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 this unique business model and particularly the incentives of the SPAC sponsors on the welfare of SPAC shareholders. 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 SPACs that completed acquisitions between 2009 and April 2022 with rich information such as sponsor concessions, earnouts, redemptions, etc. Agency costs appear pervasive: the inter-quintile range of returns to non-redeeming shareholders reaches 19% in deals sorted by their agency conflicts. Average SPAC investors make sizeable mistakes in inferring deal quality, leading them to earn a 7% lower return. Tying more of the sponsor's promote shares to earnouts significantly reduces the agency cost and improves investors' expected return, while cutting back the issuance of warrants has a limited impact on the average SPAC investors' welfare.

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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 there were 861 SPAC IPOs (more than two-thirds of all IPOs) raising close to $220 billion of new capital in the US alone. Yet, as the broader equity market sold off 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 shareholders. 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] The "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 shareholders suffer substantial losses. In contrast, if the SPAC fails to complete a deal within the allotted time (usually two years after its IPO), the SPAC is liquidated, outside investors are made whole, and SPAC sponsors get 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, and less than 8% of investors redeemed shares. 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 revenue. 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. Estimating a model using the hand-collected, comprehensive dataset on SPACs and their targets over a long horizon (2009 - April 2022), this paper aims

[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 has substantial value, while SPAC shareholders, who bought in around the IPO price ($10) or more would have lost at least 50%.

to quantify the impact of two primary frictions on the SPAC market: the agency costs associated with the compensation structure of SPAC sponsors, and the lack of information transparency on the welfare of SPAC shareholders. Using the estimated model as a laboratory, we further analyze the efficacy of several policies recently proposed by regulators and public commentators, and contribute to the ongoing debate over whether these policies are able to accomplish their stated goals.

We begin with a model that captures the interaction between the SPAC sponsor, the target, and the SPAC shareholders surrounding a proposed business combination. In our model, the 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 owners are equally informed about the target's prospects and the benefits that the SPAC can bring to the table. The sponsor and the target split the surplus created, if any, via bargaining. In particular, they negotiate deal terms that specify the sponsor's eventual stake, the offer made to the target, and any additional capital that needs to be raised externally. SPAC shareholders, 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 merged firm. If SPAC shareholders perceive dim prospects for a proposed deal, they are likely to redeem their shares, and a large number of redemption may put deal consummation at risk.

Our model characterizes the sponsor's optimal choice of deal terms and the SPAC shareholders' optimal redemption decision, taking into account the strategic interaction between them. The sponsor trades off sweeter deal terms that favor himself (but hurt SPAC shareholders) 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 shareholders, potentially tipping the scales against redemption. The sponsor can alter the value he places on the target business, by issuing fewer SPAC shares to the target owners, and forfeit a portion of his own compensation, as the bargaining protocol forces the target and the sponsor to share the cost. SPAC shareholders, 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.

With asymmetric information, 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 shareholders can make grave 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 shareholders 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 US-listed SPACs that completed acquisitions during 2009 and April 2022. One signature of our data that differentiates our work from previous studies is that it contains detailed terms regarding sponsor compensation (forfeited promote shares, private placement warrants, as well as sponsor earnouts), external financing brought in by the sponsors (e.g., forward purchase agreement (FPA), private investment in public equity (PIPE), etc), shares and cash offered to the target shareholders, and the aggregate redemption by SPAC shareholders. 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 shareholders 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 shareholders being able to partly infer deal quality based on observed deal terms. The sensitivity of SPAC shareholders' 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 shareholders to a greater extent and therefore are more likely to forfeit part of their compensation as needed. We estimate 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 estimated model fits the data well, capable of closely matching 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 shareholders, 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 shareholders. Comparing the deals in the lowest agency cost quintile with those in the highest agency cost quintile, we find that the difference in the SPAC shareholders' expected return averages 19 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 shareholders tend to subsidize the sponsor and the target, especially when deal quality is low.

