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Navn:	Shazma Viktoria Juriks og Emily Moschowits

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Navn på veileder *:	Amir Sasson

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ESG and impact investing in VC: The relationship between company-level ESG and VC fund performance

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Supervisor:
Amir Sasson, Provost Innovation and Outreach
Institute for Strategy and Entrepreneurship

Abstract

Sustainable investing has garnered increasing popularity in both public, and more recently, private markets, with the promising potential of "doing good while doing well." Studies on VC impact investing have shown mixed results, potentially due to their willingness-to-pay for their dual mission. However, within VC, little research has been done on how to incorporate ESG concerns to reduce risk and improve financial performance. Therefore, we aimed to understand to what extent funds investing in companies with greater ESG scores would have better financial performance, and how VC firm level factors, such an impact-focus strategy or ESG expertise, affect this relationship. Furthermore, we assessed the link between impact companies and fund-level returns. Using Preqin's VC fund performance data, we found that company-level ESG scores were not associated with net IRR, even when excluding impact-focused funds. However, ESG scores were tied to lower IRR:TVPI, both when including and excluding impact-focused funds. Additionally, a greater proportion of impact companies was associated with lower fund financial performance, as measured by IRR:TVPI. Finally, ESG expertise alone showed no association with financial performance, but after excluding impact funds, the interaction term between ESG score and ESG expertise showed a negative relationship with IRR. Overall, even when accounting for an impact-focused strategy, we did not find evidence for a link between higher company-level ESG scores and greater fund-level financial performance. The practical implications of these findings do not support a strategy of greater implementation of ESG in VC for greater financial performance. Future research should investigate these relationships using alternative metrics of fund performance, impact fund designation, and assess the effects of ESG on startup survival.

Key Words: venture capital, financial performance, portfolio company, impact investing, ESG expertise, ESG score, IRR, TVPI

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List of Abbreviations

CFP	Corporate Financial Performance
CSR	Corporate Social Responsibility
ESG	Environmental, Social, and Governance
GIIN	Global Impact Investing Network
GP	General Partner
II	Impact Investing
IT	Information Technology
LPs	Limited Partners
Net IRR	Net Internal Rate of Return
PC	Portfolio Company
PE	Private Equity
PME	Public Market Equivalent
SASB	Sustainable Accounting Standards Board
SI	Sustainable Investing
SRI	Socially Responsible Investment
TVPI	Total Value to Paid-In
UN	United Nations
UN SDGs	United Nations Sustainable Development Goals
VC	Venture Capital
WTP	Willingness-To-Pay

1. Introduction

Within sustainable investing, there are three main strategies that, to a differing degree, incorporate measures of sustainability and positive externalities together with traditional financial metrics when making investment decisions (Lin, 2022). Impact investing[1] is becoming increasingly relevant in today's market, and it can play an important role in the sustainable economy (GIIN, 2022). The Global Impact Investing Network (GIIN) estimates that a combined USD 715 billion in impact investments is managed by over 1,720 organizations (GIIN, 2022). Impact investing aims at having a positive outcome while generating a positive financial return; impact funds channel capital to investments pursuing social and environmental goals (GIIN, 2022; Thomas & Starr, 2020). However, there is debate over whether impact funds can match market returns (F. Li et al., 2020).

Beyond specifically focused impact funds, there is a growing interest in incorporating environmental, social, and governance (ESG) metrics when making investments (Cappucci, 2018), and using ESG as a metric for sustainability performance (Folqué et al., 2021; Widyawati, 2020). Despite being widespread in other fields of investing as a way to reduce investment risk and improve financial performance (Cappucci, 2018), venture capital (VC) has lagged behind in adopting ESG practices. There is now greater emphasis being placed on the importance of incorporating ESG in this asset class (Alfonso-Ercan, 2020; Lenhard & Winterberg, 2021). In other asset classes, such as stocks and bonds, ESG investing has been more studied as ESG has been incorporated into investment decisions for many years (Alessandrini & Jondeau, 2020; Cerqueti et al., 2021; Kumar et al., 2022; Schramade, 2016). Market trends have shifted with increasing consumers' awareness about ethical business practices, which has pushed founders to incorporate ESG principles (Lenhard & Winterberg, 2021). The United Nations (UN) Principle for Responsible Investing released a report in February 2022 detailing the need for greater consideration of ESG in all VC funds (Dunbar & Leitner, 2022). Preqin estimated that, as of October 2021, $3.1 trillion of private capital assets were managed by firms committed to ESG investing (Preqin, 2021c). According to a survey of 419 fund managers and 170 investors, almost 90% "believe [environmental, social, and governance] ESG funds tend to perform at least the same in the market as unconstrained funds," with half of all respondents

[1] GIIN defines impact investments as "...investments made with the intention to generate positive, measurable social and environmental impact alongside a financial return" (GIIN, 2022d).

saying they outperform traditional funds (Preqin, 2022a). However, the data supporting these beliefs has been lacking. Furthermore, 66% of fund managers acknowledge the challenge of the "lack of quality and consistency" of the ESG data (Preqin, 2022a). Therefore, there is a need for academic investigation into these assertions.

The COVID-19 pandemic had a large effect on investing and highlighted social and environmental issues (Wu & Juvyns, 2020). According to the Institute for Sustainable Investing, sustainable funds focused on ESG factors outperformed traditional funds and non-ESG portfolios during the early phases of the Covid-19 pandemic (Institute for Sustainable Investing, 2021; Sullivan, 2020).

Of the literature looking at sustainable investments, much has focused on investment in public companies or mutual funds. Far less has focused on private equity (PE) investments, and still fewer studies have looked at venture capital (VC) specifically. Furthermore, the research in this area has covered a variety of topics, from how VCs can influence the sustainability of the companies they invest in (Alakent et al., 2020), to the extent that mission-driven investing alters the contents of contractual agreements (Geczy et al., 2021). Croce et al. (2021) found that social impact VCs were focused on the growth and transformation of the startups they invested in and that this often helped improve the startups' sales in the long term. However, when comparing the financial performance of dual-objective impact VC funds to conventional VC funds, Barber et al. (2021) found lower performance of impact funds, accompanied by impact investors' willingness to pay (WTP) for the positive externalities created by their investment. Despite these findings, there is a lack of literature on how the implementation of a greater focus on the ESG performance of portfolio companies (PCs) affects financial returns of VC funds. Going beyond dual-objective impact funds willing to accept below-market returns for external social good, will greater ESG performance of PCs be a marker of portfolio quality and be tied to greater financial returns for VC funds?

RQ: To what extent do the ESG scores of PCs affect fund-level financial performance, and to what extent do VC-level factors, such as impact focus or ESG expertise, influence this relationship?

We used data from the Preqin alternative assets database to assess the relationship between VC funds' financial returns (net IRR and IRR:TVPI)[2] and the ESG score of their PCs. In addition, we assessed the influence of a fund's potential impact focus or ESG expertise on this relationship. Additionally, we explored the relationship between a fund's financial performance and proportion PCs very likely to have a positive impact. Interestingly, despite no association with net IRR, there was a significant negative association between ESG score and IRR:TVPI, even when excluding likely impact funds, implying that ESG score might be tied to worse financial performance regardless of impact strategy.

Similarly, a fund's proportion of PCs very likely to have a positive impact showed no significant relationship with net IRR but did have a negative association with IRR:TVPI, both when including and excluding funds with a likely impact-focused strategy. Moreover, when assessing the isolated effect of ESG expertise on financial performance, no association was seen in either model. However, when introducing an interaction term between ESG score and ESG expertise, there was an interesting and unexpected relationship between ESG expertise and ESG scores, when excluding likely impact funds. The results showed that in non-impact funds, having ESG expertise negatively affected the relationship between ESG score and net IRR.

Taken together, our results highlight the complex relationship between company level ESG metrics and fund-level performance and illuminate the effect of VC factors on this relationship. However, the differences observed when using our primary and secondary outcome measures emphasize the challenges of measuring VC performance and evaluating intermediate performance of illiquid assets, also described in previous literature (Kazemi et al., 2014; Ljungqvist & Richardson, 2003; Smith et al., 2011).

Distinguishing our results from past research, we included analyses investigating the effects of a portfolio's ESG metrics, or possible impact, across VC funds with varying focuses, not only isolating funds with a stated impact strategy. This provides a more balanced sample to work with compared to some previous research only examining impact-focused funds. However, a limitation was the potential weakness of the proxy used for identifying impact-focused funds. Another weakness of the current study was that ESG scores were not scaled proportionally

[2] For more details, see methods section 3.3.1.

to the size of the investments into the companies, biasing the fund-level metric towards the scores of their smaller holdings.

2. Literature Review

2.1 ESG and CSR as factors of company performance and start-up success

Environmental, social, and governance (ESG) are three pillars of sustainable organizations and part of a company's strategy for corporate social responsibility (CSR)[3] In general, CSR and ESG practices tend to improve company performance (Buallay, 2019; Giese et al., 2019; Gregory et al., 2014; Minutolo et al., 2019) and can act as an indicator of quality (Zhang & Lucey, 2022) and transparency (Minutolo et al., 2019) to the market, increasing investor confidence (Tarmuji et al., 2016).

There have been countless studies looking at how companies' actions to be more sustainable and socially responsible (often collectively referred to as CSR) can affect the corporate financial performance (CFP), with the majority of research finding a positive association (Albertini, 2013; Atz et al., 2021; Friede et al., 2015; Giese et al., 2019). There appears to be three main mechanisms by which greater CSR leads to improved company performance (Giese et al., 2019).

1. **Cash-flow channel:**[4] companies with a strong ESG profile are more competitive, leading to higher profitability, which results in higher dividends.
2. **Idiosyncratic risk channel:**[5] companies with a strong ESG profile have better risk management thus lower risk of severe incidents, which can increase company value and stock price.
3. **Valuation channel:**[6] companies with a strong ESG profile have reduced systematic risk, which lowers cost of capital and increases the investor base, leading to a higher valuation.

[3] CSR is defined as "the voluntary incorporation of social and environmental issues into a company's business model and operations… to meet the needs and expectations of a range of stakeholders, including but not confined to the company's shareholders" (Ioannou & Serafeim, 2015).

[4] Having a strong ESG profile is a competitive advantage (as companies engaged in ESG, for example, may use resources more efficiently, and generally have better long-term planning and incentive structures. This competitive advantage manifests in higher profitability which in turn leads to higher dividends for investors (Giese et al., 2019)6/30/22 5:31:00 PM.

[5] Giese et al. (2019) identified idiosyncratic risk as another channel by which strong ESG can lead to better financial returns. Institutional CSR activities can provide an "insurance-like" benefit (Godfrey et al., 2009), which helps reduce stock volatility (Giese et al., 2019).

[6] The final channel Giese et al., (2019) found was that greater ESG, improved efficiency, which reduced systemic risk which in turn lowered the cost of capital. This increased the valuation directly, and indirectly, as reducing systemic risk also brought in more investors, further increasing valuation.

