industry, age, size, stage of development and localization of investee firms of VCs.

2.3.2 Macro-economic effects

The literature has shown a variety of evidence that macro-economic factors influence VC activity. Gompers & Lerner (1999) and Ning et al. (2015) document that VC activity is positively associated with a growing economy (measured by GDP growth) due to entrepreneurial opportunities under strong economic conditions. Consequently, if more new ventures are founded, this has a positive effect on the demand for VC involvement (Audretsch & Acs, 1994; Gompers & Lerner, 1999). However, this evidence is not unambiguous, as Jeng & Wells (2000) did not find a relationship between VC activity and GDP growth.

As mentioned earlier, one of the ways VC investments are exited is through an IPO, which is a prerequisite for investing in the first place. Gilson & Black (1999) report that VC activity is dependent on a countries' type of financial system and the development of its stock market. In line with this, Jeng & Wells (2000) show indeed for 21 countries that IPO activity is correlated with VC activity and that this relationship is stronger represented for later stage investments, as seed or early stage investments are independent of the IPO market. In contrast, other evidence points out that later stage investments are less sensitive to the illiquidity of a market relative to early stage investments (Schertler, 2003). However, most of the written literature agrees on the notion that VC activity is directly associated with capital markets. VCs tend to prefer to invest in early stage ventures in periods of illiquid exit markets so that they can delay time until they need to exit their investment, hoping for an improvement in IPO market circumstances. The reason for this is the sensitivity of VC activity to the illiquidity of IPO markets (Cumming et al., 2005).

Other factors that influence the demand of VC involvement are the supply of human capital and the labour market. If there are no options to hire adequate employees, the drive to begin an own company is weakened, which will have a negative effect on the amount of ventures demanding VC funding (Schertler, 2003). Also, if the labour market is tight or rigid in a country (i.e. Japan or Germany), this will negatively affect VC activity (Sahlman, 1990). This association is strengthened if the investment made is in the early

stage (Jeng & Wells, 2000). Moreover, the government can also play a role in stimulating the demand for VC funding (Jeng & Wells, 2000; Bottazzi & Da Rin, 2002). Government-backed ventures focus on R&D investment, which can have a positive effect on VC activity (Gompers & Lerner, 1999). Next to this, if a government lowers the capital gains tax rate, the demand for VC will rise (Poterba, 1989).

Short-term interest rates influence the supply of VC funding as well. If interest rates rise, this means that investing in bonds becomes more attractive, which creates more competition for capital flows to VC funds, which eventually reduces VC fund sizes (Gompers & Lerner, 1999). Regarding the sources of funds VCs receive, a large amount of capital in the UK is provided by pension funds. Therefore, regulation and the degree of presence of theses funds heavily influences supply of VC activity (Gompers & Lerner, 1999; Jeng & Wells, 2000). For example, in the US until 1978, pension funds were restricted on providing capital to VCs as it was believed this was imprudent. However, after adjustment of this "prudent man" rule, VC funding started to grow heavily in the US (Gompers & Lerner, 1999).

Next to these macro-economic effects that influence VC activity, the literature has also shown that VC activity responds to specific macro-level events. Four of these events are the burst of the dot-com bubble in 2000, the global financial crisis of 2008, the Brexit uncertainty for the UK specifically in 2016 and the Covid-19 crisis of late 2019.

Recent research conducted by Howell et al. (2020) shows that in recessions, aggregate deal volume, capital invested and deal size of early stage VC deals are significantly reduced. Explanation for this is that VC investors are reluctant to engage in new investments during crises and they rather focus on their portfolio companies. This is in line with the survey of 319 PE professionals from Bernstein et al. (2019), which showed that they became more involved with their ventures during the financial crisis (i.e. more interactions, strategic advice and monitoring) and that they were more likely to inject additional equity in these ventures to tackle financing constraints, and that they were involved in less deal-making. Furthermore, the reductions in liquidity stemmed from an economic downturn can limit the probability of successfully exiting an investment through IPOs or takeovers (Townsend, 2015; Conti et al., 2019). Also, regarding the raise of funds during crises, VC investors invest on behalf of their large LPs (pension funds etc.). These investors shift their money away from risky asset classes, showing that they are adversely affected by crises. VCs therefore experience difficulties in raising new funds (Kahle & Stulz, 2013; Hochberg et al., 2018). Block & Sandner (2009) conducted a research on the differences in the pre- and post-financial crisis VC market in the US. They document that the amount of deals and the total investment volume of these deals both dropped for later-stage VC investments. After the financial crisis, later-stage ventures received 20% less capital than in the pre-crisis period, measured as the average amount of funds raised per funding round. They explain that the reason for this is that the post-crisis IPO market conditions cause ventures to be lower

valued, and as a result later stage ventures become less attractive. Another explanation for the different effect on seed and early stage investments relative to later stage investments is that later stage ventures lack flexibility in postponing their funding and expansion goals. On the contrary, ventures who are still in the start-up phase can more easily delay funding if capital markets are tight or rough and wait for these markets to stabilize. A last explanation entails the staging itself. The uncertainty surrounding the financial crisis increased the tendency of VCs to stage their investments and this effect is stronger for later stage investments, as investment amounts of later stage ventures are higher compared to early stage investments. This research showed that it became more difficult to realize returns on investment. Comparably, Ning et al. (2015) report that VCs reduced the number of deals and the total dollar volume of their investments in the US post-crisis. They further show that the percentage of capital flowing to seed and early stage ventures significantly rises, partly explained by the simultaneous dawn of a few social media firms.

Ning et al. (2015) also researched the dot-com crash and its impact on VC activity. It appears this crisis was more harmful to VC funding in the US compared to the financial crisis. Total investment amount and the number of deals significantly decreased. Post-crisis, VCs adjusted their risk-profiles by shifting their investments away from seed and early stage ventures towards later stage ventures. This finding is exactly different of the finding after the financial crisis and the explanation lies in the nature of the two events. The financial crisis mainly impacted IPO markets, whilst the dot-com bubble bursted because of excessive risk-taking, leading to a reduction of early stage venture valuations. The first case had as a consequence that more early stage investments were made to postpone exit requirements for ventures, whilst in the latter, VC funds seeked to lessen their risk exposure by targeting further developed later stage ventures. To date, there is no literature on macro-economic events for the UK.

Although no literature on the impact of the Brexit crisis on the VC market in the UK has been conducted, there is some evidence of the effects of the Covid-19 crisis on VC markets. In April 2020, the International Monetary Fund (IMF) predicted that the Covid-19 pandemic would be the worst worldwide downturn since the Great Depression and far worse than the global financial crisis (IMF, 2020). Indeed multiple countries including the US and Germany reported historic declines in GDP (Treece, 2020; German Federal Statistical Office, 2020). Although most governments started investment and aid programs, the pandemic still led to rises in business closures, stock market volatility, unemployment, more difficult financial market conditions, shifts in consumer spending, disruptions of supply chains and more volatile commodity prices (Howell et al., 2020; Nicola et al., 2020; IMF, 2020). These effects together with increased uncertainty also influenced VC markets. Demand shifts made it more difficult for VCs to evaluate potential investment opportunities, which led to more selectiveness regarding investments (Griffith, 2020; Shah, 2020a; Lewin, 2020). Also, there was more reluctance towards closing new deals and prolonged decision processes (Griffith, 2020;

Shah, 2020a). This more cautious approach reflects less incentives to buy illiquid assets which contain long time horizons in times of high uncertainty (Bellavitis et al., 2019; Shah, 2020b). Furthermore, during the Covid-19 pandemic VC investors also experienced more liquidity constraints and troubles with raising new funds (Shah, 2020a). Lastly, in line with earlier stated research by Howell et al. (2020), using Chinese and UK data respectively, Brown & Rocha (2020) and Brown et al. (2020) find large decreases in VC activity after the outbreak of Covid-19.

2.4 Cross-border Venture Capital and syndication

2.4.1 Cross-border VC: costs and benefits

Since this paper studies the effects of cross-border and syndicated VC investments on its activity, it is necessary to discuss the according literature. VC investments are made either by local VC firms or foreign VC firms. There exist various impediments of cross-border VC investing according to the written literature. This has to do with both geographical and cultural distance of the foreign VC firm. These challenges have been categorized by Mäkelä & Maula (2006) and they found that a VC firm's commitment to its investment is highly dependent on geographical distance. Monitoring an investment will be less if the investment has been made cross-border. Sapienza (1992) documents similar evidence, stating that cross-border VC firms spend less of their time on monitoring their portfolio. In line with this, Bernstein et al. (2016) show that 71% of their respondents tend to visit their local portfolio ventures more than their foreign ventures. These studies indicate that monitoring a cross-border investment entails higher transaction costs which further increases the already existing informational disadvantage for foreign VCs, and it is an interesting consideration when sourcing for new deals (Dai et al., 2009). According to Mäkelä & Maula (2006), social embeddedness, the relationship between the entrepreneur and the investor, also plays an important role. They document that this relationship is stronger for local VC firms than for foreign VC firms since local VC firms are culturally more aligned with their ventures. Wright et al. (1999) confirm this and report significant differences in expectations between VC funds and their portfolio companies. A mismatch can weaken the commitment between the two. Similarly, Buchner et al. (2018) conducted a global comparison of domestic and cross-border VC investments and find that cross-border investments significantly underperform. It appears that returns are negatively affected by geographic distances, cultural differences and institutional differences between the home and host countries. Despite poor expected returns, VCs still make cross-border investments due to saturation of their home markets and to diversify their portfolio. Furthermore, regarding exit success of cross-border VC investments, there is evidence that institutional and cultural differences can have a negative influence on an IPO or sale of a start-up backed by a foreign VC firm (Li et al., 2014). Lastly, the size of the investment can have a moderating effect on a VC's commitment,

as larger investments will lead to stronger commitment (Mäkelä & Maula, 2006). This is particularly relevant for cross-border investments, as Devigne et al. (2013) found that on average, cross-border VC investments are larger than domestic VC investments.

As shown above, cross-border VC investing can be a barrier to optimally monitor ventures, which eventually can influence development of these ventures. There are also benefits of cross-border investments and researchers have devoted time to investigate the differences between domestic VC funds and foreign VC funds. Using survey data, Pruthi et al. (2003) compare monitoring behavior of domestic and foreign VCs active in India. They document that foreign VCs put more emphasis on strategic development of the venture (i.e. brand growth), while domestic VCs focus more on its operations. Their explanation for the latter is that domestic VCs are more involved in the day-to-day decision-making and supporting the venture's management. Also, domestic VCs understand the institutional and legal environment more, which is vital for a new venture (Devigne et al., 2013). On the contrary, it seems that foreign VCs tend to use their network more instead of their knowledge when supporting their portfolio companies. Mäkelä & Maula (2008) supported these findings who investigated cross-border venture capital syndicates in Finland and their results confirmed that domestic VCs are more focused on the operational side of a venture, while foreign VCs give more strategic advice. Furthermore, their research shows that ventures prefer to receive domestic funding when they are still in their early stage development, since local market knowledge and operational help is then of higher importance. When a venture enters a later stage, it prefers to receive funding from a foreign VC firm to increase its scale and to use the foreign market knowledge provided by the VC. An explanation for this is that foreign VC firms are more likely to invest in later stage funding rounds to overcome information costs and asymmetries (i.e. communication costs) which are more present in foreign investments (Dai et al., 2012). In short, the largest benefit of foreign VCs is that they are focused on scalability and have access to more markets, which entail better opportunities for a venture to scale their business to new countries.

