# Harnessing the Overconfidence of the Crowd: A Theory of SPACs

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**Abstract**

In a SPAC transaction, a sponsor raises financing from investors using redeemable shares and rights. When investors are sophisticated, these features dilute the sponsor's stake and can lead to underinvestment in efficient projects, but may be useful in separating good projects from bad ones. However, when investors are overconfident about their ability to respond to interim news, the optionality in such features is overpriced, and SPACs can lead to over-investment in inefficient projects. The model predicts different returns for short-term and long-term investors and overall underperformance, consistent with empirical evidence. We evaluate the impact of policy interventions, including eliminating redemption rights, mandating greater disclosure and transparency, limiting investor access, and restricting the rights offered.

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# 1 Introduction

A SPAC (Special Purpose Acquisition Company) or "blank check company" raises financing via an initial public offering in order to merge with a private target and take it public. The SPAC raises capital by selling units, which consist of redeemable shares and derivative securities (e.g., warrants or rights)[1] that allow the holder to buy additional shares at a future date. The SPAC sponsor is tasked with identifying a target firm within a specified period and is compensated with an allocation of equity. Investors have the option to redeem their shares at the initial issue price if they do not approve of the proposed target, and are allowed to keep their rights and warrants even after redemption.

Despite the complex nature of these transactions, the recent boom in SPAC deals has been extraordinary. In 2021 alone, there have been 613 SPAC IPOs in the US that raised over $161 billion.[2] This corresponds to 63% of the total number of IPOs over the period, and around 48% percent of the proceeds of all IPO transactions. This boom in transactions belies the mixed performance for SPAC investors. On the one hand, Gahng, Ritter, and Zhang (2021) estimate that investors who buy shares at the SPAC IPO and redeem optimally before the merger earn average annualized returns of 12%, on an essentially risk-free investment. On the other hand, investors who buy and hold shares in the merged company earn one-year buy-and-hold returns of -15.6%. The combination of redeemable shares and warrants also lead to substantial dilution: Klausner, Ohlrogge, and Ruan (2022) show that for every $10 raised from investors at the IPO, the median SPAC only holds $6.67 in cash for each outstanding share at the time of the merger. Further, SPAC shares tend to drop by one third of their value within a year following the merger.

A number of explanations have been proposed for the recent popularity of SPACs. Proponents argue that going public via SPACs may be subject to less stringent disclosure regulations, and therefore faster or cheaper for firms who wish to go public.[3] SPACs may also provide more certainty about pricing to target firms compared to a traditional IPO and may give retail investors an avenue for investing in new companies. Moreover, a common explanation for issuing warrants and rights is that they encourage investment by long-term investors.

[1]Here, a "right" allows an investor to receive additional shares at the time of the merger. In the context of our model, a right is equivalent to a warrant with zero strike price. Section 2 provides additional details about the institutional background of SPAC transactions.

[2]For comparison, there were a total of 248 SPAC IPOs in 2020, raising around $83 billion in proceeds, while the total number of SPAC IPOs between 2003 and 2019 was 388 and the total issuance over these years was around $70 billion. See https://www.spacanalytics.com and https://spacinsider.com/stats/.

[3]For instance, practitioners argue that firms save on underwriting fees, and have to provide less disclosure to investors when going public via SPAC. However, Klausner et al. (2022) argue that SPAC transactions may not be cheaper or faster than traditional IPOs in practice.

While appealing, these explanations cannot jointly account for both the popularity of SPAC transactions and their significant underperformance, especially for long-term investors.[4] Since investors can redeem their shares at the issue price *and* keep their rights or warrants at no cost, optimal redemption strategies generate large profits for short-term investors at the expense of sponsors and long-term investors. Why would a sponsor *choose* to raise financing using a SPAC transaction when doing so leads to such substantial dilution of their stake? And why do long-term investors buy and hold shares in SPACs given their poor performance?

We propose a model of SPACs that helps resolve these puzzles. The key insight is that while redeemable shares and rights dilute the sponsor's stake when all investors are rational, they can be used to exploit investor overconfidence. Specifically, when investors over-estimate their ability to process and respond to information, they overvalue the optionality embedded in redeemable shares and warrants, which leads to over-pricing. The contract offered by the sponsor optimally trades off the costs from dilution against the benefits of overpricing.

We show that the SPAC structure can improve (ex-post) investment efficiency when investors are rational and average payoffs are low. However, when average payoffs are sufficiently high, investment decisions generally inefficient. Specifically, when the mass of overconfident investors is relatively low, we show that the optimal SPAC contract leads to underinvestment in ex-ante efficient projects. In contrast, when the mass of overconfident investors is high, the optimal SPAC contract leads to over-investment in inefficient projects.

Our model matches key stylized facts: (1) buy-and-hold investors earn negative returns while those redeeming optimally earn excess returns, (2) higher redemptions predict lower returns, and (3) firms choosing SPACs are riskier and have less tangible and more skewed payoffs. Moreover, we show that SPAC financing is more likely for investment opportunities that are risky and positively skewed, and require an intermediate level of initial financing.

Our model also provides a benchmark for policy analysis. This recent boom in SPAC deals and their severe under-performance for buy-and-hold investors has led to scrutiny by regulators and calls for changes to disclosure requirements and investor protection.[5] For instance, in a letter to Congress, Americans for Financial Reform and Consumer Federation

[4]Specifically, if disclosure requirements are lower, one would expect more risk and adverse selection in the market. While this may lead to lower valuations, however, it does not necessarily lead to negative *returns* when investors are rational. By contrast, these firms should be discounted more and, thus, have higher returns. Moreover, if redeemable shares protect investors against bad mergers, these cannot be optimal from the sponsor's perspective. In fact, we show that the sponsor would strictly prefer to not issue redeemable shares when all investors are sophisticated (see Section 4.1.3).

[5]See, for example, https://www.barrons.com/articles/spacs-ipos-sec-regulation-gensler-51624469993 and SEC Investor Alerts titled "Celebrity Involvement with SPACs" (March 10, 2021) and "What You Need to Know About SPACs" (May 25, 2021).

of America argue that:[6]

> The growth in SPACs represents attempts by sponsors and their targets to end-run longstanding rules designed to promote fair and efficient markets, and exposes investors and our markets to significant risks. These investors, many of whom are retail investors, [...] are likely unaware of the complexity of fee arrangements or the expected dilution that will eventually erode the value of their investments.

We explore the impact of several proposed policies. For instance, we show that restricting investor access by sophistication (e.g., by only allowing accredited investors to participate) leads to better returns for buy-and-hold investors but lower returns for short–term investors. Similarly, restricting or eliminating rights as part of the initial unit issuance leads to lower over-pricing and, consequently, higher returns for buy-and-hold investors.

Interestingly, we show that mandatory disclosure and transparency can have different effects on investor returns. Instead of "leveling the playing field," an increase in mandatory disclosure (e.g., increasing the precision of available information) can lead to *lower* returns for unsophisticated investors, especially when the mass of such investors is sufficiently high. In contrast, we show that an increase in transparency (e.g., due to a reduction in information processing costs) improves returns for unsophisticated investors and, as such, may be more effective at reducing the discrepancy in investor returns.

*Overview of model and results.* Section 3 presents the model. A sponsor chooses whether to search for a new investment opportunity (i.e., a private target), which requires raising a fixed amount of external capital. She raises financing by issuing units, which consist of redeemable shares bundled with rights to new shares (as in a SPAC). This reflects the fact that, by law, SPACs are required to offer investors ability to redeem their shares if they do not approve of the acquisition.[7] There is a continuum of risk neutral investors who can provide (up to) a fixed amount of capital. A fraction of these investors are sophisticated (i.e. rational) investors, while the rest are unsophisticated (i.e. overconfident) investors.

Before the investment opportunity is undertaken (i.e., the target is acquired), interim information about its profitability becomes available. Paying attention and responding to this

[6] See "Letter Urging Congress to Address Risks in Growing SPAC Mania," February 16, 2021 (https://ourfinancialsecurity.org/2021/02/letters-to-congress-letter-urging-congress-to-address-risks-in-growing-spac-mania/).

[7] See Rule 419 of the Securities Act of 1933, and Klausner et al. (2022). In practice, sponsors issue units consisting of redeemable shares, rights, and warrants. We study warrants in Section B.3 and show that our results extend to this case. Since our focus is on the understanding when the use of redeemable shares and warrants is preferred for financing, we abstract from other differences in the traditional IPO and SPAC processes (e.g., reporting requirements).

information is costly. Sophisticated investors have an advantage at processing this interim information and so optimally choose to redeem their shares when the news is sufficiently bad. However, unsophisticated investors do not pay attention to interim information and so hold on to their shares irrespective of the news.[8] Importantly, unsophisticated investors are overconfident about their ability to process information. That is, they believe that they will pay attention to interim information, but when that information arrives, they do not.

Section 4 presents the benchmark analysis. Our main result characterizes the contract chosen by the sponsor, who faces the following tradeoff when issuing redeemable shares. On the one hand, for every dollar of capital required for investment, she needs to raise more than a dollar of financing initially to account for possible redemptions by sophisticated investors. This dilution in the sponsor's stake reflects the cost of issuing redeemable shares. On the other hand, unsophisticated investors over-estimate the likelihood they will redeem their shares in the future, and so are willing to overpay for this real option. This equilibrium "overpricing" decreases the (relative) cost of issuing redeemable units.[9] The sponsor's investment decision reflects the net impact of these two forces.

We show that the impact of redeemable shares depends on both the investment opportunity and the distribution of investors. When average payoffs are low and investors are sufficiently sophisticated, redeemable shares can improve (ex-post) efficiency. In this case, enough investors withdraw their funds when they receive negative interim information, so that bad projects are not financed and only good projects are. However, when average payoffs are high, redeemable shares tend to generate inefficient investment decisions. In such cases, if most investors are sophisticated, the cost of dilution dominates, and SPAC financing leads to underinvestment in efficient projects. On the other hand, when the mass of unsophisticated investors is sufficiently large, we show that the overpricing effect dominates and can lead to over-investment in inefficient projects.

Our benchmark analysis matches a number of stylized facts about SPACs. We show that while sophisticated investors who optimally redeem their shares earn positive returns, unsophisticated investors who do not redeem their shares earn negative returns. The sponsor is more likely to pursue a SPAC transaction when the investment opportunity is riskier, which

[8]This assumption that correctly processing such information is more difficult for some investors in line with the evidence documented by Dambra, Even-Tov, and George (2021), who show that forward looking statements (e.g., revenue projections) disclosed as part of a merger proposals in SPAC transactions are (i) optimistically biased relative to future performance, and (ii) incorrectly interpreted by retail investors. As we discuss in Section 3.1, one could alternatively interpret our model as one in which unsophisticated investors have (ex-ante) incorrect beliefs about the interim information that is made available to them.

[9]As we discuss in Section 3.1, such ex-ante over-confidence and ex-post inertia is consistent with a large empirical literature documenting overconfidence in investor and consumer behavior. The resulting overpricing of redeemable units is analogous to the effective mispricing of monthly / annual gym memberships (e.g., DellaVigna and Malmendier (2006)) and cell phone plans (e.g., Grubb (2009)).

leads to lower returns for both sophisticated and unsophisticated investors. The expected payoff to the sponsor from a SPAC increases with the mass of unsophisticated investors, and with investor wealth, when the mass of sophisticated investors is sufficiently large. This helps explain the rapid increase in the popularity of SPAC transactions since 2020, which saw a sharp increase in retail investor participation in financial markets (e.g., Ozik, Sadka, and Shen (2020)).

*Policy implications and Extensions.* In Section 5, we explore the impact of possible regulatory interventions. Given the negative returns to unsophisticated, buy-and-hold investors, one recent proposal being considered is to restrict access to SPAC transactions based on measures of sophistication (e.g., by only allowing accredited investors to invest in them).[10] Another proposal is to "level the playing field" by increasing mandatory disclosures.[11] We show that such interventions may have unintended consequences. For instance, we show that restricting investor access to SPACs based on sophistication or restricting the maximum stake per investor in the SPAC serves to improve returns for unsophisticated investors, but reduces returns for sophisticated investors and decreases the surplus that accrues to the sponsor. To the extent that this drop in sponsor surplus lowers the sponsor's incentive to find a suitable target, such interventions can reduce total surplus. Similarly, an increase in the quality of interim information (e.g., due to increased mandatory disclosure) improves returns for sophisticated investors, but reduces sponsor payoffs and can reduce returns for unsophisticated investors, especially when the fraction of such investors is large.

In Section 6.1, we extend the benchmark model to allow the sponsor to raise capital from an outside investor after redemptions by sophisticated investors in a Private Investment in Public Equity, or PIPE, transaction. PIPE investments from institutional investors are extremely common in SPAC transactions - Klausner et al. (2022) estimate that around 25% of the cash at the time of the merger is from such investors. PIPE financing is often argued to be beneficial for common SPAC investors. First, it helps cover the cash short-fall due to redemptions, and thus help increase the likelihood of a successful merger. Second, many sponsors argue that participation by such investors can act as a "stamp of approval" for the proposed deal, since PIPE investors tend to be sophisticated and well informed.

In our model, while raising PIPE financing reduces the impact of redemptions, it intro-

[10] See "SPAC Bill Curbing Marketing Advanced by Key U.S. House Panel" (Nov 16, 2021, https://www.bloomberg.com/news/articles/2021-11-16/spac-bill-curbing-marketing-set-for-vote-by-key-u-s-house-panel), which discusses a recent proposal in the US Congress that would ban sponsors from marketing SPACs to retail investors.

[11] See e.g. https://consumerfed.org/wp-content/uploads/2021/02/AFR-Letter-on-SPACs-to-HFSC.pdf and https://www.sec.gov/news/public-statement/spacs-ipos-liability-risk-under-securities-laws.

duces a new tradeoff for the sponsor. Since the PIPE investor is informed and the sponsor raises more PIPE financing after bad news, bargaining leads to more dilution for the sponsor, lowering her surplus. On the other hand, by raising some of the financing from PIPE investors, the sponsor can target investors who are more overconfident, which leads to more over-pricing and higher sponsor surplus. We show that the optimal level of PIPE financing increases with the bargaining power of the sponsor and the probability of redemptions, but decreases with the mass of unsophisticated investors. We also find that the return to unsophisticated investors decreases in the level of PIPE financing, which suggests that the impact of such financing on investors is more nuanced than commonly suggested.

In Section 6.2, we characterize how the sponsor's optimal financing choice depends on the attention and processing costs for unsophisticated investors. When attention costs are sufficiently low, all investors process the interim information, so the sponsor strictly prefers to raise financing using non-redeemable shares. When attention costs are sufficiently high, none of the unsophisticated investors process the interim information, and so our benchmark analysis applies. For intermediate levels, we show that the sponsor offers a contract with redeemable shares and rights which leaves the unsophisticated investors indifferent between paying the attention cost (and optimally redeeming their shares) or not. Further, the return to unsophisticated investors decreases in their attention cost, while the return to sophisticated investors increases in it. This suggests that increases in transparency and salience, which reduce the cost of processing interim information for unsophisticated investors, have different implications than increases in amount or precision of the interim information.

The rest of the paper is as follows. The next section provides a brief discussion of the related literature. Section 3 introduces the model and provides a discussion of the key assumptions. Section 4 provides the main analysis of the paper, by characterizing the contract offered by the sponsor in equilibrium. Section 5 considers the impact of policy interventions. Section 6 considers the impact of PIPE financing and the extension to costly information processing by unsophisticated investors. Section 7 concludes. Unless mentioned otherwise, all proofs and additional analysis are in Appendix A and B, respectively.

# 2 Institutional Background and Related Literature

We provide a quick overview of the institutional background of SPAC transactions in the first part of this section. We then discuss the related literature and our relative contribution in more detail.

## 2.1 Institutional background

SPACs are a novel form of blank-check companies. First, a sponsor raises money from public markets via an IPO. In this IPO, the sponsor sells "units" which consist of redeemable shares bundled with rights to additional shares and/or warrants. A typical unit consists of 1 redeemable share and 1/3 of a warrant and most SPAC IPOs sell units at a fixed price (usually \$10). Importantly, SPACs cannot freely choose the securities they offer. Since SPACs are blank check companies, they fall under the Securities Act of 1933, which requires them to issue redeemable shares to investors. However, SPACs are not obligated to issue warrants and can choose how many they issue.

After the IPO, warrants, shares, and rights become tradable and are indeed traded separately on public exchanges. The sponsor retains a fraction of shares as compensation (called the "promote") which typically is around 20% of all shares. The cash raised from investors is held in an escrow account that earns the risk-free rate until the merger is completed. At any time before the merger is completed, investors may redeem their shares at the price of issuance - moreover, they are able keep their warrants and rights even if they redeem their shares.[12] This strategy is a strict arbitrage: by simply redeeming all shares, the investor receives his money back and keep warrants with non-negative value. The existence of this arbitrage has puzzled both practitioners and academics, and is a key feature of SPACs we seek to explain. Indeed, some institutional investors appear to exploit this arbitrage and earn excess returns, while other, less sophisticated investors do not and earn highly negative returns (see the introduction and Klausner et al. (2022) and Gahng et al. (2021)).