Additionally, strong ESG profiles in startups have been argued to be tied with lower risk, competitive advantage, and founder qualities associated with successful entrepreneurship (Battisti et al., 2022; Mansouri & Momtaz, 2021). Interestingly, Zhang (2022) experimentally tested VC investors' preferences, and found that for-profit VCs were less interested in investing in startups with a stated impact mission, but that these startups showed better overall fundraising and business performance in the following year. Relatively little literature has explored the financial benefits of adopting a strong ESG profile in startups (Tiba et al., 2018), but it has been argued that startups with a strong ESG profile stand a better chance at securing funding at favorable rates and often represent strong business models(Schramade, 2016; Ugochukwu, 2022), a key to the success of new ventures (Bocken, 2015; Cantamessa et al., 2018). Therefore, it can be argued that the competitive advantage that sustainable startups hold, could translate into a greater chance of startup survival.

Based on the positive effect of high ESG performance seen on CFP, and the proposed positive effect of a strong ESG profile on both company valuation and chance of startup success, one would expect that funds that invest in companies with higher ESG performance will have better financial performance. However, studies assessing funds that invest in ESG-focused companies do not always show this to be the case (Albertini, 2013; Atz et al., 2021; Friede et al., 2015; Kim, 2019; Revelli & Viviani, 2014). Friede et al. (2015) argue that one likely reason for this is investor strategy. Differences are seen between negatively and positively screened funds, where the avoidance of high-performing "sin stocks" cancel out the benefits of ESG-focused investing (Atz et al., 2021; Derwall et al., 2011). Another important factor related to investor strategy that could explain the apparent disconnect between company-level and fund-level performance is willingness-to-pay for non-monetary social benefits and dual-objective impact investors willing to accept below market returns (Barber et al., 2021). Barber et al. (2021) investigated the choice of limited partners (LPs) to invest in traditional VC funds versus impact VC funds with a stated dual-objective, and found that investors, especially development organizations, financial institutions, and public pensions, had a higher willingness-to-pay for impact, with, on average, a willingness to forgo 2.5-3.7 ppts in expected excess IRR (Barber et al., 2021).

2.2 The importance of investment strategy in sustainable investing

Factoring in, and distinguishing between, different investment strategies is essential when studying investment performance. As seen in **Figure 1**, three major strategies within sustainable investing (SI) that are important to differentiate are socially responsible investing (SRI), ESG investing, and impact investing (II) (Lin, 2022). The incorporation of social and ethical standards when selecting portfolio companies (PCs) began in the 1980s with SRI[7] (Ferris & Rykaczewski, 1986; Kumar et al., 2022). More recently, ESG investing and II have developed.

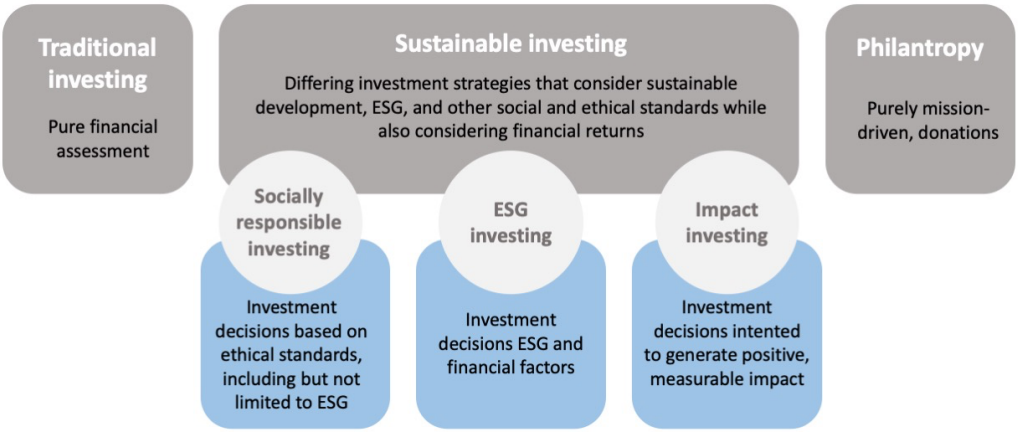

Figure 1. An overview illustrating the different strategies within sustainable investing (SI) and their conceptual placement on the spectrum from traditional investing to philanthropy. Figure adapted from Lin (2022).

Following Cojoianu et al. (2021), we will consistently use ESG investing to refer to investments where the primary objective is to generate a competitive risk-adjusted financial return, using an approach that integrates environmental, social and governance (ESG) aspects together with traditional financial metrics into the investment process (Cojoianu et al., 2021).

ESG investing is primarily based on the incorporation of ESG considerations to create value for investors in relation to risk and return (Cojoianu et al., 2021; Hvidkjær, 2017). Thus, the potential environment or social externalities of an investment decision are primarily considered valuable through their effects

[7] SRI is defined by Berry & Junkus (2013) as "integrating personal values and societal concerns with investment decisions".

on the fund's risks and returns, and financial concerns are placed over social or environmental gain (Cojoianu et al., 2021). This is contrary to impact investing.

Impact investing[8] is distinguished by its emphases on the dual purpose of doing "good while doing well" (Agrawal & Hockerts, 2019; Islam, 2021; Kumar et al., 2022; Robb & Sattell, 2016). Impact investors seek investment opportunities in companies aiming to create positive externalities potentially at the expense of higher financial returns (Cojoianu et al., 2021). II motivations differ from ESG investors as they are willing to trade-off generating financial returns for generating social impact for investing in sustainable companies (Kollenda, 2022).

This main difference between II and ESG investing is the greater focus on positive externalities and potential willingness to forgo financial returns. Impact investors have the dual purpose of creating social and environmental benefits, while generating financial returns at a desired investment risk level (Agrawal & Hockerts, 2021; Cojoianu et al., 2021; Roundy et al., 2017). This dual mission and willingness to pay for positive externalities clearly distinguishes impact investing from both traditional investors, who only focus on generating a financial return on investment, and ESG investors who in addition factor in ESG metrics in achieving competitive risk-adjusted returns (Barber et al., 2021; Roundy et al., 2017; Trelstad, 2016).

Additionally, ESG investing is typically associated with investments in publicly traded bonds, stocks, or funds, while II is primarily related to the financial market through private debt or equity asset classes (Cojoianu et al., 2021). As private financial markets are often characterized as more labor intensive for investors due to high interaction with entrepreneurs (Bachher et al., 2014), impact investors often experience a higher level of engagement with investee companies, than ESG investors (Agrawal & Hockerts, 2019).

Although, there are certain sectors with potential positive externalities where both ESG investors and impact investors are likely to invest (e.g. agriculture, forestry, cleantech or education), ESG investors do not always exclude controversial sectors to the same degree as impact investors do (e.g. gambling, tobacco or fossil fuels) (Cojoianu et al., 2021). This is because they either correct for the fact that the majority of the portfolio consists of responsible sectors or

[8] A key difference between II and SRI is that II generally focuses on positive screening methods to invest in companies likely to have a positive social or environmental impact, while SRI focuses on negative screening, or avoiding investing in companies that could have a negative social or environmental impact (Clarkin & L. Cangioni, 2016).

choose “the companies with the best ESG credentials from each sector” (Cojoianu et al., 2021).

Within VC investing, several studies have assessed the role of impact-focused investment strategies in promoting sustainable change (Alakent et al., 2020; Brest et al., 2018; Holtslag et al., 2021; J.-J. Li et al., 2021), and its effect on financial returns (Barber et al., 2021; Jeffers et al., 2021; Vecchi et al., 2017). However, similar studies related to ESG investing within VC investing are sparse (Cojoianu et al., 2021). Furthermore, the studies focused on financial returns of impact investing within VC show differing results, with Barber et al. (2021) finding lower returns in stated dual-objective impact funds, while Jeffers et al. (2021) found greater risk-adjusted returns in impact funds explicitly stating a mission of meeting market returns. However, studies examining the integration of an ESG investing strategy on fund performance, regardless of stated VC impact-focus, appear to be a gap in the literature.

As impact investors more often invest in companies with strong ESG performance, it is likely that there is a strong correlation between funds consisting of PCs with a high ESG score, and a fund having an impact-focused strategy. Therefore, as an impact investing strategy is tied to lower financial returns (Barber et al., 2021), a portfolio with PCs with high ESG scores is likely to show an overall lower financial performance. However, we argue that when excluding impact funds, higher ESG scores will be tied to better fund performance, as ESG has been shown to be a signal of quality and is tied to greater company level performance and valuations (Buallay, 2019; Minutolo et al., 2019; Xie et al., 2019). This leads us to our hypotheses 1A and 1B:

Hypothesis 1A: Funds that invest in companies with higher ESG scores[9] will have lower returns,[10] when not accounting for impact investment strategy.

Hypothesis 1B: When excluding likely impact funds,[11] funds that invest in companies with higher ESG scores will have higher returns.

[9] ESG scores are inversely related to company level ESG risk. For more information, see methods section 3.3.2.1.

[10] Financial returns are measured primarily by net IRR, with secondary analysis using IRR:TVPI. See methods section 3.3.1. for more details.

[11] For the purpose of this analysis, we are defining “likely impact funds” as those that are likely to be an impact fund based on membership in GIIN by either GPs managing the fund or LPs invested in the fund. See further description in methods 3.3.2.4.

Further exploring the findings of Barber et al. (2021), on the use of an impact investing strategy within VC investing and the observed willingness to pay for positive externalities, we aimed to assess the potential relationship between a fund's proportion of PCs very likely to generate a positive impact and the fund's financial performance. Barber et al. (2021) found dual-objective impact funds to yield 4.7 percentage points lower IRR than non-impact focused funds, when controlling for industry, vintage year, fund sequence, and geography. However, they also found that limited partners (LPs) were generally only willing to, ex ante, sacrifice up to 3.7 percentage points in returns for achieving social impact when investing (Barber et al., 2021). Additionally, Croce et al. (2021) found that VCs with an II focus more frequently invested in companies with negative profitability but interesting growth patterns. This company-level characteristic would likely have an especially strong effect on a fund net IRR, as this metric is biased in factor of short-term gains over long-term gains (Smith et al., 2011). These company-level characteristics are likely the driving factors behind the lower returns seen in II funds, as, despite their willingness-to-pay, investors are likely not actively pursuing lower returns, if given the choice. Therefore, we argue that a fund with PCs with a higher likelihood of having a positive impact will be tied to lower financial returns, especially short-term returns, also when excluding likely impact funds. This leads us to hypotheses 2A and 2B:

Hypothesis 2A: Funds that invest in a higher proportion of impact companies will have lower returns.

Hypothesis 2B: When excluding likely impact funds, funds that invest in a higher proportion of impact companies will have lower returns.

2.3 The role of ESG expertise

VCs add value to their PCs through several mechanisms beyond only providing funding, including providing industry knowledge, managerial skill and general knowhow (Feld & Mendelson, 2019; Meglio et al., 2017). According to past research, the two main types of expertise that have been shown to play a role in investment success are experience in VC investing (R. Harris et al., 2020; Kaplan & Schoar, 2005) and expertise in specific industry areas (Kwak, 2020).