2.4.2 Syndication

Often in VC financing, VC funds team up to invest in a venture together, which is called 'syndication'. Foreign VCs have been known to invest in ventures in new markets through a syndication model so that they mitigate the initial start-up risk (Wang & Wang, 2011). Syndication can either happen between local VC firms only, foreign VC firms only or local and foreign VC firms. VC funds team up to share their expertise and to overcome the barrier of being a foreign investor. Also, it helps improving the selection process of new VC opportunities.

Literature shows that syndicated investments tend to exhibit higher returns than non-syndicated investments, even if this is between local VC firms. Tian (2012) analyzed firms that are backed by a VC syndicate and found that they are more likely to experience succesful IPOs relative other firms. In line with this, Chemmanur et al. (2016) investigated the post-IPO performance of portfolio companies backed by a syndicate between both domestic and foreign VC firms relative to firms only backed by either a domestic or foreign VC fund. Their results indicate that ventures backed by a syndicate of both domestic and foreign VC funds outperform those solely backed by domestic or solely backed by foreign VC funds. This suggests that syndication can mitigate institutional and cultural risks and that it can overcome the liability of being foreign. Furthermore, Brander et al. (2002) researched the performance of investments made by Canadian VC funds and found evidence that those funds that were engaged in syndicates displayed significantly better returns than those that invested alone. They further found that syndication is mostly relevant to share knowledge and expertise, rather than that it is important for the selection process of new investments. Additionally, they conclude that syndication is a important tool for hedging risk of investment by minimizing exposure and uncertainty while at the same time VC firms keep control over the venture. Hence, syndication is still a very popular way for foreign VC funds to invest in new ventures. Lastly, Devigne et al. (2013) researched the effect of cross-border VC investment on growth of technology ventures in Europe and they found that ventures that were backed by a syndicate of domestic and foreign VC firms survived in the short term. This was attributed to the local VC firm, while the later stage scalability and internationalization was attributed to the cross-border VC investor.

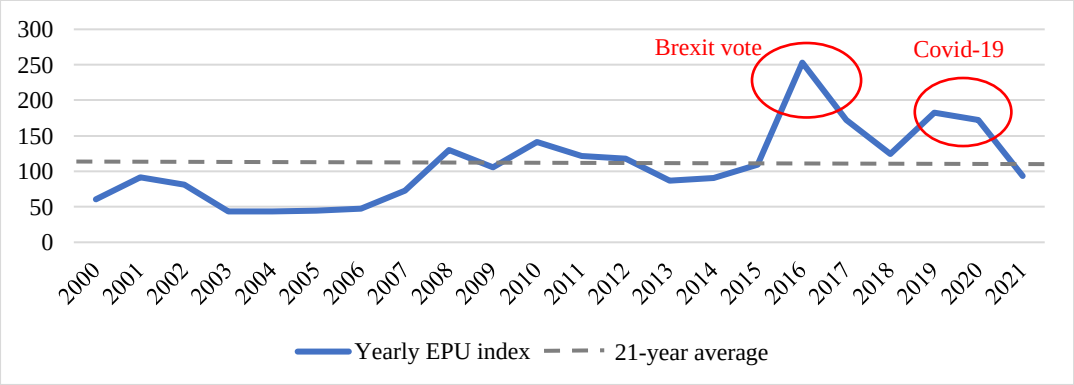
2.5 Economic Policy Uncertainty

2.5.1 Measuring Economic Policy Uncertainty

In this paper, the effects of Economic Policy Uncertainty (EPU) surrounding the Brexit referendum and the Covid-19 pandemic on VC activity in the UK are investigated. Therefore, an explanation of EPU is necessary. EPU refers to unclarity with regards to laws and government decisions on fiscal, regulatory and monetary matters, three factors which are strongly related to a country's economic wealth (Baker et al., 2016). Prior studies have measured EPU that stems from macroeconomic events by relying on stock market volatility, analysts' forecasts of profit and election outcomes (Bond & Cummins, 2004; Julio & Yook, 2012). Baker et al. (2016) recently computed a more specific, commonly recognised and well implemented method (i.e. by Bloomberg and Reuters) for measuring EPU called 'the Baker, Bloom & Davis index', or 'BBD index'. The BBD index proxies a weighted average of the amount of uncertainty surrounding specific events based on newspaper coverage on an aggregate level, by detecting the frequency of occurrence of certain word combinations that reflect EPU. They first used their method for US newspapers since 1900 and they

found particularly high levels of uncertainty during events such as presidential elections, 9/11 and the global financial crisis. They applied their index also to the UK by tracking 11 noteworthy British newspapers to look for terms relevant to EPU, such as 'policy', 'spending', 'tax', 'regulation', 'budget', 'deficit' and 'Bank of England'. Figure 2 shows the annual weighted average of EPU levels in the UK from 2000 to 2021 using the BBD index. It can be seen that particularly the period surrounding the Brexit referendum and the outbreak of the Covid-19 pandemic, EPU levels were peaking. The peak reached its highest level in 2016, the year of the Brexit referendum. After the referendum, the peak decreased, although the EPU level did not return below the 21-year average. Thus, the index displays that, unlike most regular political elections, the referendum itself is not the only source of uncertainty, but that government policy changes and implementation of Brexit remain unclear. This is the reason why EPU levels stay high even after the referendum in 2016. Furthermore, the EPU levels raised in late 2019 and 2020 due to the Covid-19 pandemic. In 2021, government policy how to cope with the pandemic was more clear and therefore the EPU level decreased under its 21-year average. Consequently, these two events provide sufficient ground to analyze their relationships with VC activity in the UK.

Figure 2: Annual weighted average of EPU level in the UK, measured by the BBD index (2000 – 2021)



Source: Baker, Bloom & Davis (2021)

2.5.2 EPU and corporate investment

Various studies have examined the relationship between policy uncertainty and corporate (firm-level) investment. It is clear that in a period of economic uncertainty, reserved investment behavior is observed. Gulen & Ion (2016) investigated the effects of policy and regulatory uncertainty by using the BBD index on firm-level investments in the US and they find a significant negative relationship. Since costs associated with uncertainty tend to rise over a year, delaying corporate investment decisions is seen as beneficial. However, at a certain point the losses incurred by delaying these investments outweigh the costs related to the uncertainty, so that investing after delaying for some time creates a positive Net Present Value (NPV) again. Also, uncertainty and irreversibility of investments tend to be positively related (Bloom et al., 2007;

Gulen & Ion, 2016). For irreversible investments a larger hurdle rate on immediate investments is demanded, even if the potential return on an investment project is subject to only a conservative amount of uncertainty (Siegel & McDonald, 1986). Bernanke (1983) shows that this leads to the existence of investment cycles and he further explains that only negative potential outcomes affect an investor's decision to postpone investments. This is confirmed by Bond & Cummins (2004) who document that impact of uncertainty on corporate investment is influenced by potential returns of investment projects. Furthermore, Julio & Yook (2012) investigated the influence of the political uncertainty surrounding national elections and investment behaviour of firms across multiple countries and find that elections are a large driver of corporate investment waves as the uncertainty significantly decreased investment expenditures prior to the elections. These findings are confirmed by Jens (2017) who finds evidence of declines in firm investment and delays in issuances of equity and debt tied to firm investment during US elections. Moreover, Górnicka (2018) who investigated the effect of political uncertainty around the Brexit referendum on business investment of UK companies. She first shows that prior to the event, business investment declined in the UK. After the referendum she finds that higher trade costs have a significant negative effect on firm investment. Smietanka et al. (2018) found that UK firms which experienced economic uncertainty during the financial crisis lowered business investment, held more cash and adjusted pay-out policies accordingly. Lastly, Melolinna et al. (2018) examined the effects of stock price volatility (as EPU measure) and cost of capital on firm-level investment during the financial crisis and found that firms react sharply to uncertainty by lowering their investments after the crisis.

2.5.3 EPU and Venture Capital

In this section the relationship between EPU and VC investment behavior will be discussed. Although the literature is scarce, the first one to examine the relationship between economic uncertainty and VC investment activity is Li (2008), who used real options theory to display that VC investments get postponed in times of uncertainty, despite a lower degree of irreversibility due to staging. Next, Geronikolaou & Papachristou (2011) analyzed the effects of various proxies for economic uncertainty for inflation, interest rates and GDP growth on VC investment activity indicators in Europe. They find that VC activity is adversely influenced by economic uncertainty regarding GDP growth and interest rates, corroborating the evidence on macro-economic effects described in section 2.3.2. Tian & Ye (2017) used the BBD index to investigate the effect of EPU on VC investment activity in the US, and their results indicate that when the EPU level increases with one standard deviation, it leads to a 8.9% lower probability that a VC fund will invest. Also, the total amount of VC funding raised and the amount invested on individual fund level are negatively influenced. The adverse impact on investment probability and investment volumes is likely

driven by a lower predictability of future returns due to the EPU (Sitorus, 2018). Sitorus (2018) reproduced his findings and the findings of Tian & Ye (2017) for non-US countries and they are robust to additional tests, such as the usage of different uncertainty measures.

To the best of my knowledge, the effects of the EPU surrounding Brexit and Covid-19 on VC activity, in particular on cross-border and syndicated investments, haven't been researched yet. In the next section, I will therefore outline the hypotheses that are being tested in this paper giving the appropriate literature.