Second, information asymmetry is substantial and it results in sizeable forecast errors in the SPAC shareholders' inference. Information asymmetry arises from two main sources: first, deal quality is not fully revealed in a pooling equilibrium, explaining about 30% of the forecast errors. Second, SPAC shareholders are unable to extract all the information embedded in the observed deal terms, and this *bounded rationality* undermines the accuracy of their inference of deal quality. This accounts for about 70% of the forecast errors. We find that eliminating this bounded rationality could improve the average returns to SPAC shareholders by 7 percentage-points.

Using the estimated model as a laboratory, we evaluate the efficacy of some regulatory changes recently proposed by the SEC and public commentators. The first proposed policy is to tie the sponsor's "promote" to earnouts, shares that are canceled if the post de-SPAC stock price fails to reach a pre-determined level (i.e., the trigger price). The proponents of this policy argue that such performance-based compensation helps better align the interest of the sponsors and shareholders.[4] The second proposed policy is to reduce the number of warrants issued in SPAC IPOs. Warrants are like call options, but when exercised, lead to the issuance of new shares and are hence dilutive. Advocates of this policy argue that cutting back warrants helps reduce dilution to the combined firm value and thus improves the returns to non-redeeming shareholders.

We carry out a few policy experiments by constructing counterfactual economies using the estimated model. In these counterfactual economies, we alter the fraction of sponsor promote tied to earnouts or cut back warrant issuance to different levels. Our policy experiments reveal that tying sponsor promote to earnouts significantly improves shareholder returns. Specifically, for every 10% increase in the fraction of sponsor promote tied to earnouts, the return to shareholders increases by 1.8 percentage-points. Such improvement is more pronounced for SPACs with high agency costs, bringing their performance close to that with low agency costs. Thus, earnouts help to curb the conflict of interest between the SPAC's sponsor and its shareholders. In contrast, we find that cutting back warrants has only limited effects on shareholder welfare: for every 10% reduction in the amount of warrants issued, the return to shareholders increases by only 0.28 percentage-points, which is about 15% of the magnitude achieved by earnouts. Moreover, cutting back warrants does little to mitigate agency costs, and the performance gap between the returns to shareholders under high and low agency costs widens. This is because the dilution due to warrant exercise is only a concern when post de-SPAC performance is strong, which is less likely when the agency cost is high.

[4] For example, "London SPACs - the Opportunity", https://www.winston.com/en/thought-leadership/london-spacs-the-opportunity.html.

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 its 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 (2022); Dambra, Even-Tov, and George (2021); Gahng, Ritter, and Zhang (2022); Lin, Lu, Michaely, and Qin (2021), etc. These studies add substantial new insights to the existing literature on SPACs, thanks to the exploding number of new observations in the last two years. Meanwhile, a few theoretical studies, notably, Alti and Cohn (2022), Bai, Ma, and Zheng (2021), Banerjee and Szydlowski (2021), Gryglewicz, Hartman-Glaser, and Mayer (2022), and Luo and Sun (2022) 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 (2022) and Luo and Sun (2022) consider the potential conflict of interests between sponsors and SPAC shareholders. 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, Hopenhayn, and Venkateswaran (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 also drags down productivity by 7-14%. Celik, Tian, and Wang (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 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 compensation is split between an up-front fee and a contingent fee, 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 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

[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 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.

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 because the PIPE financing is conditional on the completion of the business combination. 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 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 shareholders' 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

[7]Specifically, in the extreme, should SPAC shareholders 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.

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 (Kiernan, 2021). Along these lines, the Delaware Chancery Court has recently ruled 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

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

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 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 (there have been 3 since 2009, less than 1% of the total). 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

[9] 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).

[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] 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.

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.

3 Model

In this section, we set up the baseline model with the key features of SPACs introduced above. The model focuses on the de-SPAC stage, and it solves for the optimal deal terms chosen by the sponsor and target as well as the redemption decision made by the SPAC shareholders, highlighting the key frictions embedded in this process.

