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Mr. J. Matthew DeLesDernier  
Assistant Secretary  
U.S. Securities and Exchange Commission  
100 F Street, NE  
Washington D.C. 20549

RE: Order Instituting Proceedings to Determine Whether to Approve or Disapprove a Proposed Rule Change to Adopt Listing Standards for Subscription Warrants Issued by a Company Organized Solely for the Purpose of Identifying an Acquisition Target (SR-NYSE-2021-45)

Dear Mr. DeLesDernier,

I am the Nomura Professor of Finance at MIT Sloan School of Management, where I have been teaching Options and Futures, Analytics of Finance, and Asset Pricing, as well as conducting academic research since 2007. Together with my colleagues and students, I have produced dozens of research publications and working papers on asset pricing. My main research interests include asset pricing, and its connections with corporate finance, financial constraints, credit risk, liquidity risk, robustness, and financial machine learning. In addition, I am a Research Associate at the National Bureau of Economic Research and an Affiliated Researcher of the MIT Laboratory for Financial Engineering, and Co-Editor of the *Review of Asset Pricing Studies* and the *Annual Review of Financial Economics*. I have also served on the editorial board of several other leading academic finance journals. Attached in the appendix is my CV.

I am writing to provide my views on the valuation issues pertaining to the proposed subscription warrants referenced in the Proposed Rule, especially as they apply to the specific warrants that Pershing Square SPARC Holdings, Ltd. proposes to issue. I have been engaged by Pershing Square SPARC Holdings, Ltd., an entity affiliated with Pershing Square Capital Management, L.P. (“Pershing Square”), to assist them with this matter.

I understand that the U.S. Securities and Exchange Commission (“SEC”) has published an order instituting proceedings to determine whether to approve or disapprove certain rule modifications by the New York Stock Exchange relating to SPARs.<sup>1</sup> In this order, the SEC queried “how market participants would effectively value this novel listed security.”<sup>2</sup> To help the SEC and other interested parties answer this and related questions, I have written the attached working paper. In this paper, I

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<sup>1</sup> Securities and Exchange Commission Release No. 34-93741; File No. SR-NYSE-2021-45 (“SEC Proceedings”)

<sup>2</sup> SEC Proceedings, p. 11



compare the differences and similarities between subscription warrants and public SPACs securities. I show that, for the purpose of valuation, there is a close connection between subscription warrants and SPAC common shares. In addition, I propose a fundamental-based framework for how market participants can value subscription warrants.

I am hopeful that my working paper and the fundamental valuation framework will help the SEC make an informed decision on approving this proposed rule.

Thank you,

/s/ Hui Chen

# The Economics of Subscription Warrants

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January 4, 2022

## Abstract

I examine the economics behind subscription warrants, a newly proposed financial instrument that takes advantage of the market mechanism to facilitate taking companies public. I discuss their main differences and advantages relative to SPACs in improving the efficiency of IPOs. Although technically a new security, for the purpose of valuation, a subscription warrant is essentially a SPAC common share minus a zero-coupon bond. I also propose a fundamental-based valuation model for subscription warrants.

Keywords: subscription warrant, SPAC, SPARC, IPO

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\*I thank Bill Ackman and Feroz Qayyum for helpful discussions. All errors are my own.

# 1 Introduction

Special Purpose Acquisition Companies (SPAC) took the IPO market by storm in the past two years. In 2020, there were 248 SPAC IPOs raising \$76.3 billion, more than the total amount of capital raised by SPACs from all previous years combined (see [Gahng, Ritter, and Zhang, 2021](#)). This is followed by another record-breaking year in 2021, with 613 SPAC IPOs raising \$161 billion, accounting for 63% of all U.S. IPOs and 48% of total U.S. IPO proceeds for the year.<sup>1</sup>

The rapid rise of SPAC's economic significance, especially in terms of the dollar-weighted share of the U.S. IPO market that it represents (see Figure 1 for SPAC's share of U.S. IPOs in the last two decades), makes it more important than ever to understand the advantages and limitations of SPACs. Some of the commonly discussed issues with SPACs among practitioners and academics include:

1. the requirement of significant capital commitment over an extended period;<sup>2</sup>
2. hefty underwriting fees (usually 5.5% of the proceeds);
3. severe dilution due to sponsor promote (sponsors typically receive 20% of all SPAC shares essentially for free) and SPAC warrants (see e.g., [Klausner, Ohlrogge, and Ruan, 2021](#)); and
4. the agency problem in terms of sponsors pursuing negative-NPV targets, as sponsors' compensation structure and SPAC's limited lifespan (typically 2 years) incentivize sponsors to complete deals that are unprofitable to investors.<sup>3</sup>

Consistent with these concerns, [Klausner, Ohlrogge, and Ruan \(2021\)](#) and [Gahng, Ritter, and Zhang \(2021\)](#) document poor post-merger performances of the merged companies. For example, [Gahng, Ritter, and Zhang \(2021\)](#) find an average one-year post-merger return of

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<sup>1</sup>Source: <https://www.spacanalytics.com/>.

<sup>2</sup>Even though an investor could in theory get the money back at any time by selling their common shares in the secondary market, the lack of liquidity can impose additional holding costs for SPAC shares. In fact, by the end of 2021, the common shares of all but one of the top ten most active SPACs are trading at a discount to their NAV.

<sup>3</sup>[Dimitrova \(2017\)](#) shows that SPAC performance is worse for acquisitions announced near the predetermined two-year deadline. See also the theoretical analysis by [Luo and Sun \(2021\)](#).