2.6 Hypotheses

In this section the hypotheses of this paper will be discussed using the conforming literature outlined in the previous sections. First, the literature points towards adverse effects of EPU on VC investment activity (Tian & Ye, 2017; Sitorus, 2018). Also, although there is no literature regarding EPU and VC investment activity during the Brexit uncertainty, there is sufficient evidence that during recessions the total investment amount, the number of deals and the amount of VC funding can drop (Block & Sandner, 2009; Ning et al., 2015; Howell et al., 2020). Furthermore, this holds as well for the uncertainty during the Covid-19 crisis (Griffith, 2020; Shah, 2020a; Brown & Rocha, 2020; Brown et al., 2020). Therefore, the first hypotheses are as follows:

Hypothesis 1A: *"The Brexit uncertainty negatively impacted overall Venture Capital investments in the UK"*
Hypothesis 1B: *"The Covid-19 uncertainty negatively impacted overall Venture Capital investments in the UK"*

Next, cross-border VC investments can entail various disadvantages relative to domestic VC investments. Geographical distance and cultural distance can negatively affect commitment of the VC to its portfolio company due to less effective monitoring (Sapienza, 1992; Mäkelä & Maula, 2006). Also, relationships between ventures and domestic VCs tend to be stronger than those held by foreign VCs. In line with this, cross-border VC investments tend to underperform due to geographic, cultural and institutional disparities relative to domestic VC investments and those disparities can result in negative effects on eventual IPOs or sales of cross-border VC-backed ventures and on potential investment returns (Li et al., 2014; Buchner et al., 2018). Lower potential return outcomes can affect a VC investors' decision to postpone investments (Bernanke, 1983). Lastly, during economic uncertainty, it is expected that cross-border VCs would rather focus on their (domestic) portfolio companies and postpone or shy away from investing in foreign ventures due to higher monitoring and transaction costs leading to lower returns (Bernstein et al., 2016). For these

reasons, together with the fact that higher EPU levels negatively affect VC investment activity (Tian & Ye, 2017; Sitorus, 2018), I compute my second hypotheses as follows:

Hypothesis 2A: *"The Brexit uncertainty had a higher negative impact on cross-border Venture Capital investments relative to domestic Venture Capital investments in the UK"*
Hypothesis 2B: *"The Covid-19 uncertainty had a higher negative impact on cross-border Venture Capital investments relative to domestic Venture Capital investments in the UK"*

Regarding syndication of VC investments, the literature shows that syndication can mitigate cultural and institutional risks and the liability of being foreign (Chemmanur et al., 2016). Furthermore, syndication is relevant for sharing knowledge and expertise and it hedges investment risk by lowering exposure to start-up risk and uncertainty. Additionally, syndicated investments tend to exhibit better returns (Brander et al., 2002). Therefore, I expect that economic uncertainty has a less negative impact on syndicated investments relative to non-syndicated investments, and I derive the third hypotheses as follows:

Hypothesis 3A: *"The Brexit uncertainty had a lower negative impact on syndicated Venture Capital investments relative to non-syndicated Venture Capital investments in the UK"*
Hypothesis 3B: *"The Covid-19 uncertainty had a lower negative impact on syndicated Venture Capital investments relative to non-syndicated Venture Capital investments in the UK"*

Lastly, the literature on both cross-border and syndicate VC investments point towards different directions. Nevertheless, similarly to the literature outlined to compute hypotheses 2A and 2B, I expect that EPU stemmed from Brexit and Covid-19 will also have a negative influence on the amount of VC activity and funding if both the VC investments made are cross-border and syndicated. Cross-border VCs are likely to postpone and shy away from investing in foreign ventures when uncertainty levels are high (Bernanke, 1983; Bernstein et al., 2016) and I expect that this holds even when they have the opportunity to syndicate with other VCs. Therefore, the fourth hypotheses are:

Hypothesis 4A: *"The Brexit uncertainty had a higher negative impact on cross-border syndicated Venture Capital investments relative to domestic non-syndicated Venture Capital investments in the UK"*
Hypothesis 4B: *"The Covid-19 uncertainty had a higher negative impact on cross-border syndicated Venture Capital investments relative to domestic non-syndicated Venture Capital investments in the UK"*

3. Data

3.1 Sample construction

To examine the effects of EPU events such as Brexit and Covid-19 on cross-border and syndicated VC investments in the UK, VC deal data is required. The data on VC deals is retrieved from Thomson Reuters Eikon (formerly Thomson One and VentureXpert) and it is the most commonly used database on VC data (Rin, Hellmann, & Puri, 2013). Thomson Reuters Eikon reports over 30 years of daily-updated data comprising over 30,000 PE- and VC-backed companies globally (Thomson Reuters Eikon, 2022). The database contains the desired micro-variables on investor, venture and funding rounds to construct the sample with the adequate control variables. I obtain various details including investment date, venture founding date, estimated investing equity amount, total volume raised, the number of VCs investing, the VC funds' nation, type of fund, venture age, venture stage and SIC industry codes. In order to test the influence of the Brexit and Covid-19 uncertainty (the two EPU driving events) on VC investment activity in the UK, the sample period ranges from 2011 to 2021 to capture sufficient datapoints. The period comprises two major events, the Brexit referendum and the Covid-19 pandemic, that caused EPU levels to rise significantly in the UK, as measured by the BBD index (Baker et al., 2021).

The retrieved data from Thomson Reuters Eikon is gathered on an individual VC fund investment level, showing fund investments for individual funds in a certain funding round. The initial dataset contains 13,467 observations of individual VC fund investments for ventures headquartered in the UK during 2011 until 2021. First, all 897 duplicates in the dataset are removed. Observations are considered duplicates if two or more observations have the same VC fund name, company name, date of investment and estimated equity investment amount. Second, observations that lack data on VC investors' nation and observations that have negative values for estimated equity investment amount or total volume raised are omitted. As in this paper different proxies are used to measure VC investment activity, observations that lack data on either estimated equity investment amount or total volume raised are not dropped, since these observations can still have data on the number of VCs investing or vice versa. Therefore, deleting observations for such reasons would only decrease the sample size. Third, each VC investment in the dataset has been merged and supplemented with the respective monthly EPU level data provided by Baker et al. (2021), which is later used to form the Brexit and the Covid-19 dummies. The EPU levels are rebased to 100 based on the value of January 2011, transformed to average quarterly level data and linked to the according moment an investment has been made. For example, if an investment has been made on the 1st of January 2019, the investment will be linked to the average EPU level of quarter one in the UK in 2019, following the methods of Sitorus (2018) and Tian & Ye (2017). The final sample consists of 11,548 VC investments, encompassing 2,868 unique firms with a total investment amount of €54.3 billion over a 10-year period.

3.2 Variable construction

3.2.1 Dependent variables

In this paper, three proxies[3] to measure VC investment activity as the independent variables are used to research the effects of EPU regarding Brexit and Covid-19 on VC investments, following Tian & Ye (2017) and Sitorus (2018). The VC investment amount variable measures the volume invested per participating VC fund within a given venture funding round. Since the distribution of the variable is not normal, the variable is scaled by its natural logarithm to normalize the distribution. This variable gives the degree to which VCs are willing to provide capital to ventures and provides details on whether smaller or larger funding rounds are driven by individual fund commitments or by changing syndication sizes. Furthermore, the total volume raised variable measures the total amount of funding raised per funding round and indicates the total VC investment amount a venture receives in a year. Also, this variable is scaled to its natural logarithm to normalize its distribution. Lastly, a variable on the number of VCs investing in a start-up per funding round is included which displays the likelihood that VCs invest together in a start-up, and the variable is scaled to its natural logarithm to normalize its distribution.

3.2.2 Independent variables

Since this study has the intention to examine how the EPU surrounding Brexit and Covid-19 influences VC investment behavior in the UK, two independent variables of interest with respect to these events are computed as the Brexit dummy and the Covid-19 dummy. The Brexit dummy is a dummy that equals 1 for each VC investment made between Q1 2016 and Q4 2017 (which contains the build-up to the referendum and the aftermath of the referendum) where the quarterly EPU-level is higher than the EPU median of the entire sample. Similarly, the Covid-19 dummy equals 1 for each VC investment made between Q4 2019 and Q4 2020 where the quarterly EPU-level is higher than the EPU median of the entire sample. These two variables represent the two EPU events. Thus, if the Brexit dummy gets the value of 1, it refers to the period of the Brexit crisis, and if the Covid-19 dummy gets the value of 1, it refers to the Covid-19 crisis. It is expected that both the Brexit crisis and the Covid-19 crisis will have a negative effect on VC investment activity during Brexit and Covid-19, as higher uncertainty can cause VCs to postpone their investments (Li, 2008; Bernstein et al., 2016; Tian & Ye, 2017; Sitorus, 2018).

Since this study further aims to investigate the effects of cross-border and syndicated VC investments to answer hypotheses 2 - 4, additional independent variables are defined. A cross-border dummy is constructed which take the value of 1 if all VCs investing in the venture are non-UK based at

[3] In the 'robustness checks and extensions' section, another measure for VC investment activity is used.

time of investment and 0 otherwise. VCs that have partnered up with at least one local UK VC are not considered as cross-border, as they have access to the knowledge and expertise of a UK-based VC and are thus not fully seen as foreign. The expectation is that cross-border investments will have a more negative influence on VC investment activity during the Brexit and Covid-19 pandemic than domestic investments, as cross-border VCs would rather focus on their portfolio companies and postpone or shy away from investing in foreign ventures, due to higher monitoring and transaction costs in times of economic uncertainty (Li et al., 2014; Bernstein et al., 2016; Buchner et al., 2018; Tian & Ye, 2017). Furthermore, a syndication dummy is computed that takes the value of 1 if at least more than one VC firm is investing in a venture at time of investment and 0 otherwise. Presumed is that syndicated investments will have a less negative impact on VC investment behavior during Brexit and Covid-19 pandemic than non-syndicated investments, as syndication can mitigate cultural risks, institutional risks, the liability of being foreign and it is relevant for sharing knowledge and expertise. It can therefore hedge investment risk by lowering exposure to start-up risk and uncertainty (Chemmanur et al., 2016; Brander et al., 2002).

3.2.3 Control variables

To strengthen the explanatory power of the regressions performed in this study and to prevent potential omitted variable bias, various control variables are included in the models which have consistently shown to affect VC investment activity according to the previous literature.

First, a variable to reflect the age of the venture is included in the model, as Bertoni et al. (2015, 2019) document that the age of a venture is relevant for the decision of VC investment. The variable is continuous and states the age of the venture in months since the venture was founded at time of investment, and it is calculated as the investment date minus the company founded date. It is scaled to its natural logarithm to normalize its distribution. The higher the value for firm age, the older the venture is. It is expected that firm age is positively associated with the VC investment behavior dependent variables, as older and more mature ventures require larger amounts of capital to continue growth and expansion relative to younger firms (Block & Sandner, 2009). Moreover, with respect to the investing VCs, dummies on the investor type are included, each indicating their respective investment participation (at least one fund of the specified type) at each investment observation which have the value 1 or 0. As highlighted in section 2.3.1, Bertoni et al. (2015, 2019) distinguished between governmental (GVC), independent (IVC), corporate (CVC) and bank-affiliated (BVC) VC funds. The investor type is provided by Thomson Reuters Eikon and is shown in table A.3 of the appendix. Furthermore, the development stage of a entrepreneurial firm at time of investment plays an important part in VC investment decisions (Jeng & Wells, 2000; Mason & Harrison, 2002; Schertler, 2003; Bertoni et al., 2015, 2019). Therefore, dummy variables for early-stage, expansion stage and later stage investments are included in the model which represent the stage of investment of the

venture. The dummies equal 1 if the respective stage of investment is applicable. It is expected that expansion and later stage investments have a positive effect on VC investment activity relative to early-stage investments, as older more mature firms require more capital and are seen as less risky and attract therefore more capital (Sahlman, 1990). Lastly, the type of industry a venture is operating in has been identified as a factor that influences VC activity (Bertoni et al., 2015, 2019) while VCs often focus on particular sectors (Jeng & Wells, 2000; Schertler, 2003). Therefore, a technology dummy is included in the models which have the value 1 if the respective venture operates in the technology sector and 0 otherwise using the Standard Industrial Classification codes (SIC) provided by Fama & French (1997). The classification of the technology industry (SIC codes 3570 – 3695 and 7370 – 7389) is in line with the classification provided by Thomson Reuters and it includes ventures active in the computer-related, semi-conductors & other electronics, communications & media and biotechnology industries.