Having industry specific knowledge has been linked to better VC performance (De Clercq & Dimov, 2008). Key benefits of VC specialization and

industry knowledge are: better due diligence and more informed investment decisions (Camp, 2002; Parhankangas & Hellström, 2007) and information sharing between investments to mitigate risk and exploit their technical and product expertise to give advice to their PCs (Bygrave, 1988; Norton & Tenenbaum, 1993). In general, these factors are tied to better investment performance. In a recent study, information sharing within a VC network of ESG startups was seen to have a positive effect on investment performance (Xue et al., 2019).

Furthermore, being able to leverage fund manager ESG expertise has been found to have a positive effect on fund performance both within fixed income SRI funds (Hoepner & Nilsson, 2017) and equity SRI funds (Gil-Bazo et al., 2010). Information sharing and reduction of information asymmetry is a key mechanism that contributes to greater performance (Hoepner & Nilsson, 2017; Xue et al., 2019). Additionally, ESG engagement policies contributed to greater fund performance and reduced risk through improved transparency, communication, relationships, and understanding between companies and investors (Hoepner & Nilsson, 2017).

As fund manager skill has been found to be an important factor in VC fund performance (Diller & Kaserer, 2009; Ljungqvist et al., 2020), and the support of experienced VC firms improve fund performance (Harris et al., 2020; Hochberg et al., 2007; Kaplan & Schoar, 2005), leveraging fund manager ESG expertise could provide positive effects on investments also within the scope of VC investing, given the positive effects of ESG seen elsewhere. This leads us to hypothesis 3:

Hypothesis 3. Funds that are managed by VC firms with specific ESG expertise[12] will have higher returns than funds without this expertise.

As shown in the literature, expertise in a given field is important for VC performance when investing in those fields (De Clercq & Dimov, 2008; Kwak, 2020). This is also seen specifically with ESG (Gil-Bazo et al., 2010; Hoepner & Nilsson, 2017). Furthermore, Gil-Bazo et al. (2010) found that it was only when the fund had SRI specialization that an SRI fund strategy was beneficial for financial performance, while funds without SRI specialization underperformed when utilizing an SRI strategy. Therefore, we argue that within VC investing a similar

[12] See section 3.3.2.3 in methods for an in-depth explanation of ESG expertise. This variable was only available for funds in the subsample with more in-depth data.

relationship would likely be seen, where having a general partner (GP) with ESG expertise would increase the benefits of using a strategy of ESG investing. Thus, the potential positive relationship between financial performance and ESG score will likely be greater in funds with fund managers with ESG expertise compared to those without. This leads us to our hypothesis 4:

Hypothesis 4: There will be a significant positive interaction between ESG score and ESG expertise.

3. Methods

Data were assessed on three levels: (1) "Firm" level refers to fund manager/GP data, (2) "Fund" level refers to fund-specific data, (3) "Portfolio company" level refers to data tied to individual portfolio companies (PCs). All analyses of financial performance were done on a fund level, with company level data aggregated across the fund, and firm level data assigned based on the fund manager.

3.1 Data source

Data was sourced from Preqin, one of the most commonly used data sources within VC literature (Kaplan et al., 2002; Kaplan & Lerner, 2016), and an industry leader in alternative asset data (Preqin, 2022c). One strength of Preqin is that they identify GPs by fund name (Kaplan & Lerner, 2016); improving transparency and verifiability of the data. Preqin's data has been validated in past literature (Harris et al., 2014) and used extensively in peer reviewed research (Preqin, 2022b) and text books (Caselli & Negri, 2021; Metrick & Yasuda, 2021), and been found to yield similar results as other PE databases (Kaplan & Lerner, 2016). Furthermore, another strength of Preqin is the reporting of the source of fund performance metrics, with information regarding if the data comes from the VC firms themselves or public disclosures by pension and sovereign wealth funds.

3.2 Data

First, an initial sample of funds with a vintage of 2019 or older with available ESG and performance data were downloaded from Preqin. Second, fund-level data were matched with corresponding firm level data of the fund manager. 15 funds without matching firm-level data were dropped, leaving a sample of 1,204

funds. Third, from the 1,204 funds, a random sample of 400 funds was drawn for manual data entry due to the time intensity of this task. In the 400 funds, further investigation into PC level data on ESG score[13] and likelihood of positive impact[14] and the number of PCs in the fund was conducted.

Once the final dataset was constructed, descriptive statistics were run to look for outliers and determine if transformations needed to be done to any of the variables. Funds with missing age[15] were dropped, as age is an obligate confounding factor in all analyses. This resulted in an overall sample size of 393 funds.

3.3 Variable selection

3.3.1 Outcome variables

The internal rate of return (IRR) is the most commonly used metric of VC fund performance (McKenzie & Janeway, 2011), and is the main metric of fund-level financial performance used in the analyses. Specifically, the primary variable used was the net IRR (%), which is a measure of the present value of unrealized returns on investments and distribution made to investors relative to the total amount contributed after accounting for fees and applying a discount for time (Preqin, n.d.). The general formula for calculating IRR is as follows:

$$(1) \qquad 0 = NPV = \sum_{n=0}^{N} \frac{CF_n}{(1+IRR)^n}$$

in which:

NPV is the net present value

n represents each period

N is the total holding period

CF are individual cash flows

IRR is the internal rate of return

Net IRR is IRR after accounting for fees. Preqin uses a slightly more advanced model, which also adjusts for varying time periods between cash flows.

[13] See section 3.3.2.1. in methods.
[14] See section 3.3.2.2 in methods.
[15] See section 3.3.3.1. in methods.

However, net IRR has also been criticized for not being accurate when evaluating relatively new funds, as it often takes several years before returns manifest (Ljungqvist & Richardson, 2003) and funds are generally not liquid until an exit (Kazemi et al., 2014; Ljungqvist & Richardson, 2003). Furthermore, using IRR tends to favor funds with faster turnaround and not always higher overall return (Kazemi et al., 2014; Smith et al., 2011).

Therefore, to ensure results are robust to reflect both long- and short-term returns, a secondary metric of fund performance was also assessed. Following the methods of Smith et al. (2011), the hybrid metric IRR:TVPI was calculated from **Equation 2**:

$$(2) \qquad IRR{:}TVPI = ln(1+\text{IRR})+\ln(\text{TVPI})$$

in which:

IRR is the net internal rate of return[16]

TVPI is the total value to paid-in[17]

ln is the natural log

This metric was used as a more holistic assessment of the success of the fund, in accordance with the findings of Smith et al. (2011). However, for ease of interpretation, net IRR was still used as the main outcome variable of interest.

3.3.2 Independent variables

3.3.2.1 ESG score

For each individual PC, Preqin has, in collaboration with S&P Global, calculated an ESG risk magnitude score, based on an algorithm factoring in the company's specific industry and geography, and building on the industry standard framework developed by Sustainable Accounting Standards Board (SASB)(Preqin, 2021a; SASB, 2022). Each company received a risk rating from 0 to 10, calculated from weighted industry and geography factors across all combinations of the 26

[16] See **Equation 1**.

[17] The total value to paid-in is the sum of the fund's residual value and distributions paid relative to the amount paid into the fund.

SASB Factors, 5 SASB pillars, 3 ESG pillars, and ESG overall[18]. The framework created by the SASB has been evaluated and used in other studies (Busco et al., 2020). Additionally, a strength of building on SASB's framework is the inclusion of the ESG risk materiality classifications, which has been shown to be important when assessing ESG's effect on stock performance in past research (Khan et al., 2016). A similar ESG score from Sustainalytics Risk, was used in a recent study on ESG risk and stock performance (Xiong, 2021).

In this study, we calculated a fund-level ESG score for each fund using the arithmetic mean of the ESG risk magnitude scores for all PCs in the fund and then inverted the scale, for ease of interpreting. Thus, a fund with a high ESG score will consist of PCs with, on average, a low ESG risk magnitude, as shown in **Equation 3**.

$$(3) \qquad ESGscore_{(f)} = \frac{\sum_{i=1}^{n}(10 - ESGrisk_{(c)})}{n}$$

in which:

ESGscore is the fund-level average ESG score

f denotes fund-level variables

n is the number of portfolio companies

i is the first portfolio company

ESGrisk is the company level ESG risk magnitude

c denotes company level variables

3.3.2.2 Likelihood of having a positive impact

In order to give an estimate on a PC's likelihood of having a positive external social impact, Preqin has calculated a four-tiered metric from assessing this, factoring in investor and industry factors (Preqin, 2021a). PCs are labeled as either being "very likely," "likely," "possible," or "unlikely/unknown" to have an external positive impact (Preqin, 2021a).

PCs were defined as being "very likely" to have a positive externality if they are either (1) invested in by an "impact fund" or (2) operate in an "impact industry."

[18] Full information on calculation of Preqin's ESG risk magnitude score across all domains, see Preqin's full *ESG Solutions* report: https://docs.preqin.com/pro/Preqin-ESG-Solutions-Methodolgy.pdf

If the PC did not fulfill either of these criteria, the industry and geography the PC operated in was used in relation to the areas of focus defined in the UN's Sustainable Development Goals (SDGs) to assess the likelihood of positive impact on a scale from "unlikely" to "likely."[19] These data are very new in the Preqin database (first released October 2021 (Preqin, 2021b), and, therefore do not appear to have been used in research yet. However, the methodology described by Preqin is largely in line with that used by Barber et al. (2021) and Burton et al. (2021) on a fund level.

For this study, we generated a fund-level metric based on the proportion of PCs within the fund that were labeled "very likely" to have a positive impact. This was done by assigning the value "1" to PCs "very likely" to have a positive impact, and "0" to all other PCs, and taking the arithmetic mean of all PCs' values within the fund portfolio, as shown in **Equation 4**.

$$(4) \qquad Prop_{(f)} = \frac{\sum_{i=1}^{n}(impact_{(c)})}{n}$$

in which:

Prop is the proportion of PCs "very likely" to have a positive impact

f denotes fund-level variables

n is the number of portfolio companies

i is the first portfolio company

impact is the company level binary variable indicating if they are "very likely" to have a positive impact

c denotes company level variables

3.3.2.3 ESG expertise

ESG and industry specific expertise are important for fund performance.[20] Following a similar method as the proxy described by Hoepner & Nilsson (2017), relevant ESG factors were used to create a fund manager ESG expertise variable. A fund manager was determined to have ESG expertise if they had any of the following: (1) "Dedicated ESG investment staff," (2) "... engagements were

[19] For full methodology, see Preqin's full *ESG Solutions* report: https://docs.preqin.com/pro/Preqin-ESG-Solutions-Methodolgy.pdf

[20] See section 2.3 for further discussion of this topic.

conducted on ESG policies or issues," or (3) "ESG educational programs designed and run for portfolio companies."

3.3.2.4 Impact labeled funds

In Preqin, funds have the option of self-designating as an impact fund. However, only 3 that met the inclusion criteria designated as such. Therefore, we chose to supplement this data by designating funds with fund managers or investors that were affiliated with either GIIN or Operating Principles for Impact Management to be considered likely impact funds. These two affiliations were used when Burton et al. (2021) screened for impact investors. In their work, Burton et al. (2021) used further external data to apply more stringent criteria to distill their sample down to only certain impact funds. However, as we generated this variable for the purposes of excluding these from the whole sample, we opted for these less stringent criteria.

