The Incentives of SPAC Sponsors*

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Abstract

The market of Special Purpose Acquisition Companies (SPACs) has exploded in recent years, yet its volatile performance calls into question the implications of the unique business model and particularly the incentives of the SPAC sponsors on the welfare of retail SPAC investors. This paper quantitatively studies these questions by estimating a model featuring the strategic interactions between SPAC sponsors, targets, and investors. The estimation uses a comprehensive hand-collected dataset of all SPACs registered to go public between 2009 and 2019 with rich information such as sponsor concessions, earnouts, redemptions, etc. Agency costs appear to be pervasive: on average, there is an 18% difference in expected returns between deals in the bottom quintile of agency costs and those in the top quintile. The average SPAC investor also makes imperfect inferences of the underlying deal value, leading them to earn a 4.3% lower return. These results shed light on the ongoing debate over the viability and validity of the SPAC as an alternative to the traditional IPO, as well as the risks that retail investors may be exposed to when investing in SPACs.

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1 Introduction

Special Purpose Acquisition Companies (SPACs) have exploded in popularity in recent years. Created for the sole purpose of merging with a private company and taking it public, these publicly-traded blank-check companies were once touted as the "hottest thing in finance" (*Wall Street Journal*, Jan 23rd, 2021) and have seemingly taken Wall Street by storm. In the last two years alone, there were 861 SPAC IPOs (more than two-thirds of all IPOs) in the US raising close to $220 billion of new capital. Yet, as the broader equity market took a nose-dive in 2022, many investors who clamoured to join the SPAC frenzy suddenly found themselves reeling from even steeper losses. Moreover, the roller coaster ride of SPACs has drawn intensified scrutiny from regulators. Citing "heightened concerns about various aspects of the SPAC structure", the US Securities and Exchange Commission (SEC) has proposed a series of regulatory measures aimed at enhancing the protections for SPAC investors. However, as the SEC noted in its proposal, "in many cases, we are unable to quantify the relative magnitudes of various economic effects because we lack information to quantify such effects with a reasonable degree of accuracy."[1]

This paper aims to close that gap by providing a comprehensive quantitative analysis of the main economic frictions in the SPAC market. The manager of the SPAC, known as the sponsor, is delegated the responsibility of identifying a merger target and negotiating the terms of a possible deal. The sponsor then proposes a deal to the SPAC's investors, who get an up-or-down vote on the proposed deal, as well as an opportunity to redeem their shares for approximately the IPO price. If the deal is approved, the target takes over the SPAC's listing on the stock market, in what has come to be known as the "de-SPAC". This unique business model provides a useful laboratory for answering one of the fundamental questions in finance: the impact of asymmetric information and agency frictions on the welfare of investors. First, the sponsors, usually hedge fund or private equity managers, are likely far more informed about the true value and prospects of the target than are outside investors. Second, the sponsors and investors may have divergent incentives for completing a deal. When the SPAC is formed, the sponsor buys

[1] Special Purpose Acquisition Companies, Shell Companies, and Projections, RIN 3235-AM90, Securities and Exchange Commission, March 30, 2022

a large stake, known as the sponsor's "promote", at a nominal cost.[2] This "promote" represents the primary compensation for the sponsor and can imply big payoffs in many circumstances but also some potential blow-back. In particular, for deals that perform poorly after the de-SPAC, the sponsors are likely to still receive a windfall in the form of their promote shares while the SPAC investors suffer substantial losses. In contrast, if the SPAC cannot complete a deal within the allotted time (usually two years after its IPO), the SPAC is liquidated, returning its capital to outside investors, and leaving the sponsors with essentially nothing.

A recent lawsuit involving the SPAC, Churchill III (Ticker: CCXX), and its target Multiplan (Ticker: MPLN) highlights these frictions. MPLN is a leading healthcare payment processor with 40 years of operating history, more than 1 billion dollars of annual revenue, and a solid base of clients including major health insurance providers such as UnitedHealth. CCXX proposed to acquire MPLN, resulting in a public listing for MPLN following the de-SPAC. The proposal received the approval of the overwhelming majority of CCXX investors. Shortly after the deal closed, however, news emerged that UnitedHealth was developing an in-house substitute for the MPLN product over the coming quarters, which could result in an estimated 35% decline in MPLN's free cash flows. MPLN shares dropped precipitously following the announcement of this news. The original CCXX investors subsequently filed a lawsuit, alleging that the CCXX sponsor, long-time Citigroup executive Michael Klein (as well as the original MPLN management), was aware of this critical information yet intentionally withheld it from investors, pushing the deal through in order to reap a fortune for himself.[3]

CCXX-MPLN, along with a series of other notable cases involving high-profile SPACs and their targets (e.g., Nikola, Lucid Motors, Digital World Acquisition Corp, etc.), exemplify the pressing need for a deeper understanding of the various economic forces in the SPAC market, in the interest of the investors and regulators, not to mention academic researchers. Based on structural estimations using hand-collected, comprehensive data on SPACs and their targets over a long horizon (2009-2019), this paper aims to quantify

[2]SPAC sponsors usually pay just $25,000 for a stake engineered to be 25% of the SPAC's IPO shares, compared to the average hundreds of millions of dollars raised from SPAC shareholders.

[3]When CCXX was created the sponsor purchased 27,500,000 shares for $25,000, less than $0.001/share. Even at a price of $5/share, this stake still has substantial value, while SPAC shareholders who bought in around the IPO price ($10) or more would have lost at least 50%.

the impact of these two primary frictions in the SPAC market: the extent and magnitude of the agency costs associated with the compensation structure of SPAC sponsors, and the lack of information transparency and its impact on the redemption decisions of SPAC investors, and, ultimately, on their returns from SPAC investments. To do so, we model the interaction between SPAC sponsors and SPAC investors surrounding a proposed business combination. In our model, a SPAC sponsor identifies a target company, whose owners have a reservation price for the business. The SPAC sponsor can increase the value of the target business by supplying cash and offering a public listing for the target, as well as other intangible benefits. We assume that the sponsor and target owner are equally informed about the target's future prospects, as well as the benefits that the SPAC's cash and associated public listing can bring to the target, and they split this surplus via bargaining. They negotiate deal terms that specify the eventual sponsor stake, the offer made to the target, and any additional capital that needs to be raised externally. SPAC investors, on the other hand, cannot directly observe deal quality and have to infer their associated expected returns based on the announced deal terms. They decide whether to redeem their shares at face value (and earn a risk-free return) or see through the business combination and retain their ownership in the de-SPACed firm. If SPAC investors perceive dim prospects for a proposed deal, they are likely to redeem their shares, and a large number of redemptions may put deal consummation at risk.

Our model characterizes the sponsor's optimal choice of deal terms and the SPAC investors' optimal redemption decision, taking into account the strategic interaction between them. The sponsor trades off sweeter deal terms that favor himself (but hurt SPAC investors) against an increased risk of deal failure due to intensified redemption associated with such terms. If the sponsor anticipates that the risk of deal failure overwhelms the benefits of reaping additional dollars in a completed deal, he can design deal terms that are more favorable to SPAC investors, potentially tipping the scales against redemption. Specifically, the sponsor can alter the value he places on the target business, by issuing fewer SPAC shares to the target owners. As he does so, he may also have to forfeit a portion of his own compensation as the bargaining protocol forces the target and the sponsor to share the cost. Finally, the sponsor can recruit additional investors via Private Investment in Public Equity (PIPE), allowing those investors to share in the spoils associated with any completed deal. Attracting such smart money can also have the added benefit of reassuring SPAC investors of a proposed deal's quality. SPAC investors, on the other hand, calculate their expected returns from the proposed deal based on imperfect information, because they cannot observe the true deal fundamentals and thus have to infer them from the announced deal terms.

In the benchmark case with perfect information, our model suggests that only value-enhancing deals can complete, and the sponsor designs the deal terms that make the SPAC investors indifferent between redeeming and staying. When information is asymmetric, however, a pooling equilibrium emerges in which deal terms are merely partially-revealing of deal fundamentals. As the SEC noted in its proposal "As a result of the complexity inherent in the SPAC structure, investors may lack or otherwise be unable to readily decipher critical information regarding certain financial incentives (such as contingent sponsor or IPO underwriter compensation or the potential dilutive effects of PIPE financing) of the SPAC, the target company, their respective affiliates, or other parties in a manner necessary to properly assess the value of an investment position." Indeed, in the equilibrium of our model, some value-destroying deals may complete while some value-enhancing deals may be abandoned. SPAC investors can make severe mistakes that result in sizeable losses in some deals, while in others, they may reap positive returns. The sponsor's agency cost and the information frictions faced by SPAC investors are the key determinants of the overall efficiency of the SPAC market and the value split among the different participants.

To gauge the quantitative implications, we bring the model to the data. We assemble a comprehensive dataset of SPAC and deal characteristics on all US-listed SPACs that filed for a listing since the 2008 financial crisis through 2019 (230 in total). One signature of our data that differentiates our work from previous studies is that it contains detailed terms regarding sponsor compensation (forfeited promote shares and private placement warrants, as well as sponsor and target earn-outs), external financing brought in by the sponsors (e.g., FPA, PIPE, etc), shares and cash offered to the target shareholders, and the aggregate redemption by SPAC investors. Though most previous studies have focused on SPAC returns, our data allow us to answer questions related to agency cost and information frictions. To our knowledge, this paper is the first to construct and estimate a viable model of SPACs with these frictions. Our goal is to quantify the agency cost of sponsors inherent in the SPAC structure as it exists in by far its most common form. Additionally, we hope to gain an understanding of why SPAC investors refrain from redeeming shares even when conflicting interests with sponsors are obvious and some deals are quite bad ex-post.

In the model, as in the data, redemption is negatively correlated with ex-post deal performance. This is a manifestation of SPAC investors being able to partly infer deal quality based on observed deal terms. The sensitivity of SPAC investors' redemption rate to the ex-post deal performance helps us pin down a key parameter that controls the magnitude of information asymmetry in the model. The empirical distribution of the sponsor's compensation scheme disciplines our estimate of the sponsor's agency cost in the cross-section. Intuitively, sponsors with low agency cost internalize the interest of SPAC investors to a greater extent and therefore are more likely to forfeit part of their compensation as needed. We calibrate the model by searching for the set of parameters that minimize the distance between the model-implied moments and the empirical moments constructed from the data. Our calibrated model fits the data very well. Specifically, the model is able to closely match the empirical distribution of deal terms, including the sponsor's compensation, the offer made to the target, and the external capital raised. The model is also able to reproduce the empirical patterns of cash retained in the SPAC firm, aggregate redemptions by SPAC investors, and ex-post deal performance.

Our estimates yield a few novel findings. First, agency cost is pervasive in the data: the empirical distribution of agency cost across different sponsors is best captured by a uniform distribution. For the average deal, it is therefore quite difficult to infer, ex-ante, the extent to which the sponsor cares about SPAC investors. Second, information asymmetry is substantial and it results in sizeable forecast errors in the SPAC investors' inference, which accounts for 16% of the cross-sectional variation in the realized deal value. Information asymmetry arises from two main sources: first, deal value is not fully revealed in a pooling equilibrium, explaining about half of the forecast errors. Second, SPAC investors are unable to extract all the information embedded in the observed deal terms, rendering their conditional expectation of the deal value imperfect. This accounts for the other half of the forecast errors.

Using the calibrated model as a laboratory, we quantify the effect of agency costs and information asymmetry on the welfare of SPAC investors. Comparing the deals in the lowest agency cost quintile against those in the highest agency cost quintile, we find that the difference of the SPAC investors' expected return averages 18 percentage-points. This large difference is a joint consequence of more low-value deals being pushed through and a larger fraction of the combined firm value accruing to the sponsor and target. In other words, in deals with greater agency costs, SPAC investors tend to subsidize the sponsor and the target, especially when the deal quality is low.

To gauge the effect of information asymmetry, we create a hypothetical investor who can extract all information from the observed deal terms but is otherwise subject to the same information constraints as a regular SPAC investor.[4] Comparing the expected returns of this hypothetical investor with those of his more naive peers reveals the improvement one can gain by eliminating any information frictions related to imperfect expectations. We find that this hypothetical investor earns a 4.3 percentage-point higher return on average. This improved performance derives primarily from avoiding bad deals. Specifically, the hypothetical investor is more likely to redeem his shares when ex-post performance is poor, which happens in 44% of deals (i.e., the extensive margin), and the conditional gain from avoiding these deals averages 9.3 percentage-points of realized returns (i.e., the intensive margin). The hypothetical investor's redemption decision responds more strongly to deal quality when compared with his more naive peers.

Our paper contributes to the growing body of research on SPACs. Earlier studies of this topic include Lewellen (2009), Jenkinson and Sousa (2011), Cumming, Haß, and Schweizer (2014), Rodrigues and Stegemoller (2014), Chatterjee, Chidambaran, and Goswami (2016), Kolb and Tykvova (2016), Dimitrova (2017), etc. These studies explore various aspects of SPACs, in particular, their performance and the key determinants, but they are typically constrained by a limited sample size. The recent surge in SPAC activity has inspired new work such as Blomkvist and Vulanovic (2020); Klausner, Ohlrogge, and Ruan (2020); Dambra, Even-Tov, and George (2021); Gahng, Ritter, and Zhang (2021); Lin, Lu, Michaely, and Qin (2021), etc. These studies add substantial new insights to

[4]We do not assume that this hypothetical investor can observe the deal fundamentals, because it is less realistic to impose perfect information environment in the real world.

the existing literature on SPACs, thanks to the exploding number of new observations in the last two years. Meanwhile, a few theoretical studies, notably, Bai, Ma, and Zheng (2021), Banerjee and Szydlowski (2021), Gryglewicz, Hartman-Glaser, and Mayer (2021), and Luo and Sun (2021) examine the various mechanisms related to the choice of SPAC, either from the sponsor's point of view (compared to private equity or venture capital), or from the target firm's point of view (compared to traditional IPOs). In particular, Gryglewicz, Hartman-Glaser, and Mayer (2021) and Luo and Sun (2021)) consider the potential conflict of interests between sponsors and SPAC investors. We contribute to this burgeoning literature by quantifying the degree of the agency frictions and their associated losses to investors, both on the extensive margin and on the intensive margin. We also quantify the welfare gain of investors if they can more precisely gauge deal fundamentals based on observable deal terms.

Our paper is also related to the literature that estimates the effect of information frictions and/or the magnitude of agency cost through the lens of economic models. David et al. (2016) develop and estimate a model to quantify the losses in aggregate productivity and output due to informational friction, and they find that information friction results in substantial resource misallocation and drags down productivity by 7-14%. Celik et al. (2021) document sizeable information frictions between acquiring firms and target firms, and they estimate that eliminating such friction is expected to increase the capitalized gains from mergers and acquisitions by as much as 60%. Nikolov and Whited (2014) investigate how different types of agency conflicts shape corporate cash policies. Albuquerque and Schroth (2015) use trades of controlling blocks of U.S. public corporations to estimate the value of control and the cost of illiquidity in this market. Wang and Wu (2020) estimate both the dark-side and bright-side of managerial control benefits in the takeover market. Our paper contributes to this literature by focusing on the SPAC market. This market is unique in its structure and differs much from the traditional IPO market and takeover market, better thought of as a hybrid of the two. Despite abundant anecdotal evidence on opaque information and conflict of interests, little is known regarding the magnitude of agency cost and the effect of information friction in this market. Our paper aims at filling this gap by providing a quantitative assessment of these frictions.