4. Methodology

In this paper, the methodologies of Tian & Ye (2017) and Sitorus (2018) are closely followed to establish the effects of EPU surrounding Brexit and Covid-19 on cross-border and syndicated VC investments in the UK during the period from 2011 to 2021. I adopt a set of pooled data models which are estimated using OLS regressions.

4.1 Empirical strategy

Three proxies for VC investment behavior are used as dependent variables, namely VC investment amount, total volume raised and number of VCs[4], and the Brexit dummy and Covid-19 dummy are used as core explanatory variables. Additionally, the models also include the control variables firm age (scaled to its natural logarithm to normalize its distribution), investor type, development stage and technology industry.

To test hypotheses 1A *"The Brexit uncertainty negatively impacted overall Venture Capital investments in the UK"* and 1B *"The Covid-19 uncertainty negatively impacted overall Venture Capital investments in the UK"*, the following pooled OLS regression equation is estimated:

$$\text{VC Investment activity}_{it} = \alpha_t + \beta_0 + \beta_1(Brexit_i) + \beta_2(Covid_i) + \theta X_{it} + \varepsilon_{it} \quad (1)$$

where VC Investment activity represents the three proxies VC investment amount (defined as the volume invested per participating VC fund within a given venture funding round), total volume raised (defined as the total amount of funding raised per funding round) and number of VCs (defined as the number of VCs investing in a start-up per funding round) and where *i* stands for the entrepreneurial firm and *t* for the time; α_t is a year-fixed effect; β_0 is the intercept; β_1 represents the coefficient of the Brexit dummy, which equals 1 if the VC investment in entrepreneurial firm *i* has been made between Q1 2016 and Q4 2017 where the quarterly EPU-level is higher than the EPU median of the entire sample; β_2 represents the coefficient of the Covid-19 dummy, which equals 1 if the VC investment in entrepreneurial firm *i* has been made between Q4 2019 and Q4 2020 where the quarterly EPU-level is higher than the EPU median of the entire sample; X_{it} represents a set of control variables to reduce potential omitted variable bias. Included are firm age (defined as the age of the venture in months since the venture was founded at time of investment), investor type (dummies that equal 1 to indicate the respective investment participation of the VC, consisting of governmental, independent, corporate or bank-affiliated funds), development stage (dummies that equal 1 to indicate the stage of investment of the venture, consisting of early-stage, expansion stage and later stage

[4] As explained later in this section, for hypotheses 3A, 3B, 4A and 4B the third proxy for investment activity 'number of VCs' is not used in the models due to multicollinearity.

investments) and a technology industry dummy which equals 1 if the respective venture operates in the technology sector, all for entrepreneurial firms *i* at time *t*; θ contains the estimated coefficient for each of the control variables; ε_{it} is the error term. Additionally, all models contain year fixed effects but no firm fixed effects.

For hypotheses 1A and 1B, the interest is on β_1 and β_2, which represent the VC investments that are made during the Brexit and Covid-19 crises where EPU-levels were higher than the EPU median of the sample. More specifically, hypotheses 1A and 1B are to investigate β_1 and β_2 with equation (1) as follows:

H_0: there is no significant difference in VC investment activity of VC investments made during the Brexit or Covid-19 crisis compared to VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 = 0$).
H_1: there is a significant difference in VC investment activity of VC investments made during the Brexit or Covid-19 crisis compared to VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 \neq 0$).

The decision is taken at the 1%, 5%, or 10% significance level and this is the same for each hypothesis. This means that the null hypothesis is rejected if the p-value of β_1 or β_2 is less than any of the three significance levels.

To test hypotheses 2A *"The Brexit uncertainty had a higher negative impact on cross-border Venture Capital investments relative to domestic Venture Capital investments in the UK"* and 2B *"The Covid-19 uncertainty had a higher negative impact on cross-border Venture Capital investments relative to domestic Venture Capital investments in the UK"*, the following pooled OLS regression equation will be estimated:

$$\text{VC Investment activity}_{it} = \alpha_t + \beta_0 + \beta_1(Brexit_i) + \beta_2(Covid_i) + \beta_3(Cross\text{-}Border_{it}) + \beta_4(Brexit_i \times Cross\text{-}Border_{it}) + \beta_5(Covid_i \times Cross\text{-}Border_{it}) + \theta X_{it} + \varepsilon_{it} \quad (2)$$

where β_3 represents the coefficient of the Cross-border dummy, which equals 1 if the respective VC investment in entrepreneurial firm *i* has been made only by non-UK VCs at time *t* of investment. β_4 and β_5 are interaction terms which represent all VC investments made by non-UK VCs during the Brexit uncertainty (β_4) or during the Covid-19 uncertainty (β_5). All other equation parameters are the same as under equation (1). For hypotheses 2A and 2B the interest lies on β_4 and β_5 and they are estimated with equation (2) as follows:

H_0: there is no significant difference in VC investment activity of cross-border VC investments made during the Brexit or Covid-19 crisis compared to domestic VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 = 0$).
H_1: there is a significant difference in VC investment activity of cross-border VC investments made during the Brexit or Covid-19 crisis compared to domestic VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 \neq 0$).

Next, to test hypotheses 3A *"The Brexit uncertainty had a lower negative impact on syndicated Venture Capital investments relative to non-syndicated Venture Capital investments in the UK"* and 3B *"The Covid-19 uncertainty had a lower negative impact on syndicated Venture Capital investments relative to non-syndicated Venture Capital investments in the UK"*, the following pooled OLS equation will be estimated:

$$\text{VC Investment activity}_{it} = \alpha_t + \beta_0 + \beta_1(Brexit_i) + \beta_2(Covid_i) + \beta_3(Syndicated_{it}) + \beta_4(Brexit_i \times Syndicated_{it}) + \beta_5(Covid_i \times Syndicated_{it}) + \theta X_{it} + \varepsilon_{it} \quad (3)$$

where β_3 represents the coefficient of the Syndication dummy, which equals 1 if the respective VC investment in entrepreneurial firm *i* has been made by at least two or more VCs at time *t* of investment. β_4 and β_5 are interaction terms which represent all VC investments made by at least two or more VCs during the Brexit uncertainty (β_4) or during the Covid-19 uncertainty (β_5). All other equation parameters are the same as under equation (1). However, since the syndication dummy represents the number of VCs investing and since one of the three proxies of VC investment activity entails the number of VCs as well, multicollinearity would arise in the model. Therefore, hypotheses 3A and 3B will be estimated only using the two proxies VC investment amount and total volume raised. The interest again lies on β_4 and β_5 and they are estimated with equation (3) as follows:

H_0: there is no significant difference in VC investment activity of syndicated VC investments made during the Brexit or Covid-19 crisis compared to non-syndicated VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 = 0$).
H_1: there is a significant difference in VC investment activity of syndicated VC investments made during the Brexit or Covid-19 crisis compared to non-syndicated VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 \neq 0$).

Lastly, to investigate hypotheses 4A *"The Brexit uncertainty had a higher negative impact on cross-border syndicated Venture Capital investments relative to domestic non-syndicated Venture Capital investments in*

the UK" and 4B *"The Covid-19 uncertainty had a higher negative impact on cross-border syndicated Venture Capital investments relative to domestic non-syndicated Venture Capital investments in the UK"*, the following pooled OLS regression equations will be estimated:

$$\text{VC Investment activity}_{it} = \alpha_t + \beta_0 + \beta_1(Brexit_i) + \beta_2(Cross\text{-}border_{it}) + \beta_3(Syndicated_{it}) + \beta_4(Brexit_i \times Cross\text{-}border_{it}) + \beta_5(Brexit_i \times Syndicated_{it}) + \beta_6(Brexit_i \times Cross\text{-}border_{it} \times Syndicated_{it}) + \theta X_{it} + \varepsilon_{it} \quad (4)$$

$$\text{VC Investment activity}_{it} = \alpha_t + \beta_0 + \beta_1(Covid_i) + \beta_2(Cross\text{-}border_{it}) + \beta_3(Syndicated_{it}) + \beta_4(Covid_i \times Cross\text{-}border_{it}) + \beta_5(Covid_i \times Syndicated_{it}) + \beta_6(Covid_i \times Cross\text{-}border_{it} \times Syndicated_{it}) + \theta X_{it} + \varepsilon_{it} \quad (5)$$

To examine hypotheses 4A and 4B with equations (4) and (5), β_6 is investigated as follows:

H_0: there is no significant difference in VC investment activity of cross-border syndicated VC investments made during the Brexit or Covid-19 crisis compared to domestic non-syndicated VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 = 0$).
H_1: there is a significant difference in VC investment activity of cross-border syndicated VC investments made during the Brexit or Covid-19 crisis compared to domestic non-syndicated VC investments that were not made during the Brexit or Covid-19 crisis ($\beta_1 \neq 0$).

For linear regressions, several assumptions must be fulfilled to properly interpret the models. All the variables used in the analysis are tested on normal distribution. The variables that did not had a normal distribution are scaled to its natural logarithm. Next, the independent variables are checked and they have a linear relationship with the dependent variables. Furthermore, potential heteroskedasticity is solved using robust standard errors and clustering them at firm-level, as the dataset contains multiple companies that invest the same amount on the same date and this otherwise could bias the results (Petersen, 2005). Also, if variables are too highly correlated with each other, the results can be biased as variables are not independent from each other, also called 'multicollinearity'. To test if multicollinearity exists, a correlation matrix of the key variables used in the models is shown in table A.1 of the appendix. It can be seen that all correlations are relatively low except for a few of them (i.e. Syndicated and Log nVC). Those correlations are not relevant, as those variables do not appear in the same model simultaneously. In addition, a VIF test has been performed with VC investment amount as dependent variable[5] shown in table A.2 of the appendix to check whether the multicollinearity assumption is not violated. Since all values are below 10 and this is generally

[5] For the sake of this paper, only the VIF test has been shown for a regression with VC investment amount as dependent variable. VIF tests using total volume raised and number of VCs as dependent variables have similar outcomes.

seen as accepted in data analysis, the models do not contain multicollinearity (Hair et al., 1995). Lastly, during the tests of hypotheses 3A, 3B, 4A and 4B, multicollinearity arose as during the execution of those tests, the dummy variable 'Syndicated' was being investigated which represents the number of VCs, similarly to the third proxy for investment activity 'number of VCs'. Therefore, this third proxy for VC investment activity has been left out the models to avoid multicollinearity.