Thus, a fund was designated as "likely impact fund" if either (1) it was self-designated as an impact fund, or (2) fund manager or investor had affiliations to GIIN or Operating Principles for Impact Management. This resulted in 123 funds being labeled "likely impact funds." For the analysis that was conducted excluding impact funds, these funds were removed from the sample.

3.3.3 Control variables

3.3.3.1 Time

The average VC fund takes 8 years to show a positive net IRR (Ljungqvist & Richardson, 2003), and assets are generally illiquid in the meantime (Harris et al., 2014). Therefore, it is essential to control for both fund age and vintage. Fund age was calculated as the difference in months between final close date and date last reported. For liquidated funds, Preqin did not have the date of liquidation in the dataset, and erroneous extreme values were present. Thus, as the life of most PE funds is "10 years, with a possible extension of 3 years" (Phalippou & Gottschalg, 2009), the age of liquidated funds was truncated at 150 months. Fund vintage was also included in all models, to account for macroeconomic trends, in line with industry practice (Braun et al., 2017).

3.3.3.2 Geography and industry

When examining fund-level returns, geography and industry are two of the main factors that affect financial returns (Buchner et al., 2018; Gompers et al., 2009; Paglia et al., 2016). Dummy variables were created for the fund's primary region of focus (North America, Asia, Europe, Africa, Americas, Diversified, Middle East, and Australasia). The fund's primary industry was also coded as dummy variables (information technology (IT), telecoms & media, business services, consumer discretionary, energy and utilities, financial and insurance services, industrials, raw materials and natural resources, real estate, healthcare, and diversified). More than one industry was possible for any given fund.

3.3.3.3 Other control variables included in the models

Other control variables (including fund number, number of portfolio companies, fund size, and investment stage) were selected in following with what previous research has done (Barber et al., 2021; Fitza et al., 2009; Kwak, 2020). As past success in VC is a predictor of future fund performance, fund number overall was included (Harris et al., 2020; Kaplan & Schoar, 2005). "Status" was transformed to a binary variable indicating liquidated (1) or closed (0). Status was included as liquidated and closed funds may differ as liquidated funds may have a less accurate age variable but their financial performance might be more accurate compared to closed funds that are still generating returns (Jenkinson et al., 2013).

The number of portfolio companies in each fund was in all models. This variable was log transformed to meet the assumptions of linear regression. Similarly, fund size and fund number overall were also log transformed to meet the assumptions of the model. Other control variables used include fund strategy, fund manager investment stage in general, total staff of VC firm. Total staff was included as a control variable as it is an indicator of investment firm size. Larger firms generally have more resources and expertise. Additionally, when looking specifically at whether the VC firm has dedicated ESG staff, it is important to consider their overall staff number.

3.4 Data analysis

Statistical analyses were performed in STATA/SE 17.0. First, descriptive statistics were conducted to get an overview of the sample. Linear regression models were used to test the different hypotheses to evaluate the association of

different factors on the financial returns of funds. For all analyses, standard errors were clustered by firm ID to deal with the non-independence of multiple funds managed by the same firm, as discussed in Abadie et al. (2017). The control variables for each model can be seen in **Table 1**. For the theoretical form of each model, which hypotheses they are related to, and what outcome variable was used, see **Table 2**.

Table 1. Summary of variables and transformations performed

Variable	**Transformation**
Fund age (months)	Truncated liquidated funds at 150 months
Vintage (year)	None
Fund number (overall)	Natural log
Status (liquidated)	None
Fund size (USD MN)	Natural log
Net IRR (%)	None
IRR:TVPI	None
Number of portfolio companies	Natural log
Proportion of companies very likely to have a positive impact	None
ESG score	None
ESG expertise	None
Likely impact funds	None
Staff	None
Geography dummies	Exclude diversified
Industry dummies	None
Firm stage	Exclude B, C, or D for investment stage in PE
Fund strategy	Excluded general venture

Table 2. Theoretical regression models

Model number	Hypothesis tested	Regression model
Panel A: full subsample		
1	-	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
2	1A	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGscore} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
3	2A	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 impact} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
4	3	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
5	4	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \beta_8 ESGscore + \beta_9 ESGexpert + \boldsymbol{\beta_{10} ESGscore * ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
Panel B: Subsample excluding impact funds		
6	-	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
7	1B	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGscore} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
8	2B	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 impact} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
9	3	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
10	4	$net\ IRR = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \beta_8 ESGscore + \beta_9 ESGexpert + \boldsymbol{\beta_{10} ESGscore * ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$

Model number	Hypothesis tested	Regression model
Panel C: full subsample		
11	-	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
12	1A	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGscore} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
13	2A	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 impact} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
14	3	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
15	4	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \beta_8 ESGscore + \beta_9 ESGexpert + \boldsymbol{\beta_{10} ESGscore * ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
Panel B: Subsample excluding impact funds		
16	-	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
17	1B	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGscore} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
18	2B	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 impact} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
19	3	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \boldsymbol{\beta_8 ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$
20	4	$IRR: TVPI = \beta_0 + \beta_1 age + \beta_2 vintage + \beta_3 status + \beta_4 \ln(funds\ ize) + \beta_5 \ln(fund\ number) + \beta_6 \ln(number\ of\ PCs) + \beta_7 staff + \beta_8 ESGscore + \beta_9 ESGexpert + \boldsymbol{\beta_{10} ESGscore * ESGexpert} + geography\ dummies + industry\ dummies + fund\ strategy\ dummies + firm\ stage\ dummies + \epsilon$

β : beta, the correlation coefficient from the regression model, which indicates the isolated effect of the given variable on the outcome variable, IRR: internal rate of return, TVPI: total value to paid in, *ln*: the natural log, ϵ:epsilon, the error term that covers the random component of the linear relationship

4. Results

Descriptive statistics were run on the sample (n=393). The 393 funds were managed by 273 fund managers, with 69% of fund managers only managing 1 fund. The highest number of funds per fund manager was 6. Variables were visualized and their distributions checked. The main outcome variable of interest, net IRR, was slightly skewed right. The ladder of powers histograms showed that no transformations were advised. Additionally, secondary analysis was done using the log transformed hybrid variable IRR:TVPI. Mean, standard deviation, minimum, and maximum for all continuous variables were calculated for both the subsample (**Table 3**) and the full sample (Appendix **Table A1**).

Table 3. Descriptive statistics in the subsample

	n	**Mean (sd)**	**Min**	**Max**
Fund age (months)	393	110.62 (64.76)	2	288
Vintage (year)	393	2009.52 (7.06)	1989	2019
Fund number (overall)	389	4.96 (7.57)	1	96
Status (liquidated)	393	0.23 (0.42)	0	1
Fund size (USD MN)	382	280.39 (349.07)	0.49	2525.3
Net multiple	359	2.23 (3.17)	0.07	47.44
Net IRR (%)	339	19.55 (35.40)	-88.2	387.05
IRR:TVPI	266	8.09 (1.46)	3.88	12.79
Number of portfolio companies	391	18.16 (19.32)	1	143
Proportion of companies very likely to have a positive impact	391	0.43 (0.33)	0	1
Average ESG score	384	4.88 (1.22)	1.7	8.3
ESG expertise	393	0.08 (0.27)	0	1
Likely impact funds	393	0.31 (0.46)	0	1
Staff	332	40.91 (151.75)	0	1800

There were 11, non-mutually exclusive core industries. The most common was IT (182), followed by diversified (99) and healthcare (97). In terms of strategy, only 23 funds listed expansion as their goal, while the rest were either early stage (166) or general venture (189). Finally, in terms of the primary geographic focus, most funds were in North America (267), with 49 each in Asia and Europe. Only 4 were listed as diversified for their main geography.

Figure 2 shows the frequency of fund vintage in the sample. There is a clear peak around 2000, illustrating the pre-dot com bubble (Ning et al., 2014), another peak pre-2008, and a general increase in the number of funds from 2012 to 2019.

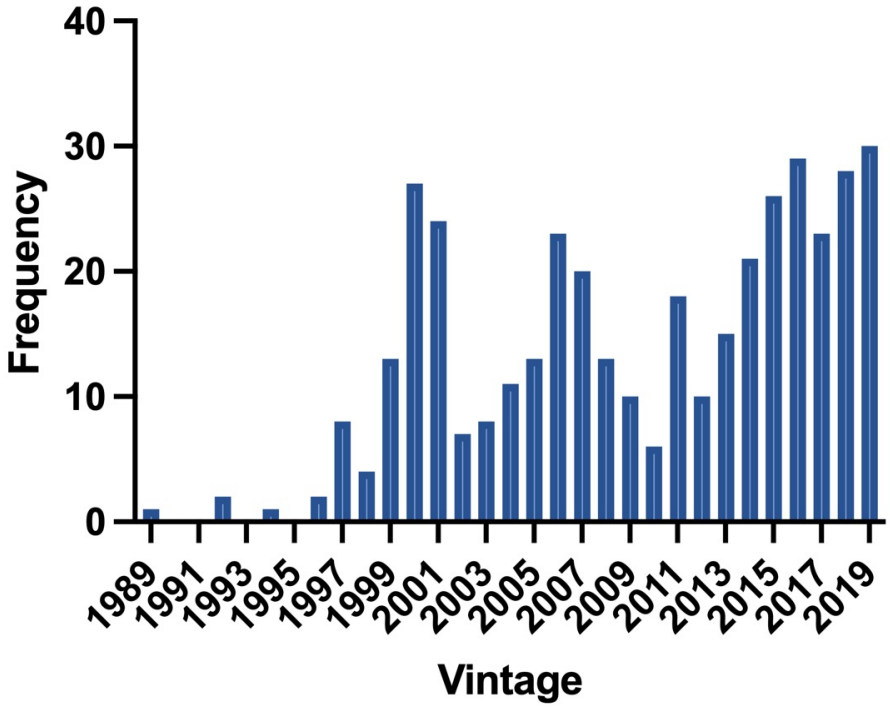

Figure 2. Distribution of funds by vintage

The distribution of mean ESG scores for funds can be seen in **Figure 3A**, while the proportion of companies very likely to have a positive impact are seen in **Figure 3B.**

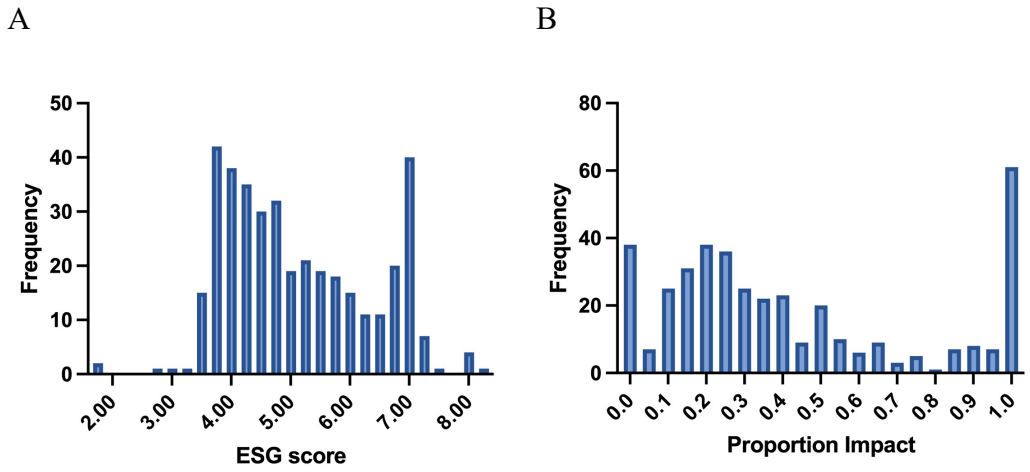

Figure 3. **A.** Histogram showing the distribution of ESG scores across funds. **B.** Histogram showing distribution of proportion of companies very likely to have a positive impact across funds.