2 An Overview of the SPAC Mechanism

A special purpose acquisition company (SPAC), sometimes called a blank check company, is formed as a shell company. SPACs go public without any formal operations, with the sole goal of eventually making an acquisition of a private company, which then takes over the SPAC's listing, thereby listing their shares. The managers of the SPAC, known as the sponsors, file a registration statement with the SEC (Form S-1) that lays out the management structure, the financial structure, and the goals of the SPAC. The SPAC engages an underwriter(s) for the purposes of going public as a shell company via a firm commitment IPO. The underwriter's fee is split between a fixed portion and a contingent portion, with the latter being the larger piece. At the time of the IPO, the SPAC sponsors must pledge that no prior negotiations have taken place with prospective acquisition targets, though the SPAC often has a designated target industry(ies) and/or regional focus.

SPACs go public as units rather than shares. The structure of units since 2009 is near uniform and is typically as follows: Units are priced at $10 each and consist of shares and fractional out-of-the-money warrants and/or fractional rights. Warrants are typically struck 15% out of the money (which means $11.50 for all but a few cases) and if rights are included, a unit will include the right to acquire 0.1 shares. Warrants are typically redeemable under certain conditions, forcing exercise, and otherwise expire five years after the completion of a business combination, while rights are converted into shares at the time of the business combination.

One of the unusual features of a SPAC is that it places essentially the entire proceeds from the IPO in a trust that the sponsors are unable to touch until they successfully complete an acquisition of sufficient size (called a "business combination") or they decide to liquidate. The SPAC has a limited time frame within which to complete a business combination (usually 12-24 months), and any proposed business combination must be approved by SPAC shareholders. Finally, whenever there is a shareholder vote of any kind, shareholders retain the right to redeem their shares for roughly the IPO price or slightly above.[5] Any SPAC that fails to complete a business combination within the

[5]In addition to voting on proposed deals, SPAC shareholders have to approve any extension of the SPAC's time horizon and can redeem shares when such votes are taken. As a result, SPAC sponsors

allotted timeframe will liquidate with all IPO investors receiving their pro-rata share of the trust fund (typically 100%+ of the IPO price), and the sponsors getting nothing. Moreover, in the event of a SPAC liquidation, underwriters of the SPAC IPO do not get their 3%+ contingency underwriting fee. Note that shareholders can redeem their shares but continue to hold any rights or warrants.

In the usual process, following the IPO, the SPAC sponsor will initiate negotiations with numerous prospective targets about the possibility of a merger. If there is sufficient interest from both sides of a prospective negotiation, the sponsor will sign a non-disclosure agreement (NDA) and enter into formal negotiations with the prospective target. Here begins the due diligence phase where the sponsor will be granted access to reams of private information about the prospective target in the hope of coming up with a valuation (and offer) that is high enough for the target owners to accept, and yet low enough for SPAC shareholders to refrain from redeeming their shares. It is critical that the sponsor not only exercise discretion over which businesses will make good investments, but also about the appropriate valuation of said businesses. Finding the best target at the right price is presumably how the sponsor justifies its compensation (the "promote" stake).[6] Since the sponsor acquires the promote stake for a nominal fee, the costs associated with said promote stake are borne by all other investors.

At this stage in the negotiations SPAC sponsors may decide to raise additional capital by offering PIPE financing to certain institutional investors, which they often do. These prospective PIPE investors also sign a limited NDA and typically pledge to invest on terms similar to the IPO investors, though by design they are unable to redeem their shares for a portion of the trust account. The additional capital raised in a PIPE can serve multiple purposes. First, a SPAC that raises a sizeable PIPE can offer more cash to a prospective target. Moreover, the added cash cushion provided by the cash invested by PIPE participants helps to guarantee a certain minimum amount of available cash, since PIPE proceeds are not subject to redemption. Finally, as sophisticated institutional investors privy to certain non-public information, PIPE investors' willingness to invest on

often bribe shareholders to stay by increasing the size of the SPAC's trust (pool of cash available to fund redemptions) by a few cents per share.

[6] For certain sponsors there is also the possibility that the executive team of the SPAC can potentially add value through strategic or other insight.

similar terms as IPO investors can help to reassure investors that the SPAC is viable and shares ought not be redeemed. However, since PIPE investors are investing on similar terms as SPAC IPO investors, they will also bare their proportional share of the burden of the sponsor's promote stake.

Finally, once the SPAC sponsor and the target firm's owners agree on the terms of a deal, the sponsor compiles an investor presentation touting the merits of the target company's business and strategy, as well as the terms of the deal, and it is up to the SPAC shareholders to approve the deal. While the technical approval of a deal is typically a formality, since few investors have an incentive to vote down a deal, the linchpin of the process is SPAC investors' stay-or-redeem decision. In this sense the real voting on a proposed transaction is done with the feet rather than via the corporate ballot box.[7] Assuming the deal is approved, the target firm takes over the SPAC's listing while simultaneously changing the ticker symbol to better reflect the target firm's name and/or business. This process has come to be known as the "de-SPAC."

It is clear from the above description that SPAC sponsors are the critical cog in the entire SPAC/de-SPAC process, serving in a role somewhat akin to that of the underwriter in an IPO, but with a sizeable stake in the ongoing enterprise. However, while the SPAC mechanism has the potential to be more efficient than a fixed price IPO, because the sponsor is privy to considerable private information and has a sizeable stake in the ongoing business, the incentives of sponsors and SPAC shareholders are not well-aligned to the downside, creating the potential for costly agency problems. Moreover, not surprisingly, given the rise in popularity of SPACs in recent years, the role of the sponsor, specifically their actions and motives, has drawn the scrutiny of regulators and the courts. In his new role as Chair of the Securities and Exchange Commission (SEC), Gary Gensler, has recently expressed concern regarding information asymmetries and incentive conflicts inherent in the SPAC structure, specifically expressing concern that SPAC sponsors may reap great benefits, even in the face of other investors facing significant losses (See Paul Kiernan (2021)). Along these lines, the Delaware Chancery Court has recently ruled

[7]Specifically, in the extreme, should SPAC investors approve the proposed deal but at the same time all request to redeem their shares for cash, the SPAC will essentially become an empty shell, with no cash and only a public listing to offer target owners. Moreover, when redemptions are extremely high, there is a serious threat of being de-listed by the exchange due to an insufficient number of shareholders.

that the entire fairness standard of review, not the more lenient business judgement rule, should be applied to de-SPAC mergers due to the inherent conflicts between fiduciaries and public shareholders in the context of value-decreasing transactions.[8]

In light of these potential conflicts, sponsors may seek to pursue strategies and structures aimed at mollifying investors in an attempt to curtail potential redemptions. To this end, there are various actions the sponsor can take to make any proposed deal more attractive to the target firm's owners, the SPAC's outside investors, or both, potentially lessening apparent incentive conflicts. First, the sponsor can raise additional capital for the business combination via a PIPE. This can make a proposed business combination more attractive to the target's owners by allowing the SPAC to offer more cash consideration to the target, or to provide more cash on the balance sheet of the ongoing (de-SPACed) business. At the same time, SPAC shareholders may be mollified by the participation of PIPE investors, and may therefore be less inclined to redeem their shares. Finally, the presence of the PIPE financing proceeds helps to provide a "backstop" against shareholder redemptions. At the same time, PIPE financing has costs (borne by the other investors) and will dilute the gains of other investors should the SPAC perform well.

Second, the sponsors can reduce their own compensation, to the benefit of all other investors (PIPE investors, SPAC shareholders, and target owners). The sponsor's main source of compensation in the SPAC/de-SPAC process is the promote stake that they purchase at the outset for a nominal fee. Recall that the typical SPAC structure sets the promote stake to 25% of IPO shares, so that the sponsor will own 20% of SPAC shares at the time of the business combination (i.e., 20% of the sum of IPO shares and sponsor promote). It is common that, during the course of the negotiation of SPAC terms, the sponsor will willingly forfeit a significant slice of their promote stake. Since the cost of the sponsor promote is borne by all other shareholders, the sponsor's willingness to forfeit a fraction of this stake is beneficial to all other shareholders, thereby making any proposed deal more attractive.[9]

Third, rather than, or in addition to, forfeiting a portion of its promote stake, the

[8] See Klausner et al. (2020), along with the case In re MultiPlan Corp. Shareholders Litigation, 2022 WL 24060, Delaware Chancery Jan. 3, 2022.

[9] Note: the sponsor can also improve the welfare of all other investors by forfeiting a sizeable fraction of their private placement warrants (or units) that were purchased to cover the non-contingent portion of the underwriter's fees (usually 2% of the IPO proceeds).

sponsor can offer to tie the vesting of a fraction of the promote stake to certain performance metrics in what is known as an "earn-out". For example, with the value of shares defined to be $10 each, the sponsor may set conditions whereby a portion of the promote shares only vests if the post de-SPAC share price surpasses and remains above, say $15, for a period of time, typically 20 out of 30 consecutive trading days, within a period of time (typically 2-5 years).[10] One can view an earn-out applied to a given fraction of promote shares as analogous to forfeiting a significantly lesser fraction of the promote stake.

Finally, the sponsor must negotiate a valuation with the target owners. While it is conceivable that the sponsor proposes to buy the target firm outright using only the cash in the SPAC trust (and possibly additional cash raised in a PIPE), deals of this type are exceedingly rare. Instead, the SPAC offers the target owners merger consideration entirely or largely in the form of newly issued SPAC shares. The more shares issued to the target owners, the smaller is the stake of the SPAC shareholders, including the sponsor and any PIPE investors.[11]

Ultimately, the sponsor presents a proposed acquisition (business combination) to the SPAC shareholders including details that may incorporate many or all of the above actions taken by the sponsors. Then SPAC shareholders must decide whether to redeem their shares for cash, or retain their shares as an ownership stake in the ongoing (de-SPACed) enterprise, knowing that the sponsor's interests are unlikely to be perfectly aligned with their own and that there may be severe financial consequences for wrong choices. Our model of the SPAC mechanism, and associated sponsor actions, is intended to capture most of the aforementioned features.

[10] The performance benchmark need not be set in terms of share price. Instead, the hurdle for vesting can be set to some accounting benchmark (e.g., EBITDA), or some non-financial criterion, such as the approval of a drug.

[11] Note: if there are disagreements between the sponsor and the target owners regarding the valuation of the target company, the target owners may offer to tie a portion of their share-based consideration to certain performance targets in what are known as target earn-outs. Similar to sponsor earn-outs, here extra share payouts to target owners are contingent on meeting specified performance metrics in ensuing years.

3 Model Setup

We normalize the amount of cash raised in a SPAC IPO to be 1 dollar. The SPAC IPO issues one unit (1 unit = 1 share + w unit of warrant, where w is deal specific and can be, for example, 0.2, 0.5, or 1). Shares and warrants can be traded separately post SPAC IPO, and therefore shareholders at the time of redemption do not necessarily hold warrants (and warrant holders do not necessarily hold shares). Our model aims to capture the negotiation between the sponsor and the target firm, the decision to raise additional capital externally, and the SPAC investors' redemption decisions.

3.1 Firm value post-DeSPAC

We assume that the target firm has a value of u if it stays private (note that u is subject to the normalization we did above, i.e., u is a multiple of the SPAC IPO dollars raised), and its value becomes $(1 + z)u$ if it merges with the SPAC and gains the public status. z therefore can be viewed as the return created by SPAC. [12]

Let δ denote the fraction of shares redeemed, the remaining $1 - \delta$ fraction of the shareholders do not redeem, and the cash they contributed during the SPAC IPO will remain in the merged firm. Let K denote the capital infusion through PIPE or FPA, and the total cash in the combined firm post DeSPAC is thus:

$$C = 1 - \delta + K, \tag{1}$$

and the value of the merged firm post DeSPAC will be:

$$\begin{aligned} V &= 1 - \delta + K + (1 + z)u + 1.15w \cdot \mathbf{1}_{\{p>1.15\}} - F \\ &= C + 1.15w \cdot \mathbf{1}_{\{p>1.15\}} - F, \end{aligned} \tag{2}$$

[12]For a richer setting, z can be a random draw from a parameterized distribution $\phi(z|y, X)$ where X is a vector of SPAC characteristics and is the vector of coefficients that describes how X affects the mean and dispersion of z. We specify $\phi(z|y, X)$ this way so that we can model the quality of target as a reduced-form function of sponsor reputation, time pressure (closeness to liquidation), and other factors we believe important. can be estimated together with other structural parameters based on the deal characteristics we observe in the data. For instance, if most deals with reputable sponsors or in relatively early stage of the SPAC's life cycle have better post DeSPAC performance, then the estimate of should reflect this.

where C is the cash brought in by the SPAC, $(1+z)u$ is the value of the target with the public status, $1.15w \cdot \mathbf{1}_{\{p>1.15\}}$ is the cash received from warrant holders who exercise their warrants when the post-merger share price is above the strike, and F is the total fee paid out including the underwriting fee and other fees.[13] Specifically, warrants are issued with a strike price of \$11.5 (equivalent to 1.15 in the model with normalization), and there are w units of warrants outstanding. $\mathbf{1}_{\{p>1.15\}}$ indicates the exercising condition.

3.2 Ownership by different agents

Let n denote the number of shares issued to the original owner of the target firm, and θ be the number of shares obtained by the sponsor (including the 0.25 promote shares minus those forfeited by the sponsor, if any). The total number of shares in the merged firm post DeSPAC is therefore:

$$N = 1 - \delta + K + n + \theta + w \cdot \mathbf{1}_{\{p>1.15\}}, \tag{3}$$

among which the non-redeeming SPAC shareholders get $1-\delta$ shares, the original owners of the target get n shares, the sponsor gets θ shares, PIPE investors get K shares, and the warrant holders get w shares if warrants are exercised.

The variables, δ, n, θ, and K will be solved endogenously in the model.

3.3 Utility of different agents

We specify the utility to different agents in two scenarios: (1) when the proposed DeSPAC completes—we use $U(\cdot)$ to denote agents' utility under DeSPAC completion and (2) when the proposed DeSPAC fails—we use $W(\cdot)$ to denote utility under DeSAPC failure.

[13]Note that underwriting fees usually include 2% upfront fee and 3.5% fee contingent on deal completion. Since we model the post-merger firm value, the total underwriting fee should be 5.5%. F also include other fees. If 2% upfront fee is financed by the sponsor's risk capital injection, then it should be deducted from F and correspondingly the sponsor should be compensated by their ownership of the risk capital (usually a combination of shares and warrants). In other words, if we model the sponsor's risk capital, then the pie is larger but the fraction allocated to the sponsor is also larger (to compensate their risk capital).