Throughout the section, the number of units issued in SPAC IPO is normalized to be one. We also normalize the proceed raised in SPAC IPO to be 1, which implies the numeraire is 10 dollars. Each SPAC unit contains one common share and a fraction, w, of warrants. w varies across SPACs, with the common value being 0, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$, or 1. For simplicity we assume w is given for each deal. In other words, we abstract away from any decisions in the SPAC IPO process, and take things such as the size of the IPO and the composition of each unit as given. These decisions are made before the SPAC sponsor meets a target and are thus less relevant for our objective of interest. Instead, we focus on the decisions during the de-SPAC process after the sponsor has found a target.

3.1 Value of the combined firm

In a proposed de-SPAC, the value of the combined firm is mainly determined by the amount of cash the SPAC firm brings to the deal and the value of the target firm post-merger. The cash brought in by the SPAC firm includes the amount of cash contributed by non-redeeming SPAC shareholders and the amount of cash raised externally through PIPE and/or FPA. Let δ denote the fraction of SPAC shares redeemed, and thus $1 - \delta$ dollars, contributed by the non-redeeming shares, are retained in the SPAC. Also denote the cash raised externally as K, then the total cash that the SPAC firm brings to the deal is:

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

We denote the value of the target firm, as a standalone, private entity, as u, and we assume that its value becomes $(1 + z) \cdot u$ if it merges with the SPAC. z therefore can be viewed as the return created through merging with the SPAC. For instance, z can represent the gains from publicly listing the target firm or any value created by SPAC sponsors for the combined firm (e.g., sponsor's network, advises, etc.). z may also go negative in some deals, if, for example, a premature target is brought to public.

In addition, for SPACs that issued warrants in their IPOs, these warrants will be exercised if the post-merger stock price is above the strike price of the warrants, which is usually set at 11.5 dollars in the data (and thus 1.15 dollars in the model). In exercising, warrant holders pay $1.15 \cdot w$ dollars to the combined firm in the model in exchange for w shares of ownership.

Adding up these components, we can write the value of the combined firm as:

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

where $\mathbf{1}_{\{p>1.15\}}$ is an indicator that equals one if the post-merger share price is above the strike and zero otherwise, and F is the total fee paid out including the underwriting fee and other fees.[12]

3.2 Ownership of the combined firm

The combined firm value is split among different agents in the model, proportional to their ownership in the merged entity post de-SPAC. The non-redeeming SPAC shareholders own $1 - \delta$ shares. The external financiers (e.g., PIPE investors), who purchase the SPAC shares at the IPO price, own K shares.

[12]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. Usually, 2% upfront fee is financed by the sponsor?s risk capital, and thus it should be deducted from F.

A unique feature of SPAC is that, right after IPO, the SPAC firms create additional promote shares, which equals 25% of the IPO shares, and award them to sponsors. The sponsors, therefore, own 0.25 shares to start with in our model. As we will model formally below, the sponsors sometimes may have incentive to forfeit part of their promote shares in order to retain shareholders, and thus we denote the sponsors' final ownership in the combined firm as $\theta \in [0, 0.25]$.

Finally, we assume that the target shareholders are offered n shares in the combined firm, compensating for the value they contribute in the merger. The warrant holders, if exercising, will own w shares.

The total number of shares in the combined firm post de-SPAC is thus equal to:

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

Given the post de-SPAC firm value V and total shares outstanding N, the post de-SPAC share price is:

$$p = \frac{V}{N}, \tag{4}$$

The above accounting identity illustrates the potential sources of dilution to the non-redeeming shareholders' ownership in the combined firm. Clearly, the sponsor's promote shares θ add to the denominator but not to the numerator, and thus dilute the firm value. The warrant holders, if exercising, cut more value out of the combined firm than what they pay for the strike price, resulting in more dilution.

3.3 Decision makers

As shown above, the SPAC market involves various agents interacting with each other. To remain focused, we divide these agents into peripheral players (with simplified decision rules) and key decision makers. The peripheral players include the external financiers and warrant holders. We assume that the SPAC sponsor decides how much external capital to raise and the external financiers simply supply that, i.e., K is one of sponsor's controls, subject to a standard convex funding costs to be specified later. The warrant holders follow the optimal exercising rule and always exercise the warrants when they are in-the-money.