Next, the sponsor searches for a suitable target to merge with, subject to a deadline (usually two years). If the sponsor fails to complete a merger within that time frame, then the cash in the escrow account is returned to investors. If the sponsor finds a suitable target, she proposes this target to investors in a shareholder vote. Since investors can redeem their shares at any time prior to the merger, investors who do not approve of the merger will simply redeem their shares (or sell them if the current market price is higher than the redemption price). The sponsor returns the cash from the redeemed shares and then uses the remainder to buy shares in the target firm. While the initial price of units is fixed at \$10, the terms of the merger are negotiated between the SPAC and the target. Thus, the terms of the merger (and in particular how many shares the SPAC gets in the target) *implicitly* determine the value of units that investors hold.[13] If many investors redeem their shares, the

[12] That is, if an investors paid \$30 for 3 units consisting of 1 share and 1/3 of a warrant each, then he can redeem the shares to receive \$30 back and then gets to keep a full warrant, which the investor can exercise or sell at his discretion.

[13] For illustration, suppose that the SPAC has 100 shares outstanding at the time of the merger, which includes redeemable shares, rights or warrants, and the sponsor's promote. Each unit is issued at \$10.

SPAC has little cash remaining. Then, either the merger fails or the sponsor finds additional investors to cover the shortfall. This is done via a PIPE ("Private Investment in Public Equity") investment at the time of the merger, which is negotiated between the sponsor and the PIPE investor. Finally, after the merger completes, the target firm is public and the investors in the SPAC (including the sponsor) end up holding shares in the merged company.

## 2.2 Related literature

While there is a growing empirical literature that documents the performance and characteristics of SPACs,[14] theoretical analysis of these transactions is sparse. Bai, Ma, and Zheng (2020) consider a model in this vein, where SPACs act as certification intermediaries. In their model, firms which differ in both risk and average return and choose whether to go public via IPO or via a SPAC. SPACs are valuable because the sponsor's promote incentivizes costly screening effort, and the market is segmented: riskier firms choose SPACs while safer ones choose IPOs. Luo and Sun (2021) focus on the timing structure of SPACs, and propose a model in which sponsors sequentially propose target for investors' approval. Sponsors start proposing bad projects closer to the deadline, and this moral hazard can be mitigated by granting fewer control rights to investors. Gryglewicz, Hartman-Glaser, and Mayer (2021) compare financing using SPACs to IPO via private equity in a setting where investors face adverse selection about both the ability of the sponsor and the quality of the target firm. In their setting, traditional private equity-IPO transactions are more effective at separating high quality sponsors from low quality ones, while SPAC transactions are more effective at separating good target firms from bad ones.

Importantly, these models do not feature redemptions, and so are unable to speak to a key puzzling feature of SPAC transactions. Our analysis, which we view as complementary to these papers, is able to jointly explain when sponsors offer redeemable shares and why we observe different returns for short-term and long-term investors. Moreover, because our analysis relies on investor overconfidence, it generates unique policy predictions, e.g., improved disclosure may reduce investors' returns and restricting access to sophisticated investors has positive spillovers.

Chatterjee, Chidambaran, and Goswami (2016) apply the model of Chemmanur and

Suppose that the SPAC receives a fraction $f$ of the shares of the target per the merger agreement. Then, the per-share value is $Vf/100$ , where $V$ is the merger value. Given initial price $P = \$10$, we can then calculate the value to each investor. Alternatively, we can divide both values by $f$, so that $\hat{P} = \$10/f$ and the per-share value is $V/100$. Thus, the fraction of shares $f$ *implicitly* defines a flexible price for the SPAC IPO.

[14] See Lewellen (2009), Jenkinson and Sousa (2011), Cumming, Haß, and Schweizer (2014), Kolb and Tykvova (2016), Dimitrova (2017), Shachmurove and Vulanovic (2017), Vulanovic (2017), and more recently Klausner et al. (2022), Gahng et al. (2021), and Dambra et al. (2021).

Fulghieri (1997) to SPACs. Sponsors issue units consisting of equity and warrants to risk-averse investors under adverse selection, and the warrant portion signals their type.[15] Since all investors are rational, their framework cannot generate the significantly negative returns for unsophisticated investors documented by Gahng et al. (2021). Our model does not rely on adverse selection, and the sponsor issues redeemable shares to exploit unsophisticated investors instead. This generates the return patterns observed empirically.

The redeemable shares in our framework are reminiscent of the mechanism design literature on sequential screening (i.e. Davis (1995), Che (1996), Courty and Hao (2000), and Krähmer and Strausz (2015)). In these papers, a principal allows a customer to return a product for a *partial* refund. Both the refund and the ex-ante price are then used to screen the customer's type. These models cannot explain SPACs, because (i) in a SPAC, investors can return their shares for a *full* refund and keep their rights (i.e. they keep part of the "product"), which is suboptimal in these papers, (ii) the SPAC is sold on a public market for a fixed price; thus neither the ex-ante price nor the refund is used to screen, and (iii) SPACs have significantly negative returns to investors who keep their shares, whereas agents are rational in these models and earn positive rents.[16]

More broadly, our paper contributes to the literature on behavioral contracting and overconfidence.[17] Our main insight is that with enough investor overconfidence, the sponsor finds it optimal to raise financing using redeemable shares, even though in principle, this leads to more dilution. The key mechanism is that when investors are overconfident about their ability to acquire information in the future, they overestimate the option value of redeeming shares, and so are willing to pay more for them. A related, but economically distinct, mechanism arises in Gervais et al. (2011), who show that firms use option-based compensation to incentivize overconfident CEOs because they over-value these options.

Finally, our model is related to the literature on book-building in IPOs (i.e. Sherman (2000), Sherman and Titman (2002), and Sherman (2005)). Consistent with these papers, we study security issuance as an optimal contracting problem, and the sponsor faces both sophisticated and unsophisticated investors.[18] Unlike these papers, our model features overconfidence and the optimal contract consists of redeemable shares.

[15] See Gibson and Singh (2001) for a related signaling model involving put warrants.

[16] That is, if we understand investors' outside option as the risk-adjusted rate of return, investors would earn excess returns in equilibrium. Instead, buy-and-hold investors earn negative returns in a SPAC.

[17] See e.g. Manove and Padilla (1999), Gervais and Odean (2001), Scheinkman and Xiong (2003), DellaVigna and Malmendier (2004), Eliaz and Spiegler (2006), Sandroni and Squintani (2007), Eliaz and Spiegler (2008), Landier and Thesmar (2008), Heidhues and Koszegi (2010), Gervais, Heaton, and Odean (2011), and Spinnewijn (2013).

[18] See also Benveniste and Spindt (1989) and Benveniste and Wilhelm (1990).

# 3 Model

**Payoffs.** There are three dates $t \in \{1, 2, 3\}$. A sponsor, or founder, ($F$, she) chooses whether or not to exert effort $e_F \in \{0, 1\}$ at a cost $\kappa$ to identify a new investment opportunity (e.g., target firm). The investment, or project, costs $K$ in external financing and has a terminal (date three) payoff $V \in \{l, h\}$, where $h > l > 0$ and $\mu_0 \equiv \Pr(V = h)$. The unconditional mean and variance of $V$ are given by

$$V_0 = \mu_0 h + (1 - \mu_0) l \text{ and } \sigma_V^2 = \mu_0 (1 - \mu_0) (h - l)^2 .$$

To distinguish the impact of changes in payoffs from changes in $\mu_0$, we refer to an increase in $V_0$ holding fixed $\mu_0$ as an increase in the *level of payoffs* and an increase in $\sigma_V^2$ holding fixed $\mu_0$ as a *mean preserving spread*.

Investment in the project is **efficient** when the unconditional expected payoff is higher than the cost of financing and effort provision, i.e., it has a positive unconditional net present value (or, $V_0 > \kappa + K$).[19] The sponsor retains one share of equity, which corresponds to the sponsor's promote, and raises financing at date one by selling $E$ additional units to investors at price $P$ per unit.[20] Each unit consists of one redeemable share of equity and $r$ rights, where each right endows the owner with an additional share of equity. Shares can be redeemed at date two at price $P$, and investors who redeem their shares keep all of their rights.[21] Our modeling of the sponsor's security offering closely follows the institutional setting. SPACs are subject to the Securities Act of 1933 and must offer redeemable shares. However, they are not obligated to offer warrants or rights, and can choose how many of them to offer.[22]

**Investors.** There is a continuum of risk-neutral investors, indexed by $i \in [0, 1]$, each with wealth $W > K$.[23] Each investor is either a sophisticated or unsophisticated investor, and

[19] As we discuss in Section 5, this ensures that the sponsor is always willing to finance the project using straight equity.

[20] Note that in practice, SPAC shares are usually issued at \$10 per share, but the eventual terms of the merger / acquisition determine an implicit price per share. We capture this relative effect by allowing the price $P$ to change. Allowing the sponsor to choose how many shares to retain does not alter any of the results. If the sponsor chooses to retain $s$ shares, then we can simply scale the number of shares and rights issued by $s$.

[21] An equity right is equivalent to a warrant with a strike price of zero. In Section B.3, we study warrants with arbitrary strike prices and show that our results go through, i.e. issuing units consisting of redeemable shares and warrants is optimal.

[22] In particular, SPACs cannot simply issue straight (i.e. non-redeemable) equity. We consider general contracts in Appendix B.1 and we show that our main intuition still holds. That is, the sponsor optimally offers a contract that is contingent on an interim action (analogous to the redemption decision), in order to exploit investor overconfidence.

[23] This ensures that, in the aggregate, investors have sufficient wealth to finance the project.

the fraction of unsophisticated investors is $m \in [0,1]$. With slight abuse of notation, we use $i = S$ to denote sophisticated investors and $i = U$ to denote unsophisticated investors. At date one, given the sponsor's offered contract $(E, r, P)$, investor $i$ chooses the optimal number $e_i \geq 0$ of units to buy at date one given wealth $W$.

At date two, investors have access to interim private information about terminal payoffs, but we assume that paying attention to (and processing) this information is costly. Specifically, investor $i \in \{S, U\}$ chooses whether or not to attend to (denoted by $a_i \in \{0,1\}$) a private signal $x_i \in \{l, h\}$ about the the project payoff $V$ by incurring attention cost $c_i$, where

$$\Pr(x_i = h | V = h) = 1, \quad \Pr(x_i = l | V = l) = \gamma. \tag{1}$$

Conditional on $V$, $x_i$ are independent across investors. Let $V_x \equiv \mathbb{E}[V | x_i = x]$ denote the conditional expected payoff if investor $i$ observes $x_i = x$. Then,

$$V_h = \frac{\mu_0}{\mu_0 + (1-\mu_0)(1-\gamma)}(h-l) + l, \quad \text{and } V_l = l,$$

since $x_i = l$ is fully revealing. Moreover, denote the unconditional likelihood of high signal by $q \equiv \Pr(x = h) = \mu_0 + (1-\mu_0)(1-\gamma)$.

Given this information, each investor chooses whether to keep the shares (denoted by $k_i = 1$) or redeem them ($k_i = 0$).[24] If investor $i$ does not pay attention to the signal, they keep the shares they own by default (i.e., $k_i = 1$) i.e., they exhibit inertia.[25] Consistent with empirical evidence, we assume that it is cheaper for sophisticated investors to pay attention to, and process, information than it is for unsophisticated investors i.e., $c_S < c_U$ (e.g., see Engelberg (2008) and the survey by Blankespoor, deHaan, and Marinovic (2020)). For expositional clarity, we normalize $c_S = 0$, so that sophisticated investors always pay attention to relevant information. In our benchmark analysis, we set $c_U$ sufficiently high so that unsophisticated investors never pay attention, as summarized by the following condition – we relax this assumption in Section 6.2.

**Assumption 1.** *The cost of attention for sophisticated investors is $c_S = 0$ and for unsophisticated investors is $c_U \geq \bar{c} \equiv (1-q)W$.*

More importantly, we assume that unsophisticated investors are overconfident in their ability to pay attention to relevant information and differ in the extent of this overconfidence, which we parameterize by $\beta \in [0,1]$. Specifically, at date one, a $\beta$-type investor is uncertain

[24]Conditional on $x_i$, it is optimal for each investor to either redeem all shares or to keep all of them. Thus, we do not need to consider investors keeping a fraction of their shares and redeeming the rest.

[25]We abstract from investors selling shares on the open market, since this does not affect the sponsor's financing constraint or payoff.

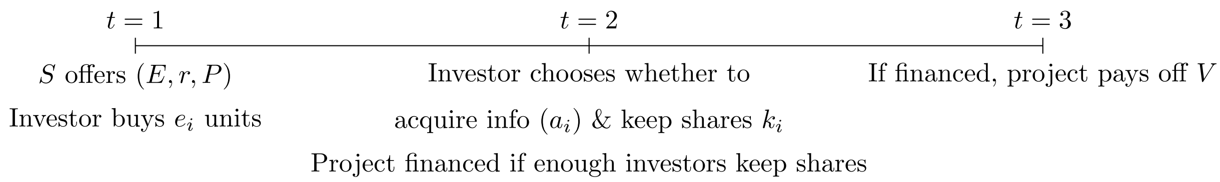


Figure 1: Timeline

about their attention cost $c_i$ and (incorrectly) believes that it will be $c_i = c_S$ with probability $\beta$ and $c_i = c_U$ with probability $1 - \beta$. Thus, at date one, $\beta$-type investors believe that they will respond to information with probability $\beta$, but they actually do not at date two. As such, $\beta$ is a measure of the unsophisticated **investors' overconfidence**: it measures the degree to which they underestimate their average attention cost, or equivalently, overestimate their ability to respond to information at date two. We assume that such investors differ in their degree of overconfidence and that $\beta$ has a continuous distribution $G(\beta)$ for the continuum of unsophisticated investors.

Figure 1 summarizes the timing of events, which we describe below.

- Date one: The sponsor offers the contract $(E, r, P)$. Investor $i$ optimally chooses to buy $e_i$ units at a price $P$, given their beliefs about future redemption decisions. The market clearing condition is given by

$$\int_i e_i di = E.$$

- Date two: Investor $i$ chooses whether to pay cost $c_i$ to observe signal $x_i$. If investor $i$ acquires information, they choose whether to keep their shares ($k_i = 1$) or redeem them ($k_i = 0$). The project is financed if a sufficiently large number of investors choose to keep their equity invested in the project, i.e., if[26]

$$P \int_i e_i k_i di \geq K. \tag{2}$$

- Date three: If the project is successfully financed at date two, it pays off $V$.

[26] In reality, the sponsor may make up shortfalls by raising additional financing. We consider this case in Section 6.1 and show that our results survive.

### 3.1 Discussion of assumptions

**Overconfidence and Inertia.** Our key assumption is that some investors are overconfident about their ability to process interim information about the project: they believe that they will pay attention to relevant information in the future and act on it, whereas in reality they do not. A large empirical literature finds evidence of investor overconfidence in the data (see the recent survey Daniel and Hirshleifer (2015)). Our modeling of overconfidence is similar to Hirshleifer, Subrahmanyam, and Titman (1994) (Section III.C) and Grubb (2015) (Section 4.4), and is in line with the observation that retail investors over-estimate their ability to trade on profitable stocks (e.g., Odean (1999), Barber and Odean (2000)) and their ability to pick better performing active funds (e.g., French (2008), Malkiel (2013)), and with experimental evidence that suggests investors overestimate the precision of their signals (e.g., Biais, Hilton, Mazurier, and Pouget (2005)).

Moreover, conditional on not paying attention to interim information, we assume investors exhibit inertia and keep their positions. This assumption reflects the standard approach of modeling rational inattention (e.g., Sims (2003), Sims (2006), Steiner, Stewart, and Matejka (2017)), and is consistent with the observation that investors often exhibit portfolio inertia (e.g., Illeditsch (2011), Bilias, Georgarakos, and Haliassos (2010), Ameriks and Zeldes (2004)) and make errors in refinancing decisions (e.g., Agarwal, Rosen, and Yao (2016), Andersen, Campbell, Nielsen, and Ramadorai (2015), Golder, Schaefer, and Szimayer (2021)). More broadly, our assumption of ex-ante overconfidence in ability and ex-post inertia are consistent with broader evidence of investor and consumer behavior (see Grubb (2015)), including over-payment for gym memberships (DellaVigna and Malmendier (2006)) and cell phone plans (Grubb (2009)).

**Other Biases.** Importantly, our assumption of overconfidence has different implications from simply assuming that investors are overly optimistic about the project value. In the latter case, such investors do not overvalue the option to redeem shares / exercise warrants, but instead overpay for equity. In such settings, the sponsor would prefer to issue non-redeemable shares. Similarly, the assumption that some investors have a preference for skewness (i.e., "lottery" like stocks) also does not imply that issuing redeemable shares is optimal for the sponsor - again, the sponsor is better off by issuing straight equity in this case.

The key feature we want to capture in the model is that some investors over-value the optionality embedded in redeemable shares and rights when buying SPAC shares, but fail to optimally exercise these options at the interim stage. While we believe costly attention provides a natural and empirically relevant mechanism which generates this feature, we expect other types of behavior to have similar implications. For instance, some investors may over-estimate the probability with which they receive informative signals, or over-estimate their ability to detect "bad" investment opportunities from interim information. Other investors may underestimate the degree to which they are subject to confirmation bias (and hence, the extent to which they dismiss negative, interim news, after having decided they want to participate ex-ante). Finally, our model of overconfidence about attention costs naturally captures the notion that investors often underestimate the amount of time, effort and attention they will need to allocate to future investment decisions.