The non-redeeming SPAC shareholders (SH)

The non-redeeming SPAC shareholders own $1-\delta$ shares of the merged firm, and therefore their utility if the proposed DeSPAC completes is:

$$U^{SH} = \frac{(1-\delta)}{N}V. \tag{4}$$

If the proposed DeSPAC fails, cash is returned to the shareholders (we normalize the interest rate on cash to zero) and thus their utility is:

$$W^{SH} = 1-\delta, \tag{5}$$

PIPE investor (PIPE)

The utility of PIPE investors has similar functional forms as the non-redeeming IPO investors because they purchase shares at the same issuing price as the IPO investors. We can write the PIPE investors' utility as:

$$U^{PIPE} = \frac{K}{N}V, \tag{6}$$

$$W^{PIPE} = K. \tag{7}$$

The original owners of the target (TAR)

The original owners of the target firm are given n shares of the merged firm stocks if the DeSPAC completes:

$$U^{TAR} = \frac{n}{N}V, \tag{8}$$

and they get the target firm value of staying private if the DeSPAC fails:

$$W^{TAR} = u. \tag{9}$$

Sponsor (SP)

The SPAC sponsor's utility is determined by three factors: first, the sponsor gets his compensation of θ shares if the DeSPAC completes; second, the sponsor will potentially internalize part of the non-redeeming shareholders' and PIPE investors' utility gains; lastly, the sponsor needs to pay a fixed cost τ regardless of the deal outcome, and he bears an additional cost to bring in PIPE investors, $\omega = \phi \cdot \mathbf{1}_{\{K>0\}} - \left(K + \frac{\alpha K^2}{2}\right)$, which is expensed only when the DeSPAC completes (when DeSPAC fails, no PIPE is needed).

$$\begin{aligned} U^{SP} &= \frac{\theta}{N} V + \lambda_{SH} \left(U^{SH} - W^{SH}\right) + \lambda_{PIPE} \left(U^{PIPE} - W^{PIPE}\right) - \omega - \tau \\ &= \frac{\theta + \bar{\lambda} C}{N} V - \bar{\lambda} C - \omega - \tau, \end{aligned} \tag{10}$$

where $\frac{\theta}{N}V$ is the sponsor's compensation. λ^{SH} and λ^{PIPE} are parameters between $[0, 1]$ that reflect agency costs. Higher λ indicates that the sponsor internalizes the non-redeeming shareholders' and PIPE investors' utility to a fuller extent and hence the conflict of interest is alleviated. We define $\bar{\lambda}$ as the weighted average of λ^{SH} and λ^{PIPE}:

$$\bar{\lambda} = \frac{1 - \delta}{C} \lambda_{SH} + \frac{K}{C} \lambda_{PIPE}. \tag{11}$$

If the DeSPAC fails, the sponsor receives no compensation and his utility will simply equal the fixed cost that he pays:

$$W^{SP} = -\tau. \tag{12}$$

It is clear that the fixed cost τ only affects the level of the sponsor's utility and is thus sunk.

Public holders of warrants

Warrant holders make optimal exercising decisions, namely, they exercise the warrants when the stock price post-merger is above the strike price of \$1.15, and their profit is defined by the price difference.

In our baseline model, we assume that neither the sponsor nor the target shareholders hold warrants. Instead, warrants are held by SPAC shareholders or other investors in the market. This assumption is motivated by the observation that warrants and shares are traded separately after SPAC went public, and thus SPAC shareholders and warrant holders do not necessarily have much overlap at the time of redemption decision. Furthermore, we prove that our model solution only depends on the total amount of warrants outstanding but not the distribution of ownership among different parties. We are therefore able to keep the modelling of warrant holdings simple in the baseline model and drive implications that are robust to more general ownership structures of warrants.

3.4 Information structure

We assume that $\lambda_{PIPE} = 1$ and is known to all agents while $\lambda_{SH} \in [0, 1]$ is only privately observed by the sponsor himself. Thus, this privately observed λ_{SH}, together with the potential synergy from the merger, z, and the target value of staying private, u, constitute the sources of information asymmetry in the model. More specifically, the joint unconditional distribution of λ_{SH}, z, and u is common knowledge and follows a PDF: $f(\lambda_{SH}, z, u)$. The information set for each agent is as follows:

1. SPAC shareholders: They only know the unconditional distribution, that is, $f(\lambda_{SH}, z, u)$. They do not know the realization of λ_{SH}, z, or u.

2. The original owners of the target: They observe the realization of λ_{SH}, z, and u.

3. PIPE investors: We do not model any actions taken by PIPE investors, and therefore we don't need to specify their information set. The role of PIPE investors in the model is that their payoff may enter the sponsor's objective function.

4. Sponsor: The sponsor observes the realization of λ_{SH}, z, and u.

3.5 Agent Action Sets

Our model characterizes the optimal decisions by the SPAC sponsor and investors, as well as the deal negotiation between the sponsor and target shareholders. The actions by different agents (conditional on their own information set) are as follows:

1. SPAC shareholders: They can (i) keep the shares and become a non-redeeming shareholder, or (ii) redeem their shares. We do not consider trading among shareholders that do not affect the ownership structure and cash reserve. Aggregating shareholders' decision, we can solve for δ in the equilibrium.

2. The original owners of the target: They negotiate with the SPAC sponsor in a Nash bargaining protocol to determine their ownership in the combined firm, n.

3. Sponsor: In addition to negotiating the deal terms with the target shareholders, the sponsor can also choose to (i) bring in K dollar of new capital through PIPE, (ii) renegotiate his compensation θ, or (iii) do nothing, in which case, $K = 0$ and $\theta = \bar{\theta}$ (which equals the default of 25% promote shares). Action (i) and (ii) are not mutually exclusive.

Figure 1 summarizes the timeline of the model. A typical DeSPAC process is divided into three phases. The information set possessed by each agent is marked in blue while the action set taken by the agent is marked in red. First, the sponsor approaches a target firm, and they both privately observe (λ_{SH}, z, u). They negotiate the deal terms (θ, K, n) and then announce the deal to the public. In the second phase, SPAC investors decide whether to redeem their shares based on the observed deal terms and signals they receive. The individual SPAC investors' redemption decisions aggregate to a fraction of shares δ being redeemed. In the third phase, the proposed DeSPAC can complete or fail, which is influenced by the SPAC investors' redemption decisions. If the deal completes, the true value of the combined firm, V, is then revealed.

4 Model Solution

We solve the model in two steps. First, we derive the total surplus accrued to the SPAC sponsor and target shareholders as a function of the investors' and the SPAC sponsor's optimal decisions, (δ, K, θ). They will negotiate the price for the stock acquisition via Nash bargaining. Then the sponsor's optimization problem solves K and θ with a rational expectation on SPAC shareholders' redemption decision, δ; and SPAC shareholders' optimization problem solves δ upon observing the capital from PIPE, K, and the SPAC sponsor's negotiated compensation, θ.

4.1 Nash bargaining outcomes

Nash bargaining is modeled as between the sponsor and the target shareholders, taking as given the policy (δ, K, θ). The bargaining conditions on a successful DeSPAC (otherwise, nothing to split), with a total surplus of:

$$
\begin{aligned}
S &= U^{SP} + U^{TAR} - W^{SP} - W^{TAR} \\
&= \frac{\theta + n + \bar{\lambda}C}{\theta + n + C + w \cdot \mathbf{1}_{\{p>1.15\}}} V - \bar{\lambda}C - u - \omega \qquad (13) \\
&= \frac{\theta + n + \bar{\lambda}C}{\theta + n + C + w \cdot \mathbf{1}_{\{p>1.15\}}} \left[C + (1+z)u + 1.15w \cdot \mathbf{1}_{\{p>1.15\}} - F\right] - \bar{\lambda}C - u - \omega. \qquad (14)
\end{aligned}
$$

Let ρ be the bargain power of the SPAC sponsor, Nash bargaining suggests that the shares that the target receives should satisfy:

$$
\frac{n}{N} V = u + (1-\rho) S, \tag{15}
$$

from which we can solve for n:

$$
\begin{aligned}
\frac{n}{N} V &= u + (1-\rho) \left(\frac{\theta + n + \bar{\lambda}C}{N} V - \bar{\lambda}C - u - \omega \right) \\
\left(n - (1-\rho)(\theta + n + \bar{\lambda}C)\right) \frac{V}{N} &= \left(\rho n - (1-\rho)(\theta + \bar{\lambda}C)\right) \frac{V}{N} = \rho u - (1-\rho)(\bar{\lambda}C + w) \\
\rho V n - (1-\rho)(\theta + \lambda\bar{C})V &= \left[\rho u - (1-\rho)(\bar{\lambda}C + w)\right] n + \left[\rho u - (1-\rho)(\bar{\lambda}C + w)\right] (\theta + C + w \cdot \mathbf{1}_{\{p>1.15\}}) \\
\left[\rho V - \rho u + (1-\rho)(\lambda\bar{C} + \omega)\right] n &= (1-\rho)(\theta + \lambda\bar{C})V + \left[\rho u - (1-\rho)(\bar{\lambda}C + w)\right] \left(\theta + C + w \cdot \mathbf{1}_{\{p>1.15\}}\right)
\end{aligned}
$$

$$
n = \frac{\left[\rho u - (1-\rho)(\bar{\lambda}C + w)\right] \left(\theta + C + w \cdot \mathbf{1}_{\{p>1.15\}}\right) + (1-\rho)(\theta + \lambda\bar{C})V}{\rho(V - u) + (1-\rho)(\lambda\bar{C} + \omega)}. \tag{20}
$$

Equation (20) suggests that n is a deterministic function of state variables (λ^{IPO}, z, u) and the policy variables (δ, n, θ, K). n needs to be solved as a fixed point, because the RHS expression contains δ, which is a function of n.

The total surplus is realized only when the proposed deal completes. We assume the likelihood of deal completion is a function of cash available in the SPAC firm ($C = 1 - \delta + K$):

$$
q_{suc} = q(C) \cdot 1_{\{S>0\}} \tag{21}
$$

where $1_{\{S>0\}}$ is the indicator function that equals one if the total surplus is positive. Obviously, if the total surplus is negative, the Nash bargaining between the sponsor and target fails and the deal cannot complete. We assume that $q(C)$ is weakly increasing in C. Other deal characteristics do not explicitly show up in equation (21), but they can still affect deal completion rate endogenously through C. For example, deal quality affects the deal completion rate through the SPAC investors' redemption decisions. If SPAC investors are more likely to redeem when deal quality is perceived poor, C will be low, and the deal is less likely to be successful. Such a specification captures the effect of deal quality on deal completion rate through SPAC investors' "voting with their feet" rather than "voting via the corporate ballot box", which is consistent with reality.

The objective of the sponsor and the target shareholders in the bargaining game is therefore to maximize the expected total surplus $\Pi = S \cdot q_{suc}$, where

$$\Pi = \max_{n,\theta,K} \left\{ z \cdot u + \frac{[n + \theta - (1+z)u]}{N} \cdot (1-\ell) \cdot (1-\delta) - \left(\phi_1 K + \frac{\phi_2}{2} K^2 \right) \right\} \cdot q\left(1 - \delta + K\right) \tag{22}$$

subject to the constraint that n and θ are bound by the Nash bargaining protocol in equation (**??**) and (**??**). The resulting choices of deal terms (θ^*, K^*, n^*) can be solved as functions of deal fundamentals (ℓ, z, u), which we denote as:

$$\theta^* = \theta\left(\ell, z, u\right) \tag{23}$$

$$K^* = K\left(\ell, z, u\right) \tag{24}$$

$$n^* = n\left(\ell, z, u\right) \tag{25}$$

The solutions to the deal terms depend on how SPAC investors will react to the proposed deal and their resulting redemption decisions, which in turn depend on the information available to SPAC investors. We therefore proceed with the two cases below.

4.2 Perfect information: A Benchmark

We first demonstrate the model solution in a benchmark environment with perfect information. In this setting, all agents observe (ℓ, z, u) and make their decisions based on this perfect information set. The agency problem still exists, because SPAC investors have to delegate the negotiation of deal terms to the sponsor. However, if SPAC investors are unhappy with the deal terms, they can redeem their shares to avoid any potential loss.

The SPAC investors' redemption decision is determined by their returns to staying. If information is perfect, then they can observe deal fundamentals (ℓ, z, u) and thus are able to calculate R_{spac}, their returns accurately, as in (**??**). If $R_{spac} \geq 0$, they choose to stay and not redeem; and if $R_{spac} < 0$, they redeem. Let variables with a subscript P denote the solutions in this perfect information environment, then

$$\delta_P^* = \begin{cases} 0 & if\ (1+z)u \geq n + \theta \\ 1 & Otherwise \end{cases} \tag{26}$$

Intuitively, SPAC investors will stay if the total value of the target when publicly-listed is sufficient to pay off the target shareholders and the sponsor, and they will redeem all shares otherwise.

Given SPAC investors' redemption policy, it is straightforward to see that any proposed deal with negative z cannot complete when information is perfect, because there is no split that makes all parties happy. When z is positive, the sponsor and target will choose:

$$n_P^* + \theta_P^* = (1+z)\,u \tag{27}$$

which leaves SPAC investors indifferent between redeeming and staying.[14]

The optimal external capital raised, K_P^*, satisfies the first-order-condition, which equates the marginal benefit of having more cash to increase the likelihood of deal completion to the marginal cost of raising external capital:

$$\frac{dq(1+K_P^*)}{dK} = \frac{(\phi_1 + \phi_2 K_P^*)\, q(1+K_P^*)}{z \cdot u - \left(\phi_1 K_P^* + \frac{\phi_2}{2} K_P^{*2}\right)} \tag{28}$$

[14]This is because, if they choose $n_P^* + \theta_P^* \leq (1+z)\,u$, then SPAC investors do not redeem and $\delta = 0$; and in this case, since $1 - \ell > 0$, $S \cdot q_{suc}$ is increasing in $n + \theta$ in equation (22). As a result, setting $n_P^* + \theta_P^* = (1+z)\,u$ is optimal in this region. If they choose $n_P^* + \theta_P^* > (1+z)\,u$, then SPAC investors redeem all shares and $\delta = 1$; and in this case, $S \cdot q_{suc}$ is independent of $n + \theta$. As a result, setting $n_P^* + \theta_P^* = (1+z)\,u$ is also optimal in this region.

As a result, under perfect information, if the sponsor and the target are allowed to freely choose the deal terms, they will have full bargaining power over SPAC investors. Deals are always efficient in the sense that all value destroying deals ($z < 0$) always fail and all value enhancing deals ($z > 0$) are financed by cash from SPAC IPO and additional capital raised externally.

4.3 Imperfect information

We now derive the model solution when information is asymmetric, as laid out in Figure 1. In this setting, only the sponsor and target observe the realization of (ℓ, z, u). They still choose the optimal deal terms (θ, K, n) by solving the same maximization problem as in equation (22). The SPAC investors, however, must infer the deal fundamentals from the common knowledge of their distribution and the observed deal terms (θ, K, n). That is, the SPAC investors have to form their *expected* returns from staying as below:

$$E\left[R_{spac}\right] = \frac{E\left[V|\mathcal{F}\right]}{N} - 1 = \frac{E\left[\left(1+z\right)u|\mathcal{F}\right] - \left(n+\theta\right)}{N} \tag{29}$$

where $\mathcal{F}$ represents the information set of SPAC investors that includes the model parameters and the observed deal terms (θ, K, n).

SPAC investors choose to stay if $E\left[R_{spac}\right] \geq 0$ and redeem otherwise. As a result,

$$\delta^* = \begin{cases} 0 & if\ E\left[\left(1+z\right)u|\mathcal{F}\right] \geq n+\theta \\ 1 & Otherwise \end{cases} \tag{30}$$

SPAC investors can only observe the deal terms publicly announced (θ, K, n), so they conjecture the deal value as:

$$E\left[\left(1+z\right)u|\mathcal{F}\right] = \iiint_{\ell,z,u} (1+z)\cdot u \cdot f(\ell, z, u|\theta, K, n) d\ell dz du \tag{31}$$

where

$$f(\ell, z, u|\theta, K, n) = \frac{f(\ell, z, u)\cdot 1_{\{\theta(\ell,z,u)=\theta^*, K(\ell,z,u)=K^*, n(\ell,z,u)=n^*\}}}{\iiint_{\ell,z,u} f(\ell, z, u)\cdot 1_{\{\theta(\ell,z,u)=\theta^*, K(\ell,z,u)=K^*, n(\ell,z,u)=n^*\}} d\ell dz du} \tag{32}$$

is the distribution of deal fundamentals conditioning on the observed deal terms (θ, K, n). The intuition of the conditional distribution is that the SPAC investors can anticipate the sponsor and target's optimal decision rules for deal terms, as laid out in equations (23) to (25), and use them to infer the possible deal fundamentals that can generate those observed deal terms. Even though this inference may not fully reveal the true deal fundamentals because of potential pooling in equilibrium, it helps refine the SPAC investors' conjecture of deal value. In equilibrium, all agents form rational expectations of others' decisions and their expectations are fulfilled.

