Empirical Analysis of DARC and IRR Comparisons

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1. Introduction

In recent years, investing in private equity and venture capital through funds has become increasingly active. There is ongoing discussion about how to evaluate the performance of these funds, and many different evaluation metrics have been suggested. In Saccone and Gentilini (2024), some common metrics for evaluating private equity (PE) funds are introduced. The advantages and weaknesses of each metric are discussed. In these discussions, it is especially focused on DARC (Duration-Adjusted Return on Capital). DARC was developed to overcome the weaknesses of IRR (Internal Rate of Return), PME (Public Market Equivalent), and

Equivalent), and

Direct Alpha. It claims to measure the performance of private equity more accurately. In this analysis, we will focus on DARC. In particular, we will organize the theoretical similarities between DARC and IRR and conduct an empirical analysis using actual PE fund data.

The rest of this study is structured as follows. Section 2 explains DARC methodology. Section 3 discusses its similarities with IRR from a theoretical perspective. Section 4 describes FactSet Private Equity Cash Flow data. In Section 5, we calculate DARC and compare it with IRR. Furthermore, we conduct an empirical analysis on the differences in characteristics by

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fund type. Finally, in Section 6, we provide a summary and discuss future issues.

2. DARC Methodology

In this section, we will explain how to calculate DARC. The DARC method is patented in Saccone, M. (2013). The information needed includes contributions, distributions and the risk-free rate at each point in time. However, it is important to note that the distribution at the final point will be the net asset value (NAV) at that time. Therefore, for each PE fund, it is necessary to have data in a matrix format like the following.

$$\begin{bmatrix} t_0 & contr_0 & distr_0 & rate_0 \\ t_1 & contr_1 & distr_1 & rate_1 \\ \vdots & \vdots & \vdots & \vdots \\ t_{n-1} & contr_{n-1} & distr_{n-1} & rate_{n-1} \\ t_n & contr_n & nav_n & rate_n \end{bmatrix}. \tag{1}$$

First, we will calculate the NPV of cash flows by discounting them using the risk-free rate. We will calculate the durations, denoted as $D_{contr,ave}$ and $D_{distr,ave}$, for contributions and distributions, using the NPV.

$$D_{contr,ave} = \frac{\sum_t t \times NPV_{contr_t}}{\sum_t NPV_{contr_t}}, \qquad D_{distr,ave} = \frac{\sum_t t \times NPV_{distr_t}}{\sum_t NPV_{distr_t}}. \tag{2}$$

Next, based on the calculated durations, we will calculate the EBC (Equivalent Bullet Contribution) and EBD (Equivalent Bullet Distribution m). In the following equations, $CompoundRate(t)$ is the return when using the risk-free rate from t_0 to t.

$$EBC = \left(\sum_t NPV_{contr_t}\right) \times CompoundRate(D_{contr,ave}). \tag{3}$$

$$EBD = \left(\sum_t NPV_{distr_t}\right) \times CompoundRate(D_{distr,ave}). \tag{4}$$

Using these calculation results, DARC is defined by the following equation.

$$DARC = \left(\frac{EBD}{|EBC|}\right)^{\frac{1}{D_{distr,ave} - D_{contr,ave}}} - 1 . \tag{5}$$

We add a bit more explanation about how to calculate DARC. Using the concept of duration, we can think of the start of the investment as $D_{contr,ave}$ and the end of the investment as $D_{distr,ave}$. In other words, to evaluate the results of the investment, we need to adjust the NPV to represent the value at each time point. We calculate EBC and EBD based on the assumption that we use the $CompoundRate(t)$ to grow the investment to each time point. By looking at the ratio of the calculated EBC and EBD, we can evaluate the performance of the PE fund, which is what DARC represents. Additionally, by looking at the difference in durations $D_{distr,ave} - D_{contr,ave}$, we can also understand the length of time it takes for that performance to be realized.