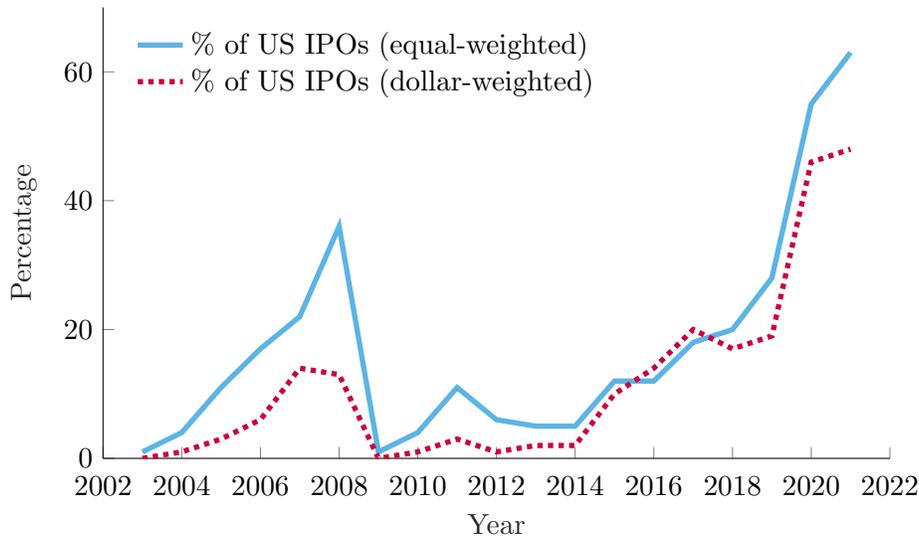


Figure 1: SPAC’s Share of US IPOs

-8.1% for the common shares (-24.7% relative to the market) in the sample period from 2012 to 2020.

Pershing Square SPARC Holdings has recently proposed a new IPO mechanism based on subscription warrants, which are issued by a company (dubbed “Special Purpose Acquisition Rights Company,” or SPARC) organized solely for the purpose of identifying an acquisition target.<sup>4</sup> This new financial product has several features that are specifically intended to address the above-mentioned concerns for SPACs:<sup>5</sup>

1. no upfront capital contribution;<sup>6</sup>
2. no underwriting fees;
3. no conventional sponsor promote; additional sponsor warrants have an exercise price that is 20% higher than that of the public subscription warrants;
4. a sizable commitment of minimum sponsor investment through a forward purchase agreement; and
5. a 10-year maturity instead of 2 years.

<sup>4</sup>Pershing Square named their subscription warrants “Special Purpose Acquisition Rights,” or SPARs. See <https://www.sec.gov/Archives/edgar/data/1895582/000119312521340602/d175920ds1.htm>.

<sup>5</sup>My discussion in this paper is based on the subscription warrant proposed by Pershing Square. Some of the contractual features could vary across different sponsors.

<sup>6</sup>The warrant will be distributed for free to the existing SPAC investors of Pershing Square Tontine Holdings in initial placement. There will be a cost to acquire it in the secondary market.

In order to list and trade subscription warrants on the exchange, NYSE has proposed a rule change (SR-NYSE-2021-45) to the SEC regarding the listing standards for this new instrument.<sup>7</sup> In response, the SEC has raised important questions regarding how to value subscription warrants, and whether the proposed rules are sufficient to ensure their orderly trading.

In this short paper, I examine the economics behind subscription warrants.

I discuss some of the main advantages SPARCs provide relative to SPACs and traditional IPOs. Relative to traditional IPOs, both SPACs and SPARCs take advantage of the price mechanism to aggregate information and identify potential IPO investors, which helps reduce marketing costs and makes investors better informed in their decisions to participate in an IPO.

Relative to SPACs, SPARCs provide direct cost savings by removing underwriting fees and liquidity discount for the cash component of SPAC common shares. Moreover, SPARCs provide interesting solutions to the agency problem embedded in SPACs. The removal of sponsor promote not only reduces the dilution to public investors, but also reduces sponsors' incentive to pursue unprofitable deals; the extended maturity largely removes the time pressure to complete a deal; the requirement of a sizable amount of sponsor co-investment in the merger serves as a credible signal of interest alignment to both warrant investors and target companies. Another interesting difference is that while SPAC investors have to "opt out" of a merger by redeeming their shares (i.e., the default option is to invest), SPARC investors have to "opt in" by exercising the warrants (the default option is not to invest). This "opt-in" feature can better protect retail investors in the presence of behavioral biases and informational frictions.

I then analyze the pricing of subscription warrants. I show that subscription warrants are tightly connected to SPAC Class A common shares for the purpose of valuation. Specifically, a SPAC common share can be decomposed into a bond and a subscription warrant. Thus, the orderly trading of SPAC shares for the last two decades should lend us some confidence in successfully running a market for subscription warrants.

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<sup>7</sup>See <https://www.sec.gov/rules/sro/nyse/2021/34-93741.pdf>.

Finally, I propose a fundamental-based valuation model for subscription warrants. The key part of the model is to compute the expected present value of the merger premium, which depends on the following factors: 1) how quickly the sponsor can identify a reasonable target; 2) the size of the surplus for taking a target public (determined by the size of the target and the net benefit of going public); 3) the share of the surplus that the sponsor can extract (determined by the sponsor’s bargaining power); and 4) the ratio of exercised warrants to sponsor investment.

The rest of the paper is organized as follows. In Section 2, we examine the differences and similarities between subscription warrants and public SPACs securities, including common shares and warrants. In Section 3, we propose a fundamental approach for valuing subscription warrants. Section 4 concludes.

## 2 Subscription Warrants vs. SPAC Securities

In this section, we briefly review the main features of SPAC securities and subscription warrants that are pertinent to valuation. For more detailed review of the contractual details of SPACs, see [Gahng, Ritter, and Zhang \(2021\)](#). For more details on subscription warrants, see the registration statement (Form S-1) of Pershing Square SPARC Holdings.