The key decision makers include the sponsor, the target, and the SPAC shareholders. The sponsor and the target negotiate the *deal terms* (θ, K, n), which consists of the sponsor's compensation θ, the capital raised externally K, and the offer made to target shareholders n. The payoff to the target is $n \cdot p$ if the deal completes and u if the deal breaks down. As a result, the target's gain from a completed de-SPAC is:

$$U_{tar} = n \cdot p - u, \tag{5}$$

The sponsor receives θ promote shares as his compensation if the merger consummates, whose value equals $\theta \cdot p$. Since the sponsor is delegated with the duty to find a good deal for the shareholders, he internalizes, at least to some extent, the gains/losses of the shareholders. Meanwhile, if the sponsor raises external capital from PIPE or FPA, he may also care about the gains/losses to those external financiers. We thus specify the sponsor's gains from a completed de-SPAC as:

$$U_{sp} = \theta \cdot p + (1 - \ell) \cdot (1 - \delta) \cdot (p - 1) + (1 - \tau) \cdot K \cdot (p - 1) - \phi, \tag{6}$$

where ϕ represents the cost of raising external capital, give by:

$$\phi = \phi_1 K + \frac{\phi_2}{2} K^2, \tag{7}$$

and ℓ and τ capture the extent to which the sponsor discounts the gains/losses by the shareholders and external financiers, i.e., the misalignment of their interests or the agency costs. Both ℓ and τ take a value between zero and one, with a higher value indicating higher agency costs associated with the sponsor in making his decisions. For example, $\ell = 0.2$ implies that for each dollar gained or lost by shareholders in the deal, the sponsor feels it like a gain/loss of $1 - 0.2 = 0.8$ dollars by himself. This approach of modeling the agent's utility with respect to the principal's gains/losses follows Taylor (2010) and Wang and Wu (2020). In the analysis henceforth, we set $\tau = 0$, because FPA often represents investment tied to the wealth of the sponsor himself or his related parties, while PIPE are provided by large institutional investors who the sponsor arguably cares more. In other words, we abstract away from the agency frictions between the sponsor and the PIPE investors, and focus on modeling and calibrating the agency friction between the sponsor and the SPAC investors.

The determination of the optimal deal terms is detailed in Section 3.5 below.

The SPAC shareholders decide whether to redeem their shares for the face value or to hold on to their shares and see through the business combination, which aggregate to a fraction of δ shares being redeemed.[13] The payoff to the shareholders is 1 if they redeem or if the deal fails, and $p - 1$ if they stay and the deal completes. The optimal choice of redemption will be detailed in Section 3.6 below.

3.4 Information and timeline

Based on the model setup so far, each deal can be characterized as a three-tuple (ℓ, z, u), with ℓ capturing the agency friction between the SPAC sponsor and shareholders, z measuring the synergy of the SPAC and the target, and u serving as the target's reservation value. The model takes the tuple as the state variable associated with each deal, which we refer to as *deal fundamentals* henceforth. The tuple varies across deals and represents the key information asymmetry among the SPAC shareholders, the sponsor, and the target.

Specifically, we assume that both the sponsor and the target can observe the *realization* of the deal fundamentals, while the SPAC shareholders only know their common *distribution*, denoted by a probability density function $f(\ell, z, u)$. Meanwhile, the deal terms, (θ, K, n), are observable to all parties. In particular, shareholders will use the observed deal terms and their knowledge about how those terms are chosen to infer the deal fundamentals, a process we will elaborate later.