3. DARC vs IRR

In this section, we will discuss the similarities and differences between DARC and IRR from a theoretical point of view. IRR is the interest rate r at which the present value of cash flows equals zero.

$$C_0 + \frac{C_1}{1+r} + \frac{C_2}{(1+r)^2} + \cdots + \frac{C_n}{(1+r)^n} = 0 \ . \tag{6}$$

Here, we can write it as follows because the cash flows at each time point can be broken down into contributions and distributions.

$$\sum_t \frac{contr_t}{(1+r)^t} + \sum_t \frac{distr_t}{(1+r)^t} = 0 \ . \tag{7}$$

If we consider IRR (r) as a risk-free rate that is constant over time, we can present that

$$NPV_{contr} + NPV_{distr} = 0 \ . \tag{8}$$

Furthermore, when we rewrite it in terms of EBC and EBD, we get

$$EBC \times \frac{1}{(1+r)^{D_{contr,ave}}} + EBD \times \frac{1}{(1+r)^{D_{distr,ave}}} = 0 \ . \tag{9}$$

If we solve this equation for r, we have

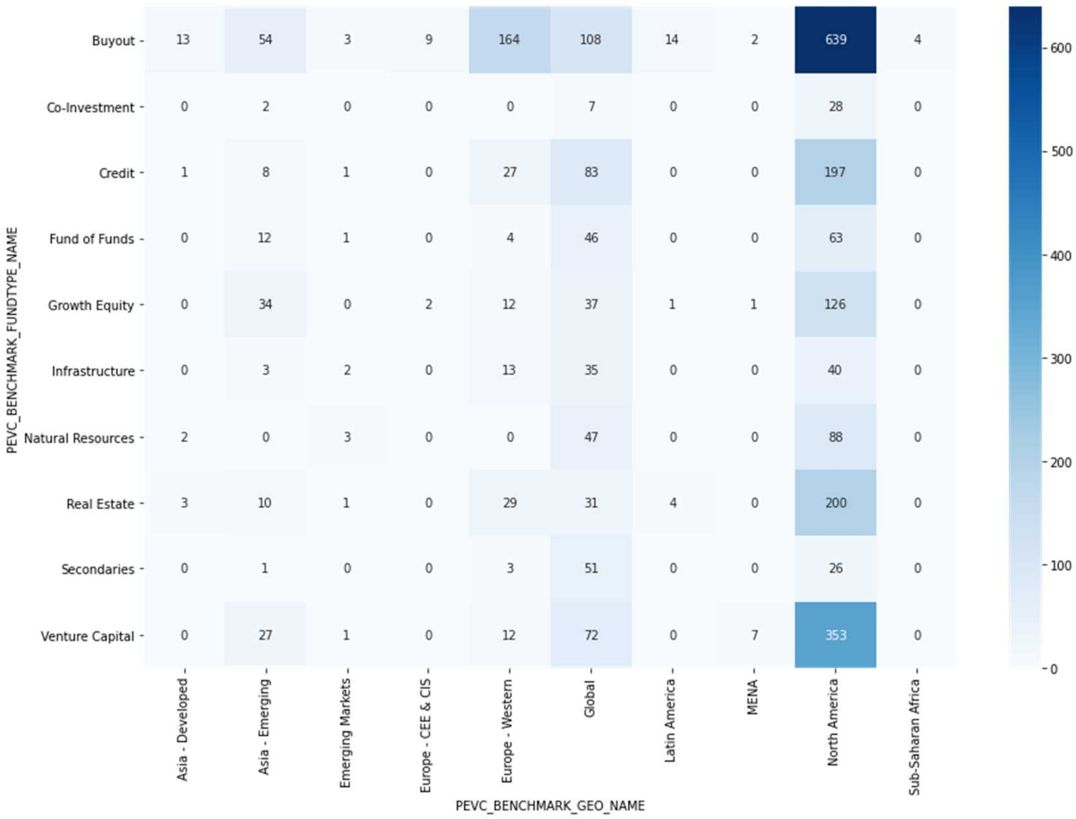
$$r = IRR = \left(\frac{EBD}{|EBC|}\right)^{\frac{1}{D_{distr,ave} - D_{contr,ave}}} - 1 \ . \tag{10}$$