A SPAC is a blank check company that goes public to raise capital by offering securities called “units.” A typical unit is priced at \$10 and consists of a “common share” and a fraction of a “warrant,” which is a call option issued by the company on the common share, typically with a strike price of \$11.50 per share and a maturity date that is 5 years after the completion of the merger. Each unit becomes unbundled shortly after the IPO (typically 52 days), so that the common shares and warrants can trade separately. The public common shares are also referred to as Class A common shares, to be distinguished from the Class B shares that are issued to the SPAC sponsor essentially for free (also known as founder shares or sponsor promote). The founder shares are typically 20% of all SPAC shares.

The sole purpose of a SPAC is to find a non-listed operating company to merge with

and in the process taking the latter public. The capital raised in the SPAC IPO will be placed in a trust and invested in Treasury securities. The market value of this trust account is the net asset value (NAV) of the SPAC. After IPO, the SPAC sponsor typically has up to two years to search for a target. Once the sponsor identifies a target company and reaches a definitive agreement for a merger, the Class A share investors can decide between redemption, which will return the investors' \$10 per share plus interest, or continue to hold onto their shares, which will be converted into common shares of the merged company. In contrast, Class B shares are not redeemable, but will be converted into Class A shares upon merger completion. Often times, the sponsor also invites PIPE (Private Investment in Public Equity) investments to provide additional capital to meet the requirement of the merger agreement. Finally, if the sponsor fails to complete an acquisition in the predetermined time frame, the SPAC will be dissolved, and the balance in the trust will be returned to its public investors.

A company that issues subscription warrants (a SPARC) has the same goal as a SPAC, which is to find a target private company to merge with. A main distinction from SPACs is that an investor in a subscription warrant is not required to contribute capital upfront (except for the cost to acquire the warrant in the secondary market). Instead, they can decide whether to exercise the option to buy a common share of the merged company at the strike price of \$10 per share when the sponsor has reached a definitive agreement with a target company and the relevant financial terms of the merger have been agreed upon, vetted by the SEC, and made public.<sup>8</sup> In the case of the SPARs proposed by Pershing Square SPARC Holdings, the sponsor could also decide to adjust the strike price of the subscription warrant upward (\$10 being the minimum) at the time of the definitive agreement if more capital is needed from public investors.

Second, there is less concern for dilution in a SPARC since there is no conventional

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<sup>8</sup>In practice, SPAR holders can elect to exercise their warrants during a period of 20 business days after the distribution of the definitive disclosure document with respect to the transaction, which is called the Election Period. Before the start of the Election Period, the sponsor needs to finalize the negotiation with the target company and satisfy the same information disclosure requirements as a traditional IPO (including three years of audited financial statements). After the company decides to proceed with the proposed business combination, those investors who have elected to exercise their warrants will submit the payment of the exercise price, and the SPARs will be formally exercised at the closing date.

sponsor promote, which is a major source of the dilution costs in typical SPACs (see e.g., [Klausner, Ohlrogge, and Ruan, 2021](#)). Instead, the SPARC sponsor commits to make a sizable investment into the merged company through a forward purchase agreement. This co-investment commitment serves as a credible signal of interest alignment to both the warrant investors (more confidence to exercise their warrants) and target company (more faith in the negotiation and in receiving mentorship from the sponsor). Potential dilution for the common shares could still come from the presence of sponsor warrants. However, this concern is mitigated by the sponsor warrants having an exercise price that is 20% higher than that of the public subscription warrants.

Third, the proposed subscription warrants have a maturity of 10 years, significantly longer than the typical 2-year term for SPACs. This aims to remove the time pressure for sponsors to complete a merger, hopefully raising the quality of the target and strengthening the bargaining power for the sponsor when negotiating with the target.

Another significant difference between SPAC and SPARC is that while SPAC investors have to “opt out” of a merger by redeeming their shares (i.e., the default option is to invest), SPARC investors have to “opt in” by exercising the warrants (the default option is not to invest). As is well documented in behavioral economics (see e.g., [Thaler and Benartzi, 2004](#)), the “opt-in” feature will nudge investors to make more-informed decisions when investing in an IPO, which can better protect retail investors in the presence of behavioral biases and informational frictions.

Finally, because Pershing Square plans to distribute the new subscription warrants at no cost to its existing SPAC (Tontine) shareholders and warrant holders, there will be no need for an underwriter or underwriting fees.

**SPAC common share = Bond + Subscription warrant** Economically, the Class A common share of a SPAC is essentially a default-free convertible bond, which can be decomposed into a bond and a call option. Moreover, under some simplifications, the call option is equivalent to a subscription warrant. This point is illustrated in [Figure 2](#).

As [Panel A of Figure 2](#) shows, the bond component of the common share is a zero-