Despite its theoretical appeal, the above model faces two main challenges in matching the actual data. First, redemption decisions in the model are homogeneous among all SPAC investors, and will thus predict a binary redemption rate of $\delta = \{0, 1\}$ across all deals. The redemption rate, however, is clearly not binary in the data, with a significant fraction of deals having a redemption rate between 10% to 90%. To capture this important feature, the model has to allow a certain degree of heterogeneity among SPAC investors to generate a more continuous distribution of redemption rates. Second, an important goal of this paper is to quantify the extent of information asymmetry between SPAC investors and the sponsor. The current model assumes that SPAC investors perfectly anticipate sponsor's optimal choices, and this assumption fully nails down the magnitude of information asymmetry in the model. In practice, SPAC investors might be more or less informed than they are in the model. For example, there is evidence suggesting that retail SPAC investors can be naive, without the necessary skills to fully process public information. In this case, their conjecture of the sponsor's optimal choices may be less accurate than assumed in the model. On the other hand, it is also possible that SPAC investors receive private signals beyond the deal terms. For example, they can learn from shareholder meetings or any disclosure of critical information regarding the merger plans. Private information can also be impounded into share prices in the equity market through active trading among SPAC shareholders.[15]

To address these two challenges, we enrich the model in two dimensions. The first

[15] Our model focuses on SPAC investors' redemption decisions. Any trading in the secondary market does not affect the number of shares outstanding directly and thus does not change the cash available to the SPAC firm. SPAC investors, however, may learn new information from trading activities, which we model below as signals.

dimension introduces heterogeneity among SPAC investors: instead of assuming a unified threshold decision of redemption as in equation (30), we assume that SPAC investors derive some utility from staying:

$$\pi = \frac{E\left[(1+z)\,u|\mathcal{F}\right] - (n+\theta)}{\sigma_\delta} \tag{33}$$

and each investor i makes a discrete choice between staying and redeeming according to the following rule:

$$\delta_i^* = \begin{cases} 0 & if\, \pi + \epsilon_i > 0 \\ 1 & Otherwise \end{cases} \tag{34}$$

where ϵ_i follows an i.i.d. Gumbel distribution (i.e., Type I Generalized Extreme Value distribution). Empirically, ϵ_i can reflect heterogeneous hurdle rate across different SPAC investors, creating noise in the investor's redemption decisions.[16]

Aggregating each SPAC investor's redemption decision implies the standard logit model solution for the aggregate redemption rate :

$$\delta^* = \frac{1}{1+e^{\pi}} \tag{35}$$

The redemption rate is now continuous and decreasing in the expected utility π. A new parameter we introduced into the model is σ_δ, and a low value of σ_δ tilts the outcome of redemption towards binary. In the extreme as $\sigma_\delta \to 0$, the redemption decision returns to the threshold decision as in equation (30).

The second dimension of enrichment pertains the precision at which SPAC investors can infer the true deal fundamentals based on the observed deal terms using the sponsor and target shareholders' optimal policy functions. To increase the model's flexibility in capturing information asymmetry, we follow the existing literature and allow SPAC investors to have possibly *imperfect* expectations regarding the sponsor's optimal decision rule in the following two ways: first, instead of believing that the sponsor always chooses the optimal deal terms (θ^*, K^*, n^*) solved from equation (22), investors believe the prob-

[16]The average hurdle rate for redemption is normalized to zero. σ_δ is a scaling factor commonly used in the literature to control the degree of this heterogeneity. If σ_δ is close to zero, then π is very large as long as $E\left[(1+z)\,u|\mathcal{F}\right] > (n+\theta)$, and $\pi + \epsilon_i > 0$ for most investors. In other words, most investors still stay (redeem) as long as the expected return is positive (negative), implying a low degree of heterogeneity.

ability of a set of policies (θ, K, n) being chosen depends on the utility they generate relative to that generated by the optimal deal terms (θ^*, K^*, n^*), i.e.,

$$g(\theta, K, n) = \frac{\Lambda(\theta, K, n)h(\theta, K, n)}{\iiint_{\theta,K,n} \Lambda(\theta, K, n)h(\theta, K, n)d\theta dK dn} \tag{36}$$

where $h(\theta, K, n)$ is the density of the deal terms (θ, K, n) and

$$\Lambda(\theta, K, n) = e^{\frac{\Pi(\theta,K,n)-\Pi(\theta^*,K^*,n^*)}{\sigma_e}} \tag{37}$$

measures the "taste shock" to the investor's inference. This specification can be micro-founded as the logit maximum utility in a continuous logit model (Ben-Akiva et al. (1985)). We introduce a new parameter σ_e into the model, which controls the degree of this imperfect expectation similar to σ_δ above: a low value of σ_e tilts the expectation towards perfect, and, in the extreme, as $\sigma_e \to 0$, SPAC investors' expectation returns to perfect as in equation (23) to (25).[17]

As the second channel through which imperfect inference can occur, we also allow for the possibility that SPAC investors observe a private signal regarding deal quality, which we denote as s. In general, s can be a signal of z, or u, or both. Observing s helps the SPAC investors refine their expectations of deal value: SPAC investors now form their expectation based on the conditional density $f(\ell, z, u|s)$ rather than the unconditional density $f(\ell, z, u)$. The precision of the signal, measured by ι_s, determines the value of the signal, and the model nests the case without signal as $\iota_s \to 0$.

With the extension to imperfect expectations and private signals, equation (32) becomes:

$$f(\ell, z, u|\theta, K, n, s) = \frac{\iiint_{\theta,K,n} f(\ell, z, u|s) \cdot g(\theta, K, n)d\theta dK dn}{\iiint_{\ell,z,u} \left[\iiint_{\theta,K,n} f(\ell, z, u|s) \cdot g(\theta, K, n)d\theta dK dn\right] d\ell dz du} \tag{38}$$

Intuitively, instead of having an indicator function that always picks up the optimal deal terms (θ^*, K^*, n^*) , SPAC investors now place some probability on alternative deal terms proportional to their "distance" to the optimal choice. We provide an example of deriv-

[17]This is because $\Pi(\theta, K, n) < \Pi(\theta^*, K^*, n^*)$ holds for any deal terms that deviate from the optimal choice. Thus, $g(\theta, K, n)$ equals one only for (θ^*, K^*, n^*) and zero anywhere else when $\sigma_e \to 0$.

ing $f(\ell, z, u|s)$ in the Online Appendix with more assumptions put in place regarding the distribution of z, u, and s. We defer the introduction of these assumptions to Section 6 where we bring the model to the data, and the distributional and functional assumptions become necessary for model calibration. The model's mechanism presented above, however, is quite general, and does not rely on those assumptions.

To solve the sponsor's optimal choice of (θ, K, n), we take the first-order conditions of the sponsor's objective function in equation (22) with repsect to the policies (θ, K, n). Note that δ is a function of (θ, K, n) determined in equation (35). We provide the full set of equations of the F.O.C. in the Online Appendix, and we demonstrate the intuition using the F.O.C. for θ as an example.[18] Recall that N is the total number of shares in the combined firm, which is a function of θ as defined in equation (3), and V is the combined firm value, as defined in equation (2). Therefore, the sponsor's optimal choice of θ satisfies the following F.O.C.:

$$\frac{\partial \Pi}{\partial \theta} = \underbrace{\left(\frac{V}{N}\right)\left(\frac{1}{N}\right)(1-\ell)(1-\delta)\,q}_{MB:more\,wealth\,transfer} + \underbrace{\frac{\Pi}{q}\frac{dq}{dC}\left(-\frac{\partial \delta}{\partial \theta}\right)}_{MC:lower\,completion\,rate} \tag{39}$$

$$+ \underbrace{\frac{n+\theta-(1+z)\,u}{N}(1-\ell)\left(-\frac{\partial \delta}{\partial \theta}\right)}_{MC:lower\,firm\,value}$$

$$= 0 \tag{40}$$

The F.O.C. equates the marginal benefits (MB) with the marginal costs (MC). The benefit arises from issuing one additional share to the sponsor, which dilutes the value owned by SPAC investors and thus transfers more wealth from SPAC investors to the sponsor. There are two costs of doing this. The first is that SPAC investors respond to the deal terms, and an increase in θ mechanically reduces SPAC investors' expected utility of staying and increases aggregate redemptions, δ (as shown in equation (33) and (35)). When the sponsor and target are overly compensated (i.e., $n + \theta > (1 + z)\,u$),

[18] Strictly speaking, since n and θ are bound by the Nash bargaining protocol in equation (**??**) and (**??**), we can write n as a function of θ and K. As a result, there are only two F.O.C. (w.r.t. θ and K) that define the optimal deal terms. We solve the model following this approach. In the example below, however, we illustrate the partial derivative w.r.t. θ while holding the value of n and k unchanged. It helps fix the intuition without adding too much complication.

SPAC investors subsidize them and thus an increase in redemption hurts firm value.[19] The second cost is that, as redemption intensifies, less cash is retained in the SPAC firm, which reduces the likelihood of deal completion.

The full set of F.O.C. w.r.t. θ, K, and n disciplines the sponsor's optimal choice of deal terms. Together with the SPAC investors' redemption decisions in equation (35), they characterize the model's solution.

5 Data

After first appearing on the scene in the late 1990s, SPAC's popularity accelerated through the 2000s, especially after gaining the ability to list shares on the AMEX starting in late 2005, and peaking in 2007 when 60+ SPACs went public raising approximately \$11.6 Billion (representing over 25% of all IPOs in number, and a larger fraction in dollars), and early 2008, after gaining the ability to list on the NASDAQ followed by the NYSE. Their structure evolved somewhat during this growth period, but then the whole space was decimated in the 2008-2009 financial crisis, with many of the 2007 vintage SPACs liquidating without a successful attempt at an acquisition. The structure since 2009 is more uniform and is typically as follows: SPACs go public as units rather than shares. Units are priced at \$10 each and consist of shares and fractional or whole out-of-the-money warrants and/or fractional rights. Warrants are typically struck 15% out of the money (which means \$11.50 for all but a few cases). Given the decimation of the SPAC sector in 2008-2009, and the near uniform structure of SPAC from 2009 onward, and also the passage of the JOBS act in 2010, we begin our sample with SPACs registering to go public in 2009, and track all SPACs that filed registration statements (Form S-1) between 2009 and 2019. This 11-year time period saw the registration and initial public offering of 230 SPACs. As of July of 2021, 187 of the 230 SPACs had successfully executed a business combination, 25 of these SPACs had liquidated without successfully completing a business combination, 16 SPACs had arranged business combinations but had not yet completed them, and two of these SPACs are still seeking prospective merger partners.

The bulk of our analysis focuses on the cohort of 187 SPACs in our sample that have

[19] Note that, when information is asymmetric, SPAC investors cannot observe $(1+z)\,u$. As a result, even if $n+\theta > (1+z)\,u$ holds, their expectation may suggests $n+\theta < E\left[(1+z)\,u\right]$.

successfully completed a business combination. We rely on several sources of information to gather data on these SPACs, much of which has to be gleaned by painstakingly going through individual SEC filings and their associated attachments. We gather information about SPAC IPOs from the registration statement, the prospectus, and any Form 8-K filed shortly after the IPO. These include information on the size of the offering, the exercise (or not) of the over-allotment option, the structure of a SPAC unit, the nature and size of the SPAC's private placement that accompanies the IPO and helps to fund the SPAC trust, the identities of the sponsor and other SPAC participants, the geographic or sector focus of the search for a target, etc.

Once the SPAC finds a target and signs an NDA, the SPAC typically announces the deal and terms and posts an investor presentation, all within and attached to a Form 8-K. These allow us to view the terms of eventual deals at the time they are announced. Finally, we observe the final terms of the deal in the "Super 8-Ks" that are filed after the deal closes. From these, we are able to gather various deal-specific variables. The Super 8K often contains numerous attachments which include a press release, a condensed pro-forma financial statement, sponsor agreements, shareholder agreements, etc., in addition to the 8-K filing itself, any of which can potentially contain useful information. We use these filings to gather information on sponsor and target earn-outs, any forfeited promote shares or sponsor warrants, information about the consideration paid in the deal, as well as any PIPE, Forward Purchase Agreement (FPA), or backstop financing raised through the unregistered sales of securities.

Though some of our information on shareholder redemption comes from the Super 8Ks as well, our main source of data on SPAC redemption is the Gritstone SPAC research database. The Gritstone data cover the vast majority of the SPACs we analyze, including not only redemptions occurring at the time of the business combination vote, but also redemptions occurring prior to that vote. Finally we utilize data from the Center for Research in Security Prices (CRSP) as our source of stock price data for our sample of SPACs. Our primary performance metric is to compute a 3-month post de-SPAC return relative to the baseline $10 redemption price, because in our model, as in reality, SPAC shareholders must choose between redeeming their shares for cash, and retaining shares post de-SPAC. For robustness we also consider 1-month and 6-month post de-SPAC returns with qualitatively similar results.

In order to put variables on the same terms as our model set-up we must do some normalizing and other adjustments. In our model, we normalize SPAC IPO investor shares to 1, so in testing the model, we normalize such variables as any PIPE financing raised, by the number of IPO shares, so such variables are stated in multiples of IPO shares. This normalization is applied to PIPE and other private placement shares, shares paid as consideration to the target owners, redemptions, and sponsor stake.

We need to make one more adjustment to our variable definitions because our model assumes that all SPAC mergers use strictly shares as consideration paid to the target shareholders. However, in reality, approximately half of our sample deals involve some cash consideration, with a handful utilizing a majority of consideration in cash. We make the following adjustment to accommodate cash consideration. We divide the cash consideration by the price at the end of the performance period (3 months in our base case), to get a cash-equivalent number of shares. This allows us to convert all cash consideration to shares, yet leave all parties returns unaffected by the adjustment. We also examine the subset of deals that are essentially all cash and get qualitatively similar results.

Our primary data of analysis are 187 SPACs that successfully completed business combinations as of July 31, 2021. Of these SPACs, there are 3 for which we are unable to find the requisite filings to gather the needed data. Of the remaining 184, we collect all the data discussed above. Table 1 provides a breakdown of the distribution of SPACs by year registered and further divides the sample by outcome (successful combination vs liquidation, etc.). It is clear that much of our sample represents SPACs that only went public in the most recent few years.

Table 2 provides summary statistics on variables of interest on the sample of 184 successful business combinations. Panel A provides the raw data, while Panel B provides summary statistics on a subset of the same variables, but with values scaled by the number of IPO shares, to better align with our model.

We should note that there are 9 SPACs that are unavailable on the CRSP database, and hence for which we are unable to calculate performance. Additionally, there are 7 more SPACs that are not usable for various reasons: they either don't trade for substantial periods of time so that their prices are unreliable, or redemption were so high that they were de-listed by the exchange shortly after the closing of the business combination, or there were so few shares outstanding that their prices were unreliably volatile. In the end, we are left with 168 SPACs that successfully completed business combinations, and have sufficient data for us to run our analysis.

6 Model Calibration

In order to bring the model to the data, it is necessary to make some assumptions regarding the distribution of state variables as well as the functional form of the likelihood of deal completion. We make the following assumptions and use them in model calibration.