4.2 Descriptive statistics

Table 1 presents the descriptive statistics for all main variables used in the analysis. Over the sample period, a total of 11,548 investments have been made with a total investment amount of €54.3 billion with the average investment being €5.2 million. Furthermore, the average number of VCs investing in a single company is around 4 with a minimum of 1 and a maximum of 22 investors. Around 12% and 16% of all investments have been made during the Brexit and Covid-19 uncertainty respectively. Moreover, 16% of investments were made cross-border, while 83% were made in a syndicate. Lastly, the average company in the sample is 5.6 years old (66.89 divided by 12 months) and 61% of the VC-backed companies operate in the technology industry, and the latter is in line with prior research (Bertoni et al., 2015, 2019).

Table 1 – Descriptive statistics

Table 1 provides descriptives of all variables used in this paper, excluding investor fund type and development stage. The variables include VC amount, total volume raised, number of VCs, Brexit dummy, Covid-19 dummy, Cross-border dummy, Syndicated dummy, firm age, and technology dummy. The table gives the count of observations, sum, mean, median, standard deviation, minimum, maximum, kurtosis and skewness for the entire sample.

	N	Sum	Mean	Median	SD	Min	Max	Kurtosis	Skewness
VCamount	10466	54329.92	5.19	1.69	17.31	.001	961.3	1017.36	23.88
Log VCamount	10466	5642.42	0.54	.53	1.44	-7.02	6.87	3.08	.13
VolRaised	10525	239877.43	22.79	5.76	58.59	.003	1153.56	78.59	7.03
Log VolRaised	10525	19154.87	1.82	1.75	1.59	-5.68	7.051	3.13	.13
nVC	11548	47123	4.08	4	2.74	1	22	10.51	2.01
Log nVC	11548	13837.07	1.19	1.39	.67	0	3.091	2.61	-.25
Brexit	11548	1341	0.12	0	.32	0	1	6.74	2.39
Covid	11548	1882	0.16	0	.37	0	1	4.33	1.83
Cross-Border	11548	1865	0.16	0	.37	0	1	4.39	1.84
Syndicated	11548	9601	0.83	1	.37	0	1	4.13	-1.77
FirmAge	10828	724277.98	66.89	54.74	54.38	0	368.86	31.79	3.48
Log FirmAge	10828	42776.61	3.95	4.02	.78	0	6.98	4.94	-.73
Tech	11548	7015	0.61	1	.49	0	1	1.19	-.44

Furthermore, table 2 shows the investor fund type classifications following Bertoni et al. (2015, 2019) and Thomson Reuters Eikon (2022). It can be seen that IVCs are by far the most active in investing (64%),

which is in line with the expectations based on previous literature (Bertoni et al., 2019). Furthermore, VC investors which had the classification 'unknown' have been kept in the sample as this would largely reduce the amount of investments made.

Table 2 – Investor fund type descriptives

Table 2 presents the investor fund type classifications for all VC funds in the sample. The types are Bank-affiliated (BVC), Corporate (CVC), Governmental (GVC), Independent (IVC) or Unknown. Additional information on the classification can be found in table A.3 of the appendix.

Type of fund	Freq.	Percent	Cum.
BVC	833	7.21	7.21
CVC	1038	8.99	16.20
GVC	1041	9.01	25.22
IVC	7339	63.55	88.77
Unknown	1297	11.23	100.00
Total	11548	100.00	

Table 3 presents the stages in which the firms backed by a VC investor are in. Most of the investments are made early stage (47%), followed by expansion stage (35%) and later stage (18%). If it is assumed that 'early stage', which is the first or second round of VC financing, lies close to an investment made in the first two years of the foundation of the start-up, the sample is in line with the sample of Bertoni et al. (2019). However, this notion should be taken with caution as it is difficult to compare early stage investments with the investments made in the first two years an entrepreneurial firm is founded.

Table 3 – Development stage descriptives

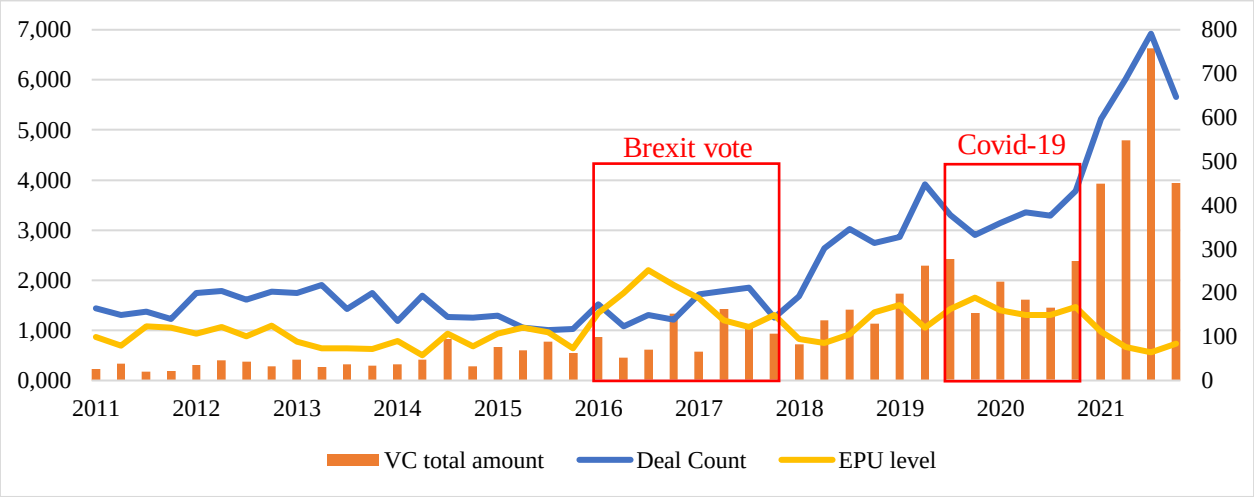
Table 3 presents the development stages for all VC investments in the sample. The development stages are early stage, expansion stage and later stage.

Stage	Freq.	Percent	Cum.
Early stage	5427	47.00	47.00
Expansion stage	4088	35.40	82.40
Later stage	2033	17.60	100.00
Total	11548	100.00	

Lastly, figure 3 displays an overview of the quarterly EPU levels combined with the VC investment activity of the entire sample period ranging from 2011 Q1 to 2021 Q4. VC investment activity here consists of total VC investment amount and the quarterly VC deal count. One can observe that both the total VC investment amount and the deal count went up over the period and that thus the sample is left-skewed in terms of VC activity. Furthermore, when EPU levels dropped, simultaneously VC investment amount and deal count

increased. This is particularly true for the Brexit vote and Covid-19 aftermath period. However, it should be taken into account in discussing the results that the later years entail more VC activity.

Figure 3 – Quarterly EPU and VC investment activity in the UK (2011-2021)



5. Results

5.1 Brexit and Covid-19

The start of the results section discusses how VC investment activity was influenced in the UK by the EPU-driving events of Brexit and Covid-19. The first hypotheses is formulated as 1A *"The Brexit uncertainty negatively impacted overall Venture Capital investments in the UK"* and 1B *"The Covid-19 uncertainty negatively impacted overall Venture Capital investments in the UK"*. Table A.4 in the appendix shows the regression results of three proxies for VC investment activity during Brexit and Covid-19. The main coefficients of interest are β_1 and β_2, which represent the period of Brexit (Q1 2016 to Q4 2017) and Covid-19 (Q4 2019 to Q4 2020) where EPU levels were higher than the median of the sample. Odd columns exclude control variables, while the even columns contain them. Furthermore, all the results from the table include year fixed effects to control for factors changing over time that are common to the sample, but no firm fixed effects, as many firms are only observed once and a pooled OLS regression using clustered standard errors is already used. The R-squared represents a goodness-of-fit measure, indicating how well the dependent variable is explained by the independent variables. The value is in most of the tables between 10% and 20%, showing that VC investment activity is well explained by the independent and control variables. Moreover, looking at the models containing all controls (model 2, 4 and 6), the coefficients of Brexit are negative and statistically significant at the 1% level for all three proxies: VC amount, total volume raised and number of VCs (0.907, 1.225 and 0.382). This means that on aggregate level during EPU of Brexit, individual VCs invested lower amounts in portfolio companies, total amounts invested were also lower and they did this with a lower number of VCs. This indicates less VC investment activity during the Brexit uncertainty, which is in line with prior research on VC activity during the financial crisis and during policy uncertainty (Block & Sandner, 2009; Tian & Ye, 2017; Sitorus, 2018). Furthermore, the coefficients of Covid are positive as well as negative but statistically insignificant, so we cannot draw conclusions on its uncertainty and how it affected VC activity, which is different from prior research (Griffith, 2020; Brown et al., 2020). This allows to partly reject the null hypothesis. Only the Brexit uncertainty negatively impact overall VC investment activity in the UK and not the Covid uncertainty, indicating evidence for hypothesis 1A but not for 1B.

Additionally, regarding the control variables, firm age is positive and significant, indicating that older firms receive more VC funds and that VCs are more inclined to invest together in older start-ups. Following Block & Sandner (2009), more mature ventures indeed require more capital for growth. Furthermore, other interesting findings are that expansion stage and later stage start-ups receive more VC funding than the base category early stage start-ups, in line with Sahlman (1990), who stated that older

entrepreneurial firms are less risky and attract more capital. Lastly, technology start-ups receive less funding relative to other start-ups.

5.2 Cross-border VC investments

To investigate whether cross-border VC funding was affected by the EPU-driving events Brexit and Covid-19, the second hypotheses are 2A *"The Brexit uncertainty had a higher negative impact on cross-border Venture Capital investments relative to domestic Venture Capital investments in the UK"* and 2B *"The Covid-19 uncertainty had a higher negative impact on cross-border Venture Capital investments relative to domestic Venture Capital investments in the UK"*. In table A.5, the results for the regression are shown. β_3 is the coefficient to show that the VC investment has been made cross-border. All coefficients are positive and significant at the 1% level, indicating that cross-border VC funding has a positive influence on VC investment activity relative to local investments (individual and total amounts as well as number of VCs). However, this finding changes when we look at the interaction term β_4 between Brexit and cross-border. The interaction term represents all cross-border VC investments that have been made during the Brexit uncertainty where the EPU level was high. For total volume raised and number of VCs the coefficients are negative and statistically significant, showing evidence that the negative influence of Brexit is partly explained by cross-border VCs shying away from investing in uncertain periods. First, this is in line with prior research of Li et al. (2014) and Buchner et al. (2018) who documented that cross-border VC investments can underperform due to geographic, cultural and institutional disparities and that this can negatively affect potential investment returns. Furthermore, it is also consistent with Julio & Yook (2012) and Bernstein et al. (2016), who find that during economic uncertainty, cross-border VCs prefer to focus on portfolio companies and postpone or shy away from investing in foreign ventures, as higher monitoring and transaction costs can lead to lower returns. As mentioned earlier under section 5.1, it is again in line with Tian & Ye (2017) and Sitorus (2018). Lastly, no evidence has been found on cross-border VC investments during the EPU surrounding Covid-19 as no coefficient is significant. Therefore, the null hypothesis can be partly rejected, as there is evidence for hypothesis 2A but not for 2B.