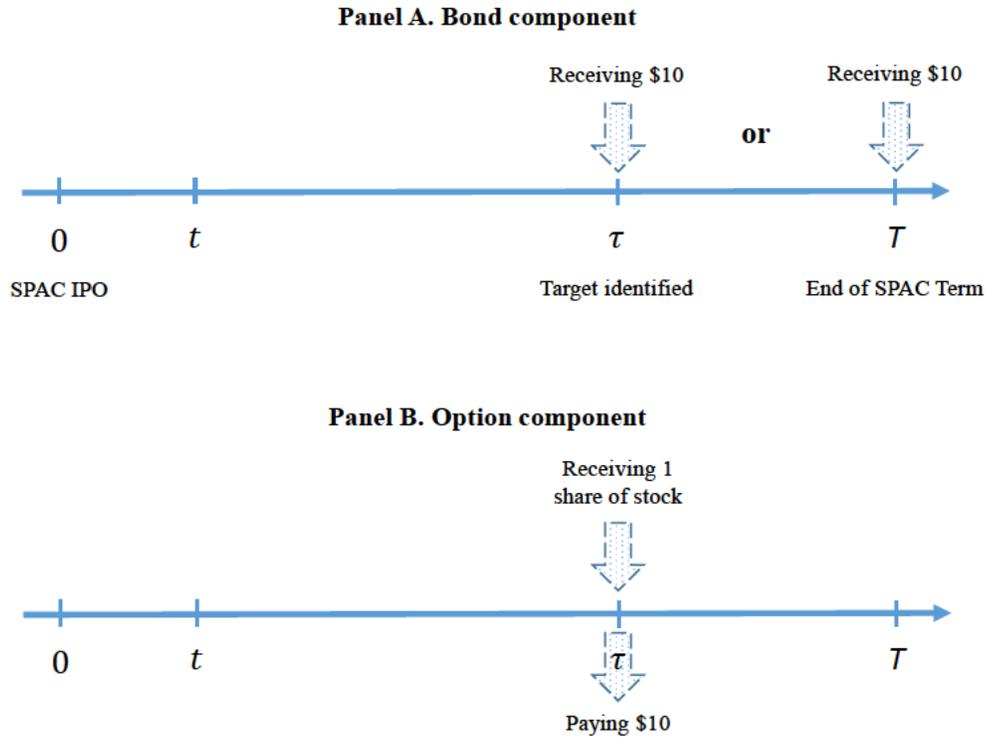


Figure 2: **Decomposing the cash flows of a SPAC common share.** Panel A plots the cash flows of the bond component of the common share. Panel B plots the cash flows of the option component in the event the option is exercised.

coupon bond that pays the principal of \$10 at a random maturity date, which is either at time  $T$ , the end of the SPAC’s pre-specified term, or at a random time  $\tau$ , when the sponsor enters into a definitive agreement with a target, provided that the sponsor does so before the end of its term (i.e.,  $\tau < T$ ). For simplicity, we have ignored the interest earned in the trust account in the illustration, which is typically small in practice.

The option component of the common share is just like a subscription warrant. Panel B of Figure 2 shows that, if a common share investor decides to exercise the option at time  $\tau$ , or equivalently, when they decide not to redeem the share, they will pay the \$10 exercise price in exchange for one share of the merged company. This is identical to the exercise of a subscription warrant with a fixed exercise price. For simplicity, we have assumed that redemption and warrant exercise occur at the same time when a target is identified as opposed to over a period of time (see Footnote 8). In addition, we have ignored the possibility that a proposed business combination might fail to go through after time  $\tau$ .

When combined, the exercise price of the option component at time  $\tau$  is covered by the principal payment of the bond component, so that there is no net cash flow for the common share investor if they decide not to redeem at time  $\tau$ . On the other hand, if the common share investor does not exercise the option at time  $\tau$ , or equivalently, when they decide to redeem the share, the option component expires, leaving only the principal payment of \$10. Thus, the combined cash flows of the bond and call option are indeed identical to those of the common share. Assuming no arbitrage, the value of a Class A common share at anytime  $t$  before the sponsor identifies a target ( $t < \tau$ ) should be the sum of the price of the bond and the price of the call option.<sup>9</sup>

The equivalence of the call option component in a SPAC common share and the subscription warrant implies that, conceptually, pricing a subscription warrant is no more difficult than pricing a SPAC common share. In light of this result, the fact that we have witnessed orderly trading of SPAC shares for the last two decade should lend us some confidence in successfully running a market for subscription warrants.

The valuation of both securities crucially depends on the expected present value of the merger premium: the excess value of a share of the merged company over the strike price. We examine how to value this merger premium in Section 3. Since additional uncertainties about SPAC dilution costs (from the sponsor promote and the future exercise of public/private SPAC warrants) and the agency problem for the SPAC sponsor will add to the difficulties in valuing the merger premium, one could argue that the pricing of SPAC common shares is more challenging than subscription warrants.

**Liquidity discount for SPAC common share** Since the value of the call option can never turn negative, it might seem puzzling that Class A common shares sometimes trade below their NAV. For example, by the end of 2021, the common shares of all but one of the top ten most active SPACs are trading at a discount to their NAV.

This discount to NAV is partly because SPAC investors will discount future risk-free cash flows at a higher risk-free rate than the Treasury rate that the trust account earns

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<sup>9</sup>Although the bond and option components are not separately traded to enable arbitrages between them and the common share, it still provides useful guidance for how to think about the relations among these financial claims.

(the difference is referred to as the Treasury premium; see e.g., [Krishnamurthy and Vissing-Jorgensen, 2012](#)). Another reason for the discount is the illiquidity of SPAC common shares on the secondary market. When an investor is hit by a liquidity shock but can neither redeem the common shares early nor sell them quickly in the market without causing significant price impact, they will be stuck with the shares and incur an implicit holding cost (see e.g., [Duffie, Garleanu, and Pedersen, 2005](#); [Chen et al., 2018](#)). Ex ante, the expected future holding costs will result in a liquidity discount in the bond component of the common share, similar to what is observed for thinly traded investment-grade corporate bonds (see e.g., [Longstaff, Mithal, and Neis, 2005](#); [Chen et al., 2018](#)). Furthermore, the less active the trading of SPAC shares, the higher this liquidity discount becomes. Since the activeness of SPAC security trading tends to be positively correlated with the value of the option component, when the prospects of a high merger premium become sufficiently dim, the total value of the common share can fall below the NAV.

The cost of the liquidity discount is ultimately shared among SPAC investors, sponsor, and the target company. In contrast, by not requiring capital contribution upfront, subscription warrants can help investors avoid such a cost.

### **3 A Valuation Framework**

As explained in the previous section, for the purpose of valuation, a subscription warrant can essentially be viewed as a SPAC Class A common share minus a zero-coupon bond. It is also worth noting that SPAC common shares have been actively traded by investors for decades. Nonetheless, it is worth examining the fundamental determinants of both securities.