**Contracting.** Our setup closely follows the institutional setting, which restricts the types of contracts SPACs can offer. By law, SPACs are bound to issue redeemable shares. They do not have to issue warrants or rights and can instead choose how many of these to issue. They are also free to set the terms of the warrants. While SPACs cannot offer arbitrary contracts in practice, as a theoretical exercise, we study general contracts in Appendix B.1. There, we allow the sponsor to offer contingent payments, depending on the realized value $V$ and investors "redemption decision" $k$. Although the optimal contract takes a different form, the central intuition survives. Whenever the mass of unsophisticated investors is sufficiently large, the sponsor optimally offers a contract that depends on the redemption decision, since such investors overvalue that information and are willing to overpay for it. Thus, when the sponsor can choose the contract freely, the economic forces closely mirror those in Proposition 4.

**Ex-ante vs. Ex-post Moral Hazard.** In the model, the sponsor has to exert effort to find a project. This assumption corresponds to the institutional setting, where sponsors first raise financing and then must find a suitable target (see Section 2.1), and can be interpreted as ex-ante moral hazard. In the discussion on SPACs, commenters have highlighted ex-post moral hazard. That is, since the sponsor gets shares in the SPAC for free, she has an incentive to push through a merger even if the target's value is low (see e.g. Klausner et al. (2022)). Our model allows for this possibility. Specifically, whenever $K > l$, the low value project has negative NPV and therefore hurts investors. However, as we show in Proposition 4 and Corollary 1 below, when investors are relatively unsophisticated, the sponsor indeed finances such projects. In contrast, when investor are sufficiently sophisticated, the SPAC structure improves efficiency by screening out low value projects.

**Entry and Secondary Market Trading.** We do not consider entry, i.e. the mass of sophisticated and unsophisticated investors is fixed, for simplicity. This assumption captures the fact that in SPACs, a relatively small number of hedge funds hold a the vast majority of investors' shares (see e.g. Klausner et al. (2022)). We expect that our main results would obtain in a model where sophisticated investors have heterogeneous costs of entry (e.g. the cost of conducting research on SPACs). Similarly, we expect that a model in which some sophisticated investors sell their shares to unsophisticated investors before the investment decision (e.g., due to liquidity concerns) will yield qualitatively similar results, but at the cost of tractability and expositional clarity.

We also abstract from explicit modeling secondary market transactions after the shares have initially been issued to maintain tractability. This is largely consistent with Klausner et al. (2022), who show that investors in SPAC IPOs are almost entirely large institutions and there is relatively little trade between the SPAC IPO and the merger announcement.[27] In practice, investors have the option of either redeeming their shares or selling these shares in the secondary market, depending on which offers the higher price. To the extent that the redemption price is lower than the secondary market price, our model underestimates the benefit to sophisticated investors and the sponsor and underestimates the losses to unsophisticated investors. However, we expect the tradeoff we focus on remains in this setting.

**Voting.** We do not explicitly model the shareholder vote that occurs in practice when a sponsor proposes a target. In our model, investors with unfavorable information redeem their shares, so any remaining shareholders would approve of the vote. We further assume that investors do not condition on the behavior of others when making their redemption decisions. This is consistent with the observation by Klausner et al. (2022) that the extent of total redemptions are not known till after the shareholder vote.

**Other Modeling Assumptions.** A number of our other assumptions are made for tractability and expositional clarity. For instance, we assume that redeemed shares are given to a third party, so that redemptions do not affect shares outstanding. This biases our model *against* issuing redeemable shares – when investors' redemptions reduce shares outstanding, they increase the sponsor's payoff, provided that the project is still financed. Then, the sponsor may benefit from inducing redemptions, whereas in our model, redemptions always hurt the sponsor. Similar assumptions are common in the literature (e.g. Benveniste and Spindt (1989) Sherman (2000), and Sherman and Titman (2002)) to avoid nonlinearities in investors' payoffs. In Appendix B.2, we relax this assumption and account explicitly for the

[27] Specifically, they show that most SPAC investors are institutions affiliated with hedge funds, who are required to file SEC Form 13F. In their sample, median holdings of 13F filers after an IPO are 85%, while immediately before the merger are 87%, and around 20% of shares are sold by these investors before the merger announcement.

fact that redemptions decrease the number of shares outstanding. While the setting is not tractable analytically, we show numerically that issuing redeemable shares is still optimal for the sponsor.

The information structure specified in Equation (1) highlights the role of "false positives" in our setting, while maintaining tractability. The key friction is that investors may not redeem their shares when the payoff is low and so the value of information is driven by the extent to which it is informative about low payoff state i.e., $V = l$. Our analysis can be extended to richer informational settings as long as the low payoff state is not perfectly revealed by the information.

In practice, SPAC units consist of equity, rights, and warrants, which allow the investor to acquire additional shares of equity at a fixed exercise price. In our model, this is equivalent to units that consist of equity, rights, and warrants with an exercise price of zero. We explicitly consider warrants with non-zero exercise price in Appendix B.3, and find that our results are qualitatively similar. Since warrants may or may not be exercised, depending on the value and the strike price, the shares outstanding now depend on the value of the target. This precludes characterizing the sponsor's problem analytically. We instead provide numerical solutions, which show that issuing redeemable shares and warrants is optimal. Thus, with warrants, our model becomes less tractable, but our main results survive.

# 4 Analysis

We solve the model by working backwards, first describing the investors' decisions and then describing the sponsor's decisions.

**Investors.** At date two, investors choose whether to attend to information $x_i$, and then whether to keep their shares. Formally, given a (date one) position of $e_i$ units and a cost $c_i$, investor $i$ chooses $k_i(x) \in \{0,1\}$ and $a_i \in \{0,1\}$ to maximize:

$$
\begin{aligned}
U(e_i; c_i) \quad = \quad \max_{a_i, k_i(x)} \quad & e_i a_i \left( \tfrac{(r+k_i(h))qV_h + (r+k_i(l))(1-q)V_l}{1+E(1+r)} - P\left(qk_i(h) + (1-q)k_i(l)\right) \right) \\
& + e_i(1-a_i)\left(\tfrac{1+r}{1+E(1+r)}V_0 - P\right) - c_i a_i,
\end{aligned}
$$

subject to the budget constraint $e_i P \leq W$.

Given a signal $x$, the expected payoff from owning a unit is

$$
\frac{1+r}{1+E(1+r)} V_x - P,
$$

which includes the share and $r$ rights, while the payoff from redeeming the equity and keeping the rights is

$$\frac{r}{1+E(1+r)}V_x.$$

Thus, conditional on observing $x$, an investor keeps their shares (i.e., $k_i(x)=1$) if and only if

$$\frac{1}{1+E(1+r)}V_x \geq P,$$

which depends on the price $P$, the amount of units issued $E$, and the amount of rights $r$. This reflects the assumption that redeemed shares are given to a third party, so that redemptions do not affect shares outstanding. As discussed in Section 3.1, this is for analytical tractability; we relax the assumption in Appendix B.2.

Now suppose that the price is such that

$$\frac{1}{1+E(1+r)}V_h \geq P \tag{4}$$

and

$$P \geq \frac{1}{1+E(1+r)}V_l. \tag{5}$$

We will show that this is true for the optimal contract. In this case, investors keep their shares if $x_i = h$ and redeem when $x_i = l$, i.e., $k_i(h)=1$ and $k_i(l)=0$. The value of paying attention is given by the difference in payoffs from optimally redeeming shares versus keeping them irrespective of $x$, i.e.

$$\begin{aligned}\Delta_i &= e_i\left(\frac{(1+r)qV_h + r(1-q)V_l}{1+E(1+r)} - Pq\right) - e_i\left(\frac{1+r}{1+E(1+r)}V_0 - P\right) \\ &= e_i(1-q)\left(P - \frac{1}{1+E(1+r)}V_l\right) \geq 0.\end{aligned} \tag{6}$$

Investor $i$ pays attention (i.e., $a_i = 1$) whenever the incremental benefit from doing so exceeds the cost i.e., $\Delta_i \geq c_i$. Assumption 1 ensures that the sophisticated investors always always pay attention, and that unsophisticated investors never do.

At date one, investor $i$ chooses how many units $e_i$ to buy to maximize their expected date two payoff $U(e_i; c_i)$. Since investors are risk neutral, they either invest all their wealth in the project or none, i.e., they optimally choose $e_i \in \{0, W/P\}$. Sophisticated investors correctly anticipate their attention cost and thus choose

$$e_S = \arg\max_{e_i \in \{0, W/P\}} U(e_i; c_S).$$

Sophisticated investors buy $e_S = W/P$ units at date one, since their per-unit expected payoff is positive whenever the project is financed, i.e.

$$\frac{(1+r)\,qV_h + r\,(1-q)\,V_l}{1+E\,(1+r)} - Pq \geq 0. \tag{7}$$

However, unsophisticated investors are overconfident in their ability to acquire information. Formally, a $\beta$-type investor chooses to buy $e_U\,(\beta)$ units, where

$$e_U\,(\beta) = \arg\max_{e_i \in \{0, W/P\}} \beta U\,(e_i; c_S) + (1-\beta)\,U\,(e_i; c_U)\,. \tag{8}$$

This implies that a $\beta$-type investor buys units if and only if

$$\beta\left(\frac{(1+r)\,qV_h + r\,(1-q)\,V_l}{1+E\,(1+r)} - Pq\right) + (1-\beta)\left(\frac{1+r}{1+E\,(1+r)}V_0 - P\right) \geq 0. \tag{9}$$

The expected per-unit payoff is increasing in $\beta$ and decreasing in $P$, all else equal. This implies that for a given price, there is a threshold type $\bar{\beta}$ such that all unsophisticated investors with $\beta \geq \bar{\beta}$ buy $e_U\,(\beta) = W/P$ units, while investors with $\beta < \bar{\beta}$ do not participate. As a result, only a fraction $1 - G\left(\bar{\beta}\right)$ of unsophisticated investors buy units at date $t = 1$. Importantly, the per-unit payoff in Equation (9) is the *perceived* expected payoff for an unsophisticated investor at date one, and reflects the degree of overconfidence $\beta$. At date two, unsophisticated investors (correctly) realize that their attention cost is $c = c_U$ and choose not to acquire information; instead, they keep their shares. As a result, their expected date two payoff is $(1+r)V_0/(1+E\,(1+r)) - P$.

**Sponsor.** Now, consider the sponsor's financing decision at date two. Generically, the financing game has multiple equilibria. For instance, there always exists an equilibrium in which investors redeem their shares, irrespective of their information, and the project is never financed. We instead focus on equilibria in which (i) the project is financed, and (ii) all investors make optimal redemption decisions. In particular, while all participating unsophisticated investors keep their shares, sophisticated investors condition their redemption decisions on interim information. This implies that the financing condition is state dependent. When $V = h$, all investors choose to keep their shares and so the financing condition is given by

$$1 - m + m\left(1 - G\left(\bar{\beta}\right)\right) \geq K/W.$$

However, when $V = l$, a fraction $\gamma$ of sophisticated investors observe $x_i = l$ and choose to redeem their shares. This implies that the financing condition is given by

$$(1-m)(1-\gamma)+m\left(1-G\left(\bar{\beta}\right)\right) \geq K/W. \tag{10}$$

The financing constraint is stricter when $V = l$, and so when inequality (10) holds, the project is financed for any value $V$.

At date one, the sponsor's optimal choice of $(E, r, P)$ maximizes the ex-ante value of her stake of the project, conditional on the project always being financed, i.e., it solves:

$$\begin{aligned} U_F &= \max_{E,r,P} \frac{1}{1+E(1+r)} V_0 \\ &\quad \text{subject to } (4), (5), (7), (9), (10), \text{ and} \\ U_F &\geq \kappa \end{aligned} \tag{11}$$

where Conditions (4) and (5) ensure incentive compatibility for optimal redemption decisions, Conditions (7) and (9) ensure participation by sophisticated and unsophisticated investors at date one, Condition (10) implies that the project is always financed, and Condition (11) ensures that the sponsor finds it worthwhile to exert effort in identifying the investment opportunity.

## 4.1 Benchmarks

In this subsection, we characterize the optimal contract under special cases that provide natural benchmarks for the general analysis.

### 4.1.1 Financing with non-redeemable shares

We begin by considering the theoretical benchmark when the sponsor can raise financing using non-redeemable shares. Blank check companies are legally required to allow investors to redeem their shares in order to ensure that they are protected from adverse decisions made by the sponsor.[28] As such, the type of financing we consider in this subsection is not feasible in practice. However, it provides a useful and transparent benchmark for our main analysis. Moreover, one can also interpret this benchmark as an approximation to the case where the sponsor finances the project using a traditional IPO instead of a SPAC transaction.

Suppose the sponsor offers the contract $(E, r, P)$, where each unit consists of one non-redeemable share (straight equity) and $r$ rights. Then, investors cannot use interim informa-

[28]See https://www.sec.gov/oiea/investor-alerts-and-bulletins/what-you-need-know-about-spacs-investor-bulletin.

tion (i.e., the incentive compatibility conditions in (4) and (5) do not apply) and all investors have the same expected payoffs at date $t = 1$, given by

$$U(e_i; c_i) = e_i \left( \frac{1+r}{1+E(1+r)} V_0 - P \right).$$

The sponsor can ensure that all investors are willing to buy $e_i = W/P$ units by setting the price so that the above payoff is non-negative. Otherwise, no investor participates. Thus, the sponsor solves

$$U_F = \max_{E,r,P} \frac{1}{1+E(1+r)} V_0 \text{ subject to } P \leq \frac{1+r}{1+E(1+r)} V_0, \; U_F \geq \kappa \text{ and } EP \geq K,$$

which reflects the participation and financing constraints, respectively. When investors are indifferent, i.e., $P = \frac{1+r}{1+E(1+r)} V_0$, the financing constraint is given by

$$E \left( \frac{1+r}{1+E(1+r)} V_0 \right) = K$$
$$\Leftrightarrow E(1+r) = \frac{K}{V_0 - K}.$$

This implies that the sponsor is indifferent between different values of $(E, r)$ such that the above equation holds, and thus $r = 0$ is optimal without loss of generality. Then, the sponsor issues

$$E^{NR} = \frac{K}{V_0 - K}$$

shares and the following proposition characterizes the offered contract.

**Proposition 1.** *If the sponsor can finance the project using non-redeemable shares, she always finances efficient projects. The optimal contract sets $r = 0$, and $P = V_0 - K$, and the value of her stake is*

$$U_F^{NR} = V_0 - K. \tag{12}$$

In our setting, if the sponsor were able to issue non-redeemable shares, she would be willing to finance all ex-ante efficient projects. Moreover, since bundling additional rights only serves to dilute her stake, she optimally sets $r = 0$. While a SPAC sponsor is legally required to issue redeemable shares, the above result allows us to clearly characterize the various effects that the redemption feature has on outcomes. As we shall see below, redeemable shares can improve ex-post efficiency when the mass of unsophisticated investors is sufficiently low. However, the same feature can lead to over-investment in inefficient projects, when the fraction of unsophisticated investors is sufficiently high.

#### 4.1.2 Only sophisticated investors

Suppose that all investors are sophisticated, i.e., $m = 0$. In this case, investors buy shares if the participation constraint (7) holds, or equivalently, if

$$P \le \frac{1}{q} \frac{(1+r)\, qV_h + r\,(1-q)\, V_l}{1 + E\,(1+r)}.$$

This condition binds in the optimal contract, since any lower price leads to more dilution for the sponsor. Then, to ensure that investors keep the shares conditional on $x = h$ (i.e., the incentive compatibility condition (4) holds), we need[29]

$$\begin{aligned} \frac{V_h}{1 + E\,(1+r)} &\ge P \\ \Leftrightarrow V_h &\ge \frac{1}{q}\left((1+r)\, qV_h + r\,(1-q)\, V_l\right), \end{aligned}$$

which is only possible if $r = 0$. In this case, the sponsor optimally issues no rights and sets

$$P = \frac{V_h}{1+E}.$$

Plugging this into the financing condition (10) and solving for the sponsor's optimal strategy gives us the following result.

**Proposition 2.** *Suppose there are only sophisticated investors. If the sponsor is restricted to offering redeemable shares, she finances the project only if*

$$V_0 - \kappa > \frac{V_0}{\max\left\{(1-\gamma)\, V_h, V_l\right\}} K.$$

*and the optimal contract features $r = 0$. Moreover, if $(1-\gamma)\, V_h \ge V_l$, then investors keep their shares if $x = h$ and redeem if $x = l$ in the optimal contract, and the sponsor's optimal value is*

$$U_F = V_0 - \frac{V_0}{V_h\,(1-\gamma)} K. \tag{13}$$

*If $(1-\gamma)\, V_h < V_l$, then investors always keep their shares and the value of the sponsor's stake is*

$$U_F = V_0 - \frac{V_0}{V_l} K. \tag{14}$$

With only sophisticated investors, the sponsor gets lower expected payoffs from offering redeemable shares than if she could offer straight equity (compare (13) and (14) to (12)).

[29]Note that Condition (5) is slack in this case.

If $(1-\gamma)V_h \geq V_l$, investors redeem their shares when $x = l$ and the sponsor must raise additional cash to ensure that the project is financed, which dilutes her share. If $(1-\gamma)V_h \leq V_l$, investors always keep their shares, but the sponsor must underprice the shares to ensure that this is optimal for investors. In both cases, the sponsor's stake in the project is diluted as a result of redemption rights. When the extent of this dilution is sufficiently severe, the sponsor may prefer not to finance the project. Importantly, note that since $\frac{V_0}{\max\{(1-\gamma)V_h, V_l\}} > 1$, not all efficient projects are pursued by the sponsor.