Figure 1 summarizes the timeline of the model. The information set possessed by each agent is marked in blue while the action set taken by the agent is marked in red. The de-SPAC process is divided into three phases. First, the sponsor approaches a target firm, and they both observe the true value of (ℓ, z, u) of the deal. They negotiate the deal

[13] SPACs place all proceeds raised in their IPO in a trust account and invest them in money market funds to earn risk free rate. Upon redemption, each share is redeemed at \$10 plus the accrued interest rate. In the model, we normalize the risk free rate to be zero, so shares are redeemed at their face value of 1 dollar in the model.

terms (θ, K, n) and then announce the deal to the public. Next, SPAC shareholders decide whether to redeem their shares, aggregating to a fraction of δ shares being redeemed. Finally, nature determines whether the proposed de-SPAC completes or fails. We assume the probability of deal completion is

$$q(C) = q(1 - \delta + K) \tag{8}$$

for an increasing function (i.e., $q'(C) > 0$), provided that $U_{sp} + U_{tar} > 0$. In other words, the deal can only possibly complete when the total surplus by the sponsor and target is positive. The more cash brought in by the SPAC, the more likely the deal completes successfully. Once the deal completes, the true value of the combined firm, V, is realized and all agents get paid accordingly. If the total surplus is negative, the sponsor and target would be better off by canceling the deal. In this case, the SPAC firm is liquidated and the target remains private.

The subsequent analysis assumes $U_{sp} + U_{tar} > 0$: that is, we focus on the deals for which there exists a set of deal terms such that he total surplus by the sponsor and target is positive, and thus a positive probability that the deal can successfully complete.

3.5 Optimal deal terms

The optimal deal terms (θ^*, K^*, n^*) are chosen to maximize the sponsor and target's joint expected surplus from de-SPAC, taking into account the probability of deal completion. That is,

$$(\theta^*, K^*, n^*) = \arg\max_{\theta, K, n} \quad \Pi(\theta, K, n), \tag{9}$$

where

$$\Pi(\theta, K, n) = (U_{tar} + U_{sp}) \cdot q(1 - \delta^* + K). \tag{10}$$

U_{tar} and U_{sp} are given by Equation 5 and 6, respectively. δ^* represents the the sponsor and target's rational expectation of the aggregate redemption of SPAC shareholders, which we specify later. Let $\rho \in [0, 1]$ denote the bargaining power of the sponsor and $1 - \rho$ the bargaining power of the target, Nash bargaining and (5) imply that:

$$n = \frac{1}{p} \cdot \left[u + (1 - \rho) \cdot (U_{sp} + U_{tar}) \right], \tag{11}$$

which is intuitive: given the per-share de-SPAC price p, the number of shares the target receives is higher if a) its intrinsic value u is higher; 2) the sponsor and target's total surplus of the from de-SPAC, $U_{sp} + U_{tar}$, is higher; and 3) the target's bargaining power $1 - \rho$ is higher. Both U_{sp} and U_{tar} also depend on the shareholders' redemption decision, which we establish next.

3.6 Shareholder redemption

Observing the deal terms, SPAC shareholders decide whether to redeem their shares or to stay and see through the merger. Obviously, the return to the staying shareholders depends on the deal fundamentals, which they do not observe directly and must infer them from the deal terms. The shareholders then formulate rational expectations on the return from staying, given by:

$$\mathrm{E}[R_{sh}|\mathcal{F}] = \int_{\ell,z,u} p \cdot f(\ell, z, u|\mathcal{F}) d\ell dz du - 1, \tag{12}$$

where $\mathcal{F}$ represents the set of information available to the SPAC shareholders, and $f(\ell, z, u|\mathcal{F})$ the conditional density function of the deal fundamentals given such information.

To find the shareholders redemption rate we need to specify two things: first, given $\mathrm{E}[R_{sh}|\mathcal{F}]$, when do the shareholders choose to stay versus redeem; and second, the shape of the conditional density function $f(\ell, z, u|\mathcal{F})$. The simplest approach would be to assume that each shareholder redeems as long as $\mathrm{E}[R_{sh}|\mathcal{F}] < 0$ and stay otherwise, and $f(\ell, z, u|\mathcal{F})$ is conditional distribution of the deal fundamentals implied by the *exact* solution to the sponsor/target's optimization problem (9). This approach, however, is confronted with two challenges in matching the data. First, the redemption decision in the model would be homogeneous among all SPAC shareholders, leading to a binary aggregate redemption rate of $\delta^* \in \{0, 1\}$ in all deals. However, aggregate redemption rate is not binary in the data, with a significant fraction of deals having a redemption rate between 10% to 90%. This implies a significant degree of heterogeneity in the redemption decision that the model needs to capture. Second, shareholders in practice may not always be able to fully utilize the information embedded in the deal terms due to lack of sophistication. They may also receive additional signal regarding the deal fundamentals besides what contained in the deal terms. Consequently, their inference of the deal fundamentals and the calculation of the return from staying can be more or less accurate than implied the solution to Equation 9.