Table 4. Results of linear regression models examining the relationship with different factors and IRR

	Model 1		Model 2		Model 3		Model 4		Model 5	
Age	-0.162	(0.208)	-0.163	(0.220)	-0.164	(0.209)	-0.154	(0.242)	-0.162	(0.242)
Vintage	-0.029	(0.985)	-0.018	(0.991)	-0.018	(0.991)	0.137	(0.932)	0.111	(0.947)
Status, liquidated	-3.913	(0.743)	-3.513	(0.774)	-4.117	(0.736)	-2.658	(0.828)	-2.756	(0.830)
Fund size	-1.201	(0.733)	-1.305	(0.717)	-1.107	(0.756)	-1.292	(0.711)	-1.078	(0.770)
Fund number	-1.550	(0.659)	-1.814	(0.611)	-1.682	(0.635)	-1.459	(0.675)	-1.973	(0.588)
Number of PCs	0.566	(0.845)	0.645	(0.828)	0.296	(0.918)	0.474	(0.870)	0.050	(0.987)
Staff	0.002	(0.806)	0.003	(0.782)	0.003	(0.753)	0.009	(0.440)	0.012	(0.347)
Geography dummies	Included		Included		Included		Included		Included	
Industry dummies	Included		Included		Included		Included		Included	
Fund strategy dummies	Included		Included		Included		Included		Included	
Firm stage dummies	Included		Included		Included		Included		Included	
ESG score	-		-0.450	(0.839)	-		-		0.009	(0.997)
Proportion of impact PCs	-		-		-7.149	(0.382)	-		-	
ESG expert	-		-		-		-9.506	(0.197)	49.924	(0.329)
ESG score*ESG expert	-		-		-		-		-11.253	(0.252)
constant	117.001	(0.970)	97.443	(0.976)	98.605	(0.975)	-219.588	(0.946)	-164.802	(0.961)
n	262		259		262		262		259	
R^2	0.1530		0.1547		0.1550		0.1564		0.1629	

Note: p-values reported in parentheses are based on robust standard errors after clustering by Firm ID.

Table 5. Results of linear regression models examining the relationship with different factors and IRR, when excluding impact funds

	Model 6		Model 7		Model 8		Model 9		Model 10	
Age	-0.177	(0.352)	-0.190	(0.315)	-0.172	(0.364)	-0.146	(0.483)	-0.194	(0.353)
Vintage	0.407	(0.863)	0.277	(0.906)	0.482	(0.837)	0.782	(0.762)	0.293	(0.909)
Status, liquidated	4.359	(0.798)	3.570	(0.832)	4.250	(0.807)	7.233	(0.695)	3.063	(0.869)
Fund size	-2.081	(0.615)	-2.350	(0.581)	-1.836	(0.661)	-2.166	(0.598)	-1.939	(0.652)
Fund number	-2.783	(0.546)	-3.003	(0.516)	-3.011	(0.512)	-2.235	(0.632)	-1.672	(0.710)
Number of PCs	1.293	(0.731)	1.556	(0.685)	0.933	(0.804)	1.216	(0.743)	-0.051	(0.990)
Staff	0.001	(0.925)	0.001	(0.919)	0.002	(0.865)	0.011	(0.500)	0.027	(0.141)
Geography dummies	Included		Included		Included		Included		Included	
Industry dummies	Included		Included		Included		Included		Included	
Fund strategy dummies	Included		Included		Included		Included		Included	
Firm stage dummies	Included		Included		Included		Included		Included	
ESG score	-		-0.188	(0.947)	-		-		-0.087	(0.975)
Proportion of impact PCs					-9.766	(0.346)				
ESG expert	-		-		-		-16.073	(0.307)	156.136*	(0.005)
ESG score*ESG expert	-		-		-		-		-35.442*	(0.001)
constant	-740.862	(0.876)	-473.430	(0.920)	-		-1501.607	(0.773)	-509.280	(0.922)
n	178		177		178		178		177	
R^2	0.1317		0.1365		0.1346		0.1363		0.1617	

Note: p-values reported in parentheses are based on robust standard errors after clustering by Firm ID. * indicate significance at $p<0.05$.

Table 6. Results of linear regression models examining the relationship with different factors and IRR:TVPI

	Model 11		Model 12		Model 13		Model 14		Model 15	
Age	-0.007	(0.251)	-0.009	(0.164)	-0.009	(0.140)	-0.008	(0.206)	-0.010	(0.123)
Vintage	-0.013	(0.864)	-0.022	(0.757)	-0.030	(0.685)	-0.024	(0.749)	-0.038	(0.606)
Status, liquidated	-0.367	(0.582)	-0.462	(0.485)	-0.557	(0.408)	-0.467	(0.488)	-0.607	(0.378)
Fund size	-0.091	(0.449)	-0.047	(0.700)	-0.032	(0.790)	-0.092	(0.450)	-0.042	(0.738)
Fund number	-0.020	(0.900)	-0.082	(0.613)	-0.063	(0.698)	-0.013	(0.935)	-0.082	(0.627)
Number of PCs	-0.095	(0.469)	-0.172	(0.192)	-0.185	(0.142)	-0.085	(0.526)	-0.165	(0.220)
Staff	0.000	(0.314)	0.001	(0.125)	0.001	(0.148)	0.000	(0.746)	0.000	(0.406)
Geography dummies	Included		Included		Included		Included		Included	
Industry dummies	Included		Included		Included		Included		Included	
Fund strategy dummies	Included		Included		Included		Included		Included	
Firm stage dummies	Included		Included		Included		Included		Included	
ESG score	-		-0.312*	(0.033)	-		-		-0.306*	(0.040)
Proportion of impact PCs	-		-		-1.561*	(0.004)	-		-	
ESG expert	-		-		-		0.394	(0.372)	1.844	(0.439)
ESG score*ESG expert	-		-		-		-		-0.259	(0.522)
constant	34.833	(0.816)	55.369	(0.699)	69.776	(0.638)	57.679	(0.704)	87.963	(0.557)
n	210		208		210		210		208	
R^2	0.2175		0.2618		0.2619		0.2198		0.2658	

Note: p-values reported in parentheses are based on robust standard errors after clustering by Firm ID. * indicate significance at $p<0.05$.

Table 7. Results of linear regression models examining the relationship with different factors and IRR:TVPI, when excluding impact funds

	Model 16		Model 17		Model 18		Model 19		Model 20	
Age	-0.008	(0.423)	-0.011	(0.237)	-0.107	(0.233)	-0.011	(0.293)	-0.014	(0.156)
Vintage	-0.006	(0.958)	-0.037	(0.722)	-0.038	(0.714)	-0.042	(0.722)	-0.073	(0.515)
Status, liquidated	-0.042	(0.965)	-0.366	(0.680)	-0.478	(0.601)	-0.390	(0.706)	-0.710	(0.456)
Fund size	-0.185	(0.189)	-0.111	(0.434)	-0.078	(0.585)	-0.173	(0.230)	-0.100	(0.495)
Fund number	-0.075	(0.700)	-0.191	(0.300)	-0.184	(0.323)	-0.101	(0.617)	-0.218	(0.256)
Number of PCs	0.014	(0.941)	-0.095	(0.592)	-0.096	(0.585)	0.015	(0.936)	-0.088	(0.622)
Staff	0.000	(0.540)	0.001	(0.140)	0.001	(0.163)	0.000	(0.592)	-0.000	(0.855)
Geography dummies	Included		Included		Included		Included		Included	
Industry dummies	Included		Included		Included		Included		Included	
Fund strategy dummies	Included		Included		Included		Included		Included	
Firm stage dummies	Included		Included		Included		Included		Included	
ESG score	-		-0.456*	(0.011)	-		-		-0.445*	(0.013)
Proportion of impact PCs					-2.259*	(0.000)				
ESG expert	-		-		-		1.129	(0.176)	-0.334	(0.959)
ESG score*ESG expert	-		-		-		-		0.340	(0.814)
constant	21.856	(0.923)	87.473	(0.677)	-		95.339	(0.691)	160.0143	(0.479)
n	143		142		143		143		142	
R^2	0.1944		0.2800		0.2856		0.2036		0.2894	

Note: p-values reported in parentheses are based on robust standard errors after clustering by Firm ID. * indicate significance at p<0.05.

4.1 Control variables

As shown in **Table 4**, Model 1 was used to test whether the control variables were related to the outcome variable, net IRR. Of all the control variables, two industry variables and one of the geography variables were significantly related to net IRR. Focusing on energy and utilities was significantly tied to lower net IRR (-19.0%, p=0.010), and real estate was significantly associated with higher net IRR (35.9%, p<0.001). Compared to funds with a diversified geography, having Europe as a primary geography was associated with a lower net IRR (-17.1%, p=0.038). This significant relation between net IRR and European focus was also seen when excluding impact funds, in control Model 6, where the effect size was even greater (-35.0%, p=0.003). In this model, North America (-26.3%, p=0.005) and the Middle East (-36.4%, p=0.003) also showed a significant negative relationship with net IRR compared to funds with a diversified geography. Beyond this, none of the other control variables were significantly associated with net IRR in this model. In the secondary analysis using the alternative outcome variable IRR:TVPI, none of the control variables were significantly associated with financial performance (Model 11). This also persisted when excluding impact funds, no control variables were significantly associated with IRR:TVPI in Model 16.

Interestingly, in the models that exclude funds managed by likely impact investors, the industries of real estate, financial services, and energy and utilities were dropped from the model due to collinearity. This is because these industries were almost exclusively seen in the likely impact funds.

4.2 Hypothesis 1A

Hypothesis 1A stated that funds that invest in companies with higher ESG scores will have lower returns, when not accounting for impact investment strategy.

First, when examining the mean net IRR data for the funds in each quartile of ESG score, no clear trend was seen. As seen in **Figure 4**, the third quartile had the lowest mean net IRR, while the second quartile had the highest. As indicated by the overlapping confidence intervals, we cannot rule out random effects in the samples.

