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 profitable targets. 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 unprofitable targets. Consistent with empirical evidence, the model predicts different returns for short-term and long-term investors and overall underperformance. While some policy interventions (e.g., eliminating redemption rights, limiting investor access, and restricting warrants) improve returns for unsophisticated investors, others (e.g., increased disclosure) can be counterproductive.

JEL Classification: G23, G24, G32, G41, D86, D90

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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) 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 and trade 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.[1] 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. In their sample, Gahng, Ritter, and Zhang (2023) estimate that investors who buy shares at the SPAC IPO and redeem optimally before the merger earn average annualized returns of 23.9%, 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 -11.3%. The structure of the transaction also leads 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.

The popularity of SPAC transactions and their significant underperformance, especially for long-term investors, is puzzling. 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 that they earn negative returns on average?

Existing rationales for SPAC transactions do not explain the above puzzles. For instance, practitioners argue that firms have to provide less disclosure to investors when going public via SPAC. While lower disclosure requirements might lead to more adverse selection and lower valuations, they do not necessarily lead to negative *returns* when investors are rational – in fact, these investments should be discounted more and, thus, generate higher returns.

[1] 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/.

Similarly, a common rationale for issuing warrants and rights is that they encourage investment by long-term investors. However, this seems to be at odds with the poor performance of buy-and-hold investors.

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.

Our model matches key stylized facts: (1) buy-and-hold investors earn negative returns while those redeeming optimally earn positive excess returns, (2) higher redemptions predict lower returns, (3) firms choosing SPACs are riskier and have less tangible and more positively-skewed payoffs, and (4) SPACs are more likely when the proportion of unsophisticated investors is higher. We show that the SPAC structure may lead to ex-ante inefficient investment decisions. When the mass of overconfident investors is relatively low, the optimal SPAC contract leads to underinvestment in ex-ante profitable targets. In contrast, when the mass of overconfident investors is high, the optimal SPAC contract leads to over-investment in unprofitable targets.[2]

The recent boom in SPAC deals and their severe under-performance has led to scrutiny by regulators and calls for changes to disclosure requirements and investor protection. Our model provides a benchmark for policy analysis. 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. Moreover, in contrast to conventional wisdom, unsophisticated investors may be better off if the sponsor is restricted to using non-redeemable shares.

Interestingly, we show that an increase in mandatory disclosure of information leads to *lower* returns for such investors, but higher returns for more sophisticated investors, when this information is difficult to process. In contrast, interventions that increase investor attention to transaction details and facilitate better information processing improve returns for unsophisticated investors and, as such, may be more effective at reducing the discrepancy in investor returns.

[2] There is underinvestment in the sense that targets whose average value exceeds the financing cost of taking them over may not be acquired by a SPAC. In principle, such targets could be acquired by simply using non-redeemable shares. On the other hand, targets whose average value is below the financing cost may end up being acquired by a SPAC, while acquiring them by selling non-redeemable shares is not feasible.

Overview of model and results. 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 the ability to redeem their shares if they do not approve of the acquisition (see Rule 419 of the Securities Act of 1933, and Klausner et al. (2022)). 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, interim information about its profitability becomes available. Paying attention and responding to this 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. 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.

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 overestimate 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. The sponsor's investment decision reflects the net impact of these two forces.

The impact of redeemable shares depends on both the investment opportunity and the distribution of investors, but investment decisions tend to be inefficient from an ex-ante perspective. When most investors are sophisticated, the cost of dilution dominates, and SPAC financing leads to underinvestment in profitable targets: such targets would be financed if the sponsor were able to issue non-redeemable shares. 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 unprofitable targets.

Our analysis matches a number of stylized facts about SPACs. 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 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 as well as their recent decline. The years 2019 and 2020 saw a sharp increase in retail investor participation in financial markets (e.g., Ozik, Sadka, and Shen (2021)), and relatively high demand for investments. More recently, funding has become scarcer, both for SPACs and IPOs overall. In these conditions, our model predicts that IPOs will dominate SPACs.

Policy implications and Extensions. 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 financial sophistication (e.g., by only allowing accredited investors to invest in them). Another proposal is to "level the playing field" by increasing mandatory disclosures.[3] We show that such interventions may have unintended consequences. For instance, 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. Similarly, an increase in the quality of interim information (e.g., due to increased mandatory disclosure) improves returns for sophisticated investors, but may reduce returns for unsophisticated investors.

Section 6 discusses two natural extensions of our model. First, we characterize how the sponsor's optimal financing choice depends on the attention and processing costs for unsophisticated investors. When costs are sufficiently low, all investors behave as if they are sophisticated (i.e., process interim information and redeem efficiently). When costs are sufficiently high, the unsophisticated investors do not process information and so our benchmark analysis applies. For intermediate levels, the optimal contract offered leaves unsophisticated investors indifferent between paying the attention or not. Intuitively, the return to such investors decreases in their attention costs, which suggests that interventions

[3] See the House Financial Services Committee proposal to restrict access by sophistication (https://www.bloomberg.com/news/articles/2021-11-16/spac-bill-curbing-marketing-set-for-vote-by-key-u-s-house-panel), "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, and 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 for proposals on disclosures. Moreover, Chapman, Frankel, and Martin (2021) provide empirical evidence on the role of SPAC disclosures.

which reduce their cost of processing interim information (e.g., increasing transparency or salience about transaction details), have different implications than increases in amount or precision of the interim information.

Next, we characterize the impact of allowing the sponsor to raise capital using a Private Investment in Public Equity, or PIPE, transaction. PIPE investments from institutional investors are extremely common in practice - Klausner et al. (2022) estimate that around 25% of the cash at the time of the merger is from such investors. Moreover, it is often argued that such financing is beneficial for common investors by acting as a "stamp of approval" for the proposed deal, since PIPE investors tend to be sophisticated and well informed. We show that this may not be true: while access to PIPE financing increases the sponsor's surplus, it can lead to more negative returns for unsophisticated investors. Intuitively, by raising some of the financing from PIPE investors, the sponsor can target more over-confident, unsophisticated investors, which leads to more severe over-pricing.

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 presents the extension to costly information processing by unsophisticated investors, the impact of PIPE financing, and additional robustness analysis. Section 7 concludes. Appendix A provides proofs of the main results, while Appendix B provides some institutional background on SPACs and additional analysis.

2 Related literature

While there is a growing empirical literature that documents the performance and characteristics of SPACs,[4] theoretical analysis of these transactions is sparse. Our paper is the first to rationalize why SPAC sponsors benefit from offering redeemable shares, why they bundle shares with rights, and why short-term investors gain at the expense of long-term investors. In related work, Bai, Ma, and Zheng (2020) consider a model in this vein, where SPACs act as certification intermediaries. Luo and Sun (2021) focus on the timing structure of SPACs, and propose a model in which sponsors sequentially propose target for investors' approval. Gryglewicz, Hartman-Glaser, and Mayer (2021) compare financing using SPACs to IPO via

[4]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. (2023), and Dambra, Even-Tov, and George (2021).

private equity in a setting where investors face adverse selection about both the ability of the sponsor and the quality of the target firm. Alti and Cohn (2022) study a signaling model of SPACs, in which firms choose between a (direct) IPO and acquisition by an expert (i.e. a SPAC). Chatterjee, Chidambaran, and Goswami (2016) apply the model of Chemmanur and 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.[5]

Importantly, these models assume all investors are rational and do not feature redemptions. As such, they are unable to speak to key features of SPAC transactions. In contrast, our analysis is able to jointly explain when sponsors offer redeemable shares and why we observe positive returns for short-term investors, but negative returns for long-term investors. Moreover, because our analysis relies on investor overconfidence, it generates distinctive policy predictions, e.g., improved disclosure may reduce investors' returns and restricting access to sophisticated investors has positive spillovers.

More broadly, our paper contributes to the literature on behavioral contracting and overconfidence.[6] 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 pay attention in the future, they overestimate the option value of redeeming shares, and so are willing to pay more for them. Dambra, Even-Tov, and George (2021), document 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, which is consistent with our predictions. 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. More generally, our model features rent extraction by a financial intermediary (the sponsor) as in Berk and Green (2004) and Berk and Van Binsbergen (2022).

3 Model

Payoffs. There are three dates $t \in \{1, 2, 3\}$. A sponsor, or founder, (F, she) seeks to finance a new investment opportunity (i.e., the private target firm). The investment, or target, costs

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

[6]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).

K in external financing and has a terminal (date three) payoff $V \in \{l, h\}$, where $h > l > 0$ and $\mu_0 \equiv \Pr(V = h)$. Investment in the target is **ex-ante efficient** when the unconditional expected payoff is higher than the cost of financing, i.e., it has a positive unconditional net present value (or, $V_0 > K$), where $V_0 \equiv \mu_0 h + (1 - \mu_0) l$ is the unconditional mean payoff. Furthermore, when $K > l$, investment is **interim efficient** if the project is financed when $V = h$ but not when $V = l$.[7]

The sponsor retains one share of equity and raises financing at date one by selling E additional units to investors at price P per unit. 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. 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.[8]

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

[7] The results in Proposition 4, where we characterize conditions so that issuing units that consist of redeemable shares and rights is optimal, do not depend on this assumption, and they continue to hold if $K \leq l$. We make use of the assumption that $K > l$ in Corollary 1 however.

[8] In particular, SPACs cannot simply issue straight (i.e. non-redeemable) equity. We consider general contracts in Internet Appendix IA2 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. Here, also note that an equity right is equivalent to a warrant with a strike price of zero. In Section 6.2 and Appendix B.5, we study warrants with arbitrary strike prices. While this model variant is not tractable analytically, we illustrate numerically that it is still optimal for the sponsor to issue units which consist of redeemable shares and warrants for a range of parameter values.

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 $q \equiv \Pr(x = h) = \mu_0 + (1-\mu_0)(1-\gamma)$.[9]

Given this information, each investor chooses whether to keep the shares (denoted by $k_i = 1$) or redeem them ($k_i = 0$). 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. 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 (e.g., see Engelberg (2008) and the survey by Blankespoor, deHaan, and Marinovic (2020)). For expositional clarity, we assume that the cost to sophisticated investors is zero, while the cost to unsophisticated investors is infinite — this ensures that sophisticated investors always pay attention, while unsophisticated investors never pay attention. In Section 6, we discuss how changes in the attention cost of unsophisticated investors affect the equilibrium.

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 β-type investor is uncertain about their attention cost and (incorrectly) believes that it will be zero with probability β and infinite with probability $1-\beta$. Thus, at date one, β-type investors believe that they will respond to information with probability β, but they actually do not at date two. As such, β 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 β 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) and investors choose actions $k_i(x)$ and e_i. Given the contract, i optimally chooses to buy e_i units at a price P, given their

[9] 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.

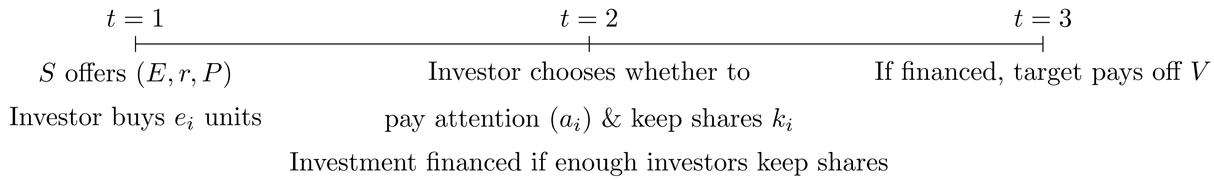

Figure 1: Timeline

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 pays attention to interim information, they choose whether to keep their shares $(k_i = 1)$ or redeem them $(k_i = 0)$. The target is acquired if a sufficiently large number of investors choose to keep their equity invested in the SPAC, i.e., if

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

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

Our equilibrium concept is familiar from optimal contracting. The sponsor offers a contract to investors and recommends actions to them. Given the contract, the actions have to be incentive compatible. Since investors are overconfident, when they accept a contract at date one, they wrongly anticipate that they will acquire information and follow the sponsor's recommendation to keep or redeem shares. At date two however, unsophisticated investors do not acquire information and keep their shares. Similar issues arise in other models of behavioral contracting (e.g., see Eliaz and Spiegler (2006) and the discussion therein).

3.1 Discussion of assumptions

Overconfidence and Inertia. Our notion of over-confidence focuses on the tendency of individuals to over-estimate their own skill or ability, and not on being biased about fundamentals or information. As such, our modeling is consistent with DellaVigna and Malmendier (2006). In a setting of fitness clubs, they empirically document that members overestimate their future attendance when signing up for memberships, or, equivalently, they underestimate the cost of future attendance. In our setting, investors are overconfident about their ability to pay attention to, and process, interim payoff relevant information, similar to Hirshleifer, Subrahmanyam, and Titman (1994) (Section III.C) and Grubb (2015). When buying SPAC units, they overestimate their likelihood of paying attention and underestimate the cost of doing so. Moreover, conditional on not paying attention to interim information, investors exhibit inertia, which reflects the standard approach of modeling rational inattention (e.g., Sims (2003), Sims (2006), Steiner, Stewart, and Matejka (2017)).