1. $ln\,(1+z)$ and $ln\,(u)$ follow normal distributions that are independent of each other: $ln\,(1+z) \sim N(\mu_z, \sigma_z)$ and $ln\,(u) \sim N(\mu_u, \sigma_u)$. We assume that ℓ follows a Beta distribution $\ell \sim B\,(a, b)$, and it is independent of z and u.[20]

2. The signal s follows a normal distribution $s \sim N\left(ln\,(1+\tilde{z}), \frac{1}{\iota_s}\right)$ where $\tilde{z}$ is the true value of z realized, and its precision is ι_s.

3. The likelihood of deal completion $q(C) = \frac{1}{1+e^{-\gamma C+\lambda}}$, with $\gamma > 0$.[21]

Even though the F.O.C. can be derived further with the above assumptions, the high-dimensional expectation and the interdependence of agents' optimal decisions preclude a full analytical solution to the model. We solve the model numerically and provide the detailed steps of the numerical solution in the Online Appendix.

6.1 Identification

There are 13 model parameters, including ϕ_1 and ϕ_2 that control the costs of raising external capital; a and b that shape the Beta distribution of the sponsor's agency cost;

[20] The Beta distribution has support of $[0, 1]$ that conforms to the definition of ℓ in our model. It also nests a few common distributions such as the uniform distribution and exponential distribution, thus providing much flexibility to match the data.

[21] Though cash is often an important consideration, some actual DeSPAC deals close without much cash (i.e., with high redemptions and no PIPE). In these deals, targets main interest is likely to list their shares as opposed to raising cash. In our model, the parameter λ determines the likelihood of deal completion when $C = 0$.

μ_z, μ_u, σ_z, and σ_u that set the mean and standard deviation of the normal distribution for $ln(1+z)$ and $ln(u)$; γ and λ that govern the probability of deal completion; σ_δ that captures the unobservable heterogeneity across SPAC investors' redemption decisions; and σ_e and ι_s that determine the magnitude of information asymmetry between SPAC investors and the sponsor. In this section, we discuss what data features help us identify these parameters in calibrating the model.

First, the distribution of external capital raised K is highly informative of ϕ_1 and ϕ_2. A high variable cost makes it more costly to raise external capital and thus decrease the average value of K in the data. Meanwhile, a high convex component ϕ_2 makes it particularly expensive to raise a large amount of external capital and thus reduces the dispersion of K.

Second, the sponsor's agency cost has a large impact on the distribution of the sponsor's compensation θ. Intuitively, if the agency cost is low, the sponsor has less incentive to transfer wealth from the SPAC investors to himself and the target and thus is more willing to take a lower compensation θ, especially when retaining cash is critical to the probability of deal completion. The mean and standard deviation of θ in the data, therefore, helps pin down a and b.

Third, the value of the target as a private entity, u, serves as the target's reservation price in (Nash) bargaining with the sponsor. Thus, the larger the private target, mechanically the more shares (or a larger fraction) of the combined firm that they ask for in merger consideration. The distribution of the number of shares offered to the target, n (or as a fraction of the combined firm , $\frac{n}{N}$) reveals much information regarding the distribution of u. We use the mean and standard deviation of $\frac{n}{N}$ to discipline the estimates of μ_u and σ_u.

Fourth, total gains from the merger are created via z, which are then shared among all agents in the deal. The combined firm's stock price relative to the face value of SPAC shares (normalized to 1 in the model and \$10 in the data) reflects this piece of information. We compute the deal return and use its mean and standard deviation across deals to infer the cross-sectional distribution of z.

Fifth, the parameter σ_δ is introduced into the model to generate a non-polarized redemption ratio. In other words, if σ_δ is small, we are more likely to observe a redemption ratio of either zero or one. If σ_δ is large, unobservable heterogeneity across SPAC investors leads to more moderate redemption. We use the fraction of deals with a redemption ratio falling between 10-90% to identify σ_δ: a higher fraction implies a greater value of σ_δ.

Last, the magnitude of information asymmetry between SPAC investors and the sponsor determines the correlation between the SPAC investors' redemption decision and their returns. Intuitively, as information asymmetry is low, SPAC investors can better infer the deal fundamentals and make more accurate and timely redemption decisions. But if information is very opaque, SPAC investors cannot assess the deal fundamentals well and thus their redemption decisions respond less accurately to the deal outcomes (and thus their returns). In the model, σ_e and ι_s drive the information asymmetry in the opposite directions, so we cannot separately identify them when they are both present in the model. To identify these two parameters, we impose that only one of them can be active. In other words, we first test whether the model implied correlation between redemption and return is above or below the data counterpart when we set $\sigma_e = 0$ and $\iota_s = 0$. This benchmark corresponds to the case of SPAC investors with perfect rational expectation of the sponsor's optimal decision rules but no additional signal. If the model-implied correlation is more negative than that in the data, we set $\sigma_e = 0$ and estimate ι_s; and if the model implied correlation is less negative than that in the data, we set $\iota_s = 0$ and estimate σ_e.

6.2 Model fit

We choose the parameter values based on the identification strategy proposed in Section 6.1. We choose these values such that the model matches the data counterparts as closely as possible. Table 3 reports the model fit.

In the model, as in the data, the average external capital raised among all deals is about 40% of the size of SPAC IPO, but the cross-sectional variation is also very large, with about one third of deals involving zero external capital. Polarized redemption ratio (below 10% or above 90%) is common, but there is also a substantial fraction (about 50%) of deals with more moderate levels of redemption.

A prominent feature in the data is that redemption and de-SPAC returns appear negatively correlated. Specifically, as we regress SPAC investors' redemption on deal returns, the loading is significantly negative, as shown in Figure 2. The univariate regression produces an R-squared of 20%, indicating that the anticipated deal return alone can explain much of the variation in redemptions. A prevalent explanation of this relation is that SPAC investors can, at least partly, infer deal quality and thus choose to jump ship by redeeming. Ex-post deal return, therefore, should have strong predictive power for the redemption rate. We replicate this regression on the model-simulated data and find a negative loading of similar magnitude. This loading, as we discussed in Section 6.1, helps pin down the magnitude of information asymmetry SPAC investors face.

The model does a good job of fitting the distribution of the sponsor's compensation in the data. In a majority of deals, the sponsor does not alter his compensation and it thus caps at 0.25 (after normalization). The small standard deviation also suggests that deviation from the compensation cap, even when it exists, is often small. So overall, there is not a lot of evidence suggesting that sponsors are willing to give up their own compensation.

The model also does well in fitting the distribution of shares offered to the target. On average, the target shareholders get about two thirds of the combined firm value, with substantial variation across deals. The model is able to match both the mean and standard deviation of $\frac{n}{N}$ in the data.

Last, the model overestimates the average deal return to SPAC investors, but the difference is statistically insignificant given the large cross-sectional variation of 438 bps across deals. The model captures the dispersion of deal returns quite closely

Overall, the model fits the data moments quite closely and it captures the main features present in the data. As a validation of the untargeted moments, we also compare the whole distribution of the observables, θ, K, $\frac{n}{N}$, δ, C, and ret in Figure 3.[22] The model matches these distributions closely, which lends further support to the model's underlying mechanism.

Table 4 reports the parameter estimates that generate the model fit. The parameter that drives information asymmetry, σ_e, is estimated to be 0.07. As σ_e is estimated to be

[22]It is worth noting that matching the first and second moment is not equivalent to matching the whole distribution. While changing model parameters is often sufficient to move the first and second moments around, the distributions are more affected by the model mechanism. It presents a much higher bar for the model to match the distribution of outcomes.

positive, ι_s must be set to zero, so SPAC investors rely only on observed deal terms, and there is no valuable private signal that helps refine their inference of deal quality. In fact, a positive value of σ_e implies that SPAC investors are unable to discern all information embedded in the observed deal terms. In this sense they have imperfect expectations regarding the sponsor's decision rules. This finding is consistent with anecdotal evidence that many retail SPAC investors may be unsophisticated.

The cost of raising external capital is estimated to be highly convex. The marginal cost of raising the first dollar from external capital is only 3 cents per dollar and this marginal cost climbs up to 9 cents per dollar as the dollar amount raised increases to the sample mean.

The parameter that controls the unobservable heterogeneity in SPAC investors' redemption decisions, σ_δ, is estimated to be 0.33. This estimate suggests that, when the redemption rate is close to the sample mean of 0.5, the sensitivity of the redemption rate w.r.t. to the SPAC investors' perceived deal value $E\left[(1+z)\,u|\mathcal{F}\right]$ (holding the deal term θ and n constant) is -0.75.[23]

Interestingly, even though the model specifies a quite flexible distribution (i.e., Beta distribution) to characterize the sponsor's agency cost, our estimate suggests that the two parameters that govern the Beta distribution, a and b are both very close to 1. In other words, the uniform distribution, as a special case of the Beta distribution, can fit the data well. A uniform distribution generates the greatest uncertainty ex ante and thus it is difficult to tell to what extent a sponsor cares about SPAC investors.

Our estimate of deal quality, z, shows that an average de-SPAC deal increases the target's value by 16%, but the cross-sectional uncertainty in value creation is also large, with a standard deviation of 18%. This high uncertainty, again, exposes SPAC investors to great risks, especially when information is asymmetric and incentives are likely to be a concern. Adding to this uncertainty, SPAC investors do not observe the target firm's reservation value u (i.e., the target's value as a private entity), and we find that the logarithm of the target private value, $ln(u)$, has a mean of 0.78 and a standard deviation

[23]This is derived by taking the derivative of equation (35) w.r.t. $E\left[(1+z)\,u|\mathcal{F}\right]$:

$$\frac{d\delta_B^*}{dE\left[(1+z)\,u|\mathcal{F}\right]} = -\delta_B^* \cdot (1-\delta_B^*) \cdot \frac{1}{\sigma_\delta}$$

and substituting in $\bar{\delta_B^*} = 0.5$ and $\sigma_\delta = 0.33$.

of 1.5.

Overall, the parameter estimates show that deal fundamentals, captured by ℓ, z, and u, exhibit large variation across deals, and they add to the uncertainty faced by SPAC investors. SPAC investors seem to have some difficulty in fully anticipating the sponsor's decision rules.

7 Model Implications

7.1 Agency cost

Using the calibrated model as a laboratory, we investigate how agency costs affect the welfare of SPAC investors. In our model, sponsors in different deals have heterogeneous agency costs, captured by the parameter ℓ, with ℓ falling between [0,1) with a higher ℓ representing a lower agency conflict. We simulate the calibrated model, generating 1,000 SPAC deals via simulation. We then partition the simulated sample into quintiles based on ℓ in each deal. Figure 4 compares the distribution of returns to SPAC investors in deals with low agency costs (bottom quintile) and high agency costs (top quintile). When agency costs are high, a large fraction of deals produce negative returns to SPAC investors and the losses can be substantial, with the 25th percentile of returns being -41% among the deals with top-quintile agency cost. When agency cost is low, most deals generate a positive return for SPAC investors, and the 25th percentile of returns is 2.4% for this subsample of deals with the lowest level (bottom-quintile) of agency costs.

Next, we explore what drives the large gap in SPAC investors' returns from deals with different levels of agency costs. The conflict of interests between the sponsor and SPAC investors are particularly strong in inferior deals with low value-added. This is because, as z is low, the deal is unable to generate sufficient gains to compensate for the premium paid to the target and the dilution brought about by the sponsor's promote stake. In this case, SPAC investors benefit if the proposed deal is called off. However, the sponsor, gets nothing if the SPAC is liquidated. His promote stake pays off only when the proposed de-SPAC completes. As a result, the sponsor has an inherent incentive to push through a deal even if it is inferior. But such misaligned incentives are mitigated if the sponsor places a larger weight on SPAC investors and internalizes their gains to a greater extent (and thus has low agency costs). As a result, we first compare the deal quality, z, in deals with low agency costs and deals with high agency costs. Panel A of Figure 5 shows that, deal quality, z, is lower in deals with high agency cost than in those with low agency cost. This is particularly true for deals with negative z: these value-destroying deals show up mainly in the group of sponsors with high agency costs. It is worth noting that the unconditional distribution of deal quality z is independent of agency cost ℓ, and therefore this negative correlation between z and ℓ in observed deals is a manifestation of the endogenous selection effect: low-value deals are more likely to complete when their sponsors have high agency costs. In other words, agency costs affect the composition of completed deals.

Agency costs affect not only the total size of the pie but also the split of the pie. A sponsor with low agency cost is more willing to give up part of his compensation to reduce the dilution of firm value and thus make the deal sweeter for SPAC investors (and, by extension, target owners). In panel B of figure 5, we plot the distribution of sponsor compensation, θ, for deals with top- and bottom-quintile agency costs. Sponsors with high agency costs rarely give up any of their promote stake and thus a large fraction of these deals have a θ of 0.25. Even in those rare instances when they choose to do so, the fraction of shares they give up is small. In contrast, sponsors with low agency costs are more likely to give up large portions of their promote stake as needed. In fact, in almost 40% of deals, sponsors choose to reduce their θ from 0.25 to around 0.05.

Overall, our analysis demonstrates that agency costs have a substantial impact on SPAC investors' returns from the de-SPAC. When the sponsor has high agency costs, he is more eager to push through a proposed deal even if it is of low quality, and at the same time, he is less willing to give up much if any of his promote stake. The combination of these two factors often drives SPAC investors to earn negative returns, effectively subsidizing the sponsor and target in these deals.

7.2 Information asymmetry

In this section, we study the second friction that is related to information asymmetry. We measure the magnitude of information asymmetry between SPAC investors and the sponsor. We also examine the effect of information asymmetry on SPAC investors' returns.

The key role of information asymmetry in our model is that it influences SPAC investors' conjecture of deal value, or $E\left[(1+z)u|\mathcal{F}\right]$. If information is perfect, then this expectation equals the true value of the deal, $(1+z)u$. But with asymmetric information, SPAC investors cannot directly observe deal fundamentals and they have to infer deal value based on observables, specifically the deal terms (θ, K, n). Our estimates suggest that, in net, SPAC investors do not receive additional signals regarding deal fundamentals. Moreover, they are not even able to decode all the information contained in (θ, K, n). To gauge the magnitude of information asymmetry, we first perform a variance decomposition:

$$Var\left(\left(1+z\right)u\right) = Var\left(E\left[(1+z)u|\mathcal{F}\right]\right) + Var\left(\varepsilon\right) \tag{41}$$

where $\varepsilon = \left(1+z\right)u - E\left[(1+z)u|\mathcal{F}\right]$ are the SPAC investors' forecast errors in deal value. Intuitively, the LHS captures the total cross-sectional variation in deal value, and the first term on the RHS is the variation explained by SPAC investors' conjecture. In this variance decomposition, the ratio $\frac{Var(\varepsilon)}{Var((1+z)u)}$ measures the magnitude of information asymmetry: it equals zero with perfect information, and it increases with the extent of information asymmetry. Panel A of Table 5 reports the decomposition results. We normalize the total variance to 1 so that the decomposition shows the fraction of total variation explained by different components. Variation in the SPAC investors' forecast explains about 84.6% of variation in the true deal value and the forecast errors account for the remaining 15.4% of variation.