To empirically test hypothesis 1A, Model 2 (**Table 4**) examined the relationship between fund-level ESG score and net IRR. As there was no significant relationship

between the two variables when correcting for the control variables, hypothesis 1A was not supported when looking at net IRR (-0.450, p=0.839). When looking at the secondary outcome measure, IRR:TVPI (**Table 6**, Model 12), there was a significant negative association between ESG score and financial performance (-0.312 p=0.033). Therefore, Model 12 supports hypothesis 1A, while Model 2 does not.

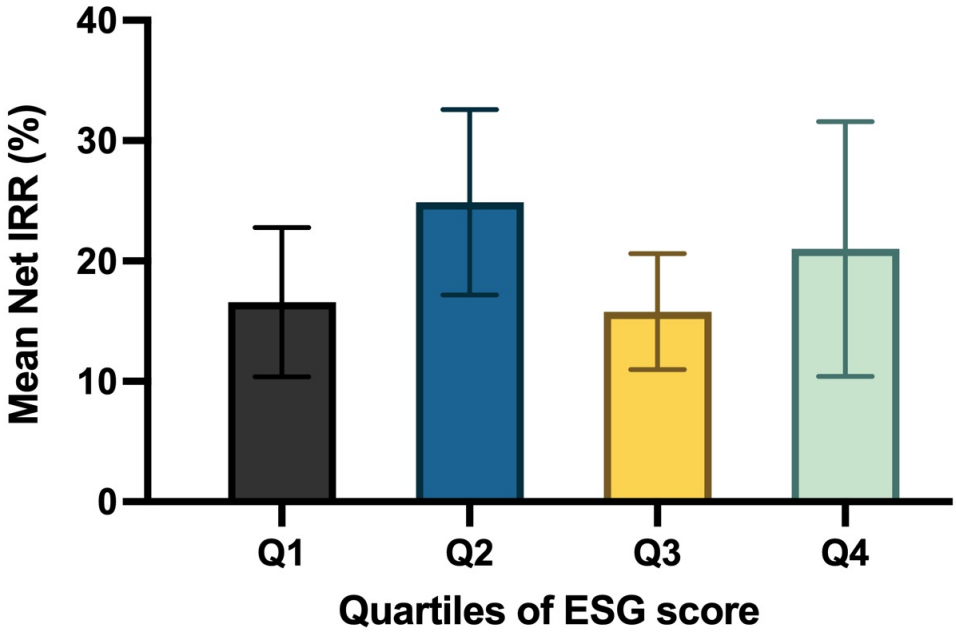

Figure 4. Mean net IRR (%) for funds in each quartile of ESG score. Error bars indicate 95% confidence intervals.

4.3 Hypothesis 1B

Hypothesis 1B stated that when excluding likely impact funds, funds that invest in companies with higher ESG scores will have higher returns.

To test hypothesis 1B, the model was run in the sample excluding likely impact funds, as shown in **Table 5** (Model 7). Even after excluding likely impact funds, ESG score did not have a significant relationship with net IRR (-0.188, p=0.947). However, using the alternative outcome variable IRR:TVPI, there was a significant negative association between ESG and financial performance (-0.456, p=0.011) (Model 17, **Table 4**). Interestingly, this association was in the opposite direction from what was predicted in the hypothesis. Therefore, we did not find support for hypothesis 1B.

4.4 Hypothesis 2A

Hypothesis 2A stated that funds that invest in a higher proportion of impact companies will have lower returns.

When fund-level net IRR data was assessed for each quartile of impact, the second quartile had the highest net IRR, while the fourth quartile had the lowest (**Figure 5**). Although the confidence intervals overlapped and the differences could therefore be explained by random effects, this possible U-shape could indicate a trade-off between focusing too much on impact and having a balanced portfolio.

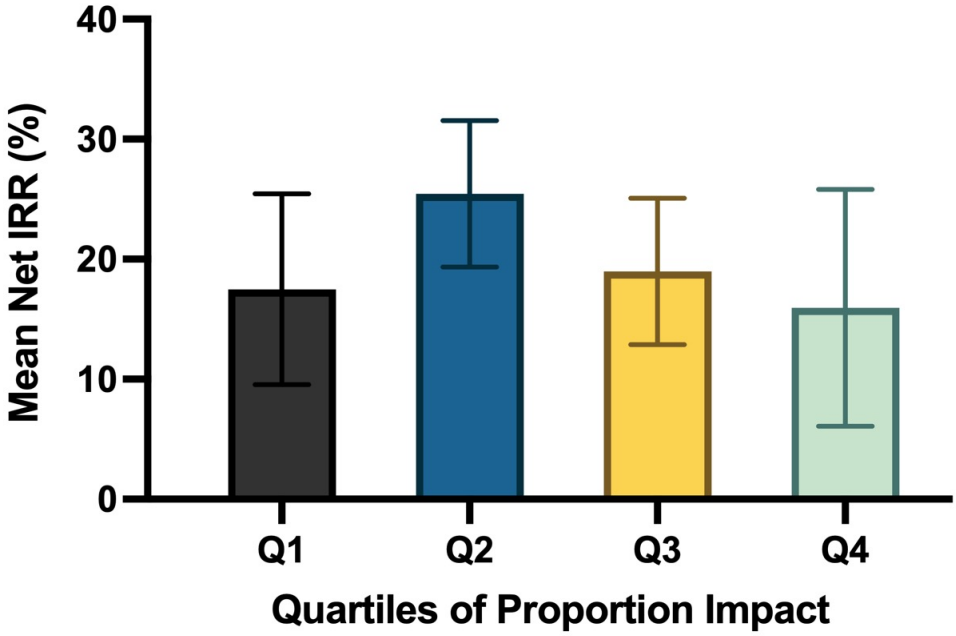

Figure 5. Mean net IRR for funds in each quartile of proportion of companies very likely to have a positive impact in the fund. Error bars indicate 95% confidence intervals.

To test hypothesis 2A empirically, regression analyses were performed to assess the relationship between proportion of the PCs "very likely" to have a positive impact and financial performance, measured by both net IRR and IRR:TVPI. As shown in Model 3 (**Table 4**), there was no significant relationship between this impact metric and net IRR (-7.149, p=0.382); however, there was a significant negative relationship (-1.561, p=0.004) when looking at IRR:TVPI, Model 13

(**Table 6**). Therefore, our hypothesis that a greater proportion of PCs "very likely" to have a positive impact was only supported in one of the two models.

4.5 Hypothesis 2B

Hypothesis 2B stated that, when excluding likely impact funds, funds that invest in a higher proportion of impact companies will have lower returns.

After excluding funds likely using an impact investing strategy, a regression analysis was run to examine the relationship between the proportion of companies in a portfolio very likely to have a positive impact and financial performance to test hypothesis 2B. Similar to the results of hypothesis 2A, there was no significant relationship between the proportion of companies in a portfolio very likely to have a positive impact and net IRR (-9.766, $p=0.346$) (Model 8, **Table 5**). However, when using the secondary outcome measure of IRR:TVPI (Model 18, **Table 7**), there was a significant negative relationship (-2.259, $p<0.001$). Therefore, only one of the two models supported the hypothesis, with the results from the analysis using IRR:TVPI, but not net IRR, supporting hypothesis 2B.

4.6 Hypothesis 3

Hypothesis 3 stated that funds that are managed by VC firms with specific ESG expertise will have higher returns than funds without this expertise.

As shown in **Figure 6**, the mean net IRR for funds with fund managers without ESG expertise was higher than for those with ESG expertise. However, the 95% confidence intervals overlapped, indicating that this difference could be due to random effects.

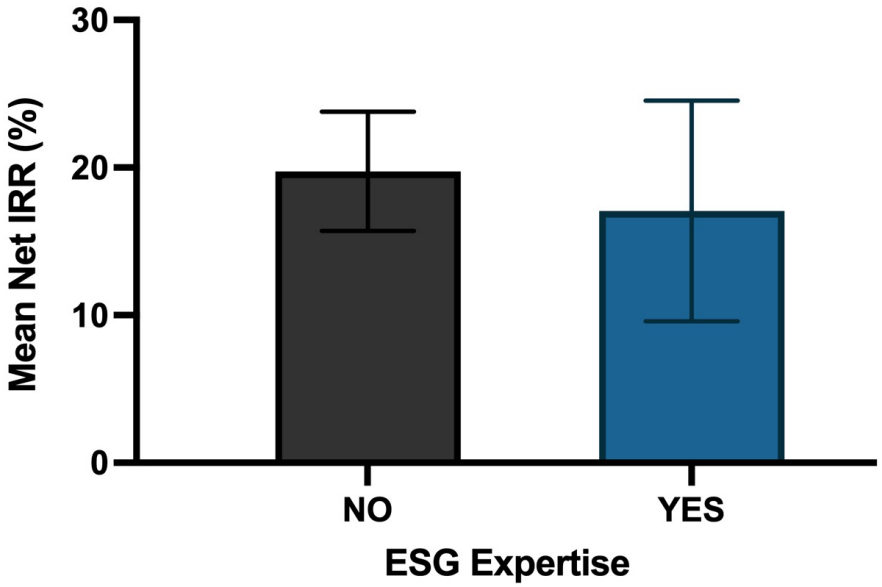

Figure 6. Mean net IRR for funds managed by firms with ESG expertise (n=25) compared to those without such expertise (n=314). Error bars show 95% confidence intervals.

To empirically test hypothesis 3, we included the variable ESG expertise in the linear regression model. Model 4 (**Table 4**) and Model 14 (**Table 6**) examined the relationship between ESG expertise and net IRR and IRR:TVPI, and neither one indicated a significant relationship, (-9.506, p=0.197 and 0.394, p=0.372, respectively). As discussed in Section 2.2, funds that are likely to use an impact-focused strategy might have lower returns due to their dual motivation. This focus might also influence returns in funds with and without ESG expertise. Therefore, the same models were also run when excluding likely impact funds from the sample. The results of these models examining ESG expertise and financial performance in non-impact funds can be found in Model 9 (**Table 5**) for net IRR and for IRR:TVPI in Model 19 (**Table 7**). Neither model showed a significant relationship (-16.073, p=0.307 and 1.129, p=0.176, respectively).

4.7 Hypothesis 4

Hypothesis 4 stated that there will be a significant positive interaction between ESG score and ESG expertise.

Finally, to test hypothesis 4, an interaction term was created to examine the role that ESG expertise might have on the relationship between ESG scores and

financial returns. Again, additional models were run to test whether this association would be skewed by the presence of likely impact funds. In Model 5 (**Table 4**), a regression model was used to look at the interaction term's effect on the relationship between ESG score and net IRR. The interaction term "ESG expertise*ESG score" was not significant in this model (-11.253, p=0.252). After excluding likely impact funds (Model 10, **Table 5**), both ESG expertise (156.136, p=0.005) and the interaction term, ESG expertise*ESG score (-35.442, p=0.001), were significantly associated with net IRR. However, as the interaction term was negatively associated with net IRR, which indicates that the combined effect is less than the individual effects of ESG score and ESG expertise, this went against hypothesis 4. Interestingly, this indicates that in funds not employing an impact-focused strategy, having ESG expertise will decrease the effect of ESG scores on performance.