### 4.1.3 No overconfidence

Now, suppose that unsophisticated investors do not exhibit overconfidence, and so correctly anticipate that they will not acquire information at date two (i.e., $G(0) = 1$). To ensure that these investors invest in the project, the participation constraint (9) must hold for $\beta = 0$, or equivalently,

$$\frac{1+r}{1+E(1+r)}V_0 \geq P.$$

This also ensures that the sophisticated investors buy units at date one (i.e., their participation condition (7) holds). Moreover, the financing constraint (10) requires that

$$((1-m)(1-\gamma)+m)EP \geq K,$$

since $W = EP$. The sponsor then solves

$$\begin{aligned}
U_F &= \max_{E,r,P} \frac{1}{1+E(1+r)}V_0 \text{ subject to} \\
U_F &\geq \kappa, \\
EP &\geq \frac{K}{(1-m)(1-\gamma)+m}, \text{ and} \\
P &\leq \frac{1+r}{1+E(1+r)}V_0.
\end{aligned}$$

When the latter two constraints bind, we have that

$$E(1+r) = \frac{K}{V_0(m+(1-m)(1-\gamma))-K},$$

assuming that $m$ is sufficiently large to ensure that the denominator in the above expression is positive.

Again, this implies that the sponsor is indifferent between different values of $(E, r)$ such that the above holds, and $r = 0$ is optimal without loss of generality. In this case, the following result characterizes the optimal contract.

**Proposition 3.** *Suppose no investors are over-confident. If the sponsor is restricted to offering redeemable shares, she finances the project only if* $U_F > \kappa$*, where the value of the sponsor's stake is*

$$U_F = V_0 - \frac{K}{m + (1-m)(1-\gamma)},$$

*and the optimal contract features* $r = 0$ *and price*

$$P = \frac{V_0}{1+E} = V_0 - \frac{K}{1-(1-m)\gamma}. \tag{15}$$

As in the previous benchmark, redemptions by sophisticated investors leads to dilution in the the sponsor's stake. The condition $U_F \geq \kappa$ ensures that there are sufficiently many investors (who do not redeem) to ensure that raising financing for the sponsor is still profitable. Again, since $\frac{1}{m+(1-m)(1-\gamma)} > 1$, not all efficient projects are pursued by the sponsor.

Propositions 2 and 3 highlight that when facing sophisticated investors, the sponsor does not benefit from issuing redeemable shares and optimally chooses to issue no rights. Moreover, in these cases, dilution due to redeemable shares leads to underinvestment in efficient projects. As we shall see next, in the presence of unsophisticated investors, this is no longer the case.

## 4.2 Optimal contract

We now characterize the optimal contract. First, note that if

$$((1-m)(1-\gamma) + m) < K/W,$$

then there are too many redemptions in equilibrium and the project cannot be financed using redeemable shares, even if all investors initially buy units and no unsophisticated investors redeem. On the other hand, if

$$(1-m)(1-\gamma) \geq K/W,$$

then only sophisticated investors need to invest to finance the project, and Proposition 2 characterizes the contract offered by the sponsor. We record these observations in the following result.

**Lemma 1.** *If* $((1-m)(1-\gamma)+m)W < K$*, then the project cannot be financed using redeemable shares. If* $(1-m)(1-\gamma)W \geq K$*, then only sophisticated investors invest and* *the equilibrium is characterized by Proposition 2.*

When

$$K/W \in \left(\left(1-m\right)\left(1-\gamma\right), \left(\left(1-m\right)\left(1-\gamma\right)+m\right)\right), \tag{16}$$

we need to ensure that both sophisticated and unsophisticated investors participate in order to finance the project. In this case, there exists a $\bar{\beta}$ such that

$$\left(1-m\right)\left(1-\gamma\right)+m\left(1-G\left(\bar{\beta}\right)\right)=K/W, \tag{17}$$

which reflects the fact that, that in equilibrium, all sophisticated investors and the most overconfident unsophisticated investors participate.[30] The marginal investor $\bar{\beta}$ is indifferent between acquiring units and not i.e., their participation constraint (9) holds with equality, which implies that

$$P=\frac{1}{\left(1-\bar{\beta}\right)+\bar{\beta}q}\frac{\left(1+r\right)V_0-\bar{\beta}\left(1-q\right)V_l}{1+E\left(1+r\right)} \equiv P\left(\bar{\beta}\right). \tag{18}$$

Denote the degree of **overpricing** due to overconfidence by $\Pi\left(\bar{\beta}\right)$, where

$$\Pi\left(\bar{\beta}\right)=\frac{P\left(\bar{\beta}\right)}{P\left(0\right)}=\frac{\left(1-\left(1-q\right)\bar{\beta}\frac{V_l}{\left(1+r\right)V_0}\right)}{1-\left(1-q\right)\bar{\beta}} \geq 1, \tag{19}$$

and $P\left(0\right)=\frac{1+r}{1+E\left(1+r\right)}V_0$ denotes the price that obtains when investors do not exhibit overconfidence (see Equation (15)). Over-pricing occurs because unsophisticated investors overvalue the option to redeem shares conditional on negative information. Hence, $\Pi\left(\bar{\beta}\right)$ increases in the probability of negative information (i.e., increases in $\left(1-q\right)$) and decreases in the relative payoff conditional on this information (i.e., decreases in $V_l/V_0$). Over-pricing also increases with $r$, since unsophisticated investors' overconfidence leads them to over-value rights more.

The optimal number of units $E$ sold by the sponsor is characterized by

$$E=\frac{\left(\left(1-m\right)+m\left(1-G\left(\bar{\beta}\right)\right)\right)}{P}W. \tag{20}$$

This implies that the sponsor must raise more than $K$ to finance the project in date one,

[30] In our model, the sponsor does not value excess cash and only cares about his stake in the project. Thus, in the optimal contract, the financing constraint (10) binds. This implies that the SPAC holds no excess cash beyond $K$ when the merger is completed.

since we can combine Equations (17) and (20) to get

$$EP = \frac{(1-m) + m\left(1 - G\left(\bar{\beta}\right)\right)}{(1-m)(1-\gamma) + m\left(1 - G\left(\bar{\beta}\right)\right)} K \equiv \Lambda\left(\bar{\beta}\right) K. \tag{21}$$

Here, $\Lambda\left(\bar{\beta}\right) \geq 1$ denotes a **financing multiplier** that reflects the extent to which date one financing exceeds $K$ to account for future redemptions. Ceterus paribus, $\Lambda\left(\bar{\beta}\right)$ decreases in the mass $m$ of unsophisticated investors and their level of overconfidence (e.g., if $G(\beta)$ shifts to the right), but increases in the precision of interim information $\gamma$. Together with the condition that informed investors redeem their shares whenever $x = l$ (i.e., Conditions (4) and (5)), the above conditions characterize the equilibrium.

**Proposition 4.** *Suppose that $K \in ((1-m)(1-\gamma)W, ((1-m)(1-\gamma)+m)W)$, and*

$$q(1-\gamma)V_h > K. \tag{22}$$

*Then, there exists a $\bar{\beta} \in [0,1]$ which is characterized by Equation (17), such that all sophisticated investors and unsophisticated investors with $\beta \geq \bar{\beta}$ buy units at date one. Let*

$$\Lambda\left(\bar{\beta}\right) = 1 + (1-m)\gamma\frac{W}{K},$$

*and*

$$\Pi\left(\bar{\beta}\right) = \frac{V_h}{V_h - (V_h - V_l)(1-q)\bar{\beta}}. \tag{23}$$

*(i) If $\kappa > \max\left\{V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right), \mu_0(h-K)\right\}$, then the project cannot be not financed using redeemable shares.*

*(ii) If $\mu_0(h-K) > \max\left\{V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right), \kappa\right\}$, then the project is only financed when $V = h$, the optimal contract sets $r = 0$ and the sponsor's optimal value is $U_F = \mu_0(h-K)$.*

*(iii) If $V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right) > \max\{\mu_0(h-K), \kappa\}$, then the project is financed in both states (i.e., $V \in \{h, l\}$), and the optimal contract is characterized by Equations (4), (5), (17)-(20). Specifically, the optimal contract sets $r = \bar{r}$, where*

$$\bar{r} = \left(1 - \bar{\beta}\right)\frac{V_h - V_0}{V_0}, \tag{24}$$

*and the sponsor's optimal value is*

$$U_F\left(\bar{\beta}\right) = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)}K. \tag{25}$$

When the investment cost is not too high or too low, the sponsor offers a contract with redeemable shares in equilibrium. As we show in the proof, a sufficient condition for this contract to be feasible is given by Condition (22), which ensures that the optimal number of shares $E$ is well-defined. Intuitively, Condition (22) requires that the project is sufficiently profitable, so that for any marginal investor $\bar{\beta}$, it is possible to issue enough shares to finance the project, taking future redemptions into account.

The Proposition characterizes three possible scenarios. Part (i) states that when the sponsor's cost of effort is sufficiently large, she does not engage in financing with redeemable shares. Part (ii) characterizes the case in which the project is financed only when $V = h$, but not when $V = l$. This highlights potential social benefit of the SPAC structure in separating good versus bad projects. Since SPACs must offer redeemable shares, investors can withdraw their funds if they receive unfavorable interim information, which ensures that bad projects are not financed. This improves ex-post efficiency when the unconditional NPV of the project is sufficiently low (e.g., $h > K > V_0$), and so financing using straight equity (non-redeemable shares) is not feasible. In this case, the sponsor optimally sets the number of rights equal to zero and optimally receives an expected payoff of $U_F = \mu_0 (h - K)$.

Part (iii) characterizes the equilibrium in which the project is always financed (i.e., when $V \in \{h, l\}$). In this case, the sponsor optimally offers $r > 0$ rights to attract sufficiently many investors to participate at date 1 to ensure that the project is financed even after some investors redeem at date 2. This scenario highlights the potential social cost of the SPAC structure. In this case, all sophisticated investors and unsophisticated investors with $\beta \geq \bar{\beta}$ buy units at date one. At date two, sophisticated investors redeem optimally given their information, while unsophisticated investors keep their shares. Since the project is financed even when $V = l$, this makes the sponsor and sophisticated investors better off at the expense of unsophisticated investors.

The sponsor prefers the contract in (iii) instead of the one in (ii) when the mass of unsophisticated investors is sufficiently high. To see why, note that the sponsor faces the following tradeoff from issuing redeemable shares. On the one hand, the sponsor has to raise more financing than $K$ when using redeemable shares - this is captured by the financing multiplier $\Lambda\left(\bar{\beta}\right) > 1$. On the other hand, since unsophisticated investors over-value shares in the firm, as captured by $\Pi\left(\bar{\beta}\right) > 1$, the sponsor needs to issue fewer units and suffers less dilution. The sponsor expected payoff in this case is $U_F = V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right)$, and she optimally chooses the contract in (iii) only when the impact of overpricing is sufficiently large relative to the financing multiplier i.e., when

$$U_F = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)} K > \max\left\{\mu_0 (h - K), \kappa\right\}. \tag{26}$$

Note that

$$\frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)} = \left(1 - \bar{\beta} + \bar{\beta}\frac{V_0}{V_h}\right)\left(1 + (1-m)\,\gamma\frac{W}{K}\right),$$

and so the RHS of Condition (26) is decreasing in $m$, decreasing in $h - l$ (holding $V_0$ fixed) and increasing in $\gamma$. Thus, the sponsor is more likely to employ SPAC financing when there are more unsophisticated investors, and when the projects available are riskier and less transparent. Consistent with this, Bai et al. (2020) document that firms choosing SPACs are riskier and have higher growth, which points to more uncertainty conditional on interim information.

Moreover, the efficiency of investment in this case is determined by the ratio of the financing multiplier to the overpricing coefficient i.e., $\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right)$. Intuitively, the sponsor's payoff in (25) captures the observation that the sponsor must initially raise $\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right)$ dollars in financing for every dollar invested in the project. When this ratio is greater than one, the dilution cost of redeemable shares dominates the benefit from overpricing, and there is underinvestment in efficient projects. On the other hand, when $\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right)$ is sufficiently below one, the sponsor may be willing to invest in projects that are not efficient (i.e., for which $V_0 - \kappa < K$), in order to capture the benefit of overpricing. This over-investment in inefficient projects is more likely when overconfidence (i.e., $\bar{\beta}$) of the marginal unsophisticated investor is higher and when projects are riskier and have more lottery like payoffs (i.e., $\frac{V_0}{V_h}$ is lower). We summarize these observations in the following corollary.

**Corollary 1.** *Suppose that $K > l$. The optimal SPAC contract in Proposition (4) leads to*

*(i) underinvestment in ex-ante efficient projects if*

$$V_0 - K > \max\left\{\mu_0\left(h - K\right), V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)}K, \kappa\right\},$$

*(ii) over-investment in ex-ante inefficient projects if*

$$V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)}K > \max\left\{V_0 - K, \mu_0\left(h - K\right), \kappa\right\},$$

*(iii) higher investment in ex-post efficient projects if*

$$\mu_0\left(h - K\right) > \max\left\{V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)}K, V_0 - K, \kappa\right\}.$$

The above result summarizes the key efficiency implications of requiring redeemable shares. In principle, redeemable shares ensure that investors are protected from adverse decisions made by the sponsor - in our setting, this corresponds to investment in projects where $K > l$. Since investors can withdraw their funds when they receive negative information about the project, such projects are not financed under some conditions. When the relative mass of over-confident investors is sufficiently small and the project's average payoff $V_0$ is not too large, the redemption feature can improve ex-post efficiency (see part (iii) above).

However, our analysis also implies that redeemable shares can reduce ex-ante efficiency. When the mass of unsophisticated investors is sufficiently low and projects have high average payoffs, redeemable shares lead to under-investment in ex-ante efficient projects because they dilute the sponsor's stake (part (i) above). In fact, the sponsor would strictly prefer to issue non-redeemable shares in this case if she could. On the other hand, when the mass of unsophisticated investors is sufficiently high, over-pricing implies that the sponsor over-invests in ex-ante inefficient projects (part (ii) above). In either of these cases, allowing sponsors to issue *non-redeemable* shares can be welfare improving.

## 4.3 Features of the optimal contract

Next, we characterize some features of the equilibrium contract with redeemable shares.

**Composition of investors.** The financing condition (17) characterizes the mix of investors that participate in equilibrium. Intuitively, one can represent the investor demand for risky investments, net of redemptions, as

$$Q(\beta) \equiv W((1-m)(1-\gamma) + m(1-G(\beta))), \tag{27}$$

where $\beta$ is the type of the marginal investor. In particular, all sophisticated investors participate and contribute $W(1-m)(1-\gamma)$ to the aggregate demand function, net of redemptions. Similarly, $Q(\beta)$ is decreasing in $\beta$, which reflects that only the most overconfident investors participate. The financing condition implies that, in equilibrium, the aggregate demand for the risky security $Q(\beta)$ equals the aggregate supply $K$ when the marginal type of unsophisticated investor is $\bar{\beta}$ i.e., $Q(\bar{\beta}) = K$.

The above immediately implies that an increase in investor wealth $W$, or a decrease in required financing $K$, leads to an increase in $\bar{\beta}$ - the marginal unsophisticated investor must be more over-confident for the financing market to clear. Similarly, when the precision of interim information $\gamma$ increases, the sophisticated investors demand less, net of redemptions, and the sponsor needs to attract more unsophisticated investors. This leads to the marginal investor being less overconfident.

The impact of an increase in the fraction $m$ of unsophisticated investors is more subtle.

To see why, note that $\frac{dQ}{dm} = 0$ implies that

$$mG'(\beta)\frac{\partial\bar{\beta}}{\partial m} = \left(1 - G\left(\bar{\beta}\right)\right) - (1-\gamma).$$

The direct effect is to scale up demand from a fraction $1 - G\left(\bar{\beta}\right)$ of unsophisticated investors, which relaxes the financing constraint and pushes $\bar{\beta}$ upwards. The indirect effect is to scale down demand from sophisticated investors net of redemptions by $1-\gamma$, which tightens the financing constraint (17), pushing $\bar{\beta}$ lower. The overall effect of $m$ on the marginal investor type then depends on which effect dominates: when the precision of interim information is sufficiently high (low), an increase in $m$ increases $\bar{\beta}$ (decreases $\bar{\beta}$, respectively).

**Rights.** In equilibrium, the sponsor offers strictly positive rights $r$ per unit (see Equation (24)). The sponsor faces the following tradeoff: an increase in $r$ leads to more dilution for the sponsor, but also attracts unsophisticated investors who over-value the optionality that these rights embed. The latter effect implies that the number of rights offered per unit decreases with the level of payoffs (i.e., an increase in $V_0$ holding $\mu_0$ fixed) but increases with a mean preserving spread (i.e., when $h-l$ increases).