This leads us to the same formula as DARC. In other words, by assuming that IRR equals the risk-free rate, we can show that IRR and DARC are equivalent. This means that DARC can also be interpreted as an extended definition of the IRR concept. By considering the r that represents performance on the left side and the risk-free rate used for calculations on the right side as separate, we think that DARC measures performance in a way that is more aligned with reality than IRR. This highlights the same issue that has been mentioned about IRR, which implicitly assumes the reinvestment of distributions at IRR (r). However, depending on changes in the risk-free rate, it is also possible for IRR and DARC to give similar results. For example, in XTAL Strategies (2020), it is mentioned that DARC can capture the features and trends of IRR, supported by actual calculation results.

4. About usage data

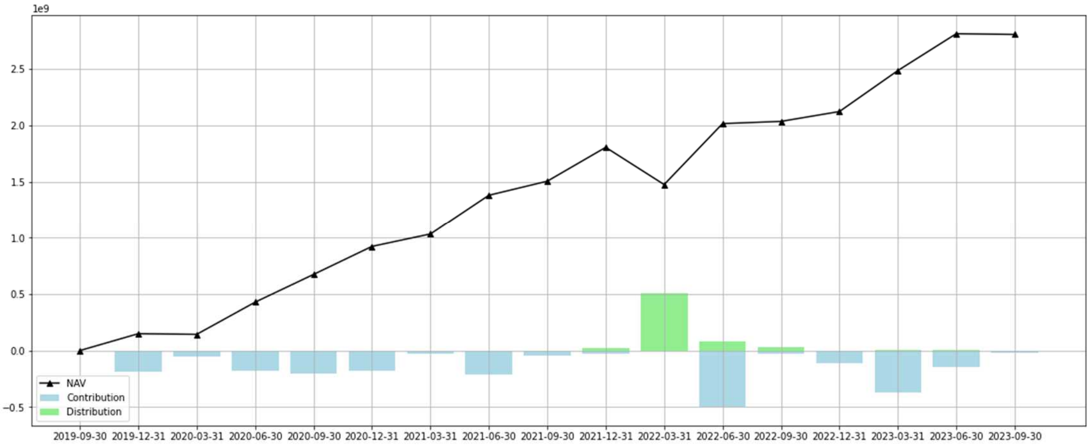
When calculating DARC, we utilize the cash flow table recorded in FactSet Private Equity Data. This table contains the time-series cash flows for individual PE funds. PE funds are categorized by attributes such as Fund Type, Geometry, and Vintage. In Figure 1, we can see the number of funds that exist based on the Fund Type and Geometry. We notice that there are relatively many funds in Geometry that are from North America, especially in the Fund Type of Buyout and Venture Capital.

Figure 1: Number of funds that exist based on the Fund Type and Geometry



When we look at the data for each individual fund, we can see the contributions, distributions and NAV at each point in time. In Figure 2, we display the three pieces of information for a specific fund in a graph.

Figure 2: An example of cash flow data for a specific fund



Unit: Dollars

5. Calculation Results

In XTAL Strategies (2020), the similarity between the time series IRR and DARC of a single PE fund was examined. In this analysis, we take a different perspective by comparing the IRR and DARC across different PE funds at the same point in time. This analysis is focused on three Fund Types: Buyout, Growth Equity and Venture Capital in North America. While IRR is stored in the performance table, there were some differences between the IRR stored and the IRR calculated from cash flow table. To make a fair comparison with DARC, we used the results calculated from the cash flow table. The calculation date is set to March 31, 2023, for all cases.

Also, the risk-free rate is based on the 10-year U.S. Treasury yield provided by FRED[2]. As shown in Figure 3, the risk-free rate is presented as a year-on-year (YoY) value. However, since the cash flows are quarterly, we use the quarterly adjusted rate to calculate the $CompoundRate(t)$.