Other Biases. Our assumption on overconfidence allows us to simultaneously explain (1) the negative average returns for buy-and-hold investors and (2) why SPAC sponsors choose to sell units with rights. *Some* behavioral friction is necessary to explain (1) — rational investors buy units if and only if they make a profit on average. Similarly, if investors were simply overconfident about the value of the target, the sponsor would not find it optimal to issue units. In fact, as we show in Internet Appendix IA3, the sponsor would prefer to issue straight equity which does not dilute her stake, since overconfident investors would overpay for such claims.

The key feature we want to capture is that some investors underestimate how distracted they will be in the future, and so overpay for the redemption option in SPAC shares, but do not optimally redeem their shares when the time comes. 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.

Redemptions. For tractability, 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 target is still financed. In Section 6.2, we relax this assumption. While the setting is not tractable analytically, we show numerically that issuing redeemable shares is still optimal for the sponsor.

One might wonder whether investors can learn from other investors' redemption decisions or from secondary market trading. First, redemptions are not *trades* — that is, the investor simply returns her shares to the sponsor and receives back the cash she paid for those shares — and so do not affect the trading price or the liquidity of the market for shares. Second, when deciding whether to redeem shares after a merger is announced, an investor is unlikely to see others' decisions because the SPAC is not obligated to disclose redemptions between the merger announcement and the completion of the merger. Finally, the price of the SPAC is generally bounded below by the redemption price, which makes inference of negative news by unsophisticated, inattentive investors difficult (if not impossible).

4 Analysis

We solve the model by working backwards. Section 4.1 first describes the investors' decisions and the sponsor's problem. Section 4.2 then presents the equilibrium for a number of relevant benchmarks. Finally, Section 4.3 presents the optimal contract for the general model.

4.1 Preliminary analysis and the sponsor's problem

In this subsection, we characterize the investors' decisions and the sponsor's problem. We have to distinguish two cases (1) the project is financed both conditional on $V = h$ and $V = l$ (Section 4.1.1) and (2) the project is not financed when $V = l$ (Section 4.1.2).

4.1.1 Project always financed (i.e., when $V = h$ and $V = l$)

Investors. At date two, investors choose whether to attend to information x_i, and then whether to keep their shares. Suppose that the price is such that

$$\frac{1}{1 + E(1 + r)} V_h \geq P \tag{3}$$

and

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

which implies that the price per unit is bounded between the high and low conditional expectations of firm payoffs, appropriately scaled by the total number of outstanding shares (i.e., $1 + E(1 + r)$). We will show that this is true for the optimal contract. In this case, investor i keeps their shares if $x_i = h$ and redeems when $x_i = l$, i.e., $k_i(h) = 1$ and $k_i(l) = 0$, where $k_i(x) \in \{0, 1\}$ is investor i's decision to keep or redeem shares.[10] For investor i, who

[10]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 Section 6.2.

buys e_i units at the initial date, the value of paying attention is given by the difference in payoffs from optimally redeeming shares versus keeping them irrespective of x, i.e.

$$\begin{aligned}\Delta_i &= e_i\left(\frac{(1+r)\,qV_h + r\,(1-q)\,V_l}{1+E\,(1+r)} - Pq\right) - e_i\left(\frac{1+r}{1+E\,(1+r)}V_0 - P\right) \\ &= e_i\,(1-q)\left(P - \frac{1}{1+E\,(1+r)}V_l\right) \geq 0.\end{aligned} \tag{5}$$

Given our assumption about attention costs, sophisticated investors always pay attention (i.e., $a_S = 1$) and the unsophisticated investors never do (i.e., $a_U = 0$).

At date one, investor i chooses how many units e_i to buy. The investor's expected date two payoff $U_i\,(e_i)$ is given by:

$$U_i\,(e_i) \quad = \quad e_i a_i\left(\tfrac{(1+r)qV_h + r(1-q)V_l}{1+E(1+r)} - Pq\right) + e_i\,(1-a_i)\left(\tfrac{1+r}{1+E(1+r)}V_0 - P\right) - c_i a_i\ ,$$

where $a_i \in \{0,1\}$ is the investor's decision of whether to pay attention, subject to the budget constraint $e_i P \leq W$. Sophisticated investors buy $e_S = W/P$ units at date one, since they correctly anticipate their attention cost (c_i) to be zero and their per-unit expected payoff is positive whenever the target 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 pay attention. Formally, a β-type investor chooses to buy $e_U\,(\beta)$ units, where

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

This implies that a β-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 β 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 β. At date two, unsophisticated investors (correctly) realize that their attention cost is infinite and do not pay attention; 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. While all participating unsophisticated investors always 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

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

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

$$(1-m)(1-\gamma) + m\left(1 - G\left(\bar{\beta}\right)\right) \geq K/W. \tag{11}$$

The financing constraint is stricter when $V = l$, because a fraction of sophisticated investors redeem, which reduces the amount available for financing. Thus, if inequality (11) holds, the target is financed for any value V. Conversely, if inequality (11) does not hold, then the project can only be financed if $V = h$. As we show in Proposition 4 below, the optimal contract may involve financing the project when $V = h$ and $V = l$ (in which case the financing condition is given by equation (11)) or financing the project only if $V = h$ (in which case the financing condition is given by equation (10)), depending on parameters.

Given Condition (11), financing the project when $V = l$ is feasible. In the case when the project is always financed (i.e., $V = h$ and $V = l$), the sponsor chooses the number of shares E, the price P, and the number of rights r at date one to maximize the ex-ante value of her stake in the target, i.e.

$$U_F = \max_{E,r,P} \frac{1}{1+E(1+r)} V_0 \tag{12}$$
$$\text{subject to } (3), (4), (7), (9), \text{ and } (11).$$

where Conditions (3) and (4) ensure incentive compatibility for optimal redemption decisions, Conditions (7) and (9) ensure participation by sophisticated and unsophisticated investors at date one, and Condition (11) implies that the target is always financed.

4.1.2 Project financed when $V = h$ only

Suppose that the sponsor finances the investment only when $V = h$. We assume that all investors receive their contributed funds back when the investment is not financed. This matches the institutional setting. In a SPAC, investors' funds are held in an escrow account and they are refunded if no merger takes place.

Since the investment is financed only if $V = h$, the IC condition (3) becomes

$$\frac{h}{1 + E(1+r)} \geq P, \tag{13}$$

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

$$\mu_0 \left(\frac{1+r}{1 + E(1+r)} h - P \right). \tag{14}$$

In particular, the signal x does not affect investors' values, since the investment is only financed when $V = h$ and since investors receive their money back when $V = l$. Thus, unsophisticated investors never pay attention to information, since that information provides no value to them. Both unsophisticated and sophisticated investors' per-share value is given by Equation (14). Sophisticated investors follow their signal without loss of generality. Whenever

$$\mu_0 \left(\frac{1+r}{1 + E(1+r)} h - P \right) \geq 0, \tag{15}$$

all investors participate, and otherwise, no investor participates and the project is not financed. Thus, the financing constraint (2) becomes

$$EP = W \geq K, \tag{16}$$

which is slack because we assumed that $W > K$. 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.

The sponsor's problem then becomes

$$\begin{aligned} U_F &= \max_{E,r,P} \frac{1}{1 + E(1+r)} \mu_0 h \\ &\quad \text{subject to (13) and (15).} \end{aligned}$$

That is, the project is only financed when $V = h$, which occurs with probability μ_0, and the sponsor must ensure that investors keep their shares when $V = h$ and redeem otherwise, and that all investors have a positive value from participating.

4.2 Benchmarks

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

4.2.1 One unsophisticated type

We first illustrate the intuition for our results in a simple model with no sophisticated investors and a single type of unsophisticated investor with $\beta \in (0, 1)$. The investor believes that he is sophisticated with probability β and that he will acquire information in that case. Suppose that

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

i.e. the Equation (3) does not hold.[11] Intuitively, the investor believes that when he acquires information, he will always redeem his shares and keep the rights. Then, the investor buys units whenever

$$\beta \frac{r}{1 + E(1 + r)} V_0 + (1 - \beta) \left(\frac{1 + r}{1 + E(1 + r)} V_0 - P \right) \geq 0, \tag{17}$$

which is a variant of Equation (9). Since there is only a single investor, who never redeems shares, the financing condition (11) simply becomes

$$W \geq K,$$

and the project is always financed (i.e., $V = h$ and $V = l$). Since we assumed that $W > K$, this constraint is slack, and we assume that the sponsor raises exactly K, i.e. $EP = K$.[12] We have the following result.

Proposition 1. *With one unsophisticated investor of type β, the project is financed whenever $V_0 > K(1 - \beta)$, and the optimal contract features $r \to \infty$ and $E \to 0$, i.e. the sponsor issues an infinite number of rights per unit and a vanishingly small number of units, and the sponsor's value equals*

$$U_F = V_0 - K(1 - \beta).$$

[11] We show in Proposition 1 below that this is indeed optimal for the sponsor.

[12] As in the baseline model, the sponsor does not benefit from raising more cash than K.

The sponsor is always better off issuing units consisting of redeemable shares and rights compared to issuing straight equity.

The sponsor faces the following tradeoff. On the one hand, an increase in r leads to more dilution for the sponsor, i.e. for a given amount of units E, the sponsor's payoff

$$\frac{1}{1+E\left(1+r\right)}V_0$$

decreases as r increases. On the other hand, increasing r allows the sponsor to raise the price P to exploit the unsophisticated investor. The investor anticipates redeeming the shares and recovering P with probability β, and anticipates retaining the rights for free (see Equation (17)). Thus, rights reduce the investor's perceived loss from redeeming shares. As a result, the investor is willing to pay a higher price P per unit when the number of rights bundled in the unit increase.

By increasing the number of rights, the sponsor can charge a higher price P per unit, and so can finance the project while issuing fewer units and thereby reducing the dilution of her own shares. With a single unsophisticated type, such a change is always profitable for the sponsor and she optimally sets $r \to \infty$ and $E \to 0$. Since the investor is only partially naive (i.e. $\beta < 1$), the sponsor can only extract rents from the investor partially. If the investor believes that he is the sophisticated type with probability one (i.e. $\beta = 1$), then the sponsor can finance the project for free. Her value in that case is $U_F = V_0$, i.e. she shifts the entire investment cost K onto the investor.

In Section 4.3, we show that the introduction of sophisticated investors limits by how much the sponsor can increase P. Specifically, if Equation (3) does not hold, sophisticated investors redeem shares even when $V = h$, which is costly for the sponsor. In equilibrium, it is then optimal to choose a finite number of rights per unit.

4.2.2 Only sophisticated investors

Suppose that all investors are sophisticated, i.e., $m = 0$. In that case, the sponsor's optimal contract features no rights. Since sophisticated investors redeem their shares conditional on the information they receive, the sponsor generally faces dilution. As a result, not all ex-ante optimal projects (i.e. those with $V_0 > K$) are financed.

Proposition 2. *Suppose there are only sophisticated investors. The optimal contract features $r = 0$, and the project can be financed for both $V = h$ and $V = l$ only if $\max\left\{\left(1-\gamma\right)V_h, V_l\right\} > K$. Otherwise, the project is only financed if $V = h$.*

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 investment 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 target is diluted as a result of redemptions. This dilution cost lowers the value for the sponsor, which implies that not all ex-ante efficient investments are financed.

4.2.3 No overconfidence

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

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

Intuitively, since investors anticipate that they will not acquire information, the sponsor cannot charge a price that exceeds the ex-ante value of units. As in the previous benchmark, the optimal contract features $r = 0$ and the sponsor may not invest in ex-ante efficient projects, i.e. those with $V_0 > K$.

Proposition 3. *Suppose no investors are over-confident. The optimal contract features $r = 0$, and the project can be financed for both $V = h$ and $V = l$ only if*

$$V_0 (m + (1-m)(1-\gamma)) > K.$$

Otherwise, the project is only financed if $V = h$.

As in the previous benchmark, redemptions by sophisticated investors lead to dilution in the the sponsor's stake. The condition $V_0 (m + (1-m)(1-\gamma)) > K$ ensures that there are sufficiently many investors (who do not redeem when $V = l$) to ensure that raising financing for the sponsor is still profitable. Since $\frac{1}{m+(1-m)(1-\gamma)} > 1$, not all ex-ante efficient investments are pursued by the sponsor if the offered contract ensures that the project is always financed.

Propositions 2 and 3 highlight that when facing sophisticated investors, the sponsor optimally chooses to issue no rights, and dilution due to redeemable shares leads to underinvestment in ex-ante efficient targets. As we shall see next, in the presence of unsophisticated investors, this is no longer the case.