When looking at the relationship with IRR:TVPI, in both the full sample (Model 10, **Table 6**) and after excluding impact funds (Model 20, **Table 7**), the interaction term was not significant (-0.259, p=0.522 and 0.340, p=0.814, respectively). However, ESG score remained negatively associated with IRR:TVPI in both models (-0.306, p=0.040 in Model 15 and -0.445, p=0.013 in Model 20).

5. Discussion

5.1 Key findings

This study aimed to explore to what extent ESG scores of portfolio companies (PCs) affect fund-level financial performance, and to what extent VC-level factors, such as impact focus or ESG expertise influence this relationship. This goal led to four literature-based hypotheses on how the implementation of a greater focus on the ESG performance of PCs can affect financial returns of VC funds, whether ESG expertise plays a role in fund financial performance, and if having an impact-focused investment strategy influences these relationships.

Data from the Preqin's alternative assets database was used to assess the relationship between fund-level financial returns (as measured by net IRR and IRR:TVPI) and different factors related to the ESG score and potential positive impact of PCs and VC expertise and strategy. Distinguishing our results from past literature on impact investing in VC, this study examines the effect of ESG performance of PCs on fund-level performance, both with and without explicitly distinguishing impact and non-impact VCs. Additionally, we consider the role of

ESG expertise and examine how this influences the relationship between ESG scores and financial performance.

Overall, there seemed to be no clear link with any of the various measures of impact, ESG scores, or ESG expertise and fund-level financial returns, as measured by net IRR. Additionally, there was not an apparent difference between the full model and the models run after excluding the likely impact funds. Furthermore, our secondary outcome measure of financial performance, IRR:TVPI, showed a significant negative relationship with ESG score, even when excluding likely impact funds, in the opposite direction of the hypothesized effect.

Although much of the previous literature had pointed to a positive relationship between higher ESG scores and better company level financial performance (Albertini, 2013; Atz et al., 2021; Friede et al., 2015), we did not see this equate to greater fund performance in our sample, even when excluding impact-focused funds. There might be a few reasons for this. First, we assessed the cumulative financial performance on a fund level, not on an individual company level. As much of the literature has shown, when aggregated to fund level, the link between positive actions and greater financial performance is much less clear (Atz et al., 2021; Kim, 2019; Revelli & Viviani, 2014). Furthermore, one issue might be that the ESG score was not scaled based on the size of the investment in each company. A simple average was taken for ESG score and proportion impact. It is possible that if deal size was used to weight the ESG score and likelihood of impact, the results may have been different. Finally, there is the question of startup survival. Although there was no literature linking ESG score to a higher likelihood of startup failure and there was some literature suggesting that better ESG performance was tied with characteristics associated with an increased chance of startup success (Battisti et al., 2022; Mansouri & Momtaz, 2021; Schramade, 2016; Tiba et al., 2018; Ugochukwu, 2022), this is still a largely unexplored question. Therefore, as this analysis did not incorporate data on startup failure or success, this could also be an underlying cause of the apparent disconnect seen in the literature between ESG's effect on CFP (Albertini, 2013; Atz et al., 2021; Friede et al., 2015; Giese et al., 2019) and the observed effect of ESG on fund-level performance.

Additionally, assessing the modifying effect of ESG expertise on the relationship between ESG score and financial performance, revealed an interesting association. The results showed that despite ESG expertise not being significantly tied to financial performance in either model, it had a significant negative

interaction effect on the relationship between ESG score and net IRR, after excluding likely impact funds. These results indicate that, in non-impact funds, having ESG expertise is in fact tied to worse performance of funds with higher ESG scores.

5.2 Interpretations and implications

This section is structured systematically according to each hypothesis, where we address how our findings compare to existing literature, and how our results relate to previous studies. To begin, we will describe some of the key differences between the primary and secondary outcome measures and why this is important considering the findings of this paper.

5.2.1 Understanding the different dependent variables

When the same models were run using the secondary financial performance metric, IRR:TVPI, instead of net IRR, differences between the models were seen. When testing hypothesis 1A & B and 2A & B, it was only in the models with IRR:TVPI that a significant association was seen, while models with net IRR showed no significant associations. There are some potential reasons for why this difference might have been seen. As described, using net IRR naturally comes with some limitations, as thoroughly investigated in past literature (Harris et al., 2014; Kazemi et al., 2014; Ljungqvist & Richardson, 2003; Smith et al., 2011). First, financial returns and the value of money is very time dependent. Using net IRR may skew the results in favor of short term gains and does not account for the costs and benefits of reinvestments (Kazemi et al., 2014). Additionally, Ljungqvist & Richardson (2003) described the lower accuracy of IRR when evaluating short term returns as developing a positive return often takes several years. Another shortcoming is that IRR tends to favor funds with faster turnaround and not always higher overall return, in addition to that it does not account for the fact that unrealized returns are generally not liquid until an exit (Kazemi et al., 2014).

As described by Smith et al. (2011), the hybrid metric of IRR:TVPI "is more closely aligned with the true dependent variable of interest, fund net present value over consistent investment horizons." Therefore, the hybrid metric might provide insights for comparing funds with differing strategies and time horizons (Kazemi, 2014; Smith et al., 2011). Additionally, as both IRR and TVPI are log transformed within the metric, it reduces the effect of outliers, and could increase the statistical

power of the model. Therefore, as the secondary, but not primary, outcome had a significant relationship this might point to that the underlying relationship could, in fact, be there, but that net IRR in the sample was too variable to show this relationship. If the sample size was expanded, it is then possible that these associations would also be seen in net IRR as well as IRR:TVPI.

5.2.2 Hypothesis 1A and 1B

When looking at net IRR and ESG scores (Model 2), we did not find a significant relationship, contrary to our initial hypothesis 1A, which was that funds that invest in companies with higher ESG scores would have lower returns, when not accounting for impact investment strategy. However, when using the secondary outcome measure of IRR:TVPI, there was a significant negative relationship between ESG scores and IRR:TVPI (Model 12), in support of our hypothesis 1A. As explained, this could be related to the robustness of the secondary outcome measure and that the relationship is related to differing results of IRR over the short- and long-term.

In Model 7 and 17, when excluding likely impact funds, the hypothesized positive relationship between financial performance and ESG scores was not seen. Instead, there was still a negative association with net IRR (nonsignificant) and IRR:TVPI (significant). These findings thus went against hypothesis 1B, as a fund's mean ESG score was not tied to greater financial performance when excluding funds with an impact strategy. The methodological differences between IRR and IRR:TVPI do not explain the unexpected direction of the associations between ESG score and financial performance, when excluding impact funds. This has two plausible explanations. First, the metric chosen to distinguish likely impact funds might not have been robust enough. Although we based our proxy on the methods by Burton et al. (2021), our metric was designed to be more inclusive when designating impact funds in hopes of ensuring the exclusion of all likely impact funds, with the knowledge that this likely also excluded some non-impact funds. The proxy was intentionally built to have a higher sensitivity than the metric used by Burton et al. (2021), and we thus accepted a lower specificity. However, it is possible that this metric still did not have sufficient sensitivity for identifying impact funds, and some impact funds remained in the sample, possibly skewing the results also after we attempted to exclude likely impact funds. Therefore, future research could follow the slightly different approach taken by Barber et al. (2021),

when defining impact funds.[21] However, it is also possible that funds that invest in companies with higher ESG scores might indeed have poorer financial performance. This could either be due to other fund-level characteristics that we were not able to correct for (i.e., a VC's professional network, syndication strategy, or risk management) or due to company-level factors tied to the survival, performance, and valuation of PCs.

5.2.3 Hypothesis 2A and 2B

There was no association between the proportion of companies very likely to have a positive impact and net IRR, in both Model 3, when assessing all funds, and in Model 8, when excluding likely impact funds. However, when the secondary measure of IRR:TVPI was used, the results supported hypothesis 2A, as funds that invested in a higher proportion of impact companies showed lower returns in Model 13. Additionally, the results of Model 18 also supported hypothesis 2B, as, when we excluded likely impact funds, the negative association between proportion impact PCs and lower fund-level financial performance was significant and showed a substantially larger effect size than in Model 13.

When mean net IRR for the funds in each quartile for the proportion of companies very likely to have a positive impact, there was an interesting U-shaped pattern in the data. Despite showing overlapping 95% confidence intervals, indicating that the results should be interpreted with care, this could indicate that the relationship might not be linear, differing depending on a fund's proportion of impact companies. When looking at the histogram of the proportion of companies very likely to have a positive impact across all funds, we see high tendencies towards either end of the spectrum with 37 funds having 0% of their PCs very likely to have a positive impact, while 62 have 100%.

As discussed above, funds that have a specified impact-driven mission have been shown to be willing to forego returns in exchange for other positive social or environmental externalities (Barber et al., 2021; Viviani & Maurel, 2019). Barber et al. (2021) found that investors are willing to sacrifice 2.5-3.7 ppts in annualized IRR when investing in impact funds, and that WTP depended on investor attributes, such as across legal and regulatory environments, investor geography, and time.

[21] When attempting to identify impact-focused funds, we reached out to the authors of Barber et al. (2021) to see if they could share their final list of impact-funds from Preqin, to run a secondary analysis using this list of impact labeled funds but did not receive a response.

In our results, even when excluding the likely impact funds, the negative relationship between the proportion of impact companies in a fund and IRR:TVPI still stood. Based on this, we interpret our findings in support of the assumptions made in hypothesis 2B, which were that a fund's proportion of PCs very likely to have a positive impact would be tied to lower financial performance, even when excluding likely impact focused funds, due to company-level characteristics. Thus, it appears likely that it is the company-level characteristics related to impact companies that is the driving factor behind the lower returns seen in impact funds. The relationship was even greater (from -1.561 to -2.259) and had a lower p-value ($p=0.004$ to $p<0.001$) after excluding likely impact funds. This could be related to the expertise of the likely impact investors. In SRI investment, Gil-Bazo et al. (2010) showed that it was only mutual funds with SRI specialization that managed to yield above-market returns by using a strategy of SRI investing, while funds without SRI specialization failed to exceed market (Gil-Bazo et al., 2010).

As the exclusion of likely impact funds, affiliated with two important impact investing organizations, which provide guidance and shared knowledge, increased the negative association between investing in impact focused companies and financial performance, it suggests both that the impact focused companies themselves have lower financial performance and that to do well in impact investing requires specific expertise in the field. This is in line with the findings of Cole et al. (2021). When examining portfolio returns of the largest and longest-operating impact investors, they found that, over its lifetime, the entire portfolio outperformed the market by 15% (Cole et al., 2021). This suggests that experience is important for financial performance in impact investing.