The results of the comparison between DARC and IRR for each Fund Type are shown in Figure 4. Please note that data with performance exceeding 100% has been excluded from the graph for visualization purposes. The correlation between DARC and IRR is about 69% for Buyout, about 76% for Growth Equity and about 86% for Venture Capital. We can see that there is a high correlation in all Fund Types. This is consistent with what was discussed in

[2] Federal Reserve Economic Data, Interest Rates: Long-Term Government Bond Yields: 10-Year: Main (Including Benchmark) for United States, https://fred.stlouisfed.org/series/IRLTLT01USQ156N

Chapter 3.

Figure 3: Trends in the U.S. 10-Year Treasury Yield

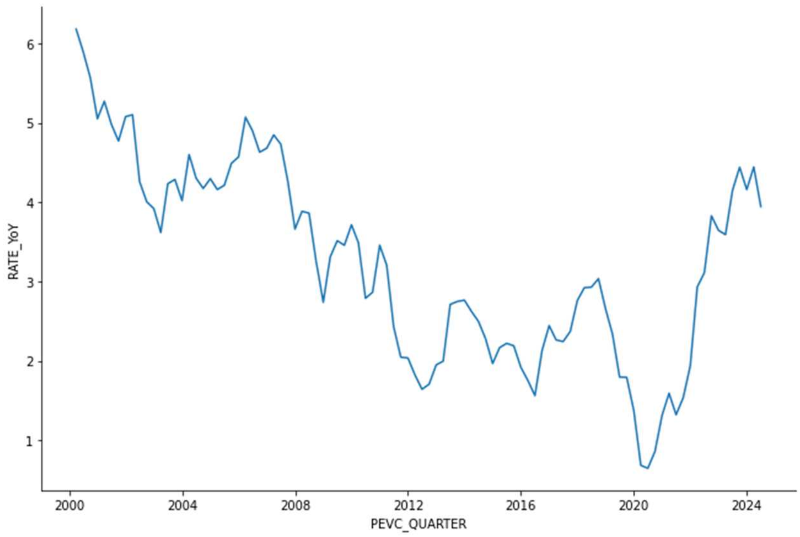
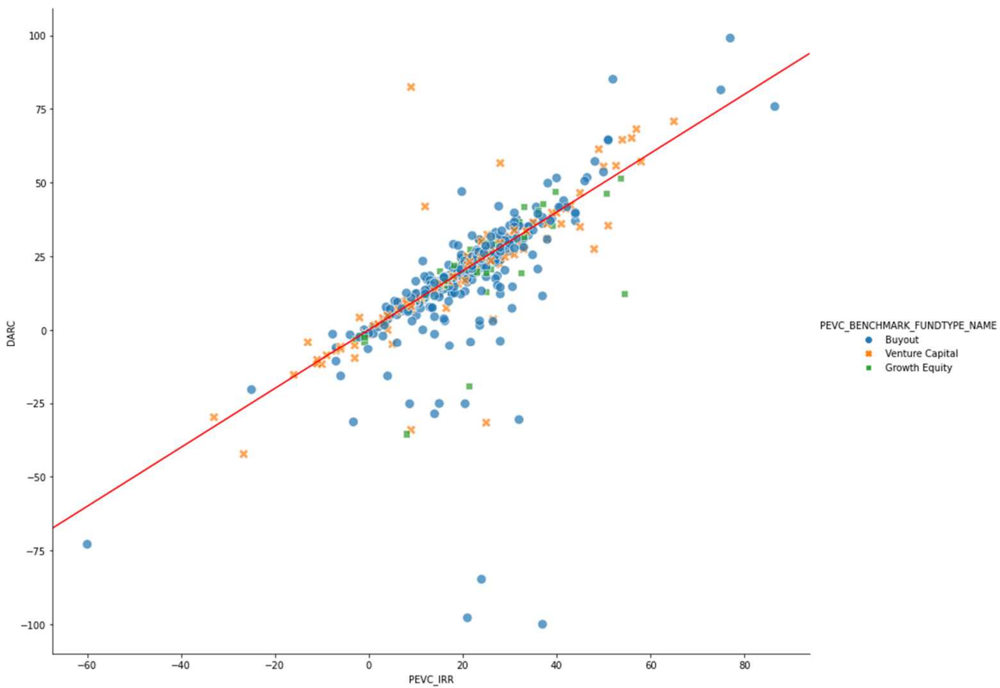


Figure 4: Comparison of DARC and IRR (%/annual.)