To address the first challenge, we follow the standard IO literature and introduce latent heterogeneity in the individual SPAC shareholder i's redemption decision by modeling it as a discrete choice as follows:

$$\delta_i = \begin{cases} 0, & \text{if } \frac{\mathrm{E}[R_{sh}|\mathcal{F}]}{\sigma_\delta} + \epsilon_i > 0, \\ 1, & \text{Otherwise,} \end{cases} \tag{13}$$

where ϵ_i is an idiosyncratic shock drawn from an i.i.d. (standard) Gumbel distribution. This shock represents the latent demand by shareholders that drives the redemption decision beyond the expected return. Importantly, with this latent demand shock, investors' redemption decision no longer follows a uniform threshold. This modification introduces a new parameter σ_δ to be estimated, which controls the importance of the latent demand shock. Equation 13 nests the simple, uniform redemption threshold rule if σ_δ approaches zero.

To address the second challenge, we incorporate two elements that allow the investors' inference about the deal fundamentals to differ from the optimal deal terms (θ^*, K^*, n^*) implied by Equation 9. The first is bounded rationality, which controls the degree of accuracy of the shareholders' inference. This is quite relevant in the market of SPAC, where a significant fraction of the investors are retail ones lacking the necessary sophistication or financial knowledge to fully process the information embedded in the deal terms.[14] Specifically, given the deal fundamentals (ℓ, z, u), for any combinations of deal

[14]In a recent proposal, SEC explicitly states that "In regard to de-SPAC transactions, investors could benefit from clearer dilution disclosure that takes into account the unique characteristics of the SPAC structure, including any terms negotiated with the target private operating company, as well as the potential for additional financing from PIPE investors... We are therefore proposing Item 1604(c) to

terms (θ, K, n), we define a function $\zeta(\theta, K, n)$ as the probability that the investors believe that (θ, K, n) is the optimal deal terms given (ℓ, z, u). Following Ben-Akiva et al. (1985), we construct $\zeta(\theta, K, n)$ as

$$\zeta(\theta, K, n) = e^{\frac{\Delta\Pi}{\sigma_e}} \left(\int_{\theta,K,n} e^{\frac{\Delta\Pi}{\sigma_e}} d\theta dK dn \right)^{-1}, \tag{14}$$

where $\Delta\Pi = \Pi(\theta, K, n) - \Pi(\theta^*, K^*, n^*) \leq 0$ is the difference in the utility generated by (θ, K, n) and that generated by the optimal deal terms (θ^*, K^*, n^*). Intuitively, $\zeta(\theta, K, n)$ is lower when $\Delta\Pi$ is more negative, implying that the likelihood that the shareholders mistakenly recognize (θ, K, n) instead of (θ^*, K^*, n^*) as the optimal deal terms under (ℓ, z, u) is proportional to the utility generated by (θ, K, n). The parameter σ_e, controls the degree of this imperfect inference as a result of bounded rationality, and its value is to be estimated together with the other model parameters. A low value of σ_e implies more precise inference, and the limit $\sigma_e \to 0$ represents the case of perfect rationality, where the shareholders can always correctly infer the set of the deal fundamentals that generate the observed deal terms. Note that, even in such cases, shareholders may still not be able to tell the deal fundamentals for sure. This is because there could be a pooling equilibrium under which multiple combinations of deal fundamentals generate the same optimal deal terms.