5.2.4 Hypothesis 3 and 4

We did not find support for hypothesis 3, stating that funds that are managed by VC firms with specific ESG expertise will have higher returns than funds without this expertise. There was no relationship between ESG expertise and either measure of financial returns. Although the literature showed that ESG expertise was associated with improved performance in mutual funds (Hoepner & Nilsson, 2017) and that it contributed to a greater performance of PCs in VC funds (Xue et al., 2019), that was not seen in this sample. Furthermore, when testing hypothesis 4, which predicted that there will be a significant positive interaction between ESG score and ESG expertise, we found no evidence to support this and some indication

of the opposite. The interaction between ESG score and expertise, a negative relationship was found when excluding likely impact funds, contrary to the predicted association. There are two factors to consider here. First, although general VC experience was controlled for in all models by including fund number, this might not have been a sophisticated enough measure of VC knowledge to properly account for the fact that previous VC experience is also important for fund performance (Ellis, 2012; Gompers et al., 2009; R. Harris et al., 2020; Kaplan & Schoar, 2005). As the incorporation of ESG in VC is a relatively recent phenomenon, it is possible that the funds with ESG expertise lacked sufficient general VC knowledge. In one study looking at VC experience in a small sample of impact funds, Vecchi et al. (2017) found that previous VC experience is important for having higher financial returns compared to impact funds without prior VC experience.

Another explanation for the unexpected results seen in the models looking at ESG expertise can be related to the trade-off between diversification and specialization. With all investment, there is a trade-off between these two strategies used to mitigate risk (Norton & Tenenbaum, 1993). Matusik & Fitza (2012) found that when looking at levels of diversification in VC, either end of the spectrum led to better outcomes, as both strategies helped mitigate risk, but committing to neither one was associated with poorer performance. Only when excluding impact funds was the interaction term between ESG score and ESG expertise significant. In this analysis, the interaction had a negative effect on the relationship between ESG score and net IRR, opposite of our hypothesis. As our measure of ESG expertise was not indicative of whether the fund was only focused on ESG investing, but rather whether the fund manager had the specific ESG expertise, it is possible that these funds could be caught in the middle of the u-shaped curve between specialization and diversification (Matusik & Fitza, 2012). This follows the findings of Gil-Bazo et al. (2010), who found that SRI expertise was beneficial for financial performance when the funds were specialized in SRI.

5.3 Limitations

There were a few limitations to the methodology used in this study. Some are in line with inherent limitations of research in this field, while others are specific to this paper and could be addressed by future research.

One limitation with the data in our study is that Preqin partially relies heavily on self-reported return data. For approximately half of the funds included, the data were reported by the VC firms, while the other half came from financial disclosure of public funds, such as pensions and government organizations. However, Preqin's data has been validated (Harris et al., 2014) and found to be largely in line with other industry databases (Kaplan & Lerner, 2016).

An inherent limitation in most studies examining both impact and ESG is the validity of the data used. There is a lot of nuance surrounding impact, how it is measured and reported, and whether or not indicators of ESG are good measures of realized positive impact (Fiaschi et al., 2020; Trautwein, 2021; Utz, 2019). Although Preqin states that their approach for creating their impact and ESG risk metrics is "largely in line with common practice and/or have been validated by the market itself," they also highlight the limitations of this methodology, especially related to potential greenwashing (Preqin, 2021a). Therefore, this might not be an accurate representation of the financial performance of funds investing in companies having an actual positive impact or good ESG performance, but rather those that externally appear as such. A larger issue with the methodology used to construct the impact and ESG score variables is likely not greenwashing, but rather the fact that they are mainly generalized based on industry and geography. Although vetted by a council of experts, there could be some issues around the reliability of these measures (Preqin, 2021a). However, Preqin's methodology is in line with industry standards (Preqin, 2021a; SASB, 2022). However, an additional limitation of both the ESG score and the likelihood of impact variables used in this study is that both were averaged across the fund without considering the relative size of investment in each PC.

5.4 Future directions

Future research should investigate other factors that could explain the mixed results seen in the financial performance of impact investing in venture capital. We hypothesized that one potential factor was ESG expertise; however, there are numerous other confounding factors that may play a role. For example, as VC experience has also been shown to be important (Ellis, 2012; Gompers et al., 2009; Harris et al., 2020; Kaplan & Schoar, 2005), it could be the combination of these two factors. Although we controlled for experience by including the fund number in our regression models, a more in-depth study of this relationship could reveal

whether there are any trade-offs between ESG knowledge and specific aspects of VC experience.

The literature has also shown that better ESG performance is tied to both lower systematic and idiosyncratic risk (Giese et al., 2019), and that when adjusting for risk, impact investing could lead to higher returns (Jeffers et al., 2021). Although we found no significant relationship between net IRR and ESG score, this could be a result of not adjusting for risk. However, as there was a negative relationship between ESG score and IRR:TVPI, future research should examine risk-adjusted returns, ideally also considering the variable time-horizon of ESG investments.

A key piece in the puzzle that is missing for understanding some of the disconnect between ESG effects on company performance and fund performance might lie in startup survival. Despite some having argued that a strong ESG profile is tied to factors related to startup success (Battisti et al., 2022; Mansouri & Momtaz, 2021), very little has been empirically shown (Zhang, 2022). Therefore, future research is needed to further the understanding of how impact or ESG focus affects startup survival.

Much of the literature looks at only specific aspects of ESG or impact investing by picking specific proxies of interest. However, few studies compare the different parameters separately (Buallay, 2019; Tamimi & Sebastianelli, 2017). One example in mutual funds is from Ito et al. (2013). They found, when dynamically considering risk and return, socially responsible funds outperformed both conventional and environmentally focused funds, which also had returns equal or greater than the conventional funds (Ito et al., 2013). Future research could repeat our analysis, while looking specifically at differences among the different ESG factors, instead of grouping them together as a whole.

Finally, future studies could repeat this research with another metric of fund financial performance, such as public market equivalent (PME). We attempted to counter some of the issues with net IRR by including the hybrid metric IRR:TVPI. However, PME is used in some studies looking at VC fund performance and compares their performance to a public market index, for instance the S&P 500 (Jenkinson et al., 2013; Jiang, 2017). Although Jeffers et al. (2021) found that VC in general underperformed compared to the market when using PME, they also show that impact investing outperformed regular VC investments, despite still not meeting public market returns. In the future, alternative measures of financial performance might also be considered, especially in the impact investing space,

where positive externalities are more important to investors. Some have attempted to create models to account for these nonpecuniary benefits (Reeder & Colantonio, 2013), but future research should explore this further.

As there is a definitive market trend towards more sustainable investments across asset classes, VC firms will need to learn how to do well while making more sustainable choices (Alfonso-Ercan, 2020). It is crucial that they quickly learn how to profitably incorporate these factors to stay ahead of the curve. Additionally, when done correctly, having an ESG or impact focus can help PE firms when raising funds (Indahl & Jacobsen, 2019), a trend likely to continue accelerate in the future (Alfonso-Ercan, 2020).

6. Conclusion

This thesis contributes to the emerging literature on sustainable investments in venture capital. Within VC investing, the incorporation of ESG performance in investment decisions to help reduce risk and improve financial performance has been little studied. Therefore, we explored to what extent the ESG performance of PCs affected the financial returns of VC funds. We also wanted to understand if this relationship was affected by VC firm level factors, such as having an impact-focus strategy or ESG expertise. Furthermore, we aimed to assess if lower returns were due to the strategy of the impact investors or the inherent characteristics of the impact companies.

The results showed that for the main outcome variable, net IRR, there was no significant association between the average ESG score of a fund's PCs and fund-level financial performance. Also, the exclusion of likely impact-focused funds did not lead to a positive association between ESG scores and net IRR. In fact, for the secondary outcome variable, there was a significant negative association between ESG score and IRR:TVPI in the linear regression models, both when assessing all funds and when excluding likely impact funds.

Furthermore, when assessing the link between a fund's proportion of PCs very likely to have a positive impact and financial performance, there was no significant association when assessing the main outcome variable, net IRR, in either regression model. However, when using the secondary outcome measure, IRR:TVPI, there was a significant negative association between the proportion of PCs very likely to have a positive impact and IRR:TVPI, both when including and excluding funds with a likely impact-focused strategy.

Lastly, when assessing the effect of the VC having ESG expertise on the association between ESG score and fund-level financial performance, we found that across all funds, there was no significant interaction effect in either outcome measure. However, when excluding impact funds, an unexpected negative interaction effect was observed, where ESG expertise negatively affected the relationship between ESG score and fund-level financial performance.

Overall, our findings indicate that there is not a clear link between ESG performance in PCs and greater VC fund performance. As the data trends towards the opposite, also when excluding likely impact funds, it does not appear prudent to advise a conventional, non-impact VC to incorporate a greater focus on ESG performance as a tool to reduce risk and increase financial returns based on these findings. However, not all hope is lost for those wishing to do good while doing well. This study was done in a relatively small sample of VC and using imperfect metrics. It should be repeated with additional data from Preqin and outside sources that can help independently assess the relationship between ESG and VC financial performance. Additionally, with the growing demand for sustainable investments, also within private equity, finding profitable ways to incorporate ESG might be the only way forward.

7. Appendix

Table A1. Descriptive statistics in the whole sample

	n (missing)	Mean (sd)	Min	Max
Fund age (months)	1,186 (0)	109.31 (62.84)	0	288
Vintage (year)	1,186 (0)	2009.53 (7.15)	1981	2019
Fund size (USD MN)	1,145 (41)	272.71 (383.46)	0.49	4605
Fund number (overall)	1,179 (7)	5.07 (7.74)	1	96
Fund number (in series)	1,165 (21)	3.42 (2.70)	1	17
Fund manager total AUM (USD MN)	624 (562)	8,086.31 (37,593.35)	0.14	731,000
Fund unrealized value (USD MN)	793 (393)	307.58 (618.53)	0.06	6,192
Fund dry powder (USD MN)	793 (393)	39.76 (183.10)	0	4101.67
Fund AUM (USD MN)	793 (393)	347.34 (674.16)	0.09	6,612
Fund manager total number of funds in market	1,186 (0)	0.87 (2.79)	0	34
Fund manager total number of funds closed	1,186 (0)	9.80 (14.63)	0	124
Fund manager total funds raised in the last 10 years	989 (197)	2514.00 (7056.65)	1.2	80773.6
Fee charges per year	144 (1042)	4.22 (1.89)	1	12
Fund manager total staff (#employees)	987 (199)	40.98 (155.70)	0	2400
RVPI (%)	1,089 (97)	107.24 (192.26)	0	4,394.69
DPI (%)	1,099 (87)	106.49 (166.55)	0	2,057.26
Called (%)	1,134 (52)	92.29 (18.96)	4.02	196.08
Net multiple (X)	1,074 (112)	2.13 (2.41)	0	47.44
Net IRR (%)	1,003 (183)	19.46 (33.79)	-88.2	514.33
IRR:TVPI	768 (418)	8.09 (1.48)	1.73	13.84
Fund manager ESG transparency score (%)	1,186 (0)	11.59 (13.69)	0	89
Source (% publicly disclosed)	893 (292)	0.49 (0.50)	0	1
Status (% liquidated)	1,186 (0)	0.24 (0.43)	0	1
Key ESG industry	1,186 (0)	0.49 (0.50)	0	1
ESG industry expertise	1,144 (42)	0.45 (0.50)	0	1

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