4.3 Optimal contract

We now characterize the optimal contract. Our exposition focuses on the case when the project is financed for both $V = h$ and $V = l$, which contains the most relevant predictions. Proposition 4 below characterizes all possible cases and provides sufficient conditions for each.

First, note that if

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

then there are too many redemptions in equilibrium when $V = l$ and the investment cannot be financed using redeemable shares if $V = l$, even if all investors initially buy units. On the other hand, if

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

then only sophisticated investors need to invest to finance the target, 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 investment cannot be financed using redeemable shares when $V = l$. If $(1 - m)(1 - \gamma) W \geq K$, then only sophisticated investors invest and the equilibrium is characterized by Proposition 2.*

When

$$K/W \in ((1 - m)(1 - \gamma), ((1 - m)(1 - \gamma) + m)), \tag{18}$$

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

$$(1 - m)(1 - \gamma) + m\left(1 - G\left(\bar{\beta}\right)\right) = K/W, \tag{19}$$

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

$$P = \frac{1}{1 - \bar{\beta} + \bar{\beta} q} \frac{(1 + r) V_0 - \bar{\beta}(1 - q) V_l}{1 + E(1 + r)} \equiv P\left(\bar{\beta}\right). \tag{20}$$

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

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

and $P(0) = \frac{1+r}{1+E(1+r)} V_0$ denotes the price that obtains when investors do not exhibit over-confidence. Over-pricing occurs because unsophisticated investors overvalue the option to redeem shares conditional on negative information. Specifically, type $\bar{\beta} > 0$ erroneously believes that he will redeem shares with probability $\bar{\beta}(1-q)$, in which case P is refunded. Thus, type $\bar{\beta} > 0$ believes that he will actually pay P with probability $1 - \bar{\beta} + \bar{\beta}q < 1$. At $t = 2$, however, type $\bar{\beta}$ does not redeem shares and ends up paying P with probability one.

The overpricing $\Pi\left(\bar{\beta}\right)$ increases in the probability of negative information (i.e., it increases in $(1-q)$) 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' over-confidence leads them to over-value rights more. Intuitively, the sponsor can increase r, and charge a higher price for each unit, because type $\bar{\beta}$ erroneously believes that he will only end up paying that price with probability $1 - \bar{\beta} + \bar{\beta}q < 1$ and that he will get r rights for free, after redeeming his shares.

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

$$E = \frac{\left((1-m) + m\left(1 - G\left(\bar{\beta}\right)\right)\right)}{P} W. \tag{21}$$

This implies that the sponsor must raise more than K to finance the investment in date one, since we can combine Equations (19) and (21) to get

$$EP = \frac{(1-m) + m\left(1 - G\left(\bar{\beta}\right)\right)}{(1-m)(1-\gamma) + m\left(1 - G\left(\bar{\beta}\right)\right)} K \equiv \Lambda\left(\bar{\beta}\right) K. \tag{22}$$

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 γ. Together with the condition that informed investors redeem their shares whenever $x = l$ (i.e., Conditions (3) and (4)), the above conditions characterize the equilibrium.

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

$$q(1-\gamma)V_h > K. \tag{23}$$

Then, there exists a $\bar{\beta} \in [0, 1]$ which is characterized by Equation (19), such that all sophisticated investors and unsophisticated investors with $\beta \geq \bar{\beta}$ buy units at date one. Let

$$\Lambda\left(\bar{\beta}\right) = 1 + (1-m)\gamma\frac{W}{K}, \tag{24}$$

and

$$\Pi\left(\bar{\beta}\right) = \frac{V_h}{V_h - (V_h - V_l)(1-q)\bar{\beta}}. \tag{25}$$

(i) If $0 > \max\left\{V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right), \mu_0(h-K)\right\}$*, then the investment cannot be financed using redeemable shares. Otherwise,*

(ii) if $\mu_0(h-K) > V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right)$*, then the investment 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 $V_0 - K\Lambda\left(\bar{\beta}\right)/\Pi\left(\bar{\beta}\right) \geq \mu_0(h-K)$*, then the investment is financed in both states (i.e.,* $V \in \{h, l\}$*), and the optimal contract is characterized by Equations (3), (4), (19)-(21). Specifically, the optimal contract sets* $r = \bar{r}$*, where*

$$\bar{r} = \left(1-\bar{\beta}\right)\frac{V_h - V_0}{V_0}, \tag{26}$$

and the sponsor's optimal value is

$$U_F\left(\bar{\beta}\right) = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)}K. \tag{27}$$

Condition (23) is a sufficient condition which ensures that the contract in which the project is financed for both $V = h$ and $V = l$ is feasible. Intuitively, Condition (23) requires that the target is sufficiently profitable, so that for any marginal investor $\bar{\beta}$, it is possible to issue enough shares to finance the investment, taking future redemptions into account.

The Proposition characterizes three possible scenarios. Part (i) states that when the cost K is sufficiently large relative to the value of the project, the sponsor does not finance the project with redeemable shares. Part (ii) characterizes the case in which the investment is financed only when $V = h$, but not when $V = l$. This highlights the potential social benefit of the SPAC structure in separating good versus bad investments. Since SPACs must offer redeemable shares, investors can withdraw their funds if they receive unfavorable interim information, which ensures that bad investments are not financed. This improves ex-post efficiency when the unconditional NPV of the investment 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 investment 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 one to ensure that the investment is financed even after some investors redeem at date two. 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 (but retain r shares since $l > 0$), while unsophisticated investors keep their shares. Since the investment 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

$$U_F = V_0 - \frac{\Lambda\left(\bar{\beta}\right)}{\Pi\left(\bar{\beta}\right)} K > \mu_0 \left(h - K\right). \tag{28}$$

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 (28) is decreasing in m, decreasing in $h-l$ (holding V_0 fixed) and increasing in γ. Thus, the sponsor's surplus is higher when there are more unsophisticated investors (i.e., m is lower), and when the targets available are riskier (i.e., $h-l$ is higher, holding V_0 fixed) and less transparent (i.e., γ is lower).

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 (27) 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 target. When this ratio is greater than one, the dilution cost of redeemable shares dominates the benefit from overpricing, and there is underinvestment in efficient targets. 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 targets that are not efficient (i.e., for which $V_0 < K$), in order to capture the benefit of overpricing. This over-investment in inefficient targets is more likely when overconfidence (i.e., $\bar{\beta}$) of the marginal unsophisticated investor is higher and when targets are riskier and have more lottery like payoffs (i.e., 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 targets if*

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

(ii) over-investment in ex-ante inefficient targets if

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

(iii) investment in ex-post efficient targets if

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

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 when $K > l$. Since investors can withdraw their funds when they receive negative information, such investments are not financed under some conditions. When the relative mass of over-confident investors is sufficiently small and the 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 investments have high average payoffs, redeemable shares lead to under-investment in ex-ante efficient targets 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 targets (part (ii) above). In either of these cases, allowing sponsors to issue *non-redeemable* shares can be welfare improving.

Finally, Proposition 4 sheds light on the relative popularity of SPACs vs. IPOs. When investors have high wealth W to invest, the optimal contract resembles a SPAC, whereas when W is low, the optimal contract features non-redeemable shares, as in an IPO. We can understand the rise and relative decline in SPACs through this lens. Industry observers have noted that the surge in SPAC financing coincided with "too much money chasing deals". More recently, funding appears to have dried up, both for SPACs and for IPOs, which we can interpret as a drop in W in our model. Then, Proposition 4 implies that IPOs dominate SPACs.

4.4 Features of the optimal contract

Next, we characterize some features of the optimal contract and show how they vary with the parameters of the model. For concreteness, we will sometimes consider the case in which the distribution of unsophisticated traders is uniform i.e., $G(\beta) = \beta$.

4.4.1 Composition of investors

The financing condition (19) characterizes the mix of investors that participate in equilibrium. Intuitively, one can represent the investor demand for units, net of redemptions, as

$$Q(\beta) \equiv W((1-m)(1-\gamma) + m(1-G(\beta))), \tag{29}$$

where β 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 β, which reflects that only the most overconfident investors participate. The financing condition implies that, in equilibrium, the aggregate demand for units $Q(\beta)$ 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 γ 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 of unsophisticated investors m is more subtle. To see why, note that $\frac{dQ}{dm} = 0$ implies that

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

The direct effect is to scale up demand from a fraction $1-G(\bar{\beta})$ 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 (19), 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). In the following result, we characterize the condition explicitly for the special case where $G(\beta) = \beta$.

Corollary 2. *The overconfidence of the marginal unsophisticated investor $\bar{\beta}$ increases in investor wealth W, decreases in required financing K, and decreases in the precision of interim information γ. Moreover, if the distribution of unsophisticated investors is uniform i.e., $G(\beta) = \beta$, then $\partial\bar{\beta}/\partial m > 0$ if and only if $\gamma > 1 - K/W$.*

4.4.2 Rights

In equilibrium, the sponsor offers strictly positive rights r per unit. As discussed in Section 4.2.1, when increasing the number of rights r, the sponsor faces a tradeoff between more dilution of her stake versus higher overpricing by unsophisticated investors. Specifically, recall that a β-type investor anticipates that with probability β they will be attentive and redeem their shares optimally, and so the net payoff from buying a unit in this case is

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

In other words, when she is attentive, the unsophisticated investor (mistakenly) anticipates that she will only end up paying P with probability q, but will on average collect $\Delta > 0$.[13] As the number of rights per unit increases, this makes the β type investor more willing to pay more for the units initially.[14]

However, unlike the benchmark analysis in Section 4.2.1, the presence of sophisticated investors limits the extent to which the sponsor can increase the number of rights r and, consequently, the price per unit. If the price becomes too high (i.e., $P > \frac{V_h}{1+E(1+r)}$), sophisticated investors will always redeem their shares but keep their rights, which leads to a loss for the sponsor. As a result, the sponsor finds it optimal to set the number of rights to

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

so that sophisticated investors keep their shares when they receive a positive signal about the target's value (i.e. $x = h$). The above leads to the following result.

Corollary 3. *The number of rights $\bar{r}$ offered per unit decreases with the level of payoffs (i.e., an increase in V_0 holding μ_0 fixed) but increases with a mean preserving spread (i.e., when $h - l$ increases), and when there is more upside in payoffs (i.e., when V_h/V_0 increases). The*

[13] In practice, she is never attentive and so her net payoff is $\frac{(1+r)V_0}{1+E(1+r)} - P$ per unit.

[14] Note the above decomposition also clarifies why issuing more equity (i.e., increasing E) does not have the same impact as increasing the number of rights — an increase in E dilutes the investor's perceived (i.e., Δ) and actual net gain from buying a unit.

number of rights offered also decreases in investor wealth W, increases in required financing K, and decreases in the precision of interim information, γ.

4.4.3 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. (2023)). Our model naturally gives rise to this prediction since sophisticated investors efficiently attend to, 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

$$R_U \equiv \frac{1}{P}\left(\frac{1+\bar{r}}{1+E\left(1+\bar{r}\right)}V_0 - P\right) = -\bar{\beta}\left(1-\frac{V_0}{V_h}\right) < 0, \tag{30}$$

while the return for sophisticated investors is

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

The above expressions imply the following result.

Corollary 4. *The return for unsophisticated investors R_U decreases, and the return for sophisticated investors R_R increases, with a mean preserving spread (i.e., when $h-l$ increases), and when there is more upside in payoffs (i.e., when V_h/V_0 increases). The returns for both groups of investors decrease with investor wealth W, but increase with required financing K. Moreover, if the distribution of unsophisticated investors is uniform (i.e., $G\left(\beta\right)=\beta$), returns for both groups of investors decrease with the mass of unsophisticated investors m if and only if $\gamma > 1-K/W$.*

Unsophisticated investors are worse off for riskier, more positively skewed payoffs. Intuitively, this is because, all else equal, these targets have higher volatility and more lottery like payoffs, and so are more overvalued by unsophisticated investors for their higher option value. However, sophisticated investors are better off in these cases.

As expected, the return to unsophisticated investors becomes more negative as the overconfidence of the marginal unsophisticated investor $\bar{\beta}$ increases. More surprisingly, 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. This implies that the returns to both groups of investors decrease with the amount of available funds W (as this increases $\bar{\beta}$) and the riskiness of the target, and are lower for smaller SPACs. Finally, when $G(\beta)$ is uniform, returns for both groups decrease with the mass m of unsophisticated investors when interim information is sufficiently precise, because in this case the overconfidence of the marginal investor increases with m.

4.5 Empirical implications

In this subsection, we summarize a testable implications of our model, based on the analysis above. While some of these are consistent with existing empirical evidence, others offer novel testable predictions of our model. A key set of predictions of our analysis, illustrated by Corollary 2, is about how the overconfidence of the marginal unsophisticated investor $\bar{\beta}$ changes with model parameters. While it is difficult to measure $\bar{\beta}$ empirically, the average overconfidence of participating unsophisticated investors is given by

$$\beta_{avg} = E\left[\beta | \beta \geq \bar{\beta}\right],$$

which is increasing in $\bar{\beta}$. In the empirical literature, common proxies for investor sophistication include wealth, age, and education level (see e.g. Chalmers and Reuter (2020)). Thus, Corollary 2 predicts that on average more sophisticated (or less naive/overconfident) investors participate whenever the SPAC raises more funds (i.e., K is higher) and less sophisticated investors participate whenever information about the target is less precise (i.e., γ is lower), as proxied by e.g. the share of intangibles or R&D expenses.