Next, we explore the sources of the forecast errors. Overall, forecast errors arise from two main sources. First, since SPAC investors can only observe the deal terms (θ, K, n), their forecast precision depends on how revealing these observables are regarding the latent deal fundamentals. In other words, if pooling is prevalent and deals with very different fundamentals are announced with similar terms, it is hard for SPAC investors to discern good deals from bad deals. But if deal terms are strong signals of deal fundamentals, SPAC investors can make more accurate inferences of deal fundamentals based on the observed terms and thus their forecast errors will be small. Second, our estimate suggests that SPAC investors are unable to extract all information embedded in the observed deal terms to infer deal fundamentals, and therefore this friction also creates forecast errors. We can further decompose the variance of forecast errors into:

$$
\begin{aligned}
Var\left(\varepsilon\right) = & \; Var\left(\left(1+z\right)u - E^{PRE}\left[(1+z)u|\mathcal{F}\right]\right) + Var\left(E^{PRE}\left[(1+z)u|\mathcal{F}\right] - E\left[(1+z)u|\mathcal{F}\right]\right) \\
& + 2Cov\left(\left(1+z\right)u - E^{PRE}\left[(1+z)u|\mathcal{F}\right], E^{PRE}\left[(1+z)u|\mathcal{F}\right] - E\left[(1+z)u|\mathcal{F}\right]\right)
\end{aligned} \tag{42}
$$

where $E^{PRE}\left[(1+z)u|\mathcal{F}\right]$ is the forecast of deal value based on deal terms if SPAC investors have perfect rational expectation (i.e., assume that they can make perfect use of the deal terms to infer deal fundamentals). The first term on the RHS represents the first source we discussed above, that is, how revealing the deal terms are regarding deal fundamentals. In calculating this term, we assume that SPAC investors can make perfect use of the observed deal terms and extract all relevant information from them. The second term on the RHS represents the second source, that is, how much of the forecast error can be attributed to the SPAC investors' imperfect expectation resulting from σ_e in equation (36). The last term on the RHS is the covariance between the two components above.

To implement this decomposition of forecast errors, we create a hypothetical SPAC investor in our model simulation. We assume that this hypothetical SPAC investor is able to make perfect use of the observed deal terms to infer deal fundamentals. More specifically, we make his $\sigma_e \to 0$ in equation (36) and therefore he is endowed with perfect expectations of the optimal deal terms (θ^*, K^*, n^*). He is, however, still subject to the two constraints in the baseline model: first, he cannot observe the deal fundamentals (ℓ, z, u), and second, he has a random component in his utility function as he makes redemption decisions and thus equation (35) describes his likelihood of redemption given his expectation of deal value. Sticking to these two constraints makes this hypothetical investor comparable to the regular SPAC investors in all aspects except his σ_e.

We first compare expected deal values in Figure 6. The left panel shows the expected deal value for "regular" SPAC investors, while the right panel shows the expected deal value for the hypothetical investor (with perfectly rational expectations). We place the true deal value $(1+z)u$ on the x-axis and the expected deal value on the y-axis

($E\left[(1+z)u|\mathcal{F}\right]$ for the left panel and $E^{PRE}\left[(1+z)u|\mathcal{F}\right]$ for the right panel). The 45-degree dash line therefore marks the forecasts with 100% accuracy. The scattered dots represent simulated deals and each deal has its true deal value and the deal value expected by investors. In general, expected deal values are positively correlated with true deal values in both panels, but the correlation is much higher for the hypothetical investor, suggesting that he is making a more accurate forecast. Forecasting the value of large deals is particularly challenging for "regular" SPAC investors, as we observe that their predicted deal value caps out at around 40, while the true deal value grows as high as 70. The intuition is that, for large deals, it is even more difficult to infer whether the deal value is driven by value creation (high z) or by the value of the target (high u), and these two cases have rather different implications for the value split. For deals with high value creation, all parties should benefit, while for deals with high target value, more shares need to be allocated to target shareholders. Pooling together these deals creates more confusion for SPAC investors and thus generates more opportunity for wealth transfer from SPAC investors to the the sponsor and target owners. This figure also shows the concept of pooling: the same level of expected deal value (i.e., fix a value of y and draw a horizontal line) maps to many different levels of true deal values on the x-axis. That means, investors are confused about deal value and sometimes cannot tell apart good deals from bad deals. Pooling is particularly pronounced for "regular" SPAC investors and when deals under consideration are large.

Using the hypothetical investor's expected deal value as $E^{PRE}\left[(1+z)u|\mathcal{F}\right]$, we are able to perform the decomposition of forecast errors in equation (42). Panel B of Table 5 shows the results. About 47% of forecast errors can be attributed to SPAC investors' imperfect use of observed deal terms as signals, while the covariance is negligible and accounts for less than 1% of the total forecast errors. That means "regular" SPAC investors can reduce their forecast errors by almost half if they can fully extract the information embedded in the deal terms. Combining our findings above that the total forecast errors are about 15.4% of the cross sectional variation in deal value, our estimate suggests that the fundamental information asymmetry is about 8% of the deal value variation ($15.4\% \times 0.52 = 8.01\%$), and investors' imperfect expectation adds another 7.4% noise.

Last, we examine the effect of information asymmetry. Bearing in mind that SPAC investors cannot, in reality, observe deal value, our focus here is on the comparison between "regular" SPAC investors and the hypothetical investor. We assess how much an individual investor can expect to gain if he can make better use of the public information embedded in the announced deal terms. We compute the expected return for an atomistic investor as follows:

$$\begin{aligned} E\left[ret\right] &= E\left[\left(\frac{V}{N}-1\right)\cdot\left(1-\delta_{i,B}^{*}\right)+0\cdot\delta_{i,B}^{*}\right] \\ &= E\left[\left(\frac{V}{N}-1\right)\cdot\left(1-\delta_{B}^{*}\right)\right] \end{aligned} \tag{43}$$

where $\delta_{i,B}^{*}$ is the redemption decision by an individual investor, defined in equation (34), and δ_{B}^{*} is its expected value as the conditional choice probability, defined in equation (35). The first line of equation (43) follows because the investor gets a return of $\frac{V}{N}-1$ if he stays with the combined firm and a return of 0 if he redeems his share. The second line follows as we apply iterated expectations on the random utility component ϵ_i in equation (34) so that $\delta_{i,B}^{*}$ averages to δ_{B}^{*}.

We compare the expected return to the hypothetical investor (denoted by subscript PRE) with that of a regular SPAC investor (denoted by subscript REG):

$$\begin{aligned} E\left[ret_{PRE}\right]-E\left[ret_{REG}\right] &= E\left[\left(\frac{V}{N}-1\right)\cdot\left(\delta_{B,PRE}^{*}-\delta_{B,REG}^{*}\right)\right] \\ &= E\left[\left(\frac{V}{N}-1\right)\cdot\Delta\delta_{B}^{*}\right] \end{aligned} \tag{44}$$

As a result, the return improvement, if any, must arise from the difference in the redemption decision made by these two investors, $\Delta\delta_{B}^{*}$. Intuitively, the hypothetical investor can earn a higher expected return if his redemption decision is more accurate, or equivalently, more negatively correlated with the return to staying shareholders. We can further break down the return difference into four components:

$$
\begin{aligned}
E\left[ret_{PRE}\right] - E\left[ret_{REG}\right] = \\
&\underbrace{E\left[\left(\frac{V}{N}-1\right)\cdot\Delta\delta_B^*|\frac{V}{N}-1<0,\Delta\delta_B^*>0\right]\cdot P\left(\frac{V}{N}-1<0,\Delta\delta_B^*>0\right)}_{avoid\ bad\ deals} \\
&+\underbrace{E\left[\left(\frac{V}{N}-1\right)\cdot\Delta\delta_B^*|\frac{V}{N}-1>0,\Delta\delta_B^*<0\right]\cdot P\left(\frac{V}{N}-1>0,\Delta\delta_B^*<0\right)}_{catch\ good\ deals} \\
&+\underbrace{E\left[\left(\frac{V}{N}-1\right)\cdot\Delta\delta_B^*|\frac{V}{N}-1>0,\Delta\delta_B^*>0\right]\cdot P\left(\frac{V}{N}-1>0,\Delta\delta_B^*>0\right)}_{miss\ good\ deals} \\
&+\underbrace{E\left[\left(\frac{V}{N}-1\right)\cdot\Delta\delta_B^*|\frac{V}{N}-1<0,\Delta\delta_B^*<0\right]\cdot P\left(\frac{V}{N}-1<0,\Delta\delta_B^*<0\right)}_{fall\ into\ bad\ deals}
\end{aligned}
\tag{45}
$$

The first term on the RHS captures the change in return due to avoiding more bad deals. Specifically, if the proposed deal is bad for investors, that is, $\frac{V}{N}-1<0$, then the expected return to an investor rises if the likelihood of redemption increases, $\Delta\delta_B^*>0$. $E\left[\left(\frac{V}{N}-1\right)\cdot\Delta\delta_B^*|\frac{V}{N}-1<0,\Delta\delta_B^*>0\right]$ measures the intensive margin while $P(\frac{V}{N}-1<0, \Delta\delta_B^*>0)$ measures the extensive margin. Similarly, the second term on the RHS reflects the change in return due to catching more good deals. This happens when $\frac{V}{N}-1>0$ and $\Delta\delta_B^*<0$. Meanwhile, even though the hypothetical investor processes public information more accurately, there is no guarantee that he does better than a regular SPAC investor in each individual deal. After all, in a pooling equilibrium, one has to infer deal fundamental from observables, and if these observables are sometimes misleading, then a more thorough interpretation of the observables can make things worse. As a result, the third and fourth term on the RHS of equation (45) capture the possible under-performance of the hypothetical investor, relative to a regular SPAC investor, which arises from possibly missing good deals and falling into bad deals. How much each component contributes to the total improvement in the return earned by the hypothetical investor is an empirical question, and we use our model to perform this decomposition.

Panel C of Table 5 reports our findings. First, the hypothetical investor, on average, earns an expected return that is 4.27 percentage-points higher than that of a "regular"

SPAC investor. Among the four components, the benefit from avoiding bad deals contributes the most to this gain, amounting to 4.07 percentage-point. This happens in about 44% of deals (i.e., extensive margin), and the average gain from a higher redemption likelihood in these deals is 9.3 percentage-point (i.e., intensive margin).

In 39% of deals, the hypothetical investor is better at catching a positive return by reducing his redemption likelihood. Despite this sizeable extensive margin, the intensive margin seems much lower and the average gain from a lower redemption likelihood in these deals is only 0.88 percentage-points. Combining the extensive margin and intensive margin, we find that this component of "catching good deals" adds 0.34 percentage-points to the return difference.

The hypothetical investor indeed under-performs regular SPAC investors occasionally. In about 17.5% of deals, the hypothetical investor seems to be too conservative and thus misses out on deals with positive returns. The conditional loss in such cases, however, is not substantial, as the average return to these deals is only 0.78 percentage-points. Missing out on these marginal deals only reduces the hypothetical investor's return by 0.14 percentage-points. Compared with a regular SPAC investor, the hypothetical investor almost always has a lower chance of falling into bad deals and the return difference attributed to this component is virtually zero.

In Figure 7, we plot the joint distribution of $\frac{V}{N}-1$ and $\Delta\delta_B^*$, with each point representing a deal simulated from the model. In general, $\frac{V}{N}-1$ and $\Delta\delta_B^*$ are negatively correlated, implying that the hypothetical investor tends to redeem more often when the return from staying is low. We observe a large mass of deals clustering in the north-west region and they represent the deals in which the hypothetical investor is better at avoiding bad deals. We also observe deals clustering in the south-east region and they represent the deals in which the hypothetical investor is better at catching good deals.[24] The hypothetical investor under-performs "regular" SPAC investors in the north-east region and south-west region, in which $\frac{V}{N}-1$ and $\Delta\delta_B^*$ have the same sign. Such incidences, however, happen with a much lower probability and have a much smaller impact on returns.

[24] In this figure, the fraction of these deals appears to be much smaller than the extensive margin we reported above in the table (39%), and this is because many deals cluster too close to each other or even overlap in this region, and thus multiple deals may show up as one point.

8 Conclusion

The recent boom in SPACs has attracted considerable attention from both researchers and practitioners. The unique structure and business model of SPACs calls into question the specific incentives of SPAC sponsors and the associated welfare of their retail investors. In this paper we quantitatively investigate these effects and the consequences of information opaqueness faced by public investors. Our results suggest that agency costs among SPACs sponsors are pervasive and have significant influence on deal outcomes: on average, there is a 18% difference in expected returns between deals in the lowest quintile of agency cost and those in the highest quintile. The average SPAC investor also makes imperfect inferences of the underlying deal value. This costs them in terms of return, which is 4.3% lower, mainly due to their inability to recognize and abandon low-value deals.

Our study contributes to the ongoing debate over possible regulations over the SPAC market. On March 30, 2022, the SEC approved the issuance of rules and amendments regarding the SPAC market, particularly highlighting the principles of "providing investors with additional information regarding a proposed de-SPAC transaction" and "addressing concerns regarding potential conflicts of interest and misaligned incentives." Meanwhile, these proposals met with a mixed reception in the financial industry, with some practitioners warning that these regulations would "kill the industry" by creating "too much liability for parties involved in SPAC deals, and as such goes further than traditional IPO and MA rules."[25] Our results shed light on this policy debate by quantifying the incentive conflicts between SPAC sponsors and SPAC investors, as well as the potential welfare impact on retail SPAC investors resulting from an improvement of the information transparency regarding the fundamentals of the de-SPAC transactions.

To maintain our focus, we prioritize the central role played by SPAC sponsors and minimize the decisions of SPAC targets regarding their willingness to accept the terms proposed. Interesting questions thus remain such as the trade-off SPAC targets face when they choose selling themselves to a SPAC over a traditional IPO or over staying private. We leave these questions to future research.

[25]U.S. financial firms push back on SEC bid to rein-in blank check company deals. *Reuters*, June 14, 2022.

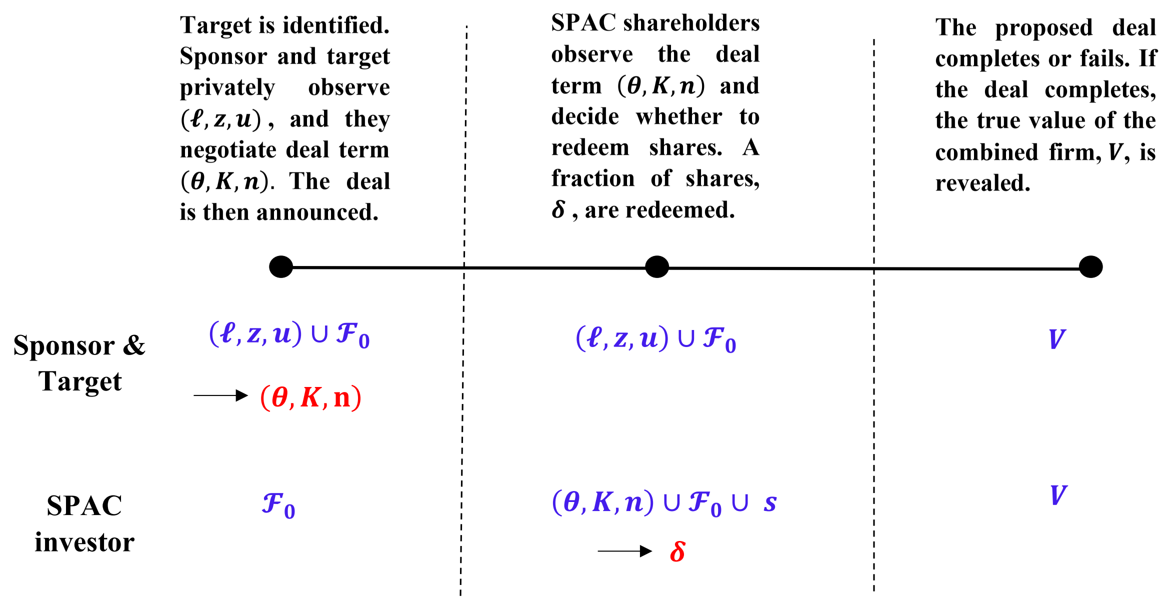

Figure 1. Model timeline.