5.3 Syndicated VC investments

Next, the third hypotheses on syndicated VC investments and Brexit and Covid are 3A *"The Brexit uncertainty had a lower negative impact on syndicated Venture Capital investments relative to non-syndicated Venture Capital investments in the UK"* and 3B *"The Covid-19 uncertainty had a lower negative impact on syndicated Venture Capital investments relative to non-syndicated Venture Capital investments in the UK"*. In table A.6 the regression results are shown. Only for total volume raised, the coefficients of

β_3 are positive and significant, meaning that relative to non-syndicated VC investments, syndicated VC investments exhibit higher VC investment activity. Furthermore, when the Syndicated dummy is interacted with the Brexit period (β_4), the positive effect is still present. This means that during EPU of Brexit, syndicated VC investment had a higher total volume raised and thus higher VC investment activity than non-syndicated VC investments overall, meaning that syndication is more robust to the lower VC activity caused by the Brexit uncertainty. This is consistent with the research findings of Chemmanur et al. (2016) and Brander et al. (2002), who report that syndication can mitigate the liability of being foreign and that syndication can entail higher returns respectively. Also, it is consistent with the papers from Tian & Ye (2017) and Sitorus (2018). However, we find no evidence of higher VC investment activity during the EPU of Covid, as all the coefficients are negative but insignificant. Therefore, the null hypothesis can be partly rejected, as evidence has only been found for hypothesis 3A but not for 3B.

5.4 Cross-border and syndication

Lastly, hypotheses 4A and 4B are *"The Brexit uncertainty had a higher negative impact on cross-border syndicated Venture Capital investments relative to domestic non-syndicated Venture Capital investments in the UK"* and 4B *"The Covid-19 uncertainty had a higher negative impact on cross-border syndicated Venture Capital investments relative to domestic non-syndicated Venture Capital investments in the UK"*. Table A.7 and A.8 show the regression results. Looking at the variable of interest β_6, there is no significant association between syndicated cross-border VC investments during the uncertainty of Brexit and Covid-19 and VC investment activity. It appears that VCs do not shy away from investing cross-border through a syndicate when EPU levels are high, particularly during the Brexit and Covid-19 pandemic. Therefore, the null hypothesis cannot be rejected and thus no evidence has been found for hypotheses 4A and 4B.

5.5 Robustness checks

In this section, two robustness checks are performed. For the first check, the data is sorted into entrepreneurial firm-quarter observations to create a panel data set. Each firm-quarter observation is again supplemented with the respective quarterly EPU level following Baker et al. (2021). The goal of this robustness check is to check whether hypotheses 1A and 1B give the same results if a different proxy for VC investment activity is used. In the prior regression tests, the three proxies used in the analyses assumed that a VC deal would happen. However, by transforming the data into a panel data set following Tian & Ye (2017), a probit model can be executed to test whether the probability of a VC deal happening during the EPU surrounding Brexit and Covid-19 is lower relative to the other time periods. By performing this test one does not research that a deal certainly happens and what its characteristics (VC amount, Total volume

raised) are, but the probability that a deal will happen in a certain quarter. Therefore, a VC deal dummy is computed that equals 1 if a deal in a certain quarter would happen and since the dependent variable is a dummy, a probit model is used to estimate the probability of the deal happening. The regression results are shown in table A.9 of the appendix. It can be seen that the margin of the Brexit dummy is negative and statistically significant, meaning that during EPU surrounding Brexit, the probability of a VC deal happening is lower relative to other periods. This indicates that because of EPU, VCs are more reluctant to invest in entrepreneurial firms. Furthermore, the Covid-19 dummy is insignificant, meaning it has no explanatory power. These results are exactly in line with the tests under section 5.1, as only for the Brexit period the VC investment activity was lower relative to other periods.

Furthermore, a second robustness check is performed by using a fourth proxy for VC investment activity. A variable 'Average investment amount per VC' is defined as Total volume raised divided by the number of VCs. Furthermore, the variable is scaled to its natural logarithm to normalize its distribution. This test is performed to check whether the results from investigating hypotheses 1A – 4B will change with a different measure for VC investment activity. The regression results are shown in table A.10 and A.11 of the appendix. It appears that using average investment amount per VC as proxy for VC investment activity does not alter the results under sections 5.1 to 5.4. Although a few significance levels have changed slightly, the coefficients are very similar in sign and size.

5.6 Contribution, limitations & future research

The evidence found in this study provides a strong contribution to the VC literature. This is the first analysis of the impact of Brexit and Covid-19 on VC investment activity for the UK market. Furthermore, the paper provides new evidence that EPU negatively impacted VC investment activity in the UK during the Brexit period and that cross-border VCs are less robust in coping with this EPU compared to local VCs. Finally, so far the research on the relation between EPU events and VC investment activity received limited attention (Geronikolaou & Papachristou, 2011; Tian & Ye, 2017; Sitorus, 2018) and this study elaborates further on the theory of understanding macro-level events such as Brexit and Covid-19.

Addressing limitations of the paper is necessary to improve the validity and integrity of it. First, a potential selection bias could be existent in the data as the data only entails VC deals and is thus not randomly selected. For example, VCs execute an extensive screening process before they invest, which makes the selection of investments not random. This could be particularly true for cross-border VCs which could outperform local VCs through this screening. A solution to this could be to match the UK VC deals in the sample with UK ventures that are not backed by VCs, or match cross-border VC deals with local VC deals, based on similar characteristics and see if they differ in results. Furthermore, when looking at either the Brexit or Covid-19 crisis dummies, their effects could be biased as one dummy is at the same time

compared to the rest of the sample period and thus compared to the other dummy. They could be put together and see whether results would change. Lastly, there could be a measurement error in using the EPU index, as there is cause for concern that increases in the index could be driven by unrelated occurrences and not particularly by Brexit and Covid-19 itself. These limitations could be addressed in future research. Lastly, the conducted analysis could be extended to other countries or venture industries to broaden the VC investment literature with new insights.

6. Conclusion

This paper sheds new light on the relationship between EPU events and VC investment activity, as it is the first one to evaluate and provide evidence for the adverse impact of EPU driving events on VC investment activity in the UK. The goal of the paper is to explore whether and how economic policy uncertainty surrounding the Brexit referendum and the Covid-19 pandemic influenced cross-border and syndicated VC investments of VCs investing in UK entrepreneurial firms. This is particularly relevant for several reasons, as Brexit and Covid-19 are modern-day topics, the UK has the largest PE market of continental Europe and VC activity in general is a large driver of innovation, economic growth and business creation in a country.

Building upon the scarce literature on EPU driving events and VC investment activity (Geronikolaou & Papachristou, 2011; Tian & Ye, 2017; Sitorus, 2018), the paper serves as the foundation for answering the research question *"How did the Brexit policy uncertainty and the Covid-19 policy uncertainty affect cross-border and syndicated Venture Capital investments in the UK?"* Using pooled OLS regressions with a sample of 11,548 VC investments encompassing 2,868 unique firms in the UK over a 10-year period, the paper finds evidence that EPU surrounding Brexit negatively impacted VC investment activity in the UK overall. Furthermore, part of this story is explained by the fact that cross-border VCs shy away from investing in uncertain periods due to their increased focus on portfolio companies and due to higher monitoring and transaction costs. However, the lower VC investment activity during Brexit is mitigated by syndication of VC investments as syndication decreases the liability of being foreign and it entails higher returns. Lastly, no significant impact of EPU surrounding the Covid-19 pandemic on VC investment activity has been found. Altogether, we may conclude that the economic policy uncertainty surrounding Brexit negatively impacts VC investment activity in the UK, in particular cross-border VC investments, and that syndication in VC investments can mitigate the adverse effect as it is more robust to the Brexit uncertainty.

Given the critical role of VC in driving innovation and economic growth, the findings in this paper underline the need for more detailed research on the drivers behind the adverse impact of EPU events on VC investment activity. This is essential to enhance the explanations for the effects given in this paper, but also to provide entrepreneurial firms more specific guidance on how to overcome challenges in finding VC funding during times of economic uncertainty.

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Appendix

A. Tables

Table A.1 – Correlation matrix

Table A.1 presents the correlation numbers for the variables, excluding investor fund type and development stage.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Log VCamount	1.000								
(2) Log VolRaised	0.900	1.000							
(3) Log nVC	0.072	0.462	1.000						
(4) Brexit	0.023	0.009	-0.018	1.000					
(5) Covid	0.056	0.056	0.026	-0.160	1.000				
(6) Cross-Border	0.191	0.139	-0.134	-0.008	0.003	1.000			
(7) Syndicated	0.001	0.274	0.727	0.015	0.033	-0.186	1.000		
(8) Log FirmAge	0.285	0.271	0.015	-0.052	0.012	0.028	-0.034	1.000	
(9) Tech	-0.059	-0.056	0.031	0.043	0.066	-0.013	0.057	-0.028	1.000

Table A.2 – VIF values

Table A.2 presents the Variance Inflation Factor values for the linear regression with VC amount as dependent variable.

	VIF	1/VIF
Brexit	1.036	.966
Covid	1.039	.963
Cross-Border	1.052	.95
Syndicated	1.054	.948
FirmAge	2.326	.43
BVC	1.548	.646
CVC	1.678	.596
GVC	1.655	.604
IVC	2.476	.404
Early stage	1.012	.988
Expansion stage	1.77	.565
Later stage	2.541	.394
Tech	1.022	.978
Mean VIF	1.555	.

Table A.3 – Investor fund type classification

Table A.3 presents the investor fund type classifications.