Next, we show the histograms of DARC for each Fund Type in Figure 5, and the statistical distribution of DARC in Table 1.

Figure 5: The histograms of DARC (%/annual.) for each Fund Type

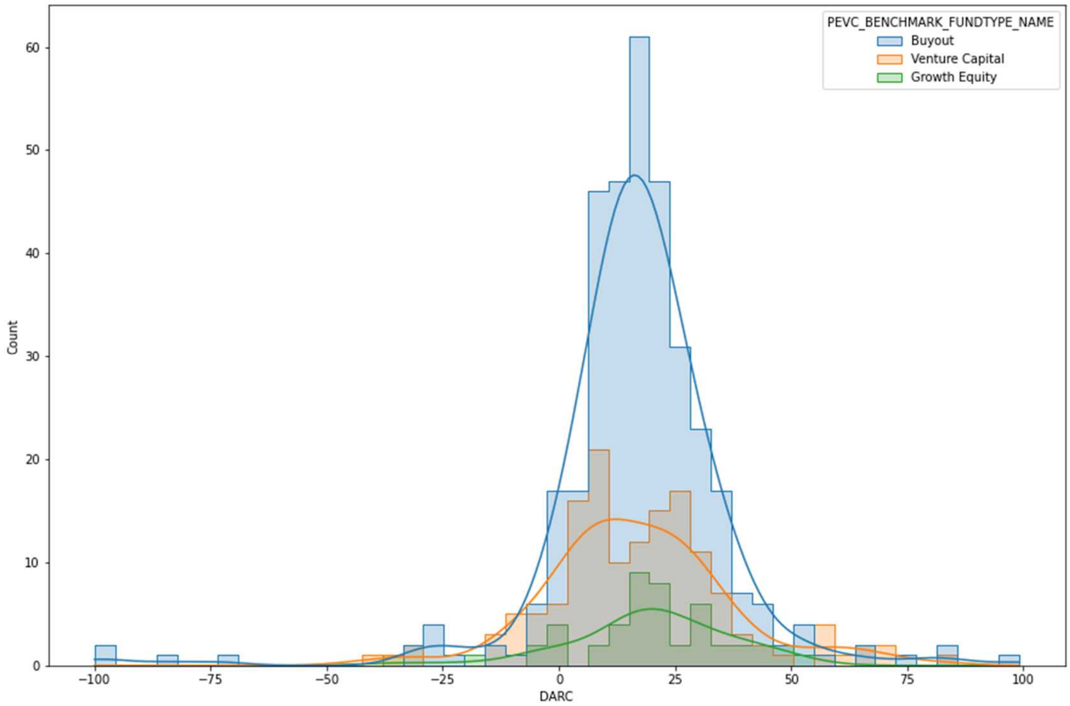
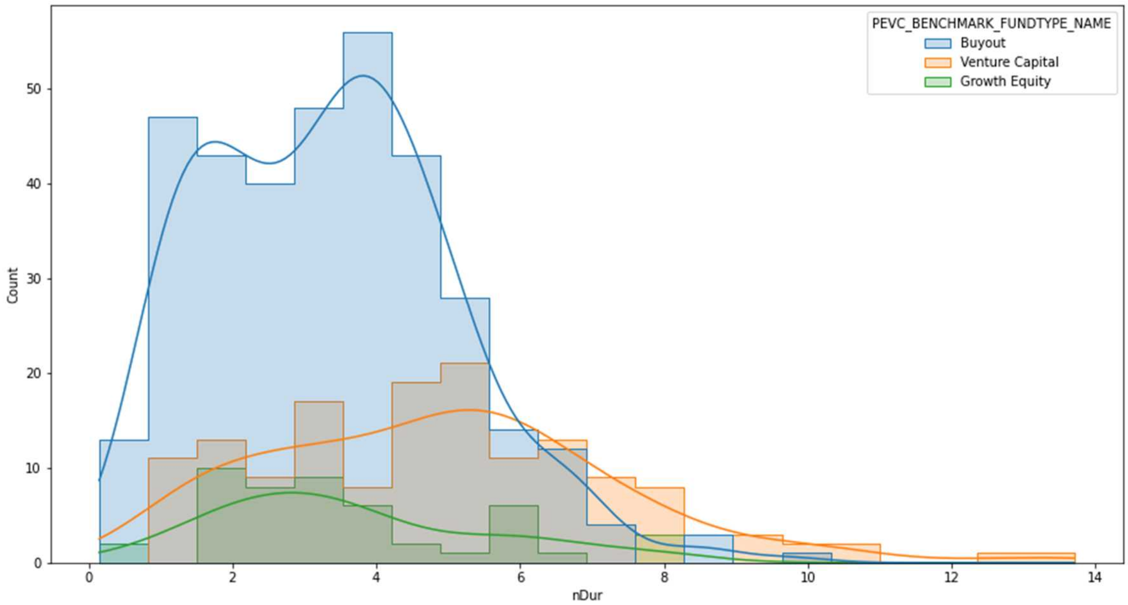