While bounded rationality introduce "mistakes" in the shareholders' inference of deal fundamentals, in practice they may also have more precise knowledge about the deal fundamentals than those inferred merely from deal terms. To incorporate such possibility we allow the shareholders to observe a signal s with precision η. Upon receiving the signal, shareholders update their knowledge about the distribution of the deal fundamentals from $f(\ell, z, u)$ to $f(\ell, z, u|s)$. The exact distribution of $f(\ell, z, u|s)$ will be specify later in Section 5, together with other distributional assumptions necessary for model calibration.

Putting everything together, the conditional probability function of the shareholders given the deal terms (θ, K, n) and the signal s is:

$$f(\ell, z, u|\mathcal{F}) = \frac{f(\ell, z, u|s) \cdot \zeta(\theta, K, n)}{\int_{\ell,z,u} f(\ell, z, u|s) \cdot \zeta(\theta, K, n)\, d\ell dz du}. \tag{15}$$

require disclosure of each material potential source of additional dilution that non-redeeming shareholders may experience at different phases of the SPAC lifecycle".

Shareholders use Equation 15 to calculate $\mathrm{E}[R_{sh}|\mathcal{F}]$, the expected de-SPAC return following Equation 12.[15] Then, they decide whether to redeem their shares or stay based on their idiosyncratic latent shocks following Equation 13. Aggregating individual shareholders' redemption decision yields the total redemption rate as:

$$\delta^* = \int_i \delta_i di = \left(1 + e^{\frac{\mathrm{E}[R_{sh}|\mathcal{F}]}{\sigma_\delta}}\right)^{-1}, \tag{16}$$

which eliminates the idiosyncratic shocks ϵ_i. Thus, while the sponsors cannot predict the redemption decision of an individual shareholder, they have rational expectations on how the deal terms they propose affect shareholders' calculation of the expected de-SPAC return and thus the amount of aggregate redemption the deal terms will trigger.

3.7 Equilibrium and model summary

We can now define the equilibrium of the model as the set of optimal decisions (the control variables) $(\theta^*, K^*, n^*, \delta^*)$ given the deal fundamentals (the state variables) (ℓ, z, u). The sponsors and the the targets jointly determine the sponsor's compensation θ^*, the amount of external financing K^*, and the shares to the target n^* by solving Equation 9, taking into account how those choices affect the shareholders' aggregate redemption rate δ^*, given by Equation 16, and the deal completion likelihood q, given by Equation 8. The aggregate redemption is the sum of individual redemption as in Equation 13, given the observed deal terms and the implied deal fundamentals, subject to bounded rationality (the degree of which is captured by σ_e) and the signal s (with precision η).

In sum, our model highlights two frictions between the sponsor and the shareholders: first, the partial alignment of the interests of the two parties captured by the state variable ℓ. Second, the information asymmetry between the two parties regarding ℓ and other deal fundamentals (z, u). Under these frictions, the sponsor faces a tradeoff in choosing the optimal deal terms. More lucrative compensation for himself and generous offer to the

[15] Note that because $\zeta(\theta, K, n) > 0$ for all (θ, K, n), Equation 15 provides a complete set of beliefs for all possible observations of the deal terms. Therefore, $\mathrm{E}[R_{sh}|\mathcal{F}]$ is uniquely determined even when the observed deal terms are "off-the-equilibrium" (i.e., not optimal under any combinations of deal fundamentals) or if the equilibrium is pooling (i.e., multiple combinations of deal fundamentals yield the same optimal deal terms). It also ensures that any equilibrium we find is globally incentive compatible, because the sponsor can calculate his utility from proposing any alternative deal terms (i.e, from any deviation).

target (i.e., high θ and n) increases their joint surplus in a completed deal. Meanwhile, such deal terms may dissuade SPAC shareholders from participating and result in a larger volume of redemption, reducing the likelihood of deal completion. External capital can help increase the cash reserve of the SPAC firm but is costly, and any losses the external financiers suffer from bad deals are fully internalizes by the sponsor. Thus, the sponsor balances between a larger gain in a completed deal and a lower likelihood of deal completion. There could exist a pooling equilibrium in which multiple combinations of deal fundamentals yield the same deal terms, complicating the shareholders' inference and leading to their inefficient redemption decision.