In this section, I propose a fundamentals-based valuation framework. The core piece of the valuation framework is to compute the expected present value of the merger premium, which depends on a few factors: 1) how quickly the sponsor can identify a reasonable target; 2) how much surplus there is for taking the target public; 3) what is the share of the surplus that the sponsor can extract in its negotiation with the target; and 4) how

much of the extracted surplus goes to warrant holders.

### **3.1 The economic value of subscription warrants**

A subscription warrant gives one the right to buy one common share of a newly listed company at the IPO price in the future. To understand how we can value such a claim before a target company has been identified, I first examine its sources of economic value.

Why do subscription warrants have value? The direct reason is simply that the value of one share of the merged company can sometimes exceed the strike price. However, the percentage ownership of the merged company that one share of common stock represent is itself uncertain. To answer this question at a more fundamental level, it is more helpful to think of the SPARC company, including its sponsor and all the warrant holders, as a whole.

Like a SPAC, the SPARC's job is to identify a private operating company, convince it to let the SPARC help the company go public, and help arrange the necessary financing for an IPO. For this reason, some view SPAC sponsors as private equity funds that also work as ad-hoc underwriters (see [Dimitrova, 2017](#); [Gahng, Ritter, and Zhang, 2021](#)). It is clear that there is a premium for going public for some companies. One way to estimate this premium is by comparing the average valuation ratios between public and private companies. Assuming the costs of compliance for being a public company and the private company valuation are relatively stable, then, over time, the variations in the premium for going public will be primarily driven by the fluctuations in the valuation ratios of public companies. Intuitively, a "hot" stock market (or sector) will induce more firms (from the sector) to go public. To the extent that sponsor expertise in marketing and mentorship can further increase this premium, we can adjust for the average premium by sponsor reputation.

Next, in a traditional IPO, the premium (or surplus) for going public will be shared among the original owners of the private company, the underwriter, and the public investors. In the case of a SPARC, the share of the surplus that goes to the latter two parties is the source of its economic value, which is further divided between the sponsor and warrant

holders. This last division is relatively easy to determine by examining the relatively simple capital structure of the SPARC.

How much of the total surplus can a SPARC extract? To answer this question, we need to consider the bargaining between a SPARC and the target company, and in particular the target's outside options. Consider a private company that is planning to go public. Its options include: 1) a traditional IPO, 2) a direct listing, 3) merging with a SPAC, or 4) merging with a SPARC.

Direct listing is relatively rare. It allows the existing shareholders of a company to sell their shares to the public directly. Its main costs are financial advisory fees, which are relatively small. However, direct listing typically does not help raise additional capital for the company, and the actual listing prices will be set by the market and can be volatile, presenting significant uncertainties for the listing company.

With a traditional IPO, the company would hire an underwriter to help create new shares and sell them to the public. The underwriter helps set the initial offering price and drum up investor demand through roadshows. The underwriter also promises to buy all the available shares and sells them to investors through book-building or auctions. As such, the final listing price will not be set until the last moment of the IPO process. The underwriter does bear part of the risk of insufficient public demand for the new shares, and they are rewarded with substantial underwriting fees.

Merging with a SPAC or SPARC is an efficient way to identify potential investors and aggregate information. Instead of relying on a lengthy and costly marketing campaign to find potential investors, the SPARC takes advantage of the market mechanism. Through trading, subscription warrants will be naturally allocated to those investors most enthusiastic in and attentive to the potential target. Through the market prices of the warrants, both the warrant investors and potential targets could also learn about the market's view of the sponsor's ability and the target's value.

Moreover, merging with a SPAC or SPARC allows the target company to secure the financial terms of the IPO (including the listing price) quickly. Even though the full SPAC/SPARC IPO process may not be significantly shorter than that of a traditional

IPO (see e.g., [Gahng, Ritter, and Zhang, 2021](#)), the listing price will be essentially finalized as soon as the sponsor and the target company enter into a definitive agreement (there is non-zero risk that the proposed business combination may be rejected by the company, typically due to insufficient funds from the exercise of warrants). This could be an important consideration for firms that care about IPO timing, as shown in [Pástor and Veronesi \(2005\)](#). IPO timing can be particularly important when the public market valuation is volatile, or when the fundamental volatility of the target company is high.

Another often-mentioned benefit of a SPAC IPO (which also applies to SPARCs) is that, like PE funds, the sponsor can use its expertise to help mentor and monitor the target firm. They might also be more capable at valuing companies that are more opaque to public investors (younger firms and firms in new industries).

There are also some notable tradeoffs between a SPAC IPO and a SPARC IPO. While a SPAC might appear to have the advantage of a deeper pocket than a SPARC thanks to the cash raised in the SPAC IPO, which would be reassuring for the target, this signal becomes less credible under high expected redemption rates. For example, [Gahng, Ritter, and Zhang \(2021\)](#) report an average redemption ratio of 37% for completed mergers since January 2015; based on data from Citi, in the second half of 2021, the average redemption ratio was consistently above 50% and approached 80% in November 2021. In comparison, not having cash in trust will make sponsor reputation even more important for the success of SPARCs. The fact that the SPARC sponsor does not receive any sponsor promote, that it is under less time pressure to complete a deal, and that it commits significant amount of own capital to co-invest in the merged company, all help boost the sponsor's credibility with both public investors and potential targets.

Although there is evidence that the total costs of SPAC IPOs are considerably higher than those of traditional IPOs, there is reason to believe that firms that choose traditional IPOs are fundamentally different and may not be the natural targets for SPARCs.