This figure describes the timeline of the model. Variables in blue denote the information set of different agents, and variables in red denote their corresponding actions. The model contains three stages. In the first stage, the sponsor identifies a potential target firm, and they negotiate the deal terms. They observe the deal fundamental including the sponsor's agency cost (1-ℓ), value creation (z), and the target's reservation value as a private entity (u). Anticipating the SPAC investors' redemption decision δ in the next stage, they choose the compensation accrued to the sponsor θ, the shares offered to the target n, and any additional capital to be raised externally K. In the second stage, the SPAC investors observe the deal terms (θ, K, n) and a possible signal regarding the deal quality s, and they choose the redemption rate δ. In the last stage, the true value of the combined firm V is revealed if the deal completes.

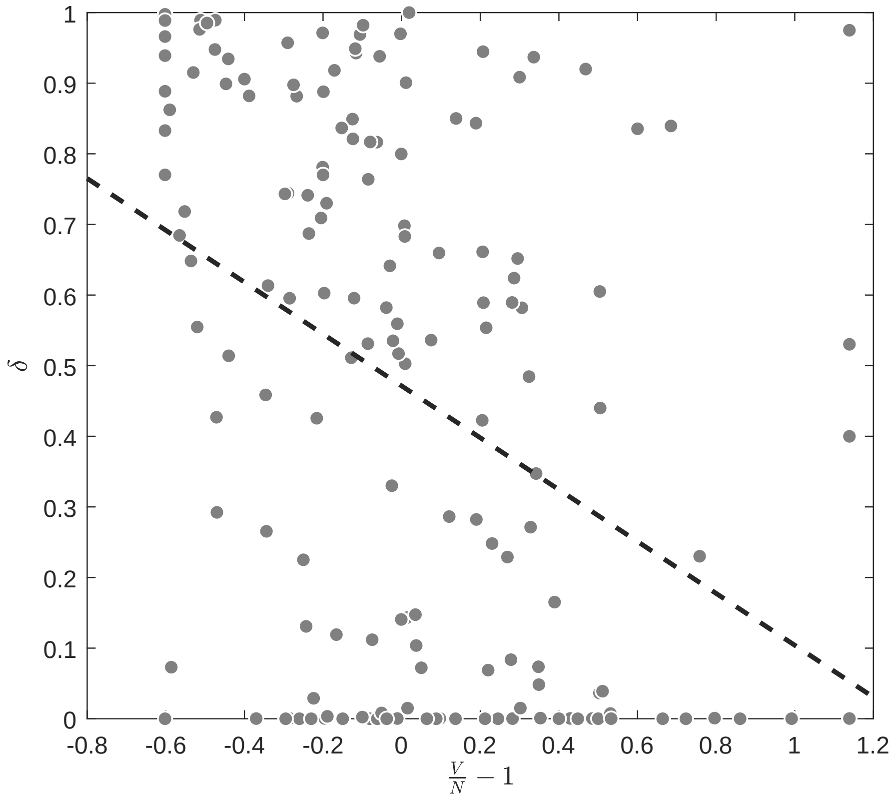

Figure 2. Redemption rate and ex-post deal performance

This figure shows the relation between the aggregate redemption rate and ex-post deal performance in the data. Deal performance is measured as the share price 3-month post deal completion relative to the face value of the shares at IPO \$10 (which is normalized to 1). The scattered dots represent individual deals and the dash line depicts the best fit of a linear relation between redemption and deal performance. There exists a significant, negative association between the redemption rate and ex-post deal performance in the data.

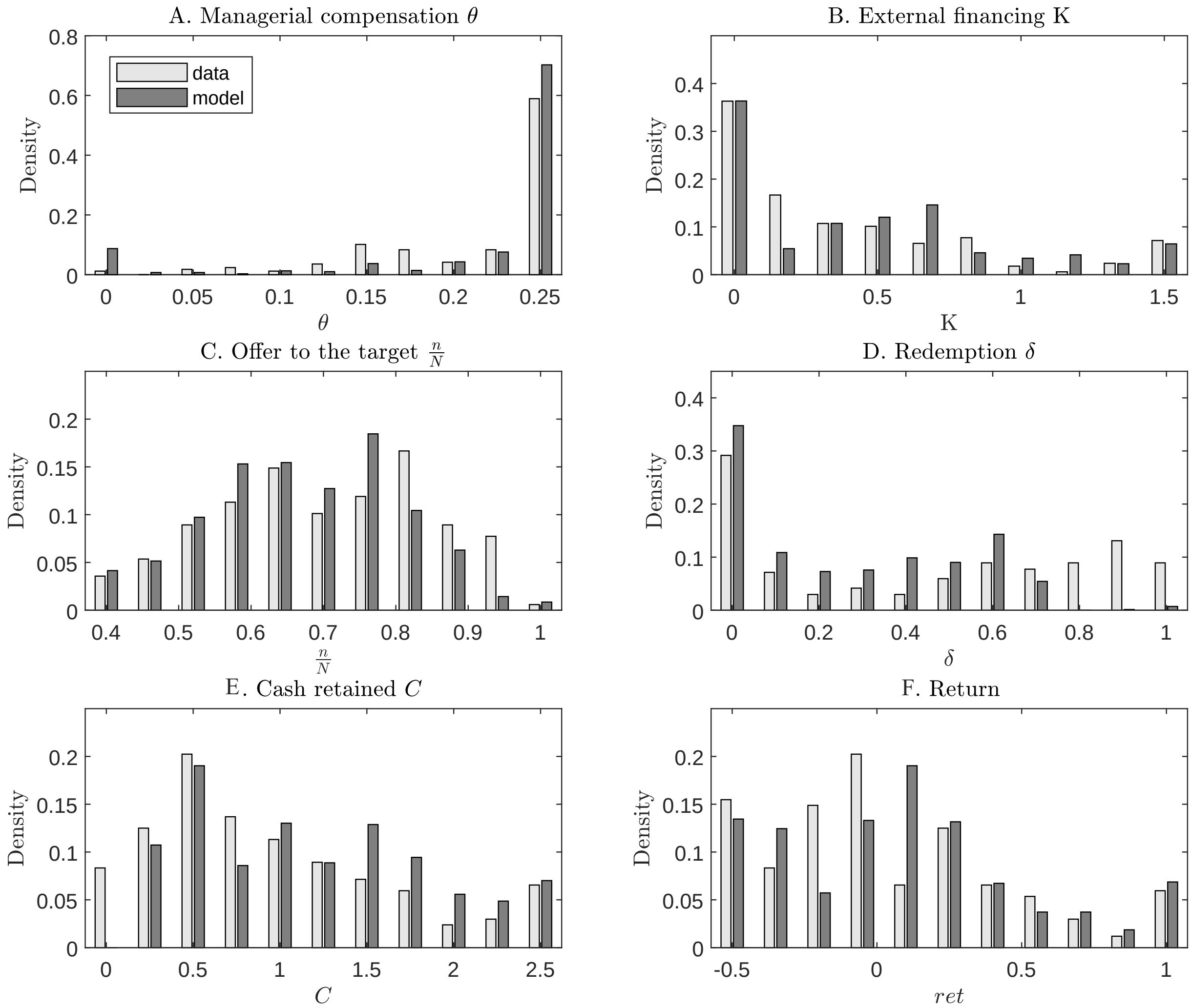

Figure 3. Model fit on variable distributions

This figure illustrates the model fit on the distribution of observable variables. We compare the empirical distribution of a variable (plotted in white bars) with its model-implied distribution (plotted in gray bars). Panel A shows the comparison for the sponsor's compensation θ, panel B shows the distribution for external capital raised K, panel C shows the distribution for offers made to the target, expressed as a fraction of ownership in the combined firm $\frac{n}{N}$, panel D compares the distribution of redemption rate δ in the model and in the data, panel E shows the distribution of cash retained in the firm C, and panel F shows the ex-post deal performance $\frac{V}{N} - 1$.

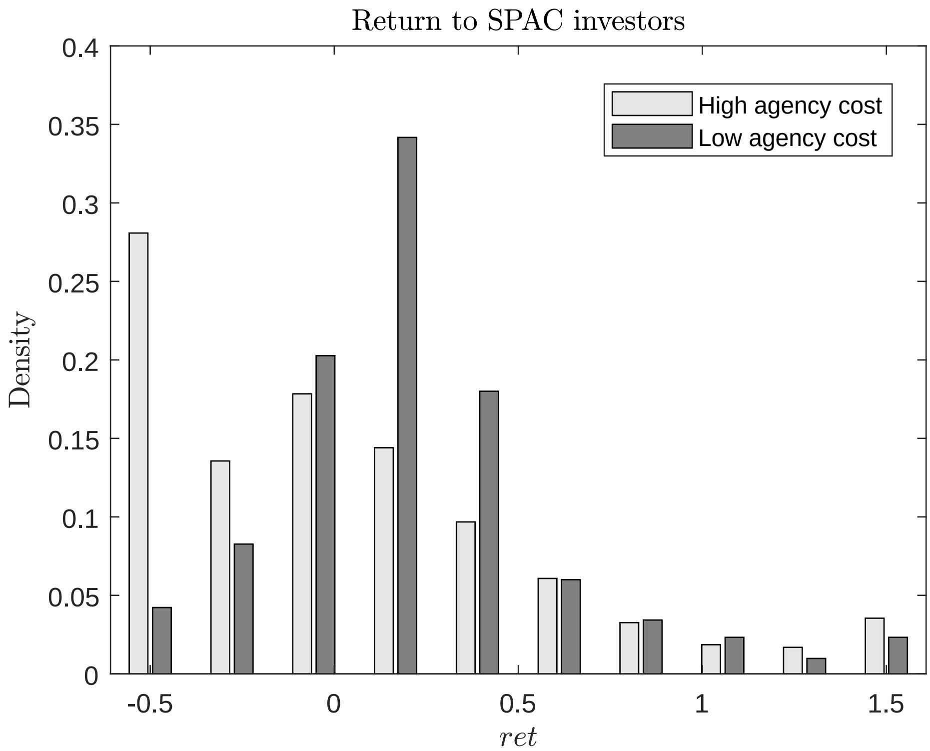

Figure 4. Returns to SPAC investors: low vs. high agency cost

This figure compares the distribution of returns to SPAC investors for deals with low agency cost (bottom quintile) and high agency cost (top quintile). The white bars show the distribution of returns in deals with high agency cost and the gray bars show that for low agency cost. Returns to SPAC investors are calculated as $\frac{V}{N} - 1$ in the simulated sample.

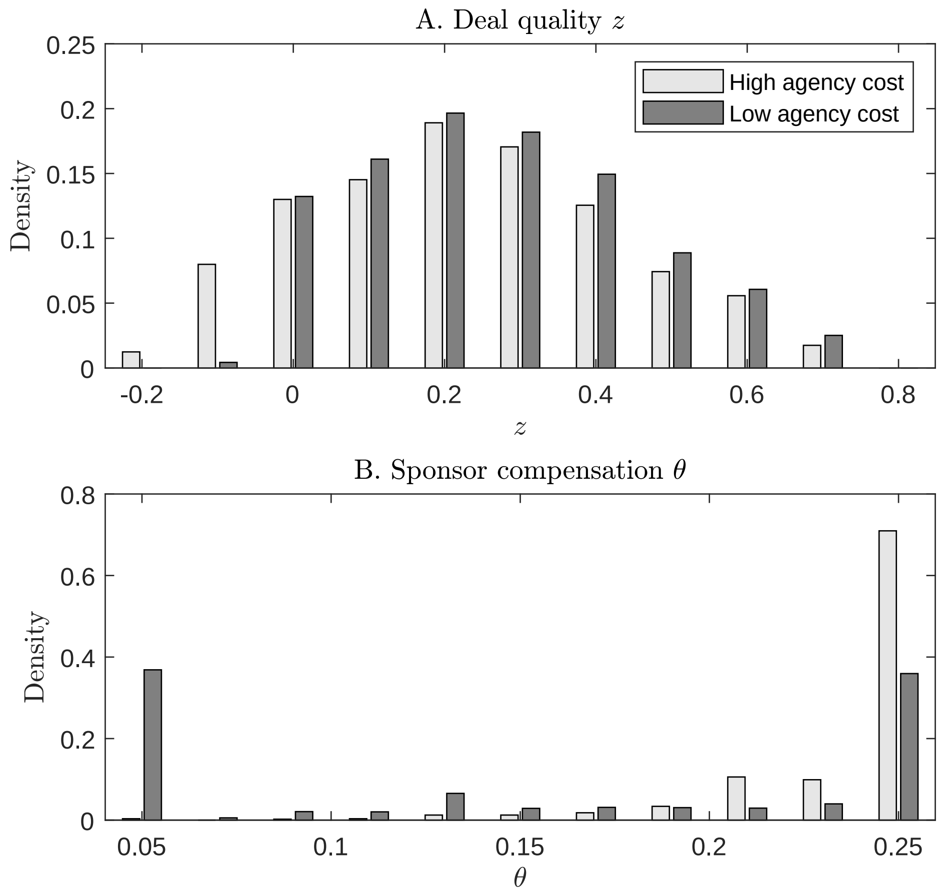

Figure 5. Deal quality and sponsor compensation: low vs. high agency cost

This figure compares the distribution of deal quality z (Panel A) and the sponsor's compensation (Panel B) for deals with low agency cost (bottom quintile) and high agency cost (top quintile). The white bars show the distribution of returns in deals with high agency cost and the gray bars show that for low agency cost.

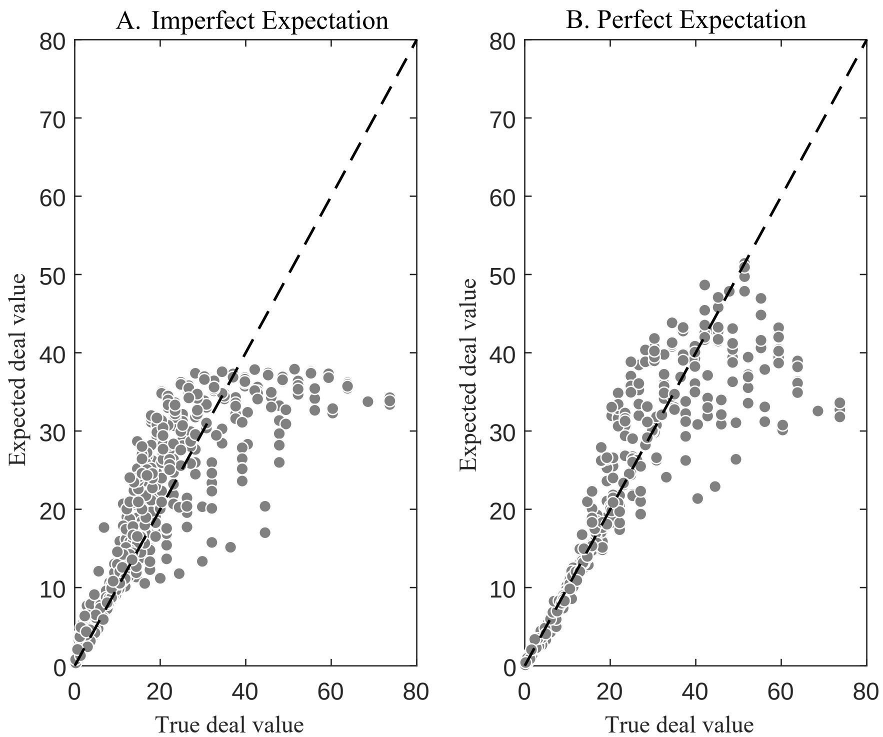

Figure 6. Forecast of deal value: imperfect vs. perfect expectation

This figure compares the forecast of deal values by an investor with imperfect expectation (panel A) and an investor with perfect expectation (panel B). The investor with imperfect expectation is a regular SPAC investor in the model, whose inference of deal value may deviate from what is implied by the observed deal terms, and the investor with perfect expectation is constructed as a hypothetical investor whose inference of deal value is perfectly consistent with the observed deal terms. The true deal value is on x-axis and the expected deal value is on y-axis, and therefore the dash line (45-degree line) represents the accurate forecast. We simulate the model and plot the simulation results in scattered dots. A better forecast, or a more accurate expectation of deal value, implies that the dots cluster closely to the dash line.