Investor fund type as defined by Bertoni et al. (2015, 2019)	Thomson Reuters Eikon investor fund types
Independent VC (IVC)	Individuals
	Independent private partnership
	Fund of funds
	Small Business Investment Company (SBIC)
	Endowment, Foundation or Pension fund
	Evergreen fund
Corporate VC (CVC)	Corporate Venture Fund
Governmental VC (GVC)	Government
	Business / community development program
	University development program
Bank-affiliated VC (BVC)	Investment bank
	Other banking / financial institution
	Investment advisory affiliate
Omitted investor types	Angel investor
	Secondary purchase
	Non-PE fund
	Other
	NA

Table A.4 – Pooled OLS regressions for three proxies of VC investment activity

Table A.4 presents the results of the pooled OLS regression models on the dependent variables consisting of three proxies for VC investment activity: VC investment amount, Total volume raised and number of VCs investing. The main parameters of interest are β_1 and β_2 and represent the Brexit dummy (if a firm received VC investment between Q1 2016 to Q4 2017 where the EPU level was higher than the median of the sample) and Covid-19 dummy (if a firm received VC investment between Q4 2019 to Q4 2020 where the EPU level was higher than the median of the sample), respectively. Odd columns present models without control variables, while the even columns present models with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	VC amount	VC amount	VolRaised	VolRaised	nVCs	nVCs
β_0 Constant	-0.182**	-1.713***	0.744***	-1.024***	0.814***	0.648***
	(0.0920)	(0.198)	(0.108)	(0.213)	(0.0468)	(0.0771)
β_1 Brexit	-0.791***	-0.907***	-1.112***	-1.225***	-0.383***	-0.382***
	(0.129)	(0.126)	(0.151)	(0.142)	(0.0625)	(0.0632)
β_2 Covid	0.0163	0.0914	-0.0515	0.0169	-0.0579	-0.0783
	(0.142)	(0.135)	(0.153)	(0.145)	(0.0682)	(0.0686)
FirmAge		0.286***		0.354***		0.0462**
		(0.0513)		(0.0555)		(0.0204)
BVC		0.588***		0.561***		-0.0274
		(0.0875)		(0.101)		(0.0362)
CVC		0.690***		0.872***		0.142***
		(0.0738)		(0.0799)		(0.0313)
GVC		0.0797		0.0616		-0.0287
		(0.0604)		(0.0650)		(0.0264)
IVC		0.335***		0.400***		0.0450**
		(0.0558)		(0.0570)		(0.0204)
Expansion stage		0.464***		0.456***		0.0173
		(0.0723)		(0.0810)		(0.0336)
Later stage		0.478***		0.288**		-0.184***
		(0.112)		(0.124)		(0.0505)
Tech		-0.287***		-0.338***		-0.00867
		(0.0722)		(0.0854)		(0.0297)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations (N)	10,466	9,865	10,525	9,922	11,548	10,828
R-squared	0.073	0.190	0.119	0.227	0.097	0.110

Table A.5 – Pooled OLS regressions for Cross-border VC for three proxies of VC investment activity

Table A.5 presents the results of the pooled OLS regression models on the dependent variables consisting of three proxies for VC investment activity: VC investment amount, Total volume raised and number of VCs investing. The main parameters of interest are β_3 , β_4 and β_5 and represent a Cross-border dummy (if a firm received Cross-border VC investment); an interaction term between the Brexit dummy (if a firm received VC investment between Q1 2016 to Q4 2017 where the EPU level was higher than the median of the sample) and the Cross-border dummy; an interaction term between the Covid-19 dummy (if a firm received VC investment between Q4 2019 to Q4 2020 where the EPU level was higher than the median of the sample) and the Cross-border dummy, respectively. Odd columns present models without control variables, while the even columns present models with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES[6]	VC amount	VC amount	VolRaised	VolRaised	nVCs	nVCs
β_0 Constant	-0.289***	-1.787***	0.653***	-1.085***	0.854***	0.680***
	(0.0925)	(0.194)	(0.109)	(0.210)	(0.0473)	(0.0784)
β_3 Crossborder	0.724***	0.683***	0.611***	0.562***	-0.214***	-0.218***
	(0.108)	(0.107)	(0.141)	(0.142)	(0.0602)	(0.0619)
β_4 Brexit x Crossborder	-0.146	-0.254	-0.459**	-0.557***	-0.327***	-0.311***
	(0.204)	(0.198)	(0.226)	(0.214)	(0.0921)	(0.0919)
β_5 Covid x Crossborder	0.0422	-0.0139	-0.0822	-0.151	-0.0480	-0.0659
	(0.168)	(0.164)	(0.202)	(0.190)	(0.0886)	(0.0924)
FirmAge		0.280***		0.350***		0.0474**
		(0.0509)		(0.0553)		(0.0202)
BVC		0.580***		0.552***		-0.0247
		(0.0835)		(0.0972)		(0.0365)
CVC		0.630***		0.828***		0.168***
		(0.0721)		(0.0773)		(0.0298)
GVC		0.127**		0.0927		-0.0503*
		(0.0595)		(0.0649)		(0.0265)
IVC		0.323***		0.390***		0.0503**
		(0.0548)		(0.0561)		(0.0200)
Expansion stage		0.468***		0.463***		0.0193
		(0.0705)		(0.0797)		(0.0336)
Later stage		0.468***		0.286**		-0.177***
		(0.110)		(0.123)		(0.0499)
Tech		-0.281***		-0.335***		-0.0138
		(0.0703)		(0.0837)		(0.0302)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Clustered SEs	Yes	Yes	Yes	Yes	Yes	Yes
Observations (N)	10,466	9,865	10,525	9,922	11,548	10,828
R-squared	0.105	0.216	0.135	0.239	0.121	0.134

[6] Note: the stand-alone components for the Brexit and Covid dummies are included in the models but not shown.

Table A.6 – Pooled OLS regressions for Syndicated VC for two proxies of VC investment activity

Table A.6 presents the results of the pooled OLS regression models on the dependent variables consisting of two proxies for VC investment activity: VC investment amount and Total volume raised. The main parameters of interest are β_3 , β_4 and β_5 and represent a Syndicated dummy (if a firm received VC investment from a syndicate); an interaction term between the Brexit dummy (if a firm received VC investment between Q1 2016 to Q4 2017 where the EPU level was higher than the median of the sample) and the Syndicated dummy; an interaction term between the Covid-19 dummy (if a firm received VC investment between Q4 2019 to Q4 2020 where the EPU level was higher than the median of the sample) and the Syndicated dummy, respectively. Odd columns present models without control variables, while the even columns present models with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)	(3)	(4)
VARIABLES[7]	VC amount	VC amount	VolRaised	VolRaised
β_0 Constant	-0.122	-1.671***	-0.0815	-1.877***
	(0.0962)	(0.199)	(0.102)	(0.208)
β_3 Syndicated	-0.0843	-0.0571	1.158***	1.181***
	(0.0632)	(0.0641)	(0.0651)	(0.0661)
β_4 Brexit x Syndicated	0.228	0.145	0.349**	0.286*
	(0.155)	(0.166)	(0.145)	(0.149)
β_5 Covid x Syndicated	-0.157	-0.144	-0.152	-0.131
	(0.136)	(0.142)	(0.138)	(0.144)
FirmAge		0.286***		0.349***
		(0.0513)		(0.0540)
BVC		0.583***		0.624***
		(0.0878)		(0.0999)
CVC		0.695***		0.836***
		(0.0737)		(0.0785)
GVC		0.0776		0.102
		(0.0605)		(0.0641)
IVC		0.333***		0.412***
		(0.0559)		(0.0553)
Expansion stage		0.463***		0.458***
		(0.0723)		(0.0792)
Later stage		0.471***		0.355***
		(0.112)		(0.120)
Tech		-0.284***		-0.359***
		(0.0723)		(0.0832)
Year fixed effects	Yes	Yes	Yes	Yes
Clustered SEs	Yes	Yes	Yes	Yes
Observations (N)	10,466	9,865	10,525	9,922
R-squared	0.074	0.190	0.173	0.281

[7] Note: the stand-alone components for the Brexit and Covid dummies are included in the models but not shown.

Table A.7 – Pooled OLS regressions for Cross-border Syndicated VC for two proxies of VC investment activity during the Brexit

Table A.7 presents the results of the pooled OLS regression models on the dependent variables consisting of two proxies for VC investment activity: VC investment amount and Total volume raised. The main parameter of interest is β_6 and represents an interaction term between the Brexit dummy (if a firm received VC investment between Q1 2016 to Q4 2017 where the EPU level was higher than the median of the sample), a Cross-border dummy (if a firm received Cross-border VC investment) and a Syndicated dummy (if a firm received VC investment from a syndicate). Odd columns present models without control variables, while the even columns present models with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)	(3)	(4)
VARIABLES[8]	VC amount	VC amount	VolRaised	VolRaised
β_0 Constant	-0.305***	-1.833***	-0.299***	-2.070***
	(0.0962)	(0.198)	(0.101)	(0.204)
β_6 Brexit x Crossborder x Syndicated	0.790*	0.570	0.424	0.143
	(0.408)	(0.430)	(0.384)	(0.385)
FirmAge		0.281***		0.344***
		(0.0509)		(0.0535)
BVC		0.581***		0.626***
		(0.0839)		(0.0948)
CVC		0.631***		0.772***
		(0.0720)		(0.0754)
GVC		0.129**		0.156**
		(0.0598)		(0.0637)
IVC		0.323***		0.402***
		(0.0548)		(0.0539)
Expansion stage		0.465***		0.464***
		(0.0706)		(0.0775)
Later stage		0.465***		0.355***
		(0.110)		(0.118)
Tech		-0.280***		-0.354***
		(0.0703)		(0.0808)
Year fixed effects	Yes	Yes	Yes	Yes
Clustered SEs	Yes	Yes	Yes	Yes
Observations (N)	10,466	9,865	10,525	9,922
R-squared	0.106	0.216	0.200	0.303

[8] Note: the stand-alone components and interactions for the Brexit, Crossborder and Syndicated dummies are included in the models but not shown.

Table A.8 – Pooled OLS regressions for Cross-border Syndicated VC for two proxies of VC investment activity during the Covid-19 pandemic

Table A.8 presents the results of the pooled OLS regression models on the dependent variables consisting of two proxies for VC investment activity: VC investment amount and Total volume raised. The main parameter of interest is β_6 and represents an interaction term between the Covid-19 dummy (if a firm received VC investment between Q4 2019 to Q4 2020 where the EPU level was higher than the median of the sample), a Cross-border dummy (if a firm received Cross-border VC investment) and a Syndicated dummy (if a firm received VC investment from a syndicate). Odd columns present models without control variables, while the even columns present models with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)	(3)	(4)
VARIABLES[9]	VC amount	VC amount	VolRaised	VolRaised
β_0 Constant	-0.282***	-1.804***	-0.276***	-2.038***
	(0.0961)	(0.198)	(0.101)	(0.205)
β_6 Covid x Crossborder x Syndicated	-0.0551	-0.349	0.00452	-0.290
	(0.313)	(0.314)	(0.332)	(0.325)
FirmAge		0.279***		0.342***
		(0.0510)		(0.0536)
BVC		0.585***		0.628***
		(0.0838)		(0.0949)
CVC		0.634***		0.774***
		(0.0720)		(0.0754)
GVC		0.132**		0.157**
		(0.0598)		(0.0635)
IVC		0.326***		0.402***
		(0.0548)		(0.0538)
Expansion stage		0.466***		0.463***
		(0.0705)		(0.0775)
Later stage		0.470***		0.361***
		(0.110)		(0.118)
Tech		-0.280***		-0.354***
		(0.0704)		(0.0811)
Year fixed effects	Yes	Yes	Yes	Yes
Clustered SEs	Yes	Yes	Yes	Yes
Observations (N)	10,466	9,865	10,525	9,922
R-squared	0.105	0.216	0.199	0.302

[9] Note: the stand-alone components and interactions for the Covid, Crossborder and Syndicated dummies are included in the models but not shown.