Moreover, if we interpret investor wealth W as a measure of available funds, we should expect that the amount of funding for SPACs increases when interest rates are low, and decreases when interest rates are high. Thus, our model predicts that in a regime with low interest rates, less sophisticated investors participate in SPACs, which appears consistent with the increase in retail participation in SPAC deals during 2020-21, and the subsequent decline in 2022.

Corollary 3 characterizes how the number of rights depend on the distribution of the target's payoffs, and on market conditions (e.g., W, K and γ) through their impact on the overconfidence of the marginal unsophisticated investor $\bar{\beta}$. In principle, the relation between the number of rights and target payoffs can be tested using the cross section of SPAC contracts and target characteristics, but in practice there is limited variation in the choice of rights and warrants in SPAC contracts historically. However, the negative relation between the number of rights and investor wealth is consistent with the recent trend towards reducing or eliminating rights and warrants in SPAC transactions.

Finally, Corollary 4 implies that the return for unsophisticated investors R_U decreases and the return for sophisticated investors R_S increases when the target firm is riskier and has more lottery like payoffs. This may help reconcile the divergence in performance between short-term (sophisticated) investors and buy-and-hold (unsophisticated) investors that has been recently documented by Gahng et al. (2023) and Klausner et al. (2022).

The result also implies that the returns to both types of investors decrease when the overconfidence of the marginal investor $\bar{\beta}$ increases. As such, a novel prediction of our analysis is that (cross-sectional) variation in average investor overconfidence should lead to a negative relation between the number of rights (or warrants) offered by the sponsor and buy-and-hold returns. The latter negative relation is consistent with the evidence in Gahng et al. (2023).

5 Regulatory intervention

In this section, we explore the implications of regulatory interventions in our setting. We first characterize the equilibrium if the sponsor were restricted to issuing non-redeemable shares. We then show that restricting access by investor sophistication or limiting / eliminating rights and warrants from the issuance can improve returns 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 Internet Appendix IA4, we consider the impact of additional regulatory interventions including mandatory redemption rights and restricting investment stakes.

5.1 Financing with 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. Suppose instead that the sponsor must issue non-redeemable shares (i.e. straight equity), for example because a regulator prohibits using redeemable shares. Then, investor overconfidence about the ability to pay attention no longer plays a role. Intuitively, because shares are non-redeemable, interim information has no impact on investors' value from buying shares. In Appendix B.6, we show that the sponsor then optimally sets $r = 0$ and $P = V_0 - K$, and only finances ex-ante efficient investments, i.e. those with $V_0 \geq K$. The sponsor realizes value

$$U_F^{NR} = V_0 - K$$

in this case.

Whenever $\Lambda(\bar{\beta})/\Pi(\bar{\beta}) < 1$, the sponsor benefits from being able to use redeemable shares compared to being forced to issue straight equity. That is, the requirement for SPACs to use redeemable shares may actually benefit sponsors at the cost of unsophisticated investors, since these investors realize return $R_U < 0$ when the sponsor issues redeemable shares. In contrast, when $\Lambda(\bar{\beta})/\Pi(\bar{\beta}) > 1$, the sponsor would also be better off if redeemable shares were prohibited.

5.2 Restricting investor access

Suppose that 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

$$(1-m)(1-\gamma) + m\left(G(\beta_{max}) - G\left(\bar{\beta}\right)\right) \geq K/W. \tag{32}$$

As more overconfident investors are excluded (i.e., β_{max} decreases), the marginal investor type decreases as well (i.e., $\bar{\beta}$ decreases), and the sponsor is forced to cater to a less overconfident 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 decrease in $\bar{\beta}$ 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 Λ is unaffected (see Equation (24)), overpricing $\Pi\left(\bar{\beta}\right)$ decreases with β_{max}. This implies that the sponsor's value decreases with β_{max} since she has to sell more units to finance the investment.

The total surplus to participating unsophisticated investors is given by

$$S_U = \int_{\bar{\beta}}^{\beta_{max}} e_i \left(\frac{1+\bar{r}}{1+E(1+\bar{r})} V_0 - P\right) dG(\beta),$$

where the term in brackets is the per-unit expected equilibrium value minus the price and where each investor buys $e_i = W/P$ units. Plugging in the optimal values for E, $\bar{r}$, and P, we can write the surplus as

$$S_U = W R_U \left(G(\beta_{max}) - G\left(\bar{\beta}\right)\right) = -W\bar{\beta}\left(1 - \frac{V_0}{V_h}\right)\left(G(\beta_{max}) - G\left(\bar{\beta}\right)\right),$$

where R_U is given by Equation (30). Using the implicit function theorem together with

Equation (32) then yields

$$\frac{\partial S_U}{\partial \beta_{max}} = -W \left(1 - \frac{V_0}{V_h}\right) \frac{G'(\beta_{max})}{G'(\bar{\beta})} < 0.$$

Thus, excluding the most overconfident investors (i.e. decreasing β_{max}) increases the total surplus of participating unsophisticated investors, even though some investors are excluded.

The total surplus of sophisticated investors is given by

$$S_S = mWR_S = mW\left(1 - \bar{\beta}\right)\left(1 - \frac{V_0}{V_h}\right),$$

which decreases when β_{max} decreases.

5.3 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. Given that the optimal unconstrained contract sets $r = \bar{r}$, eliminating rights naturally leads to lower surplus for the sponsor. Intuitively, while restricting to $r = 0$ leaves the financing condition unaffected, it leads to less overpricing:

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

since the price is given by

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

Moreover, the above implies that returns for unsophisticated investors are less negative, and returns for sophisticated investors are lower than in the unconstrained benchmark. This is intuitive — since there are no rights, unsophisticated investors do not overvalue the units as much as in the unconstrained benchmark.

5.4 Mandating greater disclosure

A common concern with SPAC transactions is that disclosure requirements are less stringent than for 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 γ. However, we find that this may be detrimental. An increase in γ leads to a decrease in overconfidence of the marginal investor $\bar{\beta}$ when the financing condition (19) binds. However, an increase in γ also leads to an increase in the equilibrium financing multiplier Λ, an increase in V_h and a decrease in q. Together this implies that the equilibrium return to sophisticated investors, R_S, increases with γ (see Equation (31)). 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 information precision γ has two offsetting effects on R_U and $\Pi\left(\bar{\beta}\right)$. On the one hand, an increase in γ 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 γ implies there are more redemptions by sophisticated investors, which forces the sponsor to cater to less overconfident investors, so that $\bar{\beta}$ decreases, which increases R_U. Specifically, implicit differentiation of the demand function $Q\left(\bar{\beta}\right)$ in Equation (29) yields:

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

and overall, we have

$$\frac{dR_U}{d\gamma} = \frac{1-m}{mG'\left(\bar{\beta}\right)}\left(1-\frac{V_0}{V_h}\right) - \bar{\beta}\frac{V_0}{V_h^2}\frac{(h-l)\,\mu_0\,(1-\mu_0)}{\left(\mu_0+(1-\mu_0)(1-\gamma)\right)^2}.$$

When m is sufficiently small or the demand function $Q(\beta)$ is sufficiently insensitive to β (i.e., $G'(\beta)$ is low), then $\partial\bar{\beta}/\partial\gamma$ is negative and large. Then, R_U increases. On the other hand, when m is large and the aggregate demand if very sensitive to β, R_U decreases. Hence, more disclosure may not improve investor welfare, when these investors are unsophisticated. The following proposition summarizes the above and provides an explicit characterization when $G(\beta) = \beta$.

Proposition 5. *An increase in the precision of interim information γ leads to an increase in the return to sophisticated investors (i.e., $\partial R_S/\partial\gamma > 0$). Moreover, if the distribution of unsophisticated investors is uniform (i.e., $G(\beta) = \beta$), then the return to unsophisticated investors decreases with interim information precision (i.e., $\partial R_U/\partial\gamma < 0$) if and only if the mass m of unsophisticated investors is sufficiently large i.e.,*

$$m > \frac{1}{1+\frac{1}{\gamma}\left(1-\frac{K-(1-m)(1-\gamma)W}{mW}\right)\left(\mu_0 h+(1-\mu_0)(1-\gamma)\,l\right)}.$$

The above result implies that mandating greater disclosure can be counterproductive when the participation by unsophisticated investors is sufficiently high. Instead of "leveling the playing field" such policies increase the informational advantage of sophisticated investors, and thereby increase their returns, but can make unsophisticated investors worse off because they cannot process this information.

6 Extensions and robustness

In this section, we discuss some natural extensions to the benchmark analysis and then explore the robustness of our results to alternate specifications. In the first subsection, we discuss how our results change when (i) unsophisticated investors can pay a cost to attend to interim information and (ii) the sponsor can raise financing from PIPE investors. In the second subsection, we explore how our results are affected when we relax the assumption that the redeemed shares are given to a third party.

6.1 Extensions

Costly attention by unsophisticated investors. In our benchmark analysis, unsophisticated investors never attend to information. In Appendix B.2, we characterize how the optimal contract varies with the attention costs of such investors. When attention costs are sufficiently high, none of the unsophisticated investors pay attention and so we recover the equilibrium characterized by Proposition 4. When costs are sufficiently low, however, all investors attend to information and redeem shares for $x = l$ - in this case, the sponsor would strictly prefer selling non-redeemable shares instead. Finally, for intermediate costs, the optimal contract with redeemable shares ensures that unsophisticated investors are indifferent between paying attention or not. In this case, as costs increase, the return to unsophisticated investors decreases, while the return to sophisticated investors increases.

These results highlight that mandates for greater transparency can have different effects on welfare, depending on the type of information being disclosed. Specifically, Section 5 shows that greater disclosure may exacerbate the wedge between sophisticated and unsophisticated investors when such information is difficult to process or interpret by all investors. However, 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.

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. Such PIPE investments often make up for the cash shortfall from redemptions at the time of the merger. For instance, Klausner et al. (2022) show that 25% of the cash raised in a SPAC merger is raised from PIPE investors. Since PIPE investors are usually sophisticated and conduct due diligence on the proposed merger, it is argued their participation benefits unsophisticated investors by serving as a "stamp of approval" for the transaction.

We show that this need not be the case. Specifically, in Appendix B.3, we allow the sponsor to raise money from a PIPE investor to cover a short-fall if there are redemptions at date two. Since there are no redemptions when $V = h$, the sponsor only approaches the PIPE investor when $V = l$. The access to additional PIPE financing relaxes the sponsor's financing condition, which allows her to target more over-confident investors and, consequently, leads to more over-pricing. However, because the PIPE investor infers that the payoff is low when approached, the sponsor has to offer more shares, which leads to more dilution of her stake. The optimal amount of PIPE financing trades off the sponsor's benefit from catering to more unsophisticated investors against the cost of higher dilution from the PIPE investor. As a result, we show that while access to PIPE investors benefits the sponsor, it leads to more negative returns for unsophisticated investors.

6.2 Robustness

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. This ensures that we can solve for the optimal price P, the optimal number of units E, and the optimal number of rights r in closed form. The assumption also biases our model *against* using redeemable shares. Specifically, shares that are redeemed do not benefit the sponsor, since they are given to a third party instead of reducing the number of shares outstanding (and thereby increasing the sponsor's per-share value). In Section 5.1 above, we show that despite this, using redeemable shares may yield a higher value for the sponsor compared to using straight equity.

In Appendix B.4, we relax this assumption and characterize how our results are affected when redemptions reduce the number of outstanding shares. Intuitively, if $R > 0$ shares are redeemed, shares outstanding are given by $1 + E\,(1 + r) - R$ and, consequently, the realized per-share value is $V/\,(1 + E\,(1 + r) - R)$. Thus, investors who redeem increase the per-share value of those who do not redeem by reducing dilution relative to the case where redeemed shares are given to a third party.

We focus on the case where (i) the project is always financed and (ii) sophisticated investors redeem their shares when observing a low signal. As a result, the total number of shares outstanding is $s_h = 1 + E(1+r)$ when $V = h$, and is $s_l = 1 + E(1+r) - \gamma(1-m)(W/P)$ when $V = l$. As we show in the appendix, the sponsor's problem is analogous to that in our main analysis after appropriately accounting for the above difference in the number of outstanding shares. While it is no longer tractable to characterize the equilibrium analytically, we show that for a wide range of parameters, the sponsor prefers selling units consisting of redeemable shares and rights to issuing straight equity, and optimally chooses a positive number of rights per unit.

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 investors who may not completely understand the terms of the warrant, and consequently, exercise them optimally.