If we consider a SPAC IPO as the primary outside option for a target company of a SPARC, then the average total costs of a SPAC IPO can be used to estimate the average

total surplus of going IPO through a SPARC.<sup>10</sup> This estimate is meant to be conservative, since the various advantages of SPARCs should result in better merger targets compared to SPACs. After that, we can estimate the share of the surplus that a SPARC sponsor is likely to extract from its negotiation with the target. This is admittedly the most subjective part of the valuation. As discussed above, the factors that can influence the sponsor’s bargaining power include the volatility of market valuation (higher volatility makes timely IPO through SPAC/SPARC more attractive), target company’s fundamental volatility (higher uncertainty about the fundamental makes it more difficult for the market to value the target), sponsor reputation (ability to identify, mentor, and monitor the target), the size of sponsor committed investment in the deal, and the size of the pool of potential targets relative to the number of SPAC/SPARCs searching for targets.

Gahng, Ritter, and Zhang (2021) estimate that the median total costs of SPAC IPOs (defined as the difference between the market value of “outside” securities and the net cash received by the operating company and selling shareholders) to be 48.3% of the IPO proceeds and 14.6% of the post-issue market cap, which are quite substantial (see their Table 1, Panel A, which is reproduced in Table 1 here). It is also worth noting that there is considerable cross-sectional variation in the costs estimates. For example, at the 75th percentile, the costs of SPAC IPOs are 88.9% of the IPO proceeds and 27.9% of the post-issue market cap. Due to the optionality, such uncertainties about the IPO costs will further increase the value of the subscription warrants.

### 3.2 A valuation model

Below, I lay out a dynamic valuation model for subscription warrants based on the key ingredients discussed above.

- Consider Sponsor  $i$ . Let  $n$  be the total number of subscription warrants outstanding, which have strike price  $K$  and maturity  $T$ . Let  $X$  be the total forward purchase amount (committed + additional) from the sponsor. We will ignore the possibility

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<sup>10</sup>Recall our earlier discussion that the time variation of this surplus can be estimated through the variation in public valuation ratios.

Table 1: **The Relative Costs of Going Public**

This table reproduces Table 1, Panel A of [Gahng, Ritter, and Zhang \(2021\)](#). Quoting from its caption: This table “reports the costs, not including registration, legal, and auditing fees, of three different going public methods: merging with a SPAC, a traditional IPO, or a direct listing. For both SPACs and traditional IPOs, the costs are defined to be the difference between the market value of outside securities and the net cash received by the operating company and selling shareholders. For SPACs, outside securities are shares and warrants held by public investors, PIPE investors, and sponsors. For traditional IPOs, outside securities are the shares issued in the IPO. For direct listings, the costs are the fees paid to financial advisors. For traditional IPOs, our cost measure is equivalent to the sum of underwriting commissions plus money left on the table. We use 150 SPAC mergers (after excluding 3 deals in which no cash was delivered due to high redemptions and no PIPE investment), 677 traditional IPOs, and 7 direct listings between January 2015 and March 2021. For the denominator, proceeds refer to the net cash delivered after underwriting commissions and other costs. Market cap refers to the post-merger (or post-issuance) market capitalization valued at the first closing market price. For SPAC mergers, cash delivered includes the dollar value of the trust account and the proceeds from the realized forward purchase agreement (FPA) and PIPE investments. For the traditional IPOs, we exclude IPOs raising more than \$500 million, those with an offer price below \$5 per share, unit offers, ADRs, closed-end funds, natural resource limited partnerships, REITs, bank and S&L IPOs, and small best efforts offers.”

	SPAC (N=150)		Traditional IPO (N=677)		Direct Listing (N=7)	
	Costs Proceeds	Costs Market Cap	Costs Proceeds	Costs Market Cap	Costs Proceeds	Costs Market Cap
10th percentile	16.1%	4.6%	-4.1%	-0.8%	-	0.1%
25th percentile	29.3%	8.3%	6.9%	1.1%	-	0.1%
Median	48.3%	14.6%	21.9%	3.2%	-	0.3%
75th percentile	88.9%	27.9%	49.9%	7.1%	-	1.1%

of strike price adjustment and additional diluting sponsor warrants for now.

- We model the arrival of potential target companies using a Poisson process. Let  $N_t$  be the number of target operating companies that the sponsor identifies up to time  $t$ , which follows a Poisson process with arrival rate  $\lambda$ . This means that the conditional probability that a new target will be identified between  $t$  and  $t + \Delta t$  is approximately  $\lambda \Delta t$ . The average amount of time between two arrivals is  $1/\lambda$ . One could make the arrival rate sponsor-specific to capture the possibility that the market might expect a sponsor to find a target sooner than others.

- The book value (size) of the target is  $B_{i,t}$ , which is drawn from a distribution with cumulative distribution function  $F_t(\cdot)$ . Investors can estimate this distribution in the data based on the size distribution of the pool of candidate firms at time  $t$ .
- For a new target arriving at time  $t$ , we need to model its total surplus of going public, which has an aggregate component and a sponsor-specific component.

1. The aggregate total surplus of going public per unit of book value  $\theta_t$ , which reflects the average gap in valuation ratio between public and private companies. We assume  $\theta$  follows a mean-reverting process with stochastic volatility:

$$d\theta_t = \kappa (\bar{\theta} - \theta_t) dt + \sqrt{\nu_t} dW_t, \quad (1)$$

where

$$d\nu_t = \phi (\bar{\nu} - \nu_t) dt + \xi \sqrt{\nu_t} dW_t^v. \quad (2)$$

$W_t$  and  $W_t^v$  are standard Brownian motions that could be correlated. The mean surplus ratio  $\bar{\theta}$  can be pinned down using the average total SPAC IPO cost.<sup>11</sup> The rest of the parameters for the processes of  $\theta_t$  and  $\nu_t$  can be estimated empirically using public market price-to-book ratios.