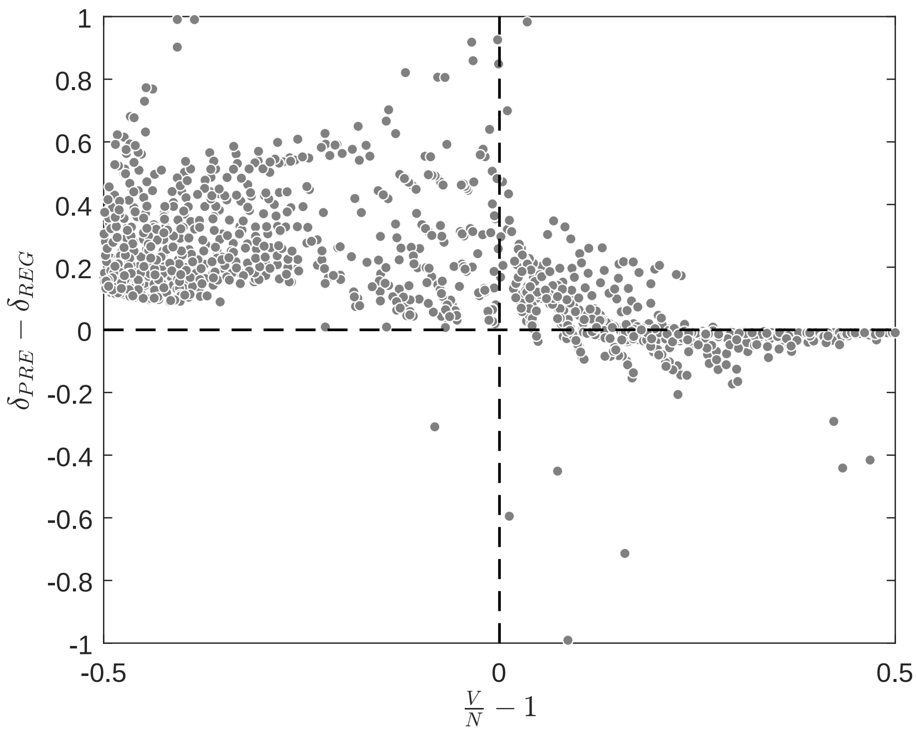

Figure 7. Redemption likelihood and deal performance: imperfect vs. perfect expectation

This figure shows the relation between the ex-post deal performance and the difference in redemption likelihood for an investor with perfect expectation and an investor with imperfect expectation. We plot the ex-post deal performance on x-axis and the difference in redemption likelihood between the two investors on y-axis. The figure is divided into four regions by the two dash lines. In the north-west and south-east region, redemption likelihood increases (decreases) as deal performance is low (high) for the investor with perfect expectation, and they characterize the deals in which the investor with perfect expectation outperform the investor with imperfect expectation in avoiding more bad deals (north-west region) or catching more good deals (south-east region). The investor with perfect expectation occasionally underperforms the investor with imperfect expectation, as in the north-east and south-west region, and this happens because the observed deal terms are sometimes misleading signals for deal quality in a pooling equilibrium.

Table 1. Number of SPACs over Time

This table reports registered number of SPACs and the deal outcomes from 2009 to 2019. A SPAC is considered "registered" if they have filed From S-1 with the SEC. "Completed Combo" refers to SPACs that have successfully completed a business combination within the designated 2-year time frame. "Liquidated" refers to SPACs that were unable to complete a business combination within the designated time frame and decided to redeem all shares and liquidate. "Deal on Table" refers to SPACs that have announced but not yet completed a business combination. Finally "Still Seeking" refers to SPACs that have yet to identify a partner with whom to pursue a business combination.

	Total Registered	Completed Combo	Liquidated	Deal on Table	Still Seeking
2009	2	2	0	0	0
2010	9	4	5	0	0
2011	20	16	4	0	0
2012	3	2	1	0	0
2013	10	8	2	0	0
2014	15	11	4	0	0
2015	16	14	2	0	0
2016	15	13	2	0	0
2017	37	34	3	0	0
2018	46	43	1	2	0
2019	57	40	1	14	2
Totals	230	187	25	16	2

Table 2. Summary Statistics

Panel A reports summary statistics for SPAC deals. Reported variables include SPAC IPO proceeds, which refers to the amount raised by SPACs in their IPOs, taking into account any exercise of the over-allotment option; Sponsor Earn-outs refers to portions of the sponsor's promote whose vesting is tied to performance metrics; Target Earn-outs refer are similar to sponsor Earn-outs, but are part of the consideration offered to the target owners; Performance is measured the 3-month post de-SPAC return relative to the baseline of 10; Private Placement refers to any funds raised via unregistered equity sales and are used to supplement the SPAC's cash trust; Total redemptions refers to the total number of shares redeemed by SPAC shareholders up to and including at the final up or down vote on the proposed business combination; Promote shares forfeited refers to the number of the sponsor's promote shares that he has offered to forfeit without compensation; Private Placement warrants forfeited are analogously defined for private placement warrants purchased by the sponsor concurrently with the SPAC's IPO; Total consideration refers to the dollar value of consideration (sum of cash and shares) paid to target owners; and Percent Cash refers to the fraction of consideration paid to that target that is cash. Panel B reports a subset of the same characteristics of SPACs as in Panel A, but stated in terms relative to IPO shares sold. Reported values are in millions of dollars.

Panel A. SPAC Deal Characteristics

	Mean	Median	75th %ile	25th %ile	Std Dev	Non-Zero Avg.	Non-Zero Obs
IPO Proceeds	227	201.25	310	80.5	166.45	n/a	n/a
Sponsor Earn-outs	n/a	0	0.5	0	3.14	2.38	49
Target Earn-outs	n/a	0	3.45	0	31.38	13.08	63
Performance (3-mth return)	6.71%	-7.5%	27.8%	-34.4%	56.61%	n/a	n/a
Private Placement (FPA, PIPE, Backstop)	n/a	30	150	0	240.24	186.31	117
Total Redemptions	8.78	4.67	14.28	0.22	10.44	n/a	n/a
Promote Shares Forfeited	n/a	0	1.25	0	1.58	1.77	87
Priv Plac Warrants Forfeited	n/a	0	0	0	4.42	4.61	29
Total Consideration	751.38	380	950	174.31	1354.85	n/a	n/a
Percent Cash	n/a	0	23.53%	0	29.64%	34.45%	87

Panel B. Relative to IPO Cash/Shares

	Mean	Median	75th %ile	25th %ile	Std Dev
Private Placement (FPA, PIPE, Backstop)	0.43	0.23	0.65	0.00	0.58
Redemptions (% of IPO Shares)	0.46	0.53	0.84	0.01	0.38
Promote Stake Retained (0.25 is Max)	0.21	0.25	0.25	0.21	0.05
Shares Granted (Consideration)	3.47	2.52	4.14	1.55	3.91
Total Shares	4.71	3.71	5.46	2.49	4.23

Table 3. Model fit: empirical moments vs. model-implied moments

This table reports the model fit. The first column lists the 11 moments we target to match in the simulated method of moments (SMM), the second column provides the definition for each moment, and the third and fourth column show the empirical value of the moments and the model-implied counterparts. K is the external capital raised by a SPAC firm via PIPE or FRA after SPAC IPO; δ is the aggregate redemption rate, measured as the amount of IPO shares redeemed scaled by the total number of IPO shares; θ is the sponsor's promote stake normalized by the number of IPO shares; $\frac{n}{N}$ is the offer made to the target, expressed as the ownership in the combined firm post deal completion; ret is the deal performance, and it is calculated as the share price 3-month post deal completion divided by the face of shares at IPO \$10 minus one in the data, and in the model, it corresponds to $\frac{V}{N} - 1$.

Moment	Definition	Empirical value	Simulated value
Frac(K=0)	The fraction of deals with zero external capital	0.361	0.333
Mean(K)	Avg. external capital raised	0.455	0.429
Std(K)	Stdev. of external capital raised across deals	0.464	0.575
Frac($0.1 < \delta < 0.9$)	The fraction of deals with redemption ratio between 10% and 90%	0.588	0.506
RegCoef(δ, ret)	Regression coefficient of regressing delta on returns to SPAC investors	-0.467	-0.367
Mean(θ)	Avg. compensation to sponsor	0.212	0.211
Std(θ)	Stdev. of compensation to sponsor across deals	0.076	0.067
Mean($\frac{n}{N}$)	Avg. fraction of the combined firm's shares offered to the target	0.670	0.698
Std($\frac{n}{N}$)	Stdev. of the fraction of the combined firm's shares offered to the target	0.136	0.158
Mean(ret)	Avg. return to SPAC investors	0.088	0.038
Std(ret)	Stdev. of returns to SPAC investors across deals	0.423	0.438

Table 4. Parameter value calibration

This table reports the calibrated model parameters. We search the value of parameters to minimize the distance between the empirical moments and the model-implied moments in SMM. The first column of the table lists the notation of parameters, the second column provides the definition of the parameters, and the third column reports the calibrated parameter values.

Parameter	Definition	Value
σ_e	The precision of SPAC investors' expectation regarding sponsors' policy	0.07
ϕ_1	The linear component of variable cost of raising external capital	0.03
ϕ_2	The quadratic (convex) component of variable cost of raising external capital	0.14
σ_δ	Heterogeneity of SPAC investors' redemption threshold	0.33
a	Beta distribution parameter for sponsor agency cost	1.00
b	Beta distribution parameter for sponsor agency cost	1.00
μ_z	Avg. of deal quality $ln(1+z)$	0.16
σ_z	Stdev. of deal quality across deals $ln(1+z)$	0.18
μ_u	Avg. of $ln(u)$, u is the target value as a private entity	0.78
σ_u	Stdev. of $ln(u)$, u is the target value as a private entity	1.50
γ	Sensitivity of deal completion rate w.r.t. cash retained	1.00
λ	Offset to control the average deal completion rate	-0.10

Table 5. The effect of information asymmetry

This table reports our estimate of the magnitude of information asymmetry between SPAC investors and the sponsor as well as the effect of information asymmetry on SPAC investors' returns. Panel A decomposes the total variance of the cross-sectional deal value into the variance of the expected deal value and the variance of the forecast errors resulted from information asymmetry. Panel B attributes the forecast errors to two sources: forecast errors resulted from the pooling equilibrium in which deal value is not fully revealed even when investors have perfect expectation, and forecast errors resulted from the investors' imperfect expectation. Panel C shows the improvement in average returns for an investor when he moves from imperfect expectation to perfect expectation. It also breaks down the improvement into four components to demonstrate the main source of the improvement.

Panel A. Variance decomposition of deal value	
$Var((1+z)u)$	1
$Var(E[(1+z)u\|F])$	0.846
$Var(\epsilon)$	0.154

Panel B. Variance decomposition of forecast errors	
$Var((1+z)u - E[(1+z)u\|F])$	1
$Var((1+z)u - E^{PRE}[(1+z)u\|F])$	0.519
$Var(E^{PRE}[(1+z)u\|F] - E[(1+z)u\|F])$	0.472
$2Cov((1+z)u - E^{PRE}[(1+z)u\|F], E^{PRE}[(1+z)u\|F] - E[(1+z)u\|F])$	0.009

Panel C. Gains from perfect expectation

	Total	Extensive Margin	Intensive Margin
Avoid bad deals	4.07%	0.438	9.29%
Catch good deals	0.34%	0.386	0.88%
Miss good deals	-0.14%	0.175	-0.78%
Fall in bad deals	-0.002%	0.001	-2.53%
Ret_{PRE}-Ret_{REG}	4.27%		

References

Albuquerque, R. and E. Schroth (2015). The value of control and the costs of illiquidity. *Journal of Finance 70*(4), 1405–1455.

Bai, J., A. Ma, and M. Zheng (2021). Segmented going-public markets and the demand for SPACs. *Available at SSRN 3746490*.

Banerjee, S. and M. Szydlowski (2021). Harnessing the overconfidence of the crowd: A theory of SPACs. *Available at SSRN 3930346*.

Ben-Akiva, M., N. Litinas, and K. Tsunokawa (1985). Continuous spatial choice: the continuous logit model and distributions of trips and urban densities. *Transportation Research Part A: General 19*(2), 119–154.

Blomkvist, M. and M. Vulanovic (2020). SPAC IPO waves. *Economics Letters 197*, 109645.

Celik, M. A., X. Tian, and W. Wang (2021). Acquiring innovation under information frictions. *Review of Financial Studies, Forthcoming*.

Chatterjee, S., N. Chidambaran, and G. Goswami (2016). Security design for a non-standard IPO: The case of SPACs. *Journal of International Money and Finance 69*, 151–178.

Cumming, D., L. H. Haß, and D. Schweizer (2014). The fast track IPO–Success factors for taking firms public with SPACs. *Journal of Banking & Finance 47*, 198–213.

Dambra, M., O. Even-Tov, and K. George (2021). Should SPAC Forecasts be Sacked? *Available at SSRN 3933037*.

David, J. M., H. A. Hopenhayn, and V. Venkateswaran (2016). Information, misallocation, and aggregate productivity. *Quarterly Journal of Economics 131*(2), 943–1005.

Dimitrova, L. (2017). Perverse incentives of special purpose acquisition companies, the "poor man's private equity funds". *Journal of Accounting and Economics 63*(1), 99–120.

Gahng, M., J. R. Ritter, and D. Zhang (2021). SPACs. *Available at SSRN 3775847*.

Gryglewicz, S., B. Hartman-Glaser, and S. Mayer (2021). PE for the Public: The Rise of SPACs. *Available at SSRN 3947368*.

Jenkinson, T. and M. Sousa (2011). Why SPAC investors should listen to the market. *Journal of Applied Finance 21*(2).

Klausner, M., M. Ohlrogge, and E. Ruan (2020). A sober look at SPACs. *Yale Journal on Regulation, Forthcoming, Stanford Law and Economics Olin Working Paper* (559), 20–48.

Kolb, J. and T. Tykvova (2016). Going public via special purpose acquisition companies: Frogs do not turn into princes. *Journal of Corporate Finance 40*, 80–96.

Lewellen, S. (2009). SPACs as an asset class. *Available at SSRN 1284999*.

Lin, C., F. Lu, R. Michaely, and S. Qin (2021). SAPC IPOs and sponsor network centrality. *Available at SSRN 3856181*.

Luo, D. and J. Sun (2021). A dynamic delegated investment model of SPACs. *Available at SSRN 3929762*.

Nikolov, B. and T. M. Whited (2014). Agency conflicts and cash: Estimates from a dynamic model. *Journal of Finance 69*(5), 1883–1921.

Paul Kiernan (2021, December). Gensler Seeks to Even Up SPACs/IPOs. The Wall Street Journal. https://www.wsj.com/articles/secs-gary-gensler-seeks-to-level-playing-field-between-spacs-traditional-ipos-11639063202.

Rodrigues, U. and M. Stegemoller (2014). What all-cash companies tell us about IPOs and acquisitions. *Journal of Corporate Finance 29*, 111–121.

Wang, W. and Y. Wu (2020). Managerial control benefits and takeover market efficiency. *Journal of Financial Economics 136*(3), 857–878.