In Appendix B.5, we consider a setting in which the sponsor can issue units that consist of 1 redeemable share and w warrants, each of which can be exercised by the investor at an exercise price X. Importantly, if exercised, the warrants increase both the number of shares outstanding and the total cash-flows of the firm. We focus on the interesting case where X is such that warrants are exercised when $x = h$ and not exercised when $x = l$.[15] Moreover, consistent with empirical evidence, we assume that while sophisticated investors optimally choose whether or not to exercise their warrants given their interim information, unsophisticated investors do not exercise the warrants.

This implies that the total number of shares outstanding is $1 + E + (1-m)we_i$ if $V = h$ and $1 + E + (1-m)(1-\gamma)we_i$ if $V = l$, where $e_i = W/P$ is the number of units bought by each participating investor. Moreover, the total firm cash-flows are given by $h + (1-m)we_iX$ if $V = h$ and $l + (1-m)(1-\gamma)we_iX$ if $V = l$, since sophisticated investors who receive a positive signal exercise their warrants when $V = l$. In the appendix, we show that the sponsor's problem is analogous to that in the main model, after accounting for the above adjustments. Because the warrants affect both cash-flows and number of shares in a non-

[15]Notably, if X exceeds the expected per-share value conditional on $x = h$, the warrants are never exercised and so irrelevant, while if X is lower than the per-share value conditional on $x = l$, they are always exercised and hence are analogous to the rights from our main analysis.

linear manner, it is no longer possible to characterize the equilibrium analytically.

However, as we illustrate in the appendix, we can solve for the equilibrium numerically, and show that for a range of parameters, the sponsor optimally chooses to issue units with redeemable shares and a positive number of warrants. This is because the key economic mechanism from our main analysis carries over to this setting. On the one hand, issuing warrants dilutes the sponsor's stake (when $V = h$) because sophisticated investors optimally exercise them. On the other hand, unsophisticated investors anticipate exercising the warrants optimally and so are willing to over-pay for the units ex-ante, even though they do not exercise these warrants eventually. The optimal contract offered by the sponsor trades off these forces.

7 Conclusions

The recent popularity of SPACs is puzzling, given the complexity of these transactions and the mixed performance across different investor classes. To better understand this phenomenon, 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 the acquisition of a target. The redemption feature introduces a tradeoff. On the one hand, it leads to dilution 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 to 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 investment is bad, and so only good targets 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 targets. On the other hand, when the mass of over-confident investors is sufficiently high, the overpricing effect dominates and there is over-investment in ex-ante inefficient targets.

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'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 per unit and more negative buy-and-hold returns.

We also 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 tend 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.

Finally, our model provides an example on how restricting the space of optimal contracts may yield unintended results in the presence of behavioral investors.[16] Regulators have forced SPACs to use redeemable shares, which are generally thought of as a way to protect investors. As our model shows, however, the sponsor may profit from using redeemable shares at the expense of investors who are unsophisticated. Instead, forcing the sponsor to use straight equity may improve returns for these investors.

[16] While SPACs cannot offer arbitrary contracts in practice, we study general contracts in Internet Appendix IA2. 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 of our analysis survives. Whenever the mass of unsophisticated investors is sufficiently large, the sponsor optimally offers a contract that depends on the redemption decision.

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A Proofs

A.1 Proof of Proposition 1

Suppose that Equations (3) and (4) both hold. In the sponsor's optimal contract, the investor's participation constraint in Equation (9) binds. Combining this equation with $EP = K$ yields

$$P = \frac{(1+r)\,V_0 - \beta\,(1-q)\,V_l}{\beta q + (1-\beta)} - K\,(1+r)\,.$$

Then, the sponsor's problem becomes

$$\max_r \frac{(1+r)\,V_0 - \beta\,(1-q)\,V_l - (\beta q + (1-\beta))\,K\,(1+r)}{(1+r)\,V_0 - \beta\,(1-q)\,V_l} V_0$$

subject to Equation (3). The objective is strictly increasing in r, which implies that at the optimum Equation (3) binds, so that

$$r = (1-\beta)\,\frac{V_h - V_0}{V_0}$$

and

$$U_F = V_0 - \frac{K}{\Pi\,(\beta)},$$

where

$$\Pi\,(\beta) = \frac{V_h}{V_h - (V_h - V_l)\,(1-q)\,\beta}.$$

Alternatively, suppose that

$$P > \frac{1}{1 + E\,(1+r)} V_h. \tag{33}$$

Now, the investor believes that he will acquire information with probability β and then always redeem the shares and keep the rights (i.e. he believes that he will redeem for both $x = l$ and $x = h$), so that the investor buys units whenever

$$\beta \frac{r}{1 + E\,(1+r)} V_0 + (1-\beta)\left(\frac{1+r}{1 + E\,(1+r)} V_0 - P\right) \geq 0.$$

In the sponsor's optimum, this constraint must bind, so that

$$P = \frac{1}{1-\beta}\frac{r + 1 - \beta}{1 + E\,(1+r)} V_0.$$

This yields a value of

$$U_F = \max_r V_0 - K \frac{(1+r)(1-\beta)}{r+1-\beta},$$

which is strictly increasing in r. Thus, it is optimal for the sponsor to set $r = \infty$, which yields

$$U_F = V_0 - K(1-\beta).$$

We have

$$V_0 - K(1-\beta) > V_0 - \frac{K}{\Pi(\beta)},$$

which follows after some algebra. Thus, it is optimal for the sponsor to finance the project whenever $V_0 > K(1-\beta)$. Thus, with a single unsophisticated investor, it is optimal for the sponsor to set $r = \infty$. To ensure that the total number of shares is finite, this requires her to set $E \to 0$, otherwise Condition (33) cannot hold.

If the sponsor were to sell straight equity, the investor participates whenever

$$\frac{1}{1+E} V_0 \geq P$$

and we again have $EP = K$. The above inequality binds in the optimal contract, which implies that

$$U_F = V_0 - K,$$

after some algebra. We have

$$V_0 - K(1-\beta) > V_0 - K.$$

Thus, the sponsor is better off financing using redeemable shares and rights compared to selling straight equity.

A.2 Proof of Proposition 2

Consider first a contract that finances the project if both $V = h$ and $V = l$. Given $m = 0$, all investors buy shares if the participation constraint (7) holds, or equivalently, if

$$P \leq \frac{1}{q} \frac{(1+r) q V_h + r(1-q) V_l}{1 + E(1+r)}.$$

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 (3) holds), we need condition

$$V_h \geq \frac{1}{q}\left(\left(1+r\right)qV_h + r\left(1-q\right)V_l\right),$$

which is only possible if $r = 0$ (note that condition (4) is slack in this case). As a result, the sponsor optimally issues no rights and sets

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

Consider a contract in which investors only redeem shares when $x = l$, i.e. Condition (3) holds. Then, the financing constraint is given by

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

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

$$U_F = V_0 - \frac{V_0}{V_h\left(1-\gamma\right)}K. \tag{34}$$

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

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

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

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

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

$$EP = W \geq K.$$

Note that 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. 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

$$U_F = V_0 - \frac{V_0}{V_l}K. \tag{35}$$

The project can be financed for both $V=h$ and $V=l$ only if $\max\{(1-\gamma)V_h, V_l\} > K$, and the optimal contract always features $r=0$. The optimal contract induces investors to redeem when $x=l$ whenever $(1-\gamma)V_h \geq V_l$, which follows by comparing the sponsor values in Equations (34) and (35).

Finally, consider a contract so that the project is financed only conditional on $V=h$. To avoid complications, assume that all investors receive their contributed funds back when the investment is not financed. It is optimal to set

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

and the financing constraint becomes $EP = W \geq K$. We can solve

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

which implies that $r=0$ is optimal, and that the sponsor's value is given by $U_F = \mu_0(h-K)$. The sponsor prefers financing the project only if $V=h$ to financing it when both $V=h$ and $V=l$ whenever

$$\mu_0(h-K) \geq V_0 - \min\left\{\frac{V_0}{V_l}, \frac{V_0}{V_h(1-\gamma)}\right\}K.$$

Note that in all cases, $r=0$ is optimal, i.e. the sponsor does not offer rights along with the shares.

A.3 Proof of Proposition 3

First, consider a contract so that the project is financed when $V = h$ and $V = l$. To ensure that the project is financed when $V = l$, the financing constraint (11) requires that

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

since $W = EP$. Given the objective in (12), the sponsor wants to set the price P as high as possible so that the number of shares E she has to issue are as low as possible. This implies that the above constraints must bind, and so

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

For this to be offered in equilibrium, we need m is sufficiently large to ensure that the denominator in the above expression is positive, specifically, a necessary condition is that

$$V_0(m+(1-m)(1-\gamma)) \geq K$$

or equivalently

$$m \geq \frac{1}{\gamma}\left(\frac{K-(1-\gamma)V_0}{V_0}\right).$$

The sponsor is indifferent between different values of (E, r) such that the above holds, and $r = 0$ is optimal without loss of generality. The sponsor's optimal value is given by

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

The project can be financed only if $V_0(m+(1-m)(1-\gamma)) > K$, which ensures that sufficiently many investors keep their shares conditional on $V = l$. Otherwise, the project cannot be financed when $V = l$.

Alternatively, consider a contract that finances the project only if $V = h$. The same derivations as in the Proof of Proposition 2 imply that $r = 0$ and $U_F = \mu_0(h-K)$.

A.4 Proof of Proposition 4

We first show that the constraint set in Proposition 4 is nonempty whenever Condition (18) holds. Plugging in the price in Equation (20), which ensures that type $\bar{\beta}$'s IR condition (9) holds, into the IC constraint (3) 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 attend to 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 (21) and the financing condition (19) 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 (20) 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 (23). 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 (20). Combining Equation (21) and the financing condition (19) 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 (23) 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 (20) into the IC constraint (3) implies that incentive compatibility holds whenever

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

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 (3) binds and $r = \bar{r}$ and the optimal (E, r, P) is determined by Conditions (3) and (19)-(21) binding.

When the IC constraint (3) 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

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

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

$$U_F = V_0 - \frac{\left(1 - \bar{\beta}\right)V_h + \bar{\beta}V_0}{V_h}\frac{m\left(1 - G\left(\bar{\beta}\right)\right) + 1 - m}{m\left(1 - G\left(\bar{\beta}\right)\right) + (1-m)(1-\gamma)}K. \tag{36}$$

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 investment only if $V = h$. This exhausts all possible cases.

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

$$V_h \geq \left(\left(1-\bar{\beta}\right) V_h + \bar{\beta} V_0\right) \frac{m\left(1-G\left(\bar{\beta}\right)\right)+1-m}{m\left(1-G\left(\bar{\beta}\right)\right)+(1-m)(1-\gamma)}, \tag{37}$$

which follows from Equation (36). Note that Condition (37) 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 (3) with

$$\frac{1}{1+E(1+r)} V_l \geq P, \tag{38}$$

which implies that investors keep their shares if they observe $x = l$. In other words, investors never redeem their shares when Condition (38) holds. Since the signal x now does not affect investors decisions, no unsophisticated investor pays attention, i.e. $a_i = 0$ for all i. Sophisticated investors pay attention, since that information is free, but the information does not affect their value. Overall, unsophisticated investors and sophisticated investors now have the identical value

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

Since $V_l < V_0$, setting

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

so that constraint (38) 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).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

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

Clearly, we have $U_F^{Keep} < U_F^{NR}$, where U_F^{NR} is given by Equation (50). 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 $U_F > U_F^{NR} > U_F^{Keep}$.

Investment financed only when $V = h$. At the optimal price P, the IC constraint (13) binds, which together with the financing constraint (16) 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 investment is only financed when $V = h$. We have $U_F > U_F^h$ whenever

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

Thus, a sufficient condition is

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

But this is just Condition (37), which we have already established.

A.5 Proofs for Section 4.4

A.5.1 Proof of Corollary 2

Using the financing condition (11) and the implicit function theorem yields

$$\frac{\partial\bar{\beta}}{\partial K} = -\frac{1}{mWG'\left(\bar{\beta}\right)} < 0 \text{ and } \frac{\partial\bar{\beta}}{\partial W} = \frac{K}{W^2}\frac{1}{mG'\left(\bar{\beta}\right)} > 0.$$

Moreover, we have

$$\frac{\partial\bar{\beta}}{\partial\gamma} = -\frac{1-m}{mG'\left(\bar{\beta}\right)} < 0.$$

When $G\left(\beta\right)$ is uniform, the financing condition (11) yields

$$\bar{\beta} = 1 - \frac{K - (1-m)(1-\gamma)W}{mW}$$

and

$$\frac{\partial}{\partial m}\bar{\beta} = \frac{K - W(1-\gamma)}{m^2 W},$$

which is positive whenever $\gamma > 1 - K/W$.