2. Sponsor  $i$ 's value-added: We assume the log value-added follows a normal distribution,

$$x_{i,t} \sim N(\mu_i, \sigma^2), \quad (3)$$

where  $\mu_i$  represents the average ability of Sponsor  $i$  to identify and mentor a target as perceived by investors, and  $\sigma$  represents the uncertainty about sponsor ability. Notice that  $x_{i,t}$  is independent of  $\theta_t$  and  $\nu_t$ . Its value is not revealed to the public until the target company has been identified and the details of the financial terms are revealed.

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<sup>11</sup>For example, we could use the estimate 14.6% of the market cap, multiplied by the average market-to-book ratio of SPAC IPOs.

- Sponsor bargaining power  $\beta_i \in [0, 1]$  : The share of the surplus of going public that belongs to the SPARC. The SPARC sponsor will have more bargaining power when the uncertainty of the premium for going public  $\nu_t$  is high, when its reputation for value-added  $\mu_i$  is high, and when the sponsor commits more capital in the deal,  $\frac{X}{X+nK}$ . Thus, we assume that

$$\beta_{i,t} = \beta(\nu_t, \mu_i, \frac{X}{X+nK}). \quad (4)$$

The function  $\beta$  is the most subjective part of this valuation model.

- Conditional on finding a target with size  $B_{i,t}$ , the total surplus extracted by the sponsor is given by

$$V_{i,t} = \beta_{i,t} \theta_t B_{i,t} e^{x_{i,t}}. \quad (5)$$

- We first consider the valuation of a subscription warrant under the assumption that the SPARC is dissolved immediately if the warrants are not exercised. In other words, we do not allow the sponsor to search for the next target when it fails to raise enough funds. This problem is simpler and will help us develop intuition for warrant valuation.

$$\begin{aligned} P_i(t, T, \theta_t, \nu_t) &= E_t^Q \left[ e^{-r(\tau-t)} \max \left( \frac{nK}{X+nK} V_{i,\tau}, 0 \right) 1_{\{\tau < T\}} \right] \\ &= E_t^Q \left[ \int_t^T \lambda e^{-(r+\lambda)(s-t)} \max \left( \frac{nK}{X+nK} \beta_{i,s} \theta_s B_{i,t} e^{x_{i,s}}, 0 \right) ds \right]. \quad (6) \end{aligned}$$

Notice that in the exercise decision in Equation (6), the pro-rated surplus is compared to the value of zero, not the strike price  $K$ . This is because the surplus should already be net of all costs.

Here we assume all warrant investors have the same beliefs. As a result, if one finds it optimal to exercise the warrant, all the rest will do the same. This is why the share of the surplus  $V_{i,\tau}$  that belongs to each warrant investor is  $\frac{nK}{X+nK}$ .

- Notice that the expectation in Equation (6) is under the risk-neutral measure. Thus, to implement (6), we need to change the measure for the processes of  $\theta_t$  and  $\nu_t$ .
- Next, we price a subscription warrant when the sponsor can repeatedly search for new targets until time  $T$ .

$$P_i(t, T, \theta_t, \nu_t) = E_t^Q \left[ \int_t^T \lambda e^{-(r+\lambda)(s-t)} \max \left( \frac{nK\beta_{i,s}\theta_s B_{i,s} e^{x_{i,s}}}{X + nK}, P_i(s, T, \theta_s, \nu_s) \right) ds \right], \quad (7)$$

The main difference between (7) and (6) is that when nobody exercises their warrants, the value of the warrant is not zero but  $P_i(\tau, T, \theta_\tau, \nu_\tau)$ , which is the value of the warrant when a new search starts. This problem can be solved on a tree.

- Pershing Square has proposed that those investors who exercise their warrants will receive a new subscription warrant for the next round. The pricing equation under such a feature is:

$$P_i(t, T, \theta_t, \nu_t) = E_t^Q \left[ \int_t^T \lambda e^{-(r+\lambda)(s-t)} \max \left( \frac{nK\beta_{i,s}\theta_s B_{i,s} e^{x_{i,s}}}{X + nK} + P_i(s, s+T, \theta_s, \nu_s), P_i(s, T, \theta_s, \nu_s) \right) ds \right]. \quad (8)$$

The main difference between (8) and (7) is that the payoff from exercising the warrant now includes the value of a new warrant with a new maturity date  $s+T$ .

Notice that the value of the warrant should increase in its time to maturity, i.e.,  $P_i(s, s+T, \theta_s, \nu_s) \geq P_i(s, T, \theta_s, \nu_s)$ . Thus, the investors will prefer to exercise their warrants as long as the surplus is positive. Again, this problem can be solved on a tree.

## 4 Conclusion

In this paper, I examine the economics behind subscription warrants, a newly proposed financial instrument for facilitating IPOs. I discuss their advantages relative to SPACs in providing a more efficient IPO mechanism. While technically a new security, I show that subscription warrant is tightly connected to SPAC common share in terms of valuation: the SPAC common share can be decomposed into a bond and a subscription warrant. I also propose a fundamental-based valuation framework for subscription warrants.

There is rich economics in the new subscription-warrant-based IPO model. For future research, it will be worthwhile to more closely examine the agency problem for the sponsors in SPARCs vs. SPACs. It will also be interesting to study empirically the effectiveness of the price mechanism for aggregating IPO-relevant information.