Table A.9 – Robustness check 1: Probit regression for Cross-border Syndicated VC with VC deal dummy during the Brexit and Covid-19 pandemic

Table A.9 presents the results of the Probit regression models on the dependent variable 'VC deal dummy'. The dummy equals 1 if a deal in a certain quarter happened. The main parameters of interest are β_1 and β_2 and represent the Brexit dummy (if a firm received VC investment between Q1 2016 to Q4 2017 where the EPU level was higher than the median of the sample) and Covid-19 dummy (if a firm received VC investment between Q4 2019 to Q4 2020 where the EPU level was higher than the median of the sample), respectively. Only marginal effects are reported. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)
VARIABLES	dVC
β_0 Constant	0.764***
	(0.0737)
β_1 Brexit	-0.376***
	(0.0213)
β_2 Covid	-0.022
	(0.0232)
Year fixed effects	Yes
Clustered SEs	Yes
Observations (N)	15,547
Number of firms	2,868

Table A.10 – Robustness check 2A: Pooled OLS regressions for Cross-border Syndicated VC using Average Investment amount per VC during the Brexit

Table A.10 presents the results of the pooled OLS regression models on the dependent variable 'Average investment amount per VC'. The main parameter of interest is β_6 and represents an interaction term between the Brexit dummy (if a firm received VC investment between Q1 2016 to Q4 2017 where the EPU level was higher than the median of the sample), a Cross-border dummy (if a firm received Cross-border VC investment) and a Syndicated dummy (if a firm received VC investment from a syndicate). The odd column presents the model without control variables, while the even column presents the model with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)
VARIABLES	AverageVC	AverageVC
β_0 Constant	-0.321***	-1.869***
	(0.0957)	(0.198)
β_1 Brexit	-1.182***	-1.185***
	(0.168)	(0.167)
β_2 Crossborder	0.876***	0.857***
	(0.0991)	(0.105)
β_3 Syndicated	0.0561	0.0866
	(0.0612)	(0.0630)
β_4 Brexit x Crossborder	-0.634**	-0.536*
	(0.271)	(0.303)
β_5 Brexit x Syndicated	0.397***	0.266*
	(0.149)	(0.151)
β_6 Brexit x Crossborder x Syndicated	0.642*	0.384
	(0.378)	(0.387)
FirmAge		0.290***
		(0.0511)
BVC		0.578***
		(0.0833)
CVC		0.624***
		(0.0694)
GVC		0.143**
		(0.0600)
IVC		0.331***
		(0.0529)
Expansion stage		0.464***
		(0.0703)
Later stage		0.450***
		(0.110)
Tech		-0.300***
		(0.0705)
Year fixed effects	Yes	Yes
Clustered SEs	Yes	Yes
Observations (N)	10,525	9,922
R-squared	0.105	0.220

Table A.11 – Robustness check 2B: Pooled OLS regressions for Cross-border Syndicated VC using Average Investment amount per VC during the Covid-19 pandemic

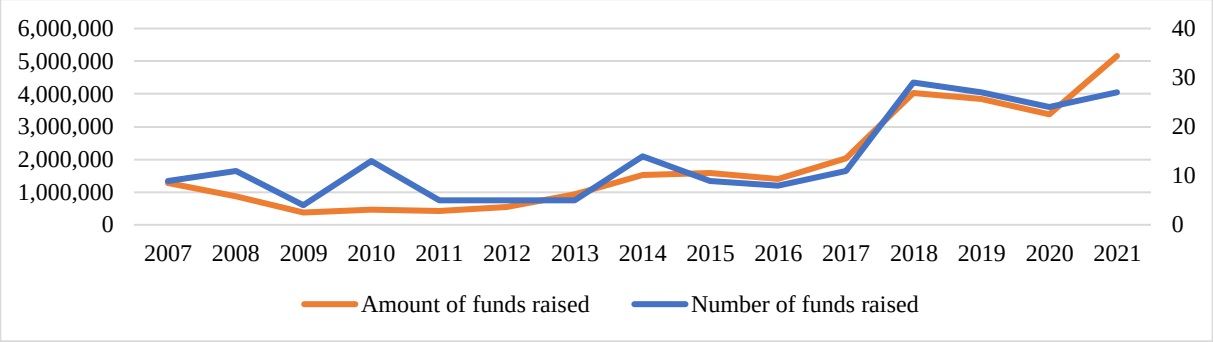
Table A.11 presents the results of the pooled OLS regression models on the dependent variable 'Average investment amount per VC'. The main parameter of interest is β_6 and represents an interaction term between the Covid-19 dummy (if a firm received VC investment between Q4 2019 to Q4 2020 where the EPU level was higher than the median of the sample), a Cross-border dummy (if a firm received Cross-border VC investment) and a Syndicated dummy (if a firm received VC investment from a syndicate). The odd column presents the model without control variables, while the even column presents the model with control variables, which include the firm's age, investor type (with 'unknown' being the base category), development stage (with 'early stage' being the base category) and a technology dummy. All models include year fixed effects and robust standard errors are clustered at firm-level and reported in parentheses. 1%, 5% and 10% significance levels are indicated by ***, **, *, respectively.

	(1)	(2)
VARIABLES	AverageVC	AverageVC
β_0 Constant	-0.302***	-1.844***
	(0.0955)	(0.198)
β_1 Covid	0.151	0.146
	(0.184)	(0.191)
β_2 Crossborder	0.801***	0.761***
	(0.104)	(0.114)
β_3 Syndicated	0.0372	0.0673
	(0.0619)	(0.0625)
β_4 Covid x Crossborder	-0.0256	-0.179
	(0.256)	(0.264)
β_5 Covid x Syndicated	-0.144	-0.0532
	(0.153)	(0.163)
β_6 Covid x Crossborder x Syndicated	-0.0415	-0.249
	(0.308)	(0.308)
FirmAge		0.288***
		(0.0512)
BVC		0.580***
		(0.0832)
CVC		0.626***
		(0.0695)
GVC		0.146**
		(0.0599)
IVC		0.332***
		(0.0528)
Expansion stage		0.465***
		(0.0703)
Later stage		0.455***
		(0.110)
Tech		-0.300***
		(0.0706)
Year fixed effects	Yes	Yes
Clustered SEs	Yes	Yes
Observations (N)	10,525	9,922
R-squared	0.105	0.220

B. Figures

Figure B.1 – Total funds raised by UK Venture Capital firms

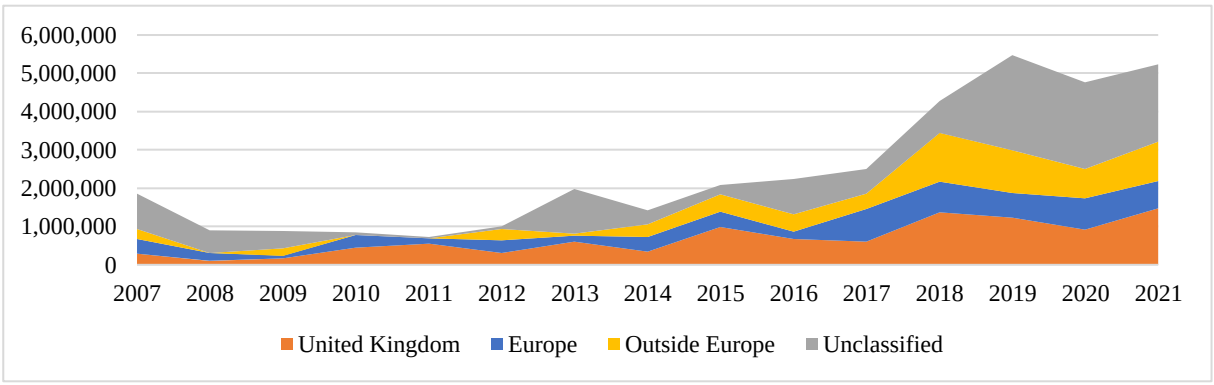
This figure shows the total number and value of funds raised in the United Kingdom from 2007 to 2021. Amounts are in € thousands.



Source: Invest Europe / EDC (2022)

Figure B.2 – Geographic breakdown of fund sources of UK Venture Capital firms

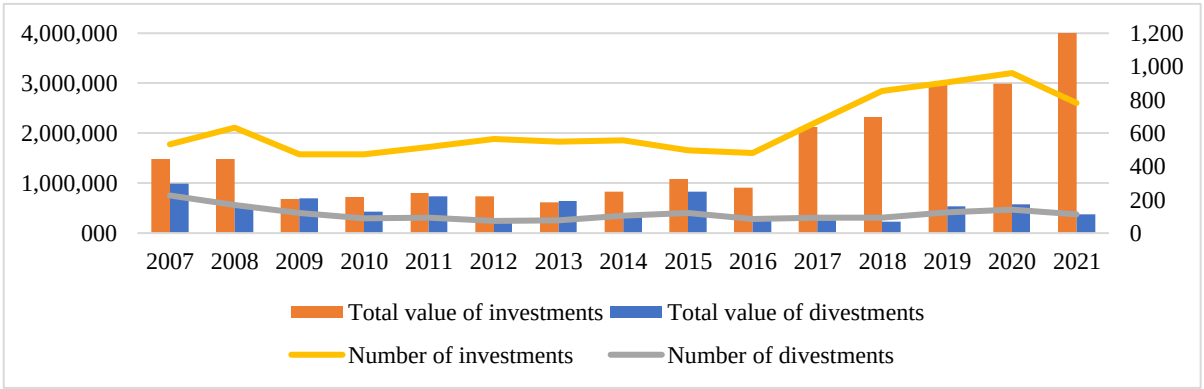
This figure shows the geographic breakdown of fund sources of Venture Capital firms in the United Kingdom from 2007 to 2021. The fund sources are from the United Kingdom, Europe, outside Europe or are unclassified. Amounts are in € thousands.



Source: Invest Europe / EDC (2022)

Figure B.3 – Total UK Venture Capital investments and divestments

This figure shows the total number and value of Venture Capital investments and divestments in the United Kingdom from 2007 to 2021 Amounts are in € thousands.



Source: Invest Europe / EDC (2022)