A.5.2 Proof of Corollary 3

Equation (26) implies that $\partial\bar{r}/\partial\bar{\beta} < 0$, which together with Corollary 2 immediately implies that $\partial\bar{r}/\partial K > 0$, $\partial\bar{r}/\partial W < 0$, and $\partial\bar{r}/\partial\gamma > 0$. Moreover, Equation (26) implies that $\partial\bar{r}/\partial(V_h/V_0) > 0$ and we have

$$\frac{\partial\bar{r}}{\partial\left(h-l\right)} = \left(1-\bar{\beta}\right)\frac{\mu_0\left(1-\mu_0\right)\gamma l}{\mu_0 + \left(1-\mu_0\right)\left(1-\gamma\right)}\frac{1}{V_0^2} > 0.$$

Let $\hat{h} = h + z$ and $\hat{l} = l + z$ for $z > 0$. Then,

$$\frac{\partial\bar{r}}{\partial z} = -\left(1-\bar{\beta}\right)\frac{\mu_0\left(1-\mu_0\right)\gamma\left(h-l\right)}{\mu_0 + \left(1-\mu_0\right)\left(1-\gamma\right)}\frac{1}{V_0^2} < 0.$$

A.5.3 Proof of Corollary 4

Equations (30) and (31), together with the fact that V_h/V_0 increases in $h-l$ (see the proof of Corollary 3 above) imply that $\partial R_U/\partial\left(h-l\right) < 0$ and $\partial R_S/\partial\left(h-l\right) > 0$ and that

$\partial R_U/\partial(V_h/V_0) < 0$ and $\partial R_S/\partial(V_h/V_0) > 0$. By Corollary 2, $\partial\bar{\beta}/\partial K < 0$ and $\partial\bar{\beta}/\partial W > 0$, which implies that $\partial R_U/\partial K > 0$ and $\partial R_S/\partial K > 0$ and $\partial R_U/\partial W < 0$ and $\partial R_S/\partial W < 0$.

In the case where $G(\beta)$ is uniform, we have $\partial R_U/\partial m = \partial R_S/\partial m = -(1 - V_0/V_h)\partial\bar{\beta}/\partial m$ and $\partial\bar{\beta}/\partial m > 0$ whenever $\gamma > 1 - K/W$ by Corollary 2.

A.6 Proof of Proposition 5

We have

$$\frac{\partial V_h}{\partial \gamma} = \frac{(1-\mu_0)\,\mu_0(h-l)}{V_0\,(\gamma\mu_0 - \gamma + 1)^{\,2}} > 0,$$

so that

$$\frac{\partial R_S}{\partial \gamma} = -\left(1 - \frac{V_0}{V_h}\right)\frac{\partial\bar{\beta}}{\partial\gamma} + \left(1 - \bar{\beta}\right)\frac{V_0}{V_h^2}\frac{\partial V_h}{\partial \gamma} > 0$$

since $\partial\bar{\beta}/\partial\gamma > 0$ by Corollary 2. If $G(\beta)$ is uniform, we have after some algebra

$$\begin{aligned}\frac{d}{d\gamma}R_U &= -\left(1 - \frac{V_0}{V_h}\right)\frac{\partial}{\partial\gamma}\bar{\beta} + \bar{\beta}\frac{\partial}{\partial\gamma}\frac{V_0}{V_h} \\ &= \left(\frac{1-m}{m}\right)\left(1 - \frac{V_0}{V_h}\right) - \bar{\beta}\frac{V_0}{V_h^2}\frac{\partial}{\partial\gamma}V_h,\end{aligned}$$

so that $\partial R_U/\partial\gamma < 0$ is equivalent to

$$m > \frac{1}{1 + \frac{1}{\gamma}\left(1 - \frac{K-(1-m)(1-\gamma)W}{mW}\right)\left(\mu_0 h + (1-\mu_0)\,(1-\gamma)\,l\right)}.$$

B Institutional Background and Additional Analysis

B.1 Institutional background

SPACs are a novel form of blank-check companies. First, a sponsor raises money via an IPO by selling "units," which are sold at a fixed price (usually \$10) and typically consist of 1 redeemable share bundled with warrants or rights to additional shares. Importantly, 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 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. This strategy is a strict arbitrage: by simply redeeming all shares, the investor receives his money back and keep warrants with non-negative value.

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. If many investors redeem their shares, the 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.

B.2 Costly attention by unsophisticated investors

In the main model, we have assumed that unsophisticated investors' cost of information acquisition is infinite. In this section, we generalize this assumption. The following proposition characterizes the equilibrium for general values of c_U.

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 (19).

(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 $c \in \left[c\left(\bar{\beta}\right), \bar{c}\right]$ *the optimal contract 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

$$\Pi\left(\bar{\beta}\right) = \frac{P}{P_0} = \frac{(1-q)\,V_l}{(1+r)\,V_0}\frac{W}{W\,(1-q)-c} = \frac{W}{W-\bar{\beta}c}. \tag{39}$$

The result is intuitive. When the attention cost to unsophisticated investors is sufficiently high (i.e., $c > \bar{c}$), then these investors do not pay attention 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 pay attention 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 4.2.2). 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 Δ_U is defined in Equation (5). In this case, the optimal contract with redeemable shares ensures that unsophisticated investors are indifferent between paying attention 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 (39), 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 investment is more opaque, i.e., c is larger, unsophisticated investors earn lower returns, while sophisticated investors earn higher returns.

B.2.1 Proof of Proposition 6

Consider the equilibrium with redeemable shares (in Proposition 4). Plugging the optimal contract into Equation (5) implies that unsophisticated investors do not pay attention 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 pay attention 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 (19).

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 β. 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 (3) 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. Paying attention to information is indeed optimal (Equation (5)) whenever

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

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 (3) 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 pay attention, i.e. Condition (40) 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 pay attention is suboptimal and the sponsor prefers to sell non-redeemable shares instead.

Next, consider a contract in which $c < \bar{c}$, such that investors do not pay attention. Given financing constraint (19) and marginal investor $\bar{\beta}$ (where $\bar{\beta}$ is determined by the financing constraint (19)), the price is again determined by Equation (20). Then, unsophisticated investors indeed do not pay attention whenever

$$W\left(1-q\right)\frac{\left(1+r\right)V_0 - V_l}{\left(1+r\right)V_0 - \bar{\beta}\left(1-q\right)V_l} \leq c, \tag{41}$$

which follows from plugging the optimal price into Equation (5). 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 pay attention when the sponsor offers redeemable shares, i.e. Condition (41) 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 (3) and (41) both tighten as r increases. Whenever $c < \bar{c}$, condition (41) binds, and the IC constraint (3) is slack. Thus, r is given by

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

so that

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

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 $c \geq c\left(\bar{\beta}\right)$. Then, using the financing constraint (19), 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.3 Private investment in public equity

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. Specifically, we assume that the PIPE investor can observe the 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 ϕ of her shares to the PIPE investor, or (ii) raise additional, external financing at a cost $L\,(C)$, which is strictly convex and satisfies $L'\,(C) \geq 1$. Here, C captures the amount of cash that is available to the sponsor from sources other than selling units. We assume that C is exogenous to the model, due to some (unmodeled) financial constraints. Since the sponsor offers a fraction of her stake, the total number of shares issued $s \equiv 1 + E\,(1+r)$ remains unchanged, which keeps the analysis tractable - however, economically, this is equivalent to issuing new shares to the PIPE investor. 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. (2023) 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 (19) changes to:

$$\left((1-m)(1-\gamma)+m\left(1-G\left(\bar{\beta}\right)\right)\right)W+C=K. \tag{42}$$

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 over-pricing against the cost of higher dilution from the PIPE investor. The optimal choice is characterized by the following proposition.

Proposition 7. *Suppose that $G'(\beta)$ is strictly increasing. Then, when μ_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 (42). The sponsor's optimal value is given by*

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

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 (25). 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 $G'(\beta)$ 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 γ (which leads to more redemptions) implies that the sponsor must raise more capital, all else equal, and so C increases.

B.3.1 Proof of Proposition 7

In the financing constraint (42), $C = 0$ corresponds to the baseline model (see Equation (19)). The case $C = \gamma(1-m)W$ corresponds to the sponsor raising just enough cash to cover redemptions, while $C = \bar{C} \equiv K - (1-m)(1-\gamma)W$ 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. Essentially, all derivations are the same, except that Equation (19) is replaced with Equation (42). Comparing these two equations, the case $C > 0$ is isomorphic to the baseline model with $\hat{K} = K - C$.

Plugging this optimal contract into the sponsor's value yields

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

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 (42), 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 $L(C)$ is convex, the sponsor's objective is concave as well. Thus, the optimal value of C is determined by the first-order condition

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

Whenever μ_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 $d^2U_F/dCdm < 0$.

B.4 Redemption mechanics

In this section, we characterize how are results are affected when redemptions reduce the number of outstanding shares. Consider the equilibrium of Section 4.3 in which investors redeem their shares when $x = l$ and keep them when $x = h$, and the project is financed for $V = h$ and $V = l$.[17] How many shares outstanding remain depends 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 (21), we can simplify this expression to

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

Anticipating this, 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 β 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 β, so that all unsophisticated investors with $\beta \geq \bar{\beta}$ participate, and $\bar{\beta}$ is again determined by the financing condition (19). 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 (22), we can reduce the financing conditions and type $\bar{\beta}$'s participation constraint to

$$\frac{E}{1-\bar{\beta}+\bar{\beta}q}\left(\mu_0\frac{(1+r)h}{1+E(1+r)} + (1-\mu_0)\,l\,\frac{1+r-\bar{\beta}(1-\gamma)}{1+\frac{E}{\Lambda(\bar{\beta})}+Er}\right) = \Lambda(\bar{\beta})K. \tag{43}$$

[17] The analysis for the equilibria in which investors always (never) redeem their shares is analogous.

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 (3) is now

$$\frac{\mu_0}{q}\frac{h}{s_h} + \left(1 - \frac{\mu_0}{q}\right)\frac{l}{s_l} \geq P. \tag{44}$$

Thus, the sponsor's problem becomes

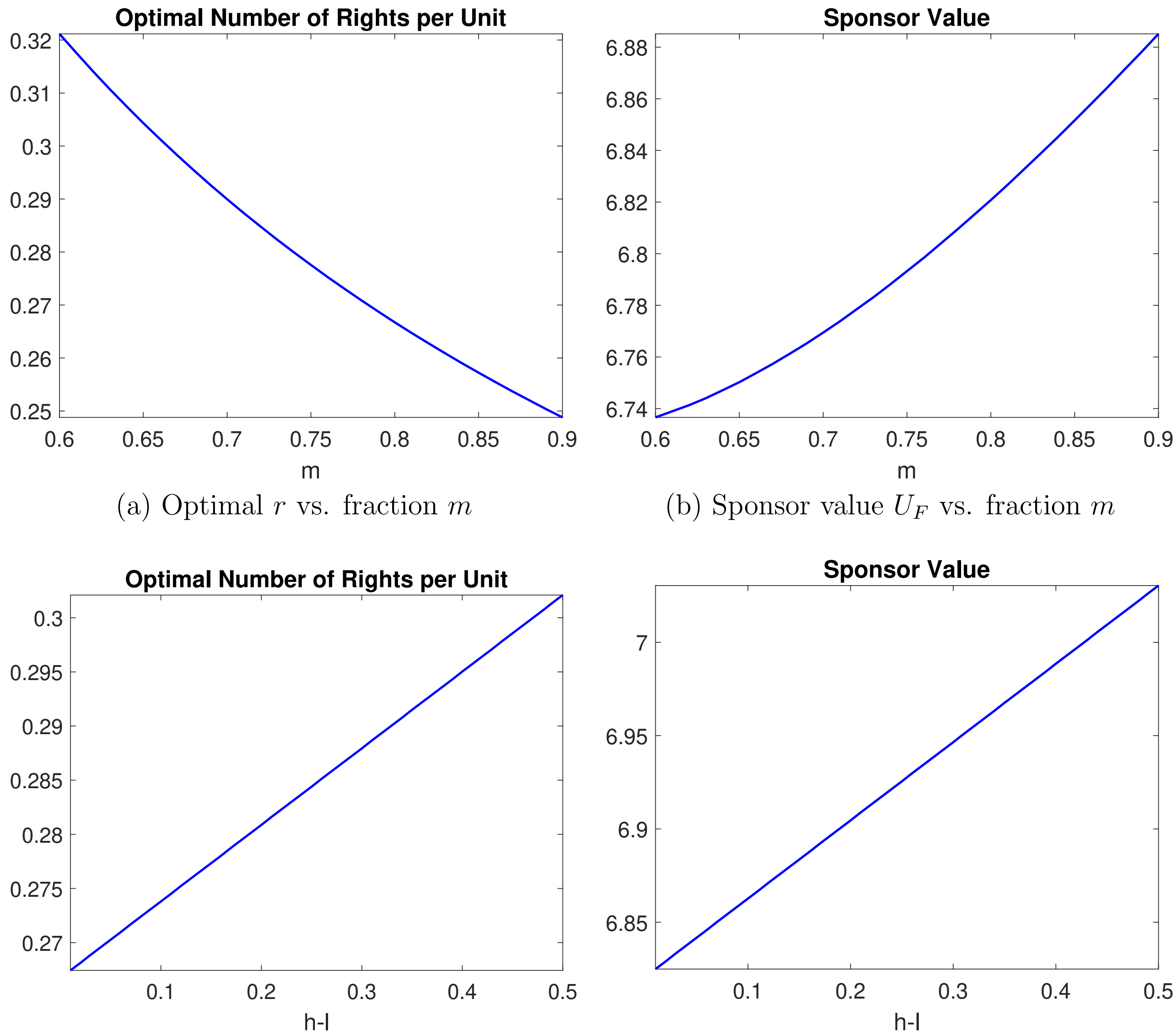
$$\max_{(E,r)} \mu_0 \frac{h}{s_h} + (1 - \mu_0)\frac{l}{s_l}$$

subject to Equations (43) and (44). Equation (43) 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 (43) 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, and we illustrate the results in Figure 2. The figure shows that issuing a positive number of rights is optimal for the given parameter values and that selling units which consist of redeemable shares and rights yields a higher value than selling straight equity for the sponsor.