**Investor Expected Returns.** A key empirical regularity about SPACs is the substantial difference in returns earned by sophisticated investors who redeem their shares and unsophisticated investors who do not (see Klausner et al. (2022) and Gahng et al. (2021)). Our model naturally gives rise to this prediction since sophisticated investors efficiently acquire and exploit information to redeem their shares, while unsophisticated investors incorrectly overestimate their ability to do so and, consequently, over-pay for their units. Specifically, the per share expected return to unsophisticated investors is

$$R_U \equiv \frac{1}{P}\left(\frac{1+\bar{r}}{1+E(1+\bar{r})}V_0 - P\right) = -\bar{\beta}\left(1 - \frac{V_0}{V_h}\right) < 0, \tag{28}$$

while the return for sophisticated investors is

$$R_S \equiv \frac{1}{P}\left(\frac{(1+\bar{r})\,qV_h + \bar{r}(1-q)\,V_l}{1+E(1+\bar{r})} - Pq\right) = \left(1-\bar{\beta}\right)\left(1 - \frac{V_0}{V_h}\right) > 0.$$

Consistent with intuition, the return to unsophisticated investors becomes more negative with the overconfidence of the marginal unsophisticated investor. Moreover, the return to sophisticated investors also decreases with $\bar{\beta}$: as the marginal unsophisticated investor becomes more overconfident, the risky security is overvalued, but this reduces the expected return for sophisticated investors. Note that unsophisticated investors are worse off for riskier, more positively skewed payoffs. Specifically, $R_U$ become more negative with (i) a mean preserving spread in payoffs, or (ii) when $V_0/V_h$ is low. Intuitively, this is because, all else equal, these projects have higher volatility and more lottery like payoffs, and so are more overvalued by unsophisticated investors for their higher option value.

In line with our results, Gahng et al. (2021) have documented that in SPACs with more rights (or warrants), buy-and-hold returns are lower. Plugging the optimal price in Equation (18) in to the return in Equation (28) implies that $dR_U/dr < 0$, i.e. returns are indeed lower when the SPAC issues more rights per unit. Moreover, Gahng et al. (2021) found that recently, increased entry by sophisticated investors has led SPACs to issue fewer rights and warrants per unit and has reduced returns. This is consistent with our model. When $\gamma < G\left(\bar{\beta}\right)$, i.e. information about the target is relatively imprecise, then a higher portion of sophisticated investors (i.e. a smaller $m$) reduces $\bar{r}$ (in Equation (24)) and reduces sophisticated investors return $R_S$.

# 5 Regulatory intervention

In this section, we explore the implications of regulatory interventions in our setting. We show that restricting access by investor sophistication or limiting / eliminating rights and warrants from the issuance can improve outcomes for unsophisticated investors. However, mandating transparency may decrease investor welfare, since it can improve outcomes for sophisticated investors and the sponsor at the expense of unsophisticated investors. In Appendix B.4, we consider the impact of additional regulatory interventions including mandatory redemption rights and restricting investment stakes.

**Restricting Investor Access.** Suppose we restrict investment in SPACs so that only sufficiently sophisticated investors (i.e., $\beta < \beta_{max}$) can participate, e.g., by restricting access to accredited investors. This implies that the financing constraint is given by

$$(1-m)(1-\gamma) + m\left(G\left(\beta_{max}\right) - G\left(\bar{\beta}\right)\right) \geq K/W.$$

As more naive investors are excluded (i.e., $\beta_{max}$ decreases), the marginal investor type decreases as well (i.e., $\bar{\beta}$ decreases), and the sponsor is forced to cater to a more sophisticated pool of investors. In equilibrium, the above condition binds, and so the overall effect of restricting investor access is to lower $\bar{\beta}$.

In turn, the increase in investor sophistication implies that the return for sophisticated investors $R_S$ decreases, while the unsophisticated investors' returns increase (i.e., $R_U$ becomes less negative). Also, while the financing multiplier $\Lambda$ is unaffected, overpricing $\Pi\left(\bar{\beta}\right)$

decreases with $\beta_{max}$. This implies the sponsor's surplus decreases with $\beta_{max}$ since she has to sell more units to finance the project. This implies that one can optimally pick $\beta_{max}$ to ensure that the sponsor's effort provision condition (i.e., Equation (11)) binds with equality in order to maximize social surplus.

**Redeemable shares without rights.** A recent innovation in SPAC design is to restrict or eliminate warrants and rights as part of initial investment in an effort to limit dilution.[31] We show that this may improve unsophisticated investors' return, provided that the sponsor is still willing to exert effort. In our setting, restricting $r = 0$ leaves the financing condition unaffected. However, the price is given by

$$P\left(\bar{\beta}; r=0\right) = \frac{1}{\left(1-\bar{\beta}\right)+\bar{\beta}q}\frac{V_0 - \bar{\beta}\left(1-q\right)V_l}{1+E},$$

and as a result, the IC constraint (4) is slack. In particular, this implies that overpricing, which is given by

$$\Pi\left(\bar{\beta}; r=0\right) = \frac{P\left(\bar{\beta}; r=0\right)}{P\left(0; r=0\right)} = \frac{1-\bar{\beta}\left(1-q\right)\frac{V_l}{V_0}}{1-\bar{\beta}\left(1-q\right)} \geq 0 \tag{30}$$

is lower than $\Pi\left(\bar{\beta}\right)$ when $r$ is unconstrained (see Equation (19)). The sponsor surplus is given by

$$U_F\left(\bar{\beta}; r=0\right) = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}; r=0\right)}K \leq U_F\left(\bar{\beta}\right),$$

where $U_F\left(\bar{\beta}\right)$ is the sponsor's optimal value in Equation (25). To ensure that the sponsor exerts effort, we require that

$$\frac{z}{1+E} = z\left(1 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}; r=0\right)}\frac{K}{V_0}\right) > \kappa.$$

Overall, returns for unsophisticated investors are given by

$$R_U\left(r=0\right) = \frac{1}{P}\left(\frac{1}{1+E}V_0 - P\right) = \left(\frac{1}{\Pi} - 1\right) = -\beta\frac{q\left(V_h - V_0\right)}{V_0\left(1-\beta\right)+\beta q V_h} > R_U\left(r\right),$$

where $R_U\left(r\right) = -\beta\left(\frac{V_h - V_0}{V_h}\right)$ is the return when $r$ is unconstrained. This is intuitive - since there are no rights, investors do not overvalue the units as much as in the unconstrained

[31] See, for example https://www.kirkland.com/news/in-the-news/2020/09/blank-check-sponsors-get-creative.

benchmark. Similarly,

$$R_S\left(r=0\right)=\frac{1}{P}\left(\frac{qV_h}{1+E}-Pq\right)=q\left(\frac{V_h}{V_0}\frac{1}{\Pi}-1\right)=\left(1-\bar{\beta}\right)\frac{q\left(V_h-V_0\right)}{V_0\left(1-\beta\right)+\beta qV_h},$$

which implies the return sophisticated investors is lower than the unconstrained benchmark.

**Mandating greater disclosure.** A common concern with SPAC transactions is that disclosure requirements are less stringent than standard IPOs. A natural response might be to propose policies that improve the quality, or precision, of interim information available to investors, i.e., increase $\gamma$. However, we find that this may be detrimental. An increase in $\gamma$ leads to a decrease in overconfidence of the marginal investor $\bar{\beta}$ when the financing condition (17) binds. However, an increase in $\gamma$ also leads to an increase in the equilibrium financing multiplier $\Lambda$, an increase in $V_h$ and a decrease in $q$. Together this implies that the equilibrium return to sophisticated investors, $R_S$, increases with $\gamma$ (see Equation (29)). However, the impact on unsophisticated investor returns $R_U$, overpricing $\Pi\left(\bar{\beta}\right)$, and sponsor surplus $U_F$ are ambiguous.

Specifically, an increase in $\gamma$ has two offsetting effects on $R_U$ and $\Pi\left(\bar{\beta}\right)$. On the one hand, an increase in $\gamma$ increases the payoff $V_h$ conditional on good news, which leads unsophisticated investors to overpay for the risky asset more, and so makes their return $R_U$ more negative and overpricing more severe. On the other hand, an increase in $\gamma$ implies there are more redemptions by sophisticated investors, which forces the sponsor to cater to less overconfident investors, so that $\bar{\beta}$ decreases. Specifically, implicit differentiation of the demand function $Q\left(\bar{\beta}\right)$ in Equation (27) yields:

$$\frac{\partial\bar{\beta}}{\partial\gamma}=-\frac{1-m}{mG'\left(\bar{\beta}\right)}.$$

This implies that when $m$ is sufficiently small or the demand function $Q\left(\beta\right)$ is sufficiently insensitive to $\beta$ (i.e., $G'\left(\beta\right)$ is low), overpricing is lower and unsophisticated investor returns are less negative as information precision increases. On the other hand, when the mass of unsophisticated investors is large and the aggregate demand if very sensitive to $\beta$, overpricing is higher and unsophisticated investor returns are more negative when interim information quality improves. Hence, more disclosure may not improve investor welfare, when these investors are unsophisticated.

# 6 Extensions

## 6.1 Private Investment in Public Equity

A common feature in SPAC transactions is that the sponsor raises part of the financing for the acquisition from large institutional investors using private investment in public equity, or PIPE, transactions. For instance, Klausner et al. (2022) show that 25% of the cash raised in a SPAC reverse merger is raised from PIPE investors. A common explanation for PIPE investment is that the investors make up for the cash shortfall from redemptions at the time of the merger. Moreover, since PIPE investors are often large institutional investors, they conduct due diligence on the proposed merger and often acquire proprietary information about the target.

In this section, we extend the benchmark model to allow the sponsor to raise money from a PIPE investor to cover a short-fall if there are redemptions at date two. We show that while PIPE investment benefits the sponsor, it may lead to lower returns for unsophisticated investors.

Specifically, we assume that the PIPE investor can observe the project payoff $V$ at this stage and is a large investor, and so has bargaining power. At the time of the merger, the sponsor can raise $C$ dollars in one of two ways: (i) offer a fraction $\phi$ of her shares to the PIPE investor, or (ii) raise additional, external financing at a cost $L(C)$, which is strictly convex and satisfies $L'(C) \geq 1$. Since the sponsor offers a fraction of her stake, the total number of shares issued $s \equiv 1 + E(1+r)$ remains unchanged. We assume that the PIPE investor and sponsor engage in Nash bargaining with bargaining power $\{\rho, 1-\rho\}$, respectively.

These assumptions closely match institutional practice. As Gahng et al. (2021) demonstrate, SPAC sponsors forfeit about 34% of their shares to induce investors to contribute capital, and these inducements are larger when there are more redemptions.

Since there are no redemptions when $V = h$, the sponsor only approaches the PIPE investor when $V = l$. In this case, the sponsor's payoff to securing PIPE investment is

$$\frac{1-\phi}{s} l,$$

while the payoff to securing alternate financing (which serves as a threat point, or outside option, for bargaining) is

$$\frac{1}{s} l - L(C).$$

Similarly, the PIPE investor's payoff from bargaining is

$$U_P = \frac{\phi}{s} l - C,$$

while their outside option is normalized to zero. The Nash bargaining solution is given by solving the problem

$$\max_{\phi} \left(\phi \frac{l}{s} - C\right)^{\rho} \left(L(C) - \phi \frac{l}{s}\right)^{1-\rho},$$

which implies that the sponsor offers a fraction

$$\phi = \frac{(1-\rho) C + \rho L(C)}{l} \times s$$

of his stake in the firm. Then, the expected payoff to the sponsor from raising $C$ from PIPE investors is given by

$$\begin{aligned} U_F &= \frac{1}{1+E(1+r)} \left(\mu_0 h + (1-\mu_0)(1-\phi) l\right) \\ &= \frac{V_0}{1+E(1+r)} - (1-\mu_0)\left((1-\rho) C + \rho L(C)\right). \end{aligned}$$

Relative to the benchmark analysis of Section 4, the second term in the above expression captures the loss due to the dilution of the sponsor's stake that results from bargaining with the PIPE investor. However, raising money from the PIPE investor also affects the sponsor's ability to exploit unsophisticated investors since it changes the financing constraint. Specifically, if the sponsor raises $C$ from the PIPE investor, then the financing constraint in (17) changes to:

$$\left((1-m)(1-\gamma) + m\left(1 - G\left(\bar{\beta}\right)\right)\right) W + C = K. \tag{31}$$

This implies that increasing $C$ relaxes the financing constraint, which leads to an increase in the overconfidence of the marginal unsophisticated investor i.e., $\bar{\beta}$. The optimal choice of $C$ trades off the sponsor's benefit from catering to more unsophisticated investors against the cost of higher dilution from the PIPE investor. The optimal choice is characterized by the following proposition.

**Proposition 5.** *Suppose that $G'(\beta)$ is strictly increasing. Then, when $\mu_0$ is sufficiently large or $m$ is sufficiently small, the sponsor optimally raises $C > 0$ via PIPE investments. The optimal contract $(E, r, P)$ is the one characterized by Proposition 4 where the marginal unsophisticated investor $\bar{\beta}$ is determined by Equation (31). The sponsor's optimal value is* *given by*

$$U_F\left(\bar{\beta}\right) = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)} K - (1-\mu_0)\left((1-\rho)\, C + \rho L\left(C\right)\right),$$

*where the financing multiplier is given by*

$$\Lambda\left(\bar{\beta}\right) = 1 + \frac{\gamma\,(1-m)\, W - C}{K},$$

*and equilibrium over pricing* $\Pi\left(\bar{\beta}\right)$ *is given by Equation (23). Moreover, the optimal level of cash raised is decreasing in the PIPE investor's bargaining power (i.e.,* $dC/d\rho \leq 0$*) and the mass of unsophisticated investors (i.e.,* $dC/dm \leq 0$*), but increasing in the initial level of financing required (i.e.,* $dC/dK \geq 0$*) and in the precision of information available to sophisticated investors (i.e.,* $dC/d\gamma > 0$*).*

Raising capital using PIPE financing (i.e., increasing $C$) has three effects on the sponsor's payoffs. First, it lowers the financing multiplier $\Lambda\left(\bar{\beta}\right)$ in equilibrium, which increases $U_F$. Second, because bargaining with the PIPE investor leads to dilution, it decreases the $U_F$. Finally, it increases the overconfidence of the marginal unsophisticated investor, and so increases over-pricing $\Pi\left(\bar{\beta}\right)$ and $U_F$. The condition on $G'\left(\beta\right)$ ensures that the threshold $\bar{\beta}$ is concave in $C$, which ensures that the sponsor's value is concave in $C$ as well. The level of cash raised via PIPE financing decreases as the bargaining power of the the PIPE investor increases. This is intuitive - an increase in the bargaining power of the PIPE investor implies the sponsor has to pay more (via dilution) to raise cash.

The response of the level of PIPE financing to underlying parameters is intuitive. For instance, an increase in the bargaining power of the PIPE investor implies it is costlier (due to higher dilution) for the sponsor to raise PIPE financing. Similarly, an increase in the mass of unsophisticated investors implies there are fewer redemptions by sophisticated investors, and so the sponsor needs to rely on PIPE financing less. In contrast, an increase in $K$ or an increase in $\gamma$ (which leads to more redemptions) implies that the sponsor must raise more capital, all else equal, and so $C$ increases.

A commonly proposed benefit of PIPE investors in SPAC transactions is that they certify the quality of the target. Because PIPE investors are often more sophisticated and better informed than unsophisticated investors, their participation in an acquisition serves a "stamp of approval." Our analysis suggests that the impact of PIPE investing on unsophisticated investors is more nuanced. Even though PIPE investors are better informed, their presence allows the sponsor to target more optimistic investors. As a result, the return to unsophisticated investors $R_U$ (in Equation (28)) becomes more negative as $C$ increases.

## 6.2 Costly attention by unsophisticated investors

Assumption 1 in the benchmark model implies that the unsophisticated investors never acquire information. In this section, we relax the assumption to study how the optimal contract and equilibrium depend on the attention cost $c_U = c$ for unsophisticated investors. The following proposition characterizes the equilibrium.

**Proposition 6.** *Let*

$$\bar{c} \equiv (1-q)\, W \frac{V_h - V_l}{V_h},$$

*and define*

$$c\left(\bar{\beta}\right) \equiv W\,(1-q)\,\frac{V_0 - V_l}{V_0 - \bar{\beta}\,(1-q)\,V_l},$$

*where $\bar{\beta}$ is the marginal investor given the financing constraint (17).*

*(i) If $c > \bar{c}$, then the optimal contract is characterized by Proposition 4.*

*(ii) If $c < c\left(\bar{\beta}\right)$, then the sponsor prefers to sell non-redeemable shares.*

*(iii) If $c \in \left[c\left(\bar{\beta}\right), \bar{c}\right]$ there exists a contract which features redeemable shares with*

$$r = \frac{1}{V_0}\left(\frac{(1-q)\,V_l\left(W - \bar{\beta}c\right)}{W\,(1-q) - c} - 1\right) > 0, \;\; \text{and } P = \frac{(1-q)\,V_l}{1+E\,(1+r)}\frac{W}{W\,(1-q)-c}.$$

*The sponsor's optimal value is given by $U_F\left(\bar{\beta}\right) = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)}K$, where the financial multiplier is given by*

$$\Lambda\left(\bar{\beta}\right) = 1 + \gamma\,(1-m)\,\frac{W}{K},$$

*and equilibrium overpricing is given by*

$$\Pi\left(\bar{\beta}\right) = \frac{P}{P_0} = \frac{(1-q)\,V_l}{(1+r)\,V_0}\frac{W}{W\,(1-q)-c} = \frac{W}{W-\bar{\beta}c}. \tag{32}$$

The result is intuitive. When the attention cost to unsophisticated investors is sufficiently high (i.e., $c > \bar{c}$), then these investors do not acquire information and so we recover the equilibrium characterized by Proposition 4. On the other hand, when costs are sufficiently low (i.e., $c < c\left(\bar{\beta}\right)$), then all investors acquire information and redeem shares for $x = l$ if the sponsor issues redeemable shares. In this case, selling redeemable shares is suboptimal and the sponsor strictly prefers selling non-redeemable shares instead (as in the benchmark with only sophisticated investors in Section 4.1.2). This observation highlights that in order to be an optimal contract from the sponsor's perspective, the payoffs to the SPAC must be sufficiently opaque i.e., $c$ needs to be high enough.