## References

- Chen, H., R. Cui, Z. He, and K. Milbradt. 2018. Quantifying liquidity and default risks of corporate bonds over the business cycle. *Review of Financial Studies* 31:852–97.
- Dimitrova, L. 2017. Perverse incentives of special purpose acquisition companies, the poor man’s private equity funds. *Journal of Accounting and Economics* 63:99–120.
- Duffie, D., N. Garleanu, and L. H. Pedersen. 2005. Over-the-counter markets. *Econometrica* 73:1815–47.
- Gahng, M., J. R. Ritter, and D. Zhang. 2021. Spacs. Working Paper, University of Florida.
- Klausner, M., M. Ohlogge, and E. Ruan. 2021. A sober look at spacs. *Yale Journal on Regulation*, Forthcoming.
- Krishnamurthy, A., and A. Vissing-Jorgensen. 2012. The Aggregate Demand for Treasury Debt. *Journal of Political Economy* 120:233–67.
- Longstaff, F. A., S. Mithal, and E. Neis. 2005. Corporate yield spreads: Default risk or liquidity? new evidence from the credit default swap market. *Journal of Finance* 60:2213–53.
- Luo, D., and J. Sun. 2021. A dynamic delegated investment model of spacs. Working Paper, MIT Sloan.
- Pástor, L., and P. Veronesi. 2005. Rational IPO Waves. *Journal of Finance* 60:1713–57.
- Thaler, R. H., and S. Benartzi. 2004. Save more tomorrow<sup>TM</sup>: Using behavioral economics to increase employee saving. *Journal of Political Economy* 112:164 – 187.

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“Rare Disasters and Risk Sharing with Heterogeneous Beliefs,” with Scott Joslin and Ngoc-Khanh Tran, *Review of Financial Studies*, 2012, 25(7): 2189-2224.

“Generalized Transform Analysis of Affine Processes and Applications in Finance,” with Scott Joslin, *Review of Financial Studies*, 2012, 25(7): 2225-2256.

“Market Timing, Investment, and Risk Management,” with Patrick Bolton and Neng Wang, *Journal of Financial Economics*, 2013, 109(1): 40-62.

“Comment on ‘Systemic Sovereign Credit Risk: Lessons from the U.S. and Europe’ by Ang and Longstaff,” *Journal of Monetary Economics*, 2013, 60: 511-516.

“Dynamic Asset Allocation with Ambiguous Return Predictability,” with Nengjiu Ju and Jianjun Miao, *Review of Economic Dynamics*, 2014, 17(4): 799-823.

“Macroeconomic Risk and Debt Overhang,” with Gustavo Manso, *Review of Corporate Finance Studies*, 2017, 6(1): 1-38.

“Quantifying Liquidity and Default Risks of Corporate Bonds over the Business Cycle,” with Rui Cui, Zhiguo He, and Konstantin Milbradt, *Review of Financial Studies*, 2018, 31(3): 852-897.

“Demand for Crash Insurance, Intermediary Constraints, and Risk Premia in Financial Markets,” with Scott Joslin and Sophie Ni, *Review of Financial Studies*, 2019, 32(1): 228-265.

“Houses as ATMs? Mortgage Refinancing and Macroeconomic Uncertainty,” with Michael Michaux and Nikolai Roussanov, *Journal of Finance*, 2020, 75(1): 323-375.

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2020: ANU Conference on Asset Pricing (Canberra, Australia); Western Finance Association Meeting (San Francisco): "Credit Market Equivalents and the Valuation of Private Firms" by Hüther, Schmid, Steri

2019: American Finance Association Meeting (Atlanta): "The Maturity Premium" by Chaderina, Weiss, and Zechner; "Low Inflation: High Default Risk and High Equity Valuations" by Bhamra, Dorion, Jeanneret, and Weber

2018: Annual AQR-Institute Academic Symposium (London): "Leverage-Induced Fire Sales and Stock Market Crashes" by Bian, He, Shue; Summer Institute of Finance (Shanghai): "Discretionary Stock Trading Suspension" by Huang, Shi, Song, and Zhao; NBER Corporate Finance Meeting (Cambridge): "The Benchmark Inclusion Subsidy" by Kashyap, Kovrijnykh, Li, Pavlova.

2017: American Finance Association Meeting (Chicago): "Option-Based Credit Spreads" by Culp, Nozawa, Veronesi; Texas Finance Festival (Austin): "Credit Allocation under Economic Stimulus: Evidence from China" by Cong and Ponticelli; 6th Annual JRCPPF Conference (Princeton): "Liquidity Regulation and Credit Booms: Theory and Evidence from China" by Hachem and Song; NTU Finance Conference (Singapore): "Stock Price Patterns When Overconfident Traders Overestimate Their Ability and Underestimate the Competition" by Luo, Subrahmanyam, Titman; CICF (Hangzhou): "Optimal Dynamic Momentum Strategies" by Li and Liu; Hanqing Summer Workshop in Finance (Beijing): "Time-inconsistent Risk Preferences and the Term Structure of Dividend Strips" by Guo; HK-SZ Summer Finance Conference (Shenzhen): "Managing Bank Run Risk: The Perils of Discretion" by Huang; CBOE Conference on Derivatives and Volatility (Chicago): "Credit and Option Risk Premia" by Kuehn, Schreindorfer, Schulz

2016: American Finance Association Meeting (San Francisco): "The Risk Anomaly Tradeoff of Leverage" by Baker, Hoyer, and Wurgler; NBER Chinese Economy Meeting (Cambridge): "Shadow Banking: China's Dual-Track Interest Rate Liberalization" by Wang, Wang, Wang, Zhou

2015: NBER Asset Pricing Meeting (Chicago): "The Credit Spread Puzzle in the Merton Model – Myth or Reality?" by Feldhutter and Schaefer; China International Conference

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2013: American Finance Association Meeting (San Diego): “Order Flow and Expected Option Returns” by Muravyev; UNC-Duke Corporate Finance Conference: “Beyond Q: Investment without Asset Prices” by Gala and Gomes; Foundation for the Advancement of Research in Financial Economics Conference (Boston): “Short-term Debt and Financial Crises” by Krishnamurthy and Vissing-Jorgensen; NBER Commodity Meeting (Cambridge): “Exploration Activity, Long Run Decisions, and Roll Returns in Energy Futures” by David

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	Anton Petukhov (2019; Co-Chair; Citadel)
	Mazi Kazemi (2022; Chair)
	Jian Sun (2022; Chair)