B.5 Warrants

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 investment. Moreover, we assume that while the sophisticated investors optimally choose whether or not to exercise their warrants and whether to redeem shares conditional on their signal x, unsophisticated investors do not exercise their warrants and do not redeem their shares. To ease comparison with the benchmark model, we consider equilibria in which sophisticated investors keep their shares and exercise their warrants if $x = h$ and redeem



(a) Optimal r vs. fraction m

(b) Sponsor value U_F vs. fraction m

(c) Optimal r vs. spread $h-l$

(d) Sponsor value U_F vs. spread $h-l$

Figure 2: Optimal number of rights and sponsor value as a function of the fraction m of unsophisticated investors (panels (a) and (b)) and a mean-preserving spread in payoffs $h-l$ (panels (c) and (d)). Common parameters (unless changed in the above figures) are: $\mu_0 = 0.5$, $K = 1$, $h = 12$, $l = 1$, $\gamma = 0.75$, and $m = 0.8$. The value from issuing straight equity is $U_F^{NR} = 5.5$ in all panels above.

their shares and do not exercise them when $x = l$. We assume for tractability that warrants are exercised after financing is committed for the project.[18]

Conditional on $V = h$, the shares outstanding are now given by $s_h = 1+E+we_i(1-m)$. Intuitively, each investor purchases $e_i = W/P$ units, and each unit has w warrants attached. Thus, each investor can potentially exercise $e_i w$ warrants. If $V = h$, all sophisticated investors receive signal $x = h$ and exercise their warrants and the unsophisticated investors do not exercise their warrants. Then, the firm receives additional cash flows $we_iX(1-m)$ from investors' warrant exercise. Conditional on $V = l$, the shares outstanding are given by $s_l = 1+E+we_i(1-m)(1-\gamma)$, i.e. a fraction $1-\gamma$ of sophisticated investors receive signal $x = h$ and exercise their warrants, whereas fraction γ receive signal $x = l$ and do not exercise them. The firm receives additional cash flow of $we_iX(1-m)(1-\gamma)$ from warrant exercise in this case. Using Equation (21), we can simplify

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

so that e_i is only a function of E and $\bar{\beta}$. In equilibrium, exercising warrants must be optimal conditional on $x = h$, i.e.

$$X \leq \frac{\mu_0}{q}\frac{h+we_iX(1-m)}{s_h} + \left(1-\frac{\mu_0}{q}\right)\frac{l+we_iX(1-m)(1-\gamma)}{s_l}.$$

Here, μ_0/q is the probability that $V = h$ conditional on $x = h$, and each investor anticipates the impact of other investors' warrant exercise decision on firm value and shares outstanding. Similarly, not exercising warrants must be optimal conditional on $x = l$, i.e.

$$X \geq \frac{l+we_iX(1-m)(1-\gamma)}{s_l}.$$

If X is smaller, then sophisticated investors always exercise their warrants, so that warrants are analogous to rights, and if X is larger, then they never exercise their warrants and the model is equivalent to one where $w = 0$.

[18]Otherwise, the cash flows from exercising warrants affect the financing constraint, which becomes

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

or equivalently

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

so that $\bar{\beta}$ depends on E, X, and w, unlike in the baseline model.

Given future warrant exercise decisions, the per-unit expected payoff to an sophisticated investor is given by

$$U_S = \begin{array}{c} \mu_0 \left(\frac{h + we_i X(1-m)}{s_h} - P \right) + (1-\mu_0)(1-\gamma) \left(\frac{l + we_i X(1-m)(1-\gamma)}{s_l} - P \right) \\ + \mu_0 w \left(\frac{h + we_i X(1-m)}{s_h} - X \right) + (1-\mu_0)(1-\gamma) w \left(\frac{l + we_i X(1-m)(1-\gamma)}{s_l} - X \right). \end{array}$$

Here, the first line represents the investor's expected value from keeping or redeeming shares, and the second line represents his value from exercising warrants or letting them lapse. An unsophisticated investor of type β has expected payoff

$$U_U(\beta) = \beta U_S + (1-\beta) \left(\mu_0 \frac{h + we_i X(1-m)}{s_h} + (1-\mu_0) \frac{l + we_i X(1-m)(1-\gamma)}{s_l} - P \right),$$

since such an investor always keeps his shares and never exercises his warrants. The financing constraint is the same as in the benchmark model, since warrants are exercised after the financing stage, i.e.,

$$(1-m)(1-\gamma) + m\left(1 - G\left(\bar{\beta}\right)\right) = K/W, \tag{45}$$

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

$$E = \left(1 - m + m\left(1 - G\left(\bar{\beta}\right)\right)\right) W/P, \tag{46}$$

which implies

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

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

$$U_U\left(\bar{\beta}\right) = 0, \tag{47}$$

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

$$\begin{aligned} &\frac{\mu_0}{q} \frac{h + we_i X(1-m)}{s_h} + \left(1 - \frac{\mu_0}{q}\right) \frac{l + we_i X(1-m)(1-\gamma)}{s_l} \\ &\geq P \geq \frac{l + we_i X(1-m)(1-\gamma)}{s_l}, \end{aligned} \tag{48}$$

and it is optimal to exercise warrants if and only if $x = h$, i.e.,

$$\begin{aligned}
&\frac{\mu_0}{q}\frac{h + we_iX(1-m)}{s_h} + \left(1 - \frac{\mu_0}{q}\right)\frac{l + we_iX(1-m)(1-\gamma)}{s_l} \\
&\geq X \geq \frac{l + we_iX(1-m)(1-\gamma)}{s_l}.
\end{aligned} \tag{49}$$

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

$$U_F \equiv \mu_0\frac{h + we_iX(1-m)}{s_h} + (1-\mu_0)\frac{l + we_iX(1-m)(1-\gamma)}{s_l},$$

subject to (45), (46), (47), (48), and (49). 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

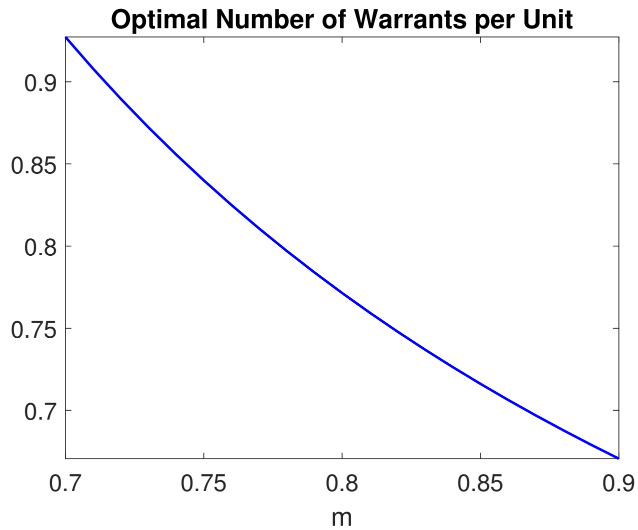
$$X > \frac{\mu_0}{q}\frac{h + we_iX(1-m)}{s_h} + \left(1 - \frac{\mu_0}{q}\right)\frac{l + we_iX(1-m)(1-\gamma)}{s_l}.$$

In this case, the value of the warrant is zero, since warrants are never exercised, 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 (45) and the equilibrium overpricing

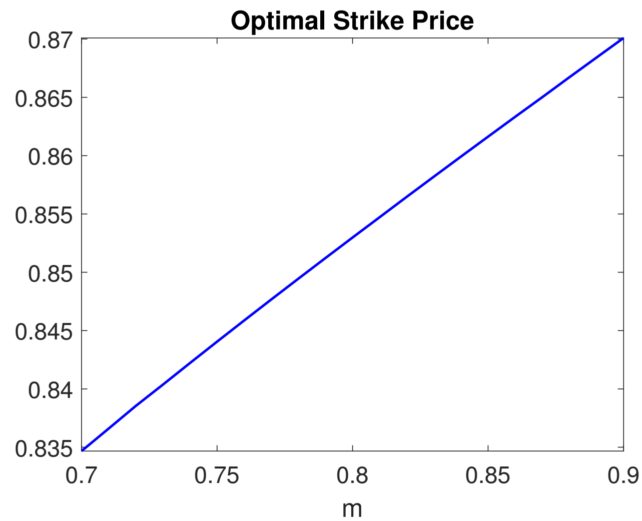
$$\Pi\left(\bar{\beta}\right) = \frac{1 - \bar{\beta}(1-q)\frac{V_l}{V_0}}{1 - \bar{\beta}(1-q)}.$$

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

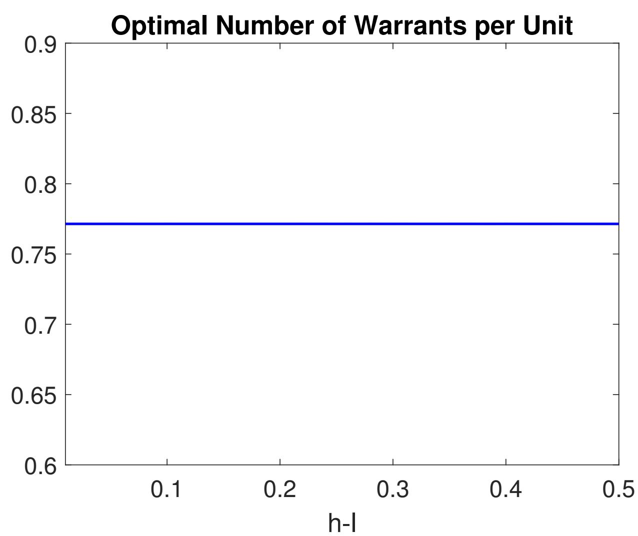
Now, if we relax the constraint so that Condition (49) holds the value of the warrants is no longer zero. However, unsophisticated investors anticipate exercising the warrants ex-ante but do not exercise them ex-post, so they over-value the warrants. When the fraction of unsophisticated investors is large, this makes the sponsor better off by increasing equilibrium overpricing. The numerical illustrations in Figure 3 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.



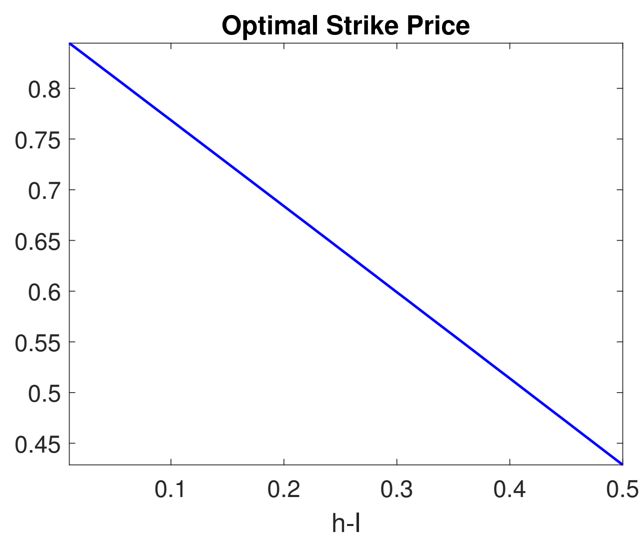
(a) Optimal w vs. fraction m



(b) Strike price X vs. fraction m



(c) Optimal w vs. spread $h - l$



(d) Strike price X vs. spread $h - l$

Figure 3: Optimal number of warrants and optimal strike price as a function of the fraction m of unsophisticated investors (panels (a) and (b)) and a mean-preserving spread in payoffs $h - l$ (panels (c) and (d)). Common parameters (unless changed in the above figures) are: $\mu_0 = 0.5$, $K = 1$, $h = 12$, $l = 1$, $\gamma = 0.75$, and $m = 0.8$.