Finally, for intermediate levels of attention cost, the information constraint $\Delta_U = c$ binds, where $\Delta_U$ is defined in Equation (6). In this case, the optimal contract with redeemable shares ensures that unsophisticated investors are indifferent between acquiring information and not, and dominates the contract with non-redeemable shares when the mass of unsophisticated investors is sufficiently high. While the equilibrium financing multiplier $\Lambda\left(\bar{\beta}\right)$ remains the same as in the benchmark model, equilibrium overpricing is now given by Equation (32), and increases with the attention cost $c$. Moreover, in this case, we can show that the expected return to unsophisticated investors and sophisticated investors are given by

$$R_U = -\bar{\beta}\frac{c}{W} \text{ and } R_S = \left(1-\bar{\beta}\right)\frac{c}{W},$$

respectively. Consistent with intuition, this implies that when the project is more opaque, i.e., $c$ is larger, unsophisticated investors earn lower returns, while sophisticated investors earn higher returns.

As such, policy interventions that increase the salience and transparency about SPAC (i.e., lower $c$) improve unsophisticated investor returns and lower sophisticated investor returns. This is in contrast to the implications of increased disclosure (higher $q$), as discussed in Section (5). Our analysis highlights that mandating greater disclosure of information need not "level the playing field," but in fact, may exacerbate the wedge between sophisticated and unsophisticated investors, especially when such information is difficult to process or interpret by all investors. Instead, policy interventions that encourage investors to be more attentive to the details of SPAC transactions and facilitate better information processing are likely to be more effective at improving unsophisticated investor welfare. This is consistent with the recent focus of SEC Chair Gensler on ensuring that investors are made more aware of SPAC fees, projections and conflicts, and restricting SPAC sponsors from inappropriately "advertising" transactions before making required disclosures.[32]

# 7 Conclusions

The recent popularity of SPACs is puzzling, given the complexity of these transactions and the mixed performance across different investor classes. We develop a model SPACs which incorporates important institutional features. Specifically, we characterize the optimal SPAC contract offered by a sponsor, who is restricted to issue redeemable shares to finance a project. The redemption feature introduces a tradeoff. On the one hand, it leads to dilution

[32]See https://www.bloomberg.com/news/articles/2021-12-09/gensler-targets-spac-disclosures-as-sec-considers-tougher-rules.

in the sponsor's stake. On the other hand, unsophisticated investors overvalue the optionality embedded in redeemable shares because they overestimate their own ability to process payoff relevant information and optimally redeem their shares.

We show that when investors are sophisticated and average payoffs are low, redeemable shares can improve ex-post efficiency: in this case, sufficiently many investors redeem when the project is bad, and so only good projects are financed. However, when average payoffs are high, redeemable shares lead to inefficient investment decisions. When the mass of over-confident investors is low, the dilution effect leads to under-investment in (ex-ante) efficient projects. On the other hand, when the mass of over-confident investors is sufficiently high, the overpricing effect dominates and there is over-investment in inefficient projects.

Our model matches a number of stylized facts that have already been empirically documented, including positive returns for short-term investors who redeem their shares optimally, negative returns for buy-and-hold investors, and overall underperformance of SPACs. Moreover, our model provides a number of new predictions relating the target project's characteristics to the composition and sophistication of investors, the equilibrium number of rights per unit, and investor returns. For instance, our model predicts that smaller SPAC transactions (i.e., with lower levels of required financing $K$) should be associated with more unsophisticated investors (i.e., higher $\bar{\beta}$), higher overpricing and lower returns for buy-and-hold investors. Similarly, SPAC transactions with more risky targets are associated with more rights / warrants per unit and more negative buy-and-hold returns.

Finally, we are able to characterize the impact of potential policy interventions. We show that while increases in transparency (decreasing costs of information processing) and restricting access to sophisticated investors tends to improve outcomes for unsophisticated investors, mandating disclosure of more information can be counterproductive. Similarly, while PIPE financing in a SPAC transaction is often interpreted as being favorable to unsophisticated investors, we show that this can actually leave such investors worse off. Our analysis highlights the importance of understanding the underlying structure of such transactions when evaluating regulatory changes.

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# A Proofs

## A.1 Proof of Proposition 2

Consider a contract in which investors only redeem shares when $x = l$, i.e. Condition (4) holds. Then, the financing constraint is given by

$$(1-\gamma) P \int_i e_i di = (1-\gamma) W \geq K.$$

In the following, we assume that this constraint is satisfied, i.e. $W \geq K/(1-\gamma)$. We have $EP = W$ and thus

$$EP = \frac{K}{1-\gamma},$$

which together with $P = V_h/(1+E)$ implies that the sponsor's value satisfies Equation (13).

Now, consider a contract in which investors always keep their shares. This contract must satisfy the IC constraint

$$\frac{V_l}{1+E(1+r)} \geq P,$$

otherwise it is optimal to redeem conditional on $x = l$. Since investors never redeem their shares, their participation constraint is given by

$$\frac{(1+r) V_0}{1+E(1+r)} \geq P.$$

At the optimal contract, the IC constraint above binds and the IR constraint is slack. Since investors never redeem, the financing constraint is given by[33]

$$EP = W \geq K$$

and we have

$$\frac{E}{1+E(1+r)} V_l = K,$$

which implies that

$$1 + E(1+r) = \frac{V_l}{V_l - (1+r) K},$$

i.e. the dilution for the sponsor is increasing in $r$ and setting $r = 0$ is optimal. Then, the sponsor's value is given by Equation (14).

[33] Whenever the constraint is slack, we can allocate shares randomly among investors to raise exactly $K$, since all investors are willing to participate. Since all investors keep their shares, the sponsor's value does not depend on the method of allocation.

Finally, that the optimal contract induces investors to redeem when $x = l$ whenever $(1-\gamma) V_h \geq V_l$ follows by comparing the sponsor values in Equations (13) and (14).

## A.2 Proof of Proposition 4

We first show that the constraint set in Proposition 4 is nonempty whenever Condition (16) holds. Plugging in the price in Equation (18), which ensures that type $\bar{\beta}$'s IR condition (9) holds, into the IC constraint (4) yields

$$\frac{V_h}{1+E(1+r)} \geq \frac{1}{\left(1-\bar{\beta}\right)+\bar{\beta}q} \frac{(1+r) V_0 - \bar{\beta}(1-q) V_l}{1+E(1+r)},$$

which is equivalent to

$$V_h \left(\left(1-\bar{\beta}\right)+\bar{\beta}q\right) \geq (1+r) V_0 - \bar{\beta}(1-q) V_l$$

or

$$\bar{\beta} V_0 + \left(1-\bar{\beta}\right) V_h \geq (1+r) V_0,$$

which clearly holds at $r = 0$ for any $\bar{\beta} \in [0,1]$. Since sophisticated investors always acquire information, their value is larger than any unsophisticated investor's for any $(E, r, P)$. Thus, the sophisticated investors' IR constraint (7) always holds. Finally, combining Equation (20) and the financing condition (17) yields

$$EP = \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)} K$$

and we can plug in the price $P$ from Equation (18) and $r = 0$ to solve for $E$, which yields

$$1+E = \frac{V_0 - \bar{\beta}(1-q) V_l}{V_0 - \bar{\beta}(1-q) V_l - \left(1-\bar{\beta}+\bar{\beta}q\right) \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)} K}.$$

For $E$ to be well defined, we need that $E \geq 0$, which holds whenever the denominator in the above expression is positive. Since the term

$$\frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)} K$$

is strictly increasing in $\bar{\beta}$, a sufficient condition is given by

$$V_0 - (1-q)\, V_l > \frac{K}{1-\gamma},$$

which is equivalent to Condition (22). Thus, there exists a $(E, r, P)$ satisfying all constraints.

We now consider optimality. The IR constraint of type $\bar{\beta}$ must bind at any optimal contract and thus $P$ is given by Equation (18). Combining Equation (20) and the financing condition (17) yields

$$EP = \frac{m\left(1 - G\left(\bar{\beta}\right)\right) + 1 - m}{m\left(1 - G\left(\bar{\beta}\right)\right) + (1-m)(1-\gamma)} K$$

and plugging in $P$ yields, after some algebra,

$$1 + E\,(1+r) = \frac{(1+r)\, V_0 - \bar{\beta}\,(1-q)\, V_l}{(1+r)\, V_0 - \bar{\beta}\,(1-q)\, V_l - (1+r)\left(1 - \bar{\beta} + \bar{\beta} q\right) \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)} K}.$$

Condition (22) implies that the denominator is positive for any $r > 0$ and $\bar{\beta} \in [0, 1]$. Then, $1 + E\,(1+r)$ is strictly decreasing in $r$, which follows by differentiating the above expression, i.e. the sponsor sets $r$ as high as possible.

Plugging $P$ in Equation (18) into the IC constraint (4) implies that incentive compatibility holds whenever[34]

$$V_h\left(1 - \bar{\beta} + \bar{\beta} q\right) \geq (1+r)\, V_0 - \bar{\beta}\,(1-q)\, V_l,$$

or equivalently

$$r \leq \left(1 - \bar{\beta}\right) \frac{V_h - V_0}{V_0} \equiv \bar{r}.$$

Thus, the sponsor optimally increases $r$ until the IC constraint (4) binds and $r = \bar{r}$ and the optimal $(E, r, P)$ is determined by Conditions (4) and (17)-(20) binding.

When the IC constraint (4) binds, we have

$$1 + E\,(1+r) = \frac{V_h}{V_h - (1+r) \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)} K}$$

so that the sponsor's value is given by

$$U_F = \left(V_h - (1+r) \frac{m\left(1 - G\left(\bar{\beta}\right)\right) + 1 - m}{m\left(1 - G\left(\bar{\beta}\right)\right) + (1-m)(1-\gamma)} K\right) \frac{V_0}{V_h}.$$

[34] Note that Condition (5) is slack in this case.

Then, plugging in $r = \bar{r}$ yields

$$U_F = V_0 - \frac{\left(1-\bar{\beta}\right) V_h + \bar{\beta} V_0}{V_h} \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)} K. \tag{33}$$

To establish that $(E, r, P)$ characterized in the proposition statement is indeed optimal, we compare the sponsor's value to her value in the following cases: (1) issuing non-redeemable shares; (2) issuing redeemable shares such that investors keep their shares conditional on $x = l$; (3) financing the project only if $V = h$. This exhausts all possible cases.

**Non-redeemable shares.** We have $U_F > U_F^{NR}$ whenever

$$V_h \geq \left(\left(1-\bar{\beta}\right) V_h + \bar{\beta} V_0\right) \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)}, \tag{34}$$

which follows from Equation (33). Note that Condition (34) is equivalent to

$$\frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)} \leq 1,$$

which follows from algebra.

At $\bar{\beta} = 0$, this condition cannot hold, since

$$\frac{1}{m+(1-m)(1-\gamma)} > 1.$$

At $\bar{\beta} = 1$, the condition holds whenever

$$V_h \geq \frac{V_0}{1-\gamma},$$

which is true. Thus, the optimal contract in Proposition (4) dominates selling non-redeemable shares whenever $\bar{\beta}$ is sufficiently close to 1. This holds whenever the mass of unsophisticated investors is sufficiently large, i.e. there exists a $\hat{\beta}$ close to 1 and and $M$ close to 0 such that $1 - G(\hat{\beta}) = M$.

**Investors never redeem.** Replace the IC constraint (4) with

$$\frac{1}{1+E(1+r)} V_l \geq P, \tag{35}$$

which implies that investors keep their shares if they observe $x = l$. In other words, investors never redeem their shares when Condition (35) holds. Since the signal $x$ now does not affect investors decisions, no unsophisticated investor acquires information, i.e. $a_i = 0$ for all $i$. Sophisticated investors acquire information, since that information is free, but the information does not affect their value. Overall, unsophisticated investors and sophisticated investors now have the identical value

$$U(e_i; c_S) = U(e_i; c_U) = e_i \left( \frac{1+r}{1+E(1+r)} V_0 - P \right).$$

Since $V_l < V_0$, setting

$$P = \frac{1}{1+E(1+r)} V_l,$$

so that constraint (35) binds is optimal, which leaves the IR conditions (7) and (9) slack. The financing constraint (2) becomes

$$EP = W \geq K,$$

which is slack given Condition (2).[35] Then, the sponsor's value is given by

$$U_F = \frac{V_l - (1+r)K}{V_l} V_0$$

and setting $r = 0$ is optimal, so that the sponsor's optimal value is

$$U_F^{Keep} = V_0 - \frac{V_l}{V_0} K.$$

Clearly, we have $U_F^{Keep} < U_F^{NR}$, where $U_F^{NR}$ is given by Equation (12). Thus, the optimal contract in which investors always keep their shares is dominated by selling non-redeemable shares. Under the conditions of Proposition 4, we have $U_F > U_F^{NR} > U_F^{Keep}$.

**Project financed only when $V = h$.** Now, the project is not financed when $V = l$. To avoid complications, assume that all investors receive their contributed funds back when the

[35] Whenever the constraint is slack, we can allocate shares randomly among investors to raise exactly $K$, since all investors are willing to participate. Since all investors keep their shares, the sponsor's value does not depend on the method of allocation.

project is not financed.[36] Then, since the project is financed only if $V = h$, the IC condition

$$\frac{h}{1 + E(1 + r)} \geq P \tag{36}$$

must hold, i.e. investors do not redeem their shares conditional on $V = h$. If that condition does not hold, clearly the project is never financed. Now, each investor's value from buying units is

$$\mu_0 \left( \frac{1 + r}{1 + E(1 + r)} h - P \right). \tag{37}$$

In particular, the signal $x$ does not affect investors values, since the project is only financed when $V = h$ and since investors receive their money back when $V = l$. Thus, unsophisticated investors never acquire information, since that information provides no value to them and both unsophisticated and sophisticated investors per-share value is given by Equation (37). Sophisticated investors follow their signal without loss of generality. Whenever

$$\mu_0 \left( \frac{1 + r}{1 + E(1 + r)} h - P \right) \geq 0,$$

all investors participate. Thus, the financing constraint (2) becomes simply

$$EP = W \geq K, \tag{38}$$

which is generally slack.[37] At the optimal price $P$, the IC constraint (36) binds, which together with the financing constraint (38) implies that

$$1 + E(1 + r) = \frac{h}{h - (1 + r) K},$$

which is increasing in $r$. Thus, $r = 0$ is optimal and the sponsor's value is given by

$$U_F^h = \mu_0 (h - K),$$

since the project is only financed when $V = h$. We have $U_F > U_F^h$ whenever

$$(1 - \mu_0) l + K \left( 1 - \frac{\left(1 - \bar{\beta}\right) V_h + \bar{\beta} V_0}{V_h} \frac{m \left(1 - G\left(\bar{\beta}\right)\right) + 1 - m}{m \left(1 - G\left(\bar{\beta}\right)\right) + (1 - m)(1 - \gamma)} \right) > 0.$$

[36] This fits the empirical structure of SPACs well, since investors' cash is held in an escrow account until the merger is completed, see e.g. Klausner et al. (2022).

[37] As in the previous case, we can randomly allocate shares between investors to raise exactly $K$.

Thus, a sufficient condition is

$$V_h > \left(\left(1-\bar{\beta}\right)V_h + \bar{\beta}V_0\right)\frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+\left(1-m\right)\left(1-\gamma\right)}.$$

But this is just Condition (34), which we have already established.

## A.3 Proof of Proposition 5

In the financing constraint (31), $C = 0$ corresponds to the baseline model (see Equation (17)). The case $C = \gamma\left(1-m\right)W$ corresponds to the sponsor raising just enough cash to cover redemptions, while $C = \bar{C} \equiv K - \left(1-m\right)\left(1-\gamma\right)W$ implies that the sponsor raises no cash from unsophisticated investors, i.e. $\bar{\beta} = 1$. Since setting $C > \bar{C}$ results in excess cash, we have $C \in [0, \bar{C}]$ without loss of generality.

For any $C \in [0, \bar{C}]$, the optimal contract is determined by Proposition (4). This follows from a similar argument as in the proof of Proposition (4), which we omit.[38] Plugging this optimal contract into the sponsor's value yields

$$U_F = \left(1 - \frac{\left(1-\bar{\beta}\right)V_h + \bar{\beta}V_0}{V_h}\left(K - C + \gamma\left(1-m\right)W\right)\right)V_0 - \left(1-\mu_0\right)\left(\rho L\left(C\right) + \left(1-\rho\right)C\right).$$

The sponsor's problem thus consists of choosing $C \in [0, \bar{C}]$ to maximize this value. Implicitly, the marginal investor $\bar{\beta}$ depends on $C$ via the financing constraint (31), and and the implicit function theorem yields

$$\frac{d\bar{\beta}}{dC} = \frac{1}{mWg\left(\bar{\beta}\right)}.$$

Whenever $G'\left(\bar{\beta}\right)$ is increasing, $\bar{\beta}$ is a concave function of $C$, and since $L\left(C\right)$ is convex, the sponsor's objective is concave as well. Thus, the optimal value of $C$ is determined by the first-order condition

$$\left(\frac{\left(1-\bar{\beta}\right)V_h + \bar{\beta}V_0}{V_h} + \frac{d\bar{\beta}}{dC}\frac{V_h - V_0}{V_h}\left(K - C + \gamma\left(1-m\right)W\right)\right)V_0 = \left(1-\mu_0\right)\left(\rho L'\left(C\right) + \left(1-\rho\right)\right).$$

Whenever $\mu_0$ is sufficiently large or $m$ is sufficiently small, we have $dU_F/dC > 0$ at $C = 0$, and thus $C > 0$ is optimal.