Table 1: The statistical distribution of DARC (%/annual.)

	Buyout	Growth Equity	Venture Capital
Mean	16.91	19.78	17.20
Std	19.24	16.94	19.88
Skew	-1.44	-0.76	0.34
Kurt	11.56	1.55	1.38

When we look at the differences in Fund Type, we see that the standard deviation (Std) of Venture Capital is the biggest and the kurtosis (Kurt) is the smallest. This shows that the distribution is relatively wide. From the DARC perspective, this suggests that Venture Capital is relatively high risk and high return. It also matches the fact that the investment stage of Venture Capital is still immature and has high uncertainty for the future. Furthermore, we find that only for Venture Capital, the skewness (Skew) of the distribution is positive, meaning that the right side of the distribution is relatively wide. This result is consistent with the idea that in early-stage investments, some can produce huge returns while most fail. However, when we evaluate the uncertainty of investments from the perspective of the Max-Min distribution of DARC, we find that Buyout has a high risk. This suggests that the risks depend a lot on the specific factors of each PE fund, which also shows the limits of statistical discussion.

Figure 6 The histograms of $\boldsymbol{D_{distr,ave} - D_{contr,ave}}$ (%/annual.)



We show the histogram of the difference in duration, which is $D_{distr,ave} - D_{contr,ave}$, for each Fund Type in Figure 6. We can see that Venture Capital takes a longer time to gain returns. This result suggests a high level of uncertainty in early-stage investments, like the distribution statistics in Table 1.

6. Conclusion

In this analysis, we focused on DARC as one of the indicators to evaluate the performance of PE funds and examined the differences from IRR. First, we organized the theoretical aspects to show the relationship between DARC and IRR, showing that DARC is defined as an extension of IRR. We compared DARC and IRR on a cross-sectional basis and confirmed that there is a high correlation. This result is consistent with past examples that show similarities between DARC and IRR. Furthermore, we looked at the differences in trends by Fund Type from the perspective of DARC. We found results that support the uncertainty of

Venture Capital investments from a quantitative viewpoint, such as distribution statistics and the difference in duration.

However, in general, PE funds have specific risk factors that cannot be explained by statistical discussions grouped by attribute information. Performance indicators like DARC can observe the manifestation of risks, but it is essential to manage and monitor risks from other perspectives before they even appear in performance.

References

[1] Saccone, M. and Gentilini, A. (2024), "Duration-Adjusted Return on Capital: A Novel Approach to Measuring Private Equity Performance", *The Journal of Portfolio Management*, Issue 7 - Private Markets, Volume 50, pp.72-99.

[2] Saccone, M. (2013), "Method for calculation of time weighted returns for private equity", https://patents.google.com/patent/US20120296843A1/en. 2013.

[3] XTAL Strategies (2020), "Resetting the Clock on Private Equity Performance", https://www.xtalstrategies.com/wp-content/uploads/2021/06/Private-Equity-Performance-Unwrapped_DARC-metric-3ES.pdf.