B.6 Non-redeemable shares

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 information (i.e., the incentive compatibility conditions in (3) and (4) do not apply) and all investors have the same expected payoffs at date $t = 1$, given by

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

In this case, the following result characterizes the equilibrium.

Proposition 8. *If the sponsor can finance the investment using non-redeemable shares, she always finances ex-ante efficient investments. The optimal contract sets $r = 0$, and $P = V_0 - K$, and the value of her stake is*

$$U_F^{NR} = V_0 - K. \tag{50}$$

Proof. The sponsor can ensure that all investors are willing to buy $e_i = W/P$ units by setting the price so that the payoff

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

is non-negative. Otherwise, no investor participates. Thus, the sponsor solves

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

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 proposition characterizes the offered contract. $\square$

Internet Appendix - Additional Analysis

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IA1 Model with Homogeneous Unsophisticated Investors and Sophisticated Investors

In this section, we consider a simplified version of our model in which there is only type of unsophisticated investors. Specifically, suppose that there is a mass m of unsophisticated investors, all with identical type $\beta \in (0,1)$. The mass of sophisticated investors is still given by $1-m$. All other aspects of the model are unchanged.

In this setting, we can find a close analog of Proposition 4.

Proposition 9. *Suppose that* $K \in \left(\left(1-m\right)\left(1-\gamma\right)W, \left(\left(1-m\right)\left(1-\gamma\right)+m\right)W\right)$ *and*

$$V_h > \frac{K}{m+\left(1-m\right)\left(1-\gamma\right)}.$$

Let

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

and

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

(i) If $0 > \max\left\{V_0 - K\Lambda\left(\beta\right)/\Pi\left(\beta\right), \mu_0\left(h-K\right)\right\}$*, then the investment cannot be financed using redeemable shares.*

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

(iii) If $V_0 - K\Lambda\left(\beta\right)/\Pi\left(\beta\right) \geq \mu_0\left(h-K\right)$*, then the investment is financed in both states and the optimal contract sets* $r=\bar{r}$ *where*

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

and the sponsor's optimal value is

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

In particular, $\Pi\left(\beta\right)$, which measures the impact of overconfidence on the cost of financing, is the same as in the baseline model. However, $\Lambda\left(\beta\right)$ is different, because we randomly allocate shares instead of having the marginal type $\bar{\beta}$ ensure that the financing constraint binds. Beyond that, the results are similar.

Proof. First, in the case where the project is financed only if $V=h$, the analysis is identical to the baseline model. Then, $r=0$ and the sponsor's value is given by

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

Since there is only a single type of unsophisticated investor, we must consider two cases (1) the project is financed without unsophisticated investors buying units and (2) the project is financed with unsophisticated investors buying units.

Without unsophisticated investors, it must hold that

$$\beta \left(\frac{(1+r) qV_h + r(1-q) V_l}{1+E(1+r)} - Pq \right) + (1-\beta) \left(\frac{1+r}{1+E(1+r)} V_0 - P \right) \leq 0, \tag{IA1}$$

i.e. buying units is indeed suboptimal for those investors (this is the same equation as Equation (12) in the main model). We must distinguish two cases (i) sophisticated investors never redeem shares or (ii) sophisticated investors redeem shares when $x=l$.

Suppose that sophisticated investors never redeem shares. Then, the optimal price satisfies

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

But then, we can show that the value from buying shares to unsophisticated investors is strictly positive, by plugging in P into the Inequality (IA1). Thus, we have a contradiction.

Suppose instead that sophisticated investors redeem shares when $x=l$. Financing is feasible whenever

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

In the case that the constraint is slack, assume that units are allocated randomly between sophisticated investors (so that each investor has the same probability of receiving units), so that the financing constraint binds. The optimal price is given by

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

as in the baseline model. Plugging in P into Inequality (IA1), implies that unsophisticated investors do not participate whenever

$$rV_0 + (1-\beta)(V_0 - V_h) \leq 0. \tag{IA2}$$

In particular, this inequality holds at $r=0$. Given the price P, the sponsor's value is given by

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

which implies that setting $r = 0$ is optimal. Thus, the sponsor's value becomes

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

Now, consider the case where unsophisticated investors participate. Suppose that sophisticated investors never redeem shares. Then the financing condition is simply given by

$$W \geq K,$$

and we have

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

As in the previous case, if the financing constraint is slack, we allocate shares randomly between investors with equal probability. Setting $r = 0$ is optimal without loss of generality, because no investor redeems in equilibrium so that shares and rights are equivalent. Then, the sponsor's value is given by

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

Finally, suppose that unsophisticated investors participate and that sophisticated investors redeem shares when $x = l$. Then, financing is feasible if

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

and the optimal price is

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

Now, the sponsor must set $r > 0$ to that unsophisticated investors participate. In particular, she optimally sets r to make Equation (IA2) bind, which yields

$$r = (1-\beta)\frac{V_h - V_0}{V_0}.$$

Note that this is the same expression as in the baseline model. Then, we have,

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

i.e. given E units are issued, after redemptions the financing constraint binds. A similar calculation as in the baseline model yields

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

and

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

where

$$\Pi(\beta)=\frac{V_h}{V_0\beta+(1-\beta)V_h}$$

and

$$\Lambda(\beta)=\frac{1}{m+(1-m)(1-\gamma)}.$$

□

The model with a single unsophisticated type yields a similar optimal unit structure for the sponsor, but it differs in the following results: (1) there is no notion of "investor composition" and no comparative statics about who participates in SPACs, (2) the fraction of sophisticated investors m has (locally) no effect on returns,[19] (3) restricting investor access does not change returns of participating unsophisticated investors, (4) removing rights leads all unsophisticated investors to stop participating, and (5) mandating greater disclosure cannot improve returns.

IA2 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 sponsor.

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 investment is financed when the investor chooses action $k\in\{0,1\}$ and the investment 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 the payoff contingent on k (and therefore on x), i.e. the sponsor can choose $p_V^k=p_V^{k'}$ for all

[19] This, however, is driven by having binary payoffs and binary signals. In a model with continuous payoffs and signals, m would have a local effect even when unsophisticated investors are homogeneous.

$V \in \{l, h\}$ 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.

$$\frac{\mu_0}{q} p_h^1 + \left(1 - \frac{\mu_0}{q}\right) p_l^1 \geq \frac{\mu_0}{q} p_h^0 + \left(1 - \frac{\mu_0}{q}\right) p_l^0 \tag{IA3}$$

and

$$p_l^0 \geq p_l^1. \tag{IA4}$$

We maintain the inertia assumption from the baseline model, i.e. when unsophisticated investors do not pay attention, they choose $k = 1$. The perceived value of investor type β 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 naïveté. Type β 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

$$1 - m + m \left(1 - G\left(\bar{\beta}\right)\right) = \frac{K}{W}. \tag{IA5}$$

Since the sponsor can condition payments on both k and V, she can trivially circumvent the interim financing condition (11). 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 (27). 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 investment 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

$$\frac{p_h^1}{P}\leq\frac{h}{K}\tag{IA6}$$

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

$$K\frac{p_1^l}{P}+\frac{W}{P}\left(1-m\right)\gamma\left(p_l^0-p_l^1\right)\leq l.\tag{IA7}$$

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 (IA3), (IA4), (IA5), (IA6), and (IA7).

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 10. *The optimal contract is as follows. If $K\bar{\beta}>\left(1-m\right)W$, then the optimal contract sets $p_h^1=p_l^1=0$ and $p_l^0>0$, and the investment 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 (IA6) and (IA7) hold and the investment 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 sponsor 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 from 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.

IA3 Overconfidence about target value

We now characterize the case when investors are overconfident about the value of the target, but not about their cost of paying attention. Then, the optimal contract features non-redeemable shares. Thus, our main results cannot be obtained in such a setting.

We maintain all modeling assumptions of Section 3, except the following changes. Both sophisticated and unsophisticated investors correctly anticipate their cost of paying attention. However, unsophisticated investors overestimate the value of the target at the IPO stage. Specifically, there is again a continuum of types $\beta \in [0,1]$, with $\beta \sim G(\beta)$, so that type β believes that the probability that $V = h$ is given by

$$\mu(\beta) \equiv \beta + (1-\beta)\,\mu_0.$$

Sophisticated investors correctly estimate the probability that $V = h$, and believe that this probability is μ_0.

Since unsophisticated investors correctly anticipate their attention cost, it immediately follows that the optimal contract features non-redeemable equity. Otherwise, the option to redeem generates rents for investors which reduce the sponsor's value. In equilibrium, only unsophisticated investors participate, since they overvalue shares and are willing to pay a higher price. The following proposition establishes these results.

Proposition 11. *When investors are overconfident about target value, the optimal contract* *features straight equity. Whenever m is sufficiently large, only unsophisticated investors participate in the IPO and we have $P > V_0$.*

Proof. Since unsophisticated investors correctly anticipate that $c = c_U$, investor type β buys units if and only if

$$P \leq (1+r)\frac{\mu(\beta)h + (1-\mu(\beta))l}{1+E(1+r)}.$$

Suppose that the sponsor sells non-redeemable shares. Then, if only unsophisticated investors $\beta \geq \bar{\beta}$ participate, the financing condition is given by

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

and combining this condition with $EP = W$ yields

$$EP \geq \frac{K}{m\left(1 - G\left(\bar{\beta}\right)\right)}.$$

Then, the sponsor's problem becomes

$$\begin{aligned} U_F &= \max_{E,r,P} \frac{1}{1+E(1+r)}V_0 \text{ subject to} \\ EP &\geq \frac{K}{m\left(1-G\left(\bar{\beta}\right)\right)}, \text{ and} \\ P &\leq (1+r)\frac{\mu\left(\bar{\beta}\right)h + \left(1-\mu\left(\bar{\beta}\right)\right)l}{1+E(1+r)}. \end{aligned}$$

Without loss of generality, this contract features $r = 0$, and plugging in

$$P = \frac{\mu\left(\bar{\beta}\right)h + \left(1-\mu\left(\bar{\beta}\right)\right)l}{1+E}$$

yields

$$\frac{1}{1+E}V_0 = \frac{K}{m\left(1-G\left(\bar{\beta}\right)\right)\left(\mu\left(\bar{\beta}\right)h + \left(1-\mu\left(\bar{\beta}\right)\right)l\right) - K}V_0$$

and hence the sponsor's problem becomes

$$U_F = \max_{\beta\in[0,1]} \frac{K}{m\left(1-G\left(\bar{\beta}\right)\right)\left(\mu\left(\bar{\beta}\right)h + \left(1-\mu\left(\bar{\beta}\right)\right)l\right) - K}V_0.$$

If both sophisticated and unsophisticated investors participate, it must be the case that

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

Again, setting $r = 0$ is optimal without loss of generality, so that

$$P = \frac{1}{1+E} V_0.$$

The financing condition becomes

$$EP \geq K,$$

since given the price all unsophisticated investors participate. Then, the optimal value is given by

$$U_F = V_0 - K.$$

Since $\mu\left(\bar{\beta}\right) h + \left(1 - \mu\left(\bar{\beta}\right)\right) l > V_0$ for all $\beta > 0$, whenever m is sufficiently large, we have

$$\max_{\beta \in [0,1]} \frac{K}{m\left(1 - G\left(\bar{\beta}\right)\right)\left(\mu\left(\bar{\beta}\right) h + \left(1 - \mu\left(\bar{\beta}\right)\right) l\right) - K} V_0 \geq V_0 - K.$$

Finally, we compare redeemable and non-redeemable shares. If only unsophisticated investors participate, then offering redeemable shares yields the same payoff as offering non-redeemable shares, since these investors never redeem. If both unsophisticated and sophisticated investors participate, offering redeemable shares leaves the sponsor with a strictly smaller payoff, since sophisticated investors earn rents from their ability to redeem. Thus, offering non-redeemable shares is optimal. □

IA4 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 (26), 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 (19) no longer pins down the marginal investor type. To see why, suppose the marginal investor $\bar{\beta}$ is determined by Equation (19) 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 (3) 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 (3) binds so that

$$P = \frac{V_h}{1 + E(1+\bar{r})}. \tag{IA8}$$

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

$$\frac{(1+\bar{r})V_0 - V_h + \beta(1-q)(V_h - V_l)}{1 + E(1+\bar{r})} \geq 0 \tag{IA9}$$

for all unsophisticated investors who participate. Since the above expression is increasing in β, 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 (19) is slack, the sponsor randomly rations shares to raise exactly $\Lambda\left(\tilde{\beta}\right)K$, so the investment is financed. In equilibrium, this implies

$$E = \frac{\Lambda\left(\tilde{\beta}\right)K}{P} = \frac{K\Lambda\left(\tilde{\beta}\right)}{V_h - K\Lambda\left(\tilde{\beta}\right)(1+\bar{r})}. \tag{IA10}$$

Overall, the equilibrium is now determined by Equations (IA8), (IA9), and (IA10). 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 $\bar{r}$. 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 investment 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 $Q(\beta)$ in Equation (29) is sufficiently flat in β (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.