The comparative statics in the proposition statement follow by super-or sub-modularity, i.e. $d^2U_F/dCdK > 0$, $d^2U_F/dCd\gamma > 0$, and $d^2U_F/dCdm < 0$.

[38] Essentially, all derivations are the same, except that Equation (17) is replaced with Equation (31). Comparing these two equations, the case $C > 0$ is isomorphic to the baseline model with $\hat{K} = K - C$.

## A.4 Proof of Proposition 6

Consider the equilibrium with redeemable shares (in Proposition 4). Plugging the optimal contract into Equation (6) implies that unsophisticated investors do not acquire information whenever $c \geq \bar{c}$, which follows after some algebra.

Consider now the case $c < \bar{c}$. Then, the contract in Proposition 4 is not feasible. Unsophisticated investors acquire information and redeem their shares whenever $x = l$, so that the financing constraint becomes

$$\left(1 - m + m\left(1 - G\left(\bar{\beta}\right)\right)\right)(1 - \gamma) \geq K/W,$$

i.e. both unsophisticated and sophisticated investors redeem when $x = l$, instead of Equation (17).

We now characterize the optimal contract in this case. Since unsophisticated investors anticipate that they will redeem shares, their value is given by

$$\frac{W}{P}\left(\frac{(1+r)\,qV_h + r\,(1-q)\,V_l}{1+E\,(1+r)} - qP\right) - (1-\beta)\,c,$$

which follows from Equation (8). The value of sophisticated investors is given by Equation (7).

As in the baseline model, the value of an unsophisticated investor is increasing in $\beta$. Thus, whenever $K/W \in ((1-\gamma)(1-m), 1-\gamma)$, there exists a $\bar{\beta}$ such that the financing constraint binds. The optimal contract renders type $\bar{\beta}$ indifferent, which implies that

$$P = W\frac{(1+r)\,V_0 - (1-q)\,V_l}{(1+E\,(1+r))\left(Wq + \left(1-\bar{\beta}\right)c\right)}.$$

Then, the financing condition yields

$$EP = \left(1 - m + m\left(1 - G\left(\bar{\beta}\right)\right)\right)W = \frac{K}{1-\gamma}$$

so that

$$1 + E\,(1+r) = \frac{(1-\gamma)\left((1+r)\,V_0 - (1-q)\,V_l\right)}{(1-\gamma)\left((1+r)\,V_0 - (1-q)\,V_l\right) - K\,(1+r)\,\frac{Wq + \left(1-\bar{\beta}\right)c}{W}},$$

which is decreasing in $r$. Thus, the sponsor value increases in $r$. The IC constraint (4) is now given by

$$V_h \geq \frac{W}{Wq + \left(1-\bar{\beta}\right)c}\left(\left(1+r\right)V_0 - \left(1-q\right)V_l\right).$$

Since the RHS is increasing in $r$, this constraint tightens when $r$ is higher. Acquiring information is indeed optimal (Equation (6)) whenever

$$\left(1-q\right)\frac{W\left(\left(1+r\right)V_0 - \left(1-q\right)V_l\right) - V_l\left(Wq + \left(1-\bar{\beta}\right)c\right)}{\left(1+r\right)V_0 - \left(1-q\right)V_l} \geq c. \tag{39}$$

The LHS is increasing in $r$, which implies that the constraint slackens when $r$ is higher. Thus, in the optimal contract, the sponsor sets $r$ so that the IC constraint (4) binds, i.e.

$$r = \frac{1}{V_0}\left(\frac{Wq + \left(1-\bar{\beta}\right)c}{W}V_h + \left(1-q\right)V_l - V_0\right).$$

The condition $c < \bar{c}$ implies that given the optimal $r$, unsophisticated investors indeed acquire information, i.e. Condition (39) holds.

Overall, the sponsor's value is now given by

$$U_F = V_0 - \frac{K}{1-\gamma}\left(\frac{V_0}{V_h} + \frac{\left(1-\bar{\beta}\right)c}{V_h}\right)$$

and

$$U_F < V_0 - \frac{K}{1-\gamma}\frac{V_0}{V_h} < U_F^{NR}.$$

Here, the last inequality follows from the fact that $V_0/((1-\gamma)\,V_h) > 1$. Thus, any contract in which unsophisticated investors acquire information is suboptimal and the sender prefers to sell non-redeemable shares instead.

Next, consider a contract in which $c < \bar{c}$, such that investors do not acquire information. Given financing constraint (17) and marginal investor $\bar{\beta}$ (where $\bar{\beta}$ is determined by the financing constraint (17)), the price is again determined by Equation (18). Then, unsophisticated investors indeed do not acquire information whenever

$$W\left(1-q\right)\frac{\left(1+r\right)V_0 - V_l}{\left(1+r\right)V_0 - \bar{\beta}\left(1-q\right)V_l} \leq c, \tag{40}$$

which follows from plugging the optimal price into Equation (6). The LHS is strictly increasing in $r$ and holds at $r = 0$ whenever

$$c \geq c\left(\bar{\beta}\right) \equiv W\left(1-q\right)\frac{V_0 - V_l}{V_0 - \bar{\beta}\left(1-q\right)V_l}.$$

If $c < c\left(\bar{\beta}\right)$ then unsophisticated investors always acquire information when the sponsor offers redeemable shares, i.e. Condition (40) does not hold for any $r \geq 0$. As in the previous case, selling redeemable shares is then suboptimal.

In the following, suppose that $c\left(\bar{\beta}\right) \leq c < \bar{c}$. Then, the two IC constraints (4) and (40) both tighten as $r$ increases. Whenever $c < \bar{c}$, condition (40) binds, and the IC constraint (4) is slack. Thus, $r$ is given by[39]

$$r = \frac{1}{V_0}\left(\frac{(1-q)\,V_l\left(W-\bar{\beta}c\right)}{W\,(1-q)-c} - 1\right)$$

so that

$$P = \frac{(1-q)\,V_l}{1+E\,(1+r)}\frac{W}{W\,(1-q)-c}.$$

Then, using the financing constraint (17), we get

$$1+E\,(1+r) = \frac{1}{1-\frac{W-\bar{\beta}c}{WV_0}\left(K+\gamma\,(1-m)\,W\right)}$$

and the sponsor's value is

$$U_F = V_0 - \frac{W-\bar{\beta}c}{W}\left(K+\gamma\,(1-m)\,W\right).$$

Whenever $m$ is sufficiently large, we have $U_F > U_F^{NR}$.

# B Additional Analysis

## B.1 General Contracts

We now consider an abstract contracting setup. In reality, SPACs are bound by law to issue redeemable shares, i.e. they cannot choose an arbitrary contract as described in this section. Thus, the results here are a theoretical benchmark, which is not applicable in practice. For simplicity, we abstract from any moral hazard issues on part of the sender.

The sponsor now sells contracts consisting of contingent payments $\{p_V^k\}_{V\in\{l,h\},k\in\{0,1\}}$ at a price $P$. Here, $p_V^k$ is the payment to an investor after the project is financed when the investor chooses action $k \in \{0,1\}$ and the project value is $V$. The action $k$ is contingent on the signal $x$. Since $p_V^k$ depends on both $V$ and $k$, the sponsor does not have to make

[39] Here, note that $c < \bar{c}$ implies that $c < W\,(1-q)$ and in particular that $c < W$, which implies that $W > \bar{\beta}c$. That $r \geq 0$ follows from the assumption $c \geq c\left(\bar{\beta}\right)$.

the payoff contingent on $k$ (and therefore on $x$), i.e. the sponsor can choose $p_V^k = p_V^{k'}$ for all $V \in \{l, h\}$ and $k, k' \in \{0, 1\}$. However, with unsophisticated investors it is generally optimal to set $p_V^1 \neq p_V^0$, to exploit investors' overconfidence.

Specifically, suppose that it is optimal to choose $k = 1$ if and only if $x = h$, i.e.

$$\frac{\mu_0}{q} p_h^1 + \left(1 - \frac{\mu_0}{q}\right) p_l^1 \geq \frac{\mu_0}{q} p_h^0 + \left(1 - \frac{\mu_0}{q}\right) p_l^0 \tag{41}$$

and

$$p_l^0 \geq p_l^1. \tag{42}$$

We maintain the inertia assumption from the baseline model, i.e. when unsophisticated investors do not acquire information, they choose $k = 1$. The perceived value of investor type $\beta$ from buying the contract is given by

$$\beta \left( q \left( \frac{\mu_0}{q} p_h^1 + \left(1 - \frac{\mu_0}{q}\right) p_l^1 \right) + (1 - q)\, p_l^0 \right) + (1 - \beta) \left(\mu_0 p_h^1 + (1 - \mu_0)\, p_l^1\right) - P$$

or equivalently

$$\mu_0 p_h^1 + (1 - \mu_0)\, p_l^1 + \beta\gamma\, (1 - \mu_0) \left(p_l^0 - p_l^1\right) - P.$$

This equation is the analog to Equation (9). The first two terms are the expected value conditional on choosing $k = 1$, which is the value a sophisticated investor ($\beta = 0$) would have. The second term captures the overvaluation due to the investor's naivete. Type $\beta$ buys the contract if and only if

$$\mu_0 p_h^1 + (1 - \mu_0)\, p_l^1 + \beta\gamma\, (1 - \mu_0) \left(p_l^0 - p_l^1\right) - P \geq 0.$$

The value of an sophisticated investor is instead given by

$$\mu_0 p_h^1 + (1 - \mu_0)\, p_l^1 + \gamma\, (1 - \mu_0) \left(p_l^0 - p_l^1\right) - P \geq 0.$$

As in the baseline model, this constraint is slack. Thus, the total demand for shares is

$$\left(1 - m + m \left(1 - G\left(\bar{\beta}\right)\right)\right) \frac{W}{P}$$

and the marginal investor $\bar{\beta}$ is pinned down via

$$1 - m + m \left(1 - G\left(\bar{\beta}\right)\right) = \frac{K}{W}. \tag{43}$$

Since the sponsor can condition payments on both $k$ and $V$, she can trivially circumvent the interim financing condition (10). Thus, the condition is always slack with general contracts. The expected payments from the sponsor to investors are now given by

$$\frac{W}{P}\left(m\left(1-G\left(\bar{\beta}\right)\right)\left(\mu_0 p_h^1+\left(1-\mu_0\right)p_l^1\right)+\left(1-m\right)\left(\mu_0 p_h^1+\left(1-\mu_0\right)p_l^1+\gamma\left(1-\mu_0\right)\left(p_l^0-p_l^1\right)\right)\right)$$

or equivalently

$$K\frac{\mu_0 p_h^1+\left(1-\mu_0\right)p_l^1}{P}+\left(1-m\right)\left(1-\mu_0\right)\gamma\frac{p_l^0-p_l^1}{P}W.$$

This expression mirrors Equation (25). Since $P>\mu_0 p_h^1+\left(1-\mu_0\right)p_l^1$, the first term is smaller than $K$. Thus, just as in the baseline model, exploiting unsophisticated investors renders capital cheaper for the sponsor. The second term captures the sponsor's loss from sophisticated investors optimally choosing their action $k$. In particular, the first term is decreasing in the wedge $p_l^0-p_l^1$, which benefits the sponsor and the second term is increasing, which hurts the sponsor.

We impose an ex-post limited liability, i.e. conditional on any $V$, the sponsor cannot pay out more money than the project generates. Specifically,

$$\frac{W}{P}\left(1-m+m\left(1-G\left(\bar{\beta}\right)\right)\right)p_h^1\leq h$$

or equivalently

$$\frac{p_h^1}{P}\leq\frac{h}{K}\tag{44}$$

and

$$\frac{W}{P}\left(\left(\left(1-m\right)+m\left(1-G\left(\bar{\beta}\right)\right)\right)p_l^1+\left(1-m\right)\gamma\left(p_l^0-p_l^1\right)\right)\leq l$$

or equivalently

$$K\frac{p_1^l}{P}+\frac{W}{P}\left(1-m\right)\gamma\left(p_l^0-p_l^1\right)\leq l.\tag{45}$$

The sponsor's problem is thus given by

$$\min_{\left\{p_V^K\right\}_{V\in\{l,h\},k\in\{0,1\}}} K\frac{\mu_0 p_h^1+\left(1-\mu_0\right)p_l^1}{P}+\left(1-m\right)\left(1-\mu_0\right)\gamma\frac{p_l^0-p_l^1}{P}W$$

subject to Equations (41), (42), (43), (44), and (45).

Whenever $\left(1-m\right)W<K$, the objective is decreasing $p_l^0$ and whenever $K\beta<\left(1-m\right)W$, the objective is decreasing in the value $p_h^1$ and $p_l^1$. This immediately leads to the following Proposition.

**Proposition 7.** *The optimal contract is as follows. If $K\bar{\beta}>\left(1-m\right)W$, then the op-*

*timal contract sets* $p_h^1 = p_l^1 = 0$ *and* $p_l^0 > 0$, *and the project is financed at expenditure* $(1-m)\,W/\bar{\beta} < K$. *If* $(1-m)\,W \geq K\bar{\beta}$, *the optimal contract sets* $p_h^1$ *and* $p_l^1$ *such that Equations* (44) *and* (45) *hold and the project is financed at expenditure* $\mu_0 h + (1-\mu_0)\,l$.

This result closely mirrors Proposition 4. When $m$, the mass of unsophisticated investors, is sufficiently large, then offering a contract which exploits their overconfidence is optimal, even though sophisticated investors earn excessive rents. In particular, the sender offers a contract that is contingent on $k_i$, which in turn depends on the signal $x_i$, knowing that unsophisticated investors overestimate the value of this information. When $m$ is small, however, then such a contract cannot dominate offering straight equity.

Thus, the key insight form our analysis, i.e. the sponsor offering contracts that are contingent on unsophisticated investors private signals, survives once we move away from the institutional setting and consider general contracts. To reiterate, such contracts are not feasible in practice, since SPACs are bound by law to issue redeemable shares. Thus, the optimal contract in this section is mainly of theoretical interest.

## B.2 Redemption Mechanics

In our benchmark model, we assume that redeemed shares are given to a third party so that redemptions do not affect the number of shares outstanding. In this appendix, we relax this assumption and characterize how are results are affected when redemptions reduce the number of outstanding shares. While an analytical treatment is not tractable, we can show numerically that issuing redeemable shares is still optimal for the sponsor in this case.

Mechanically, if $R > 0$ shares are redeemed, shares outstanding are given by $1+E\,(1+r)-R$ and each investor's realized per-share value is $V/\left(1+E\,(1+r)-R\right)$. Thus, investors who redeem increase the per-share value of those who do not redeem by reducing dilution. Consider the equilibrium of Section 4.2, i.e. investors redeem their shares when $x = l$ and keep them when $x = h$. How many shares outstanding remain depend on the realized value $V$. If $V = h$, then no investors redeem, and shares outstanding are simply $s_h = 1 + E\,(1+r)$. When $V = l$, all investors who get a signal $x = l$ redeem, so that total redemptions are given by $\gamma\,(1-m)\,e_i$, where $e_i = W/P$, and shares outstanding are given by $s_l = 1+E\,(1+r)-\gamma\,(1-m)\,W/P$. Using Equation (20), we can simplify this expression to

$$s_l = 1 + E\left(\frac{1}{\Lambda\left(\bar{\beta}\right)} + r\right).$$

Each sophisticated investor's per-share value is now given by

$$\mu_0\left(\frac{(1+r)\,h}{s_h}-P\right)+(1-\mu_0)\left(\gamma\left(\frac{(1+r)\,l}{s_l}-P\right)+(1-\gamma)\,\frac{rl}{s_l}\right),$$

while the value of unsophisticated investor with type $\beta$ is

$$\beta\left(\mu_0\left(\frac{(1+r)\,h}{s_h}-P\right)+(1-\mu_0)\left(\gamma\left(\frac{(1+r)\,l}{s_l}-P\right)+(1-\gamma)\,\frac{rl}{s_l}\right)\right)$$
$$+(1-\beta)\left(\mu_0\frac{(1+r)\,h}{s_h}+(1-\mu_0)\,\frac{(1+r)\,l}{s_l}-P\right).$$

As in the baseline model, this value is increasing in $\beta$, so that all unsophisticated investors with $\beta \geq \bar{\beta}$ participate, and $\bar{\beta}$ is again determined by the financing condition (17). The sponsor optimally sets the price $P$ so that the type-$\bar{\beta}$ investor is indifferent, which now yields

$$P=\frac{1}{1-\bar{\beta}+\bar{\beta}q}\left(\mu_0\frac{(1+r)\,h}{s_h}+(1-\mu_0)\,\frac{(1+r)\,l}{s_l}-\bar{\beta}\,(1-\mu_0)\,(1-\gamma)\,\frac{l}{s_l}\right).$$

Using Equation (21), we can reduce the financing conditions and type $\bar{\beta}$'s participation constraint to

$$\frac{E}{1-\bar{\beta}+\bar{\beta}q}\left(\mu_0\frac{(1+r)\,h}{1+E\,(1+r)}+(1-\mu_0)\,l\frac{1+r-\bar{\beta}\,(1-\gamma)}{1+\frac{E}{\Lambda\left(\bar{\beta}\right)}+Er}\right) \quad = \quad \Lambda\left(\bar{\beta}\right)K.$$

In equilibrium, it must be optimal for investors to redeem shares when $x=l$ and keep them when $x=h$. The analog of the IC constraint (4) is now

$$\frac{\mu_0}{q}\frac{h}{s_h}+\left(1-\frac{\mu_0}{q}\right)\frac{l}{s_l}\geq P. \tag{47}$$

Thus, the sponsor's problem becomes

$$\max_{(E,r)}\mu_0\frac{h}{s_h}+(1-\mu_0)\,\frac{l}{s_l}$$

subject to Equations (46) and (47). Equation (46) is non-monotone in $E$, which implies that the sponsor's problem cannot be characterized via first-order conditions. In the proof of Proposition 4, we used the analog of Equation (46) to solve for $E$ as a function of $r$. Now, this approach yields a quadratic equation for $E$, which is difficult to characterize analytically. However, the sponsor's problem can be solved numerically. Table 1 reports our numerical

| $\mu_0$ | $r$ | $K$ | $r$ | $h$ | $r$ | $l$ | $r$ | $W$ | $r$ | $\gamma$ | $r$ | $m$ | $r$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | 0.43 | 0.5 | 0.09 | 10 | 0.25 | 0.5 | 0.3 | 1.5 | 0.38 | 0.6 | 0.18 | 0.7 | 0.28 |
| 0.5 | 0.26 | 1 | 0.26 | 12 | 0.26 | 1 | 0.26 | 2 | 0.26 | 0.75 | 0.26 | 0.8 | 0.26 |
| 0.7 | 0.13 | 1.5 | 0.43 | 14 | 0.27 | 1.5 | 0.23 | 2.5 | 0.19 | 0.9 | 0.38 | 0.9 | 0.24 |

Table 1: Numerical solutions to the sponsor's problem. Baseline parameters are $\mu_0 = 0.5$, $K = 1$, $h = 12$, $l = 1$, $W = 2$, $\gamma = 0.75$, and $m = 0.8$.

solutions for different parameter values. Generally, the optimal contract features $r > 0$, just as in the baseline model.

## B.3 Warrants

In our benchmark model, we assume that the sponsor issues units that consist of redeemable shares and rights, which can be converted to shares at no cost. In practice, SPAC sponsors often use warrants instead, which allow the owner of a unit to acquire additional shares at a fixed, exercise price. The terms for warrant exercise vary significantly across transactions, and sponsors often reserve the right to redeem (or call) their warrants at a time of their choosing. The complexity of these transactions has raised concerns from the SEC and FINRA, especially on behalf of unsophisticated, unsophisticated investors who may not completely understand the terms of the warrant, and consequently, exercise them optimally.[40]

In this section, we show that our main results go through when SPACs issue warrants instead of rights. In particular, issuing units which consist of redeemable shares and warrants is optimal. Intuitively, the key mechanic in our model is that unsophisticated investors are overconfident and hence overestimate the value of the option to redeem shares. Whether the sponsor issues rights or warrants as part of the units is secondary. With warrants, the sponsor's problem becomes nonlinear, because the number of shares outstanding depends on how many warrants are exercised, which precludes an analytical characterization. Instead, we numerically characterize the optimal contract consisting of redeemable shares and warrants in this subsection.

Specifically, suppose the sponsor sells $E$ units consisting of 1 redeemable shares and $w$ warrants, each of which can be exercised by the investor at an exercise price $X$. Consistent with stylized facts, we assume that warrants can be exercised after the financing stage for the project.[41] Moreover, we assume that while the sophisticated, investors optimally choose

[40] For example, see https://www.finra.org/investors/insights/spac-warrants-5-tips, and https://www.sec.gov/oiea/investor-alerts-and-bulletins/what-you-need-know-about-spacs-investor-bulletin.

[41] Since there is no discounting in our model, it is optimal for investors to wait as long as possible before choosing whether to exercise the warrant. In practice, while warrants are initially issued with long expiration dates, they may be called by the sponsor around the time of the merger (see

whether or not to exercise their warrants, while unsophisticated, unsophisticated investors do not exercise their warrants. Note that if the project's cash-flows are $V$, the warrant should only be exercised if and only if

$$\frac{1}{1+E\left(1+w\right)}\left(V+wEX\right)>X\Leftrightarrow\frac{V}{1+E}>X.$$

Suppose that $X\in\left(\frac{l}{1+E},\frac{h}{1+E}\right)$ so the warrants are only exercised when $V=h$. Note that if $X>\frac{h}{1+E}$, then the warrants are never exercised, and so irrelevant; on the other hand, if $X<\frac{l}{1+E}$, then the warrants are always exercised and so are analogous to rights we consider in the benchmark analysis.

Since sophisticated investors exercise their warrants, but unsophisticated investors do not, the total number of shares when $V=h$ is $1+E\left(1+\left(1-m\right)w\right)$, while the total number of shares when $x=l$ is $1+E$. Moreover, the terminal payoff reflects the cash added due to the exercise of the warrants i.e., the firm's total payoffs are $h+E\left(1-m\right)wX$ when $V=h$. Moreover, suppose $P$ is such that the sophisticated investor redeems shares when $x=l$ but keeps them when $x=h$.

This implies the per-unit expected payoff to an sophisticated investor is given by

$$U_R=\begin{array}{c}\mu_0\left(\frac{h+E(1-m)wX}{1+E(1+(1-m)w)}-P\right)+\left(1-\mu_0\right)\left(1-\gamma\right)\left(\frac{l}{1+E}-P\right)\\+\mu_0 w\left(\frac{h+E(1-m)wX}{1+E(1+(1-m)w)}-X\right)\end{array},$$

and an unsophisticated investor of type $\beta$ has expected payoff

$$U_U\left(\beta\right)=\beta U_R+\left(1-\beta\right)\left(\mu_0\frac{h+E\left(1-m\right)wX}{1+E\left(1+\left(1-m\right)w\right)}+\left(1-\mu_0\right)\frac{l}{1+E}-P\right).$$

The financing constraint is the same as in the benchmark model, since warrants are exercised after this stage i.e.,

$$\left(1-m\right)\left(1-\gamma\right)+m\left(1-G\left(\bar{\beta}\right)\right)=K/W, \tag{48}$$

which pins down the threshold investor $\bar{\beta}$. Moreover, the total number of units sold is given by

$$E=\left(1-m+m\left(1-G\left(\bar{\beta}\right)\right)\right)W/P, \tag{49}$$

https://www.spacresearch.com/faq). Assuming that warrants must be exercised at the time of the merger does not substantially change our results.

which implies

$$EP = \Lambda\left(\bar{\beta}\right) K, \quad \text{where}$$
$$\Lambda\left(\bar{\beta}\right) = \frac{1 - m + m\left(1 - G\left(\bar{\beta}\right)\right)}{\left(1 - m\right)\left(1 - \gamma\right) + m\left(1 - G\left(\bar{\beta}\right)\right)},$$

is the financing multiplier. For a given $(w, X)$, units must be priced so that the marginal unsophisticated investor is indifferent, i.e.,

$$U_U\left(\bar{\beta}\right) = 0, \tag{50}$$

and so that it is optimal to redeem shares iff $x = l$ i.e.,

$$\frac{\mu_0\left(\frac{h+E(1-m)wX}{1+E(1+(1-m)w)}\right) + \left(1 - \mu_0\right)\left(1 - \gamma\right)\left(\frac{l}{1+E}\right)}{\mu_0 + \left(1 - \mu_0\right)\left(1 - \gamma\right)} > P > \frac{l}{1 + E}, \tag{51}$$

and it is optimal to exercise warrants iff $V = h$ i.e.,

$$\frac{h}{1 + E} \geq X > \frac{l}{1 + W}. \tag{52}$$

The sponsor's problem is to choose $(w, X, E, P)$ to maximize:

$$U_F \equiv \mu_0 \frac{h + E\left(1 - m\right) wX}{1 + E\left(1 + \left(1 - m\right) w\right)} + \left(1 - \mu_0\right) \frac{l}{1 + E},$$

subject to (48), (49), (50), (51), and (52).Now, outstanding shares depend on how many warrants are exercised, which in turn depends on the realized value $V$. Because of this, the sponsor's problem cannot be solved analytically in general.

To gain some intuition, consider a constrained version, where we restrict $X = \frac{h}{1+E}$. In this case, the value of the warrant is zero and so the sponsor is indifferent to the number of warrants issued, and the optimal contract with redeemable shares is characterized by the financing condition (48) and the equilibrium overpricing

$$\Pi\left(\bar{\beta}\right) = \frac{1 - \bar{\beta}\left(1 - q\right)\frac{V_l}{V_0}}{1 - \bar{\beta}\left(1 - q\right)}.$$

This is identical to the overpricing when we restrict $r = 0$ in the benchmark model (see equation (30)). The benchmark analysis already implies that the sponsor may prefer issuing redeemable units in this case when the fraction of unsophisticated investors is sufficiently

| $\mu_0$ | $w$ | $X$ | $K$ | $w$ | $X$ | $h$ | $w$ | $X$ | $l$ | $w$ | $X$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | 1.03 | 0.03 | 0.5 | 0.19 | 0.42 | 10 | 0.7 | 0.11 | 0.5 | 0.74 | 0.03 |
| 0.5 | 0.7 | 0.08 | 1 | 0.7 | 0.08 | 12 | 0.7 | 0.08 | 1 | 0.7 | 0.08 |
| 0.7 | 0.35 | 0.27 | 1.5 | 0 | 0 | 14 | 0.72 | 0.09 | 1.5 | 0.68 | 0.13 |

| $W$ | $w$ | $X$ | $\gamma$ | $w$ | $X$ | $m$ | $w$ | $X$ |
|---|---|---|---|---|---|---|---|---|
| 1.5 | 1.84 | 0 | 0.6 | 0.44 | 0.16 | 0.7 | 0.85 | 0.06 |
| 2 | 0.7 | 0.08 | 0.75 | 0.7 | 0.08 | 0.8 | 0.7 | 0.08 |
| 2.5 | 0.43 | 0.08 | 0.9 | 1.12 | 0 | 0.9 | 0.62 | 0.12 |

Table 2: Numerical solutions to the sponsor's problem. Baseline parameters are $\mu_0 = 0.5$, $K = 1$, $h = 12$, $l = 1$, $W = 2$, $\gamma = 0.75$, and $m = 0.8$. The distribution $G(\beta)$ is assumed to be uniform.

large.

Now, if we relax the constraint and allow $X < \frac{h}{1+E}$, the value of the warrants is no longer zero. However, unsophisticated investors anticipate exercising the warrants ex-ante but do not exercise them ex-post, they over-value the warrants. When the fraction of unsophisticated investors is large, this makes the sponsor better off by increasing equilibrium overpricing. The numerical illustrations in Table 2 confirm this intuition. In this table, we solve the sponsor's problem numerically for various parameter configurations and report the optimal choices of $(w, X)$. Generally, issuing units with redeemable shares is optimal and the sponsor issues $w > 0$ warrants with each unit. Thus, introducing warrants does not substantially change the results of our benchmark model.

## B.4 Additional regulatory interventions

This subsection considers additional regulatory interventions in our benchmark model.

**Mandatory Redemption Rights.** An alternate regulatory proposal is to require that each unit has at least $\bar{r}$ redemption rights. When this minimum threshold is below the optimal number of rights $r$ issued in equilibrium in Equation (24), the mandate has no effect. Instead, suppose the mandatory minimum exceeds the optimal choice i.e., $\bar{r} > r$.

Note that in this case the financing condition in Equation (17) no longer pins down the marginal investor type. To see why, suppose the marginal investor $\bar{\beta}$ is determined by Equation (17) and that the price $P$ is set so that the IR constraint (9) of type $\bar{\beta}$ binds given $r = \bar{r}$, i.e.

$$P = \frac{1}{\left(1 - \bar{\beta}\right) + \bar{\beta} q} \frac{\left(1 + \bar{r}\right) V_0 - \bar{\beta}\left(1 - q\right) V_l}{1 + E\left(1 + \bar{r}\right)}.$$

Then, the IC constraint (4) cannot hold, since $\bar{r} > r$ implies that

$$P > \frac{V_h}{1 + E(1 + \bar{r})}$$

for any number of shares $E$.

Instead, suppose that the IC constraint (4) binds so that

$$P = \frac{V_h}{1 + E(1 + \bar{r})}. \tag{53}$$

Then, the marginal unsophisticated investor type is determined by the IR constraint (9) which yields

$$\frac{(1 + \bar{r})V_0 - V_h + \beta(1 - q)(V_h - V_l)}{1 + E(1 + \bar{r})} \geq 0 \tag{54}$$

for all unsophisticated investors who participate. Since the above expression is increasing in $\beta$, there exists a threshold type $\tilde{\beta}$ such that all types $\beta > \tilde{\beta}$ participate. Moreover, we can verify that $\tilde{\beta} < \bar{\beta}$. Intuitively, when the minimum number of rights increases, more unsophisticated investors participate in equilibrium, and consequently, the marginal type is less overconfident.

Since the financing condition in (17) is slack, the sponsor randomly rations shares to raise exactly $\Lambda\left(\tilde{\beta}\right)K$, so the project is financed. In equilibrium, this implies

$$E = \frac{\Lambda\left(\tilde{\beta}\right)K}{P} = \frac{K\Lambda\left(\tilde{\beta}\right)}{V_h - K\Lambda\left(\tilde{\beta}\right)(1 + \bar{r})}. \tag{55}$$

Overall, the equilibrium is now determined by Equations (53), (54), and (55). The sponsor's payoff can be expressed as

$$U_F = V_0 - \frac{\Lambda\left(\tilde{\beta}\right)}{\tilde{\Pi}}K,$$

where overpricing is given by

$$\tilde{\Pi} = \frac{P}{P(0)} = \frac{V_h}{(1 + \bar{r})V_0}.$$

Importantly, overpricing *decreases* with the mandatory threshold $\bar{r}$ (since the marginal investor becomes less overconfident), and this implies sponsor surplus decreases with $\bar{r}$. As before, to ensure that the sponsor exerts effort, we require that

$$z\left(1-\frac{\Lambda\left(\tilde{\beta}\right)}{\tilde{\Pi}\left(\tilde{\beta}\right)}\frac{K}{V_0}\right)>\kappa,$$

which implies $\bar{r}$ is not too large. Finally, note that returns for unsophisticated and sophisticated investors are given by

$$\tilde{R}_R=\frac{(1+\bar{r})\,V_0-V_h}{V_h},\quad \text{and}\quad \tilde{R}_I=\bar{r}\frac{V_0}{V_h},$$

which implies both groups of investors earn higher returns as $\bar{r}$ increases.

**Restricting investment stakes.** Now consider a policy that restricts the stake of any investor to be at most $\bar{W}<W$. As long as $K\in\left((1-m)\,(1-\gamma)\,\bar{W},((1-m)\,(1-\gamma)+m)\,\bar{W}\right)$, the project can be financed using redeemable shares. The financing condition is now given by

$$(1-m)\,(1-\gamma)+m\left(1-G\left(\bar{\beta}\right)\right)\geq K/\bar{W},$$

which binds in equilibrium. A decrease in $\bar{W}$ leads to a decrease in $\bar{\beta}$ - limiting investor stakes implies the sponsor has to cater to more sophisticated investors on average - and so affects both the financing multiplier and equilibrium overpricing. In particular, overpricing $\Pi\left(\bar{\beta}\right)$ decreases as $\bar{W}$ decreases - since unsophisticated investors are forced to invest less, they cannot bid up the shares as much. In turn, this implies that returns for sophisticated investors decrease while unsophisticated investors earn less negative returns. However, a decrease in $\bar{W}$ also lowers the financing multiplier, since sophisticated investors are forced to invest less and financing is less sensitive to redemptions.

The overall effect on sponsor surplus depends on the relative magnitude of these effects, and how sensitive the marginal investor's type is to changes in $\bar{W}$. Recall that

$$\frac{d\Lambda}{d\bar{W}}=\frac{(1-m)\,\gamma}{K},\quad \frac{d\Pi}{d\bar{W}}=\frac{\partial\Pi}{\partial\bar{\beta}}\times\frac{\partial\bar{\beta}}{\partial\bar{W}},$$

where

$$\frac{\partial\bar{\beta}}{\partial W}=\frac{(1-m)\,(1-\gamma)+m\left(1-G\left(\bar{\beta}\right)\right)}{WmG'\left(\bar{\beta}\right)}.$$

These expressions suggest that when (i) $m$ is sufficiently large, or (ii) the demand function $Q\left(\beta\right)$ in Equation (27) is sufficiently flat in $\beta$ (i.e., $G'\left(\bar{\beta}\right)$ is sufficiently low), the over-pricing effect dominates and restricting investment stakes leads to a lower surplus for the sponsor.