Because the model is highly non-linear with multiple state and control variables, we proceed to solve it numerically and describe the details of the numerical algorithm in Appendix A. Below, we describe the data we use to estimate the model parameters, the various analyses we conduct based on the result of the estimation, and their economic and policy implications.

4 Data

Our data consists of all the SPACs that filed registration statements (Form S-1) to go public between 2009 and 2020. This 12-year time period saw the registration and initial public offering of 548 SPACs. As of April of 2022, 364 of the 548 SPACs had successfully executed a business combination, 28 of these SPACs had liquidated without successfully completing a business combination, 34 SPACs had arranged business combinations but had not yet completed them, and 122 of these SPACs were still seeking prospective merger partners.

For each SPAC we rely on several sources of data to gather its information, much of which has to be meticulously gleaned by going through individual SEC filings and their associated attachments. Specifically, 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 a non-disclosure agreement (NDA), the SPAC typically announces the deal and terms and posts an investor presentation, all within or attached to a Form 8-K. These allow us to view the terms of eventual deals at the time they are announced. We obtain the final terms of the deal in the "Super 8-Ks" that are filed shortly 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, FPA, or backstop financing raised through the unregistered sale of securities.

We obtain information on redemptions primarily from the Gritstone SPAC research database. This database covers 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. For deals outside the Gritstone data, we find the redemption information from the aforementioned Super 8-Ks.

Finally, we obtain pricing data from the Center for Research in Security Prices (CRSP). 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. Given that most SPAC targets are small growth firms, we use the return on Russell 2000 growth ETF index (IWO) to calculate the post de-SPAC risk-adjusted return (alpha). We also consider 1-month and 6-month post de-SPAC returns for robustness and find 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, some deals in our sample involve cash consideration. 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. Note that these adjustments tend to be minor, as less than 10% of our sample of SPAC acquisitions (only 29 of our sample of 325) have majority of their consideration paid in cash.

Altogether, our primary data of analysis contains the 364 SPACs that successfully completed business combinations as of April 30, 2022. Of these SPACs, there are 14 that are not on CRSP, there are 19 whose business combinations were too recent to have 3+ months of return data on CRSP post de-SPAC, and there are 6 SPACs for which we are either unable to find the requisite filings to gather the needed data, or their pricing data are on CRSP are unreliable. Of the remaining 325, 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, especially 2020.[16]

Table 2 provides summary statistics on variables of interest. Panel A provides the raw data, and Panel B provides summary statistics on a subset of the same variables, with their values scaled by the number of IPO shares, to better align with our model.

5 Model Estimation

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

[16]Note that by April of 2022, very few SPACs that went public in 2021 had actually closed business combinations.

of deal completion. We make the following assumptions and use them in estimation.

1. $1+z$ and u follow log-normal distributions that are independent of each other, i.e., $\ln(1+z) \sim N(\mu_z, \sigma_z^2)$ and $\ln(u) \sim N(\mu_u, \sigma_u^2)$.

2. ℓ follows a Beta distribution $\ell \sim B(\alpha, \beta)$, independent of z and u.[17]

3. The signal $s = (1+z) \cdot u \cdot \nu$, where ν follows a log-normal distribution with mean 1. That is, $\ln s \sim N((1+z)u, \sigma_s^2)$, where $\sigma_s^2 \geq \sigma_z^2 + \sigma_u^2$. We define $\eta = [\sigma_s^2 - (\sigma_z^2 + \sigma_u^2)]^{-1}$ as the precision of the signal. The higher η is, the more informative the signal is in predicting the value of the combined firm after de-SPAC.

4. The likelihood of deal completion $q(C) = \frac{1}{1+e^{-\gamma(C-\lambda)}}$. Here, λ determines the likelihood of deal completion when $C = 0$ (no cash from SPAC), and $\gamma > 0$ measures the sensitivity of deal completion rate on the cash brought from SPAC.[18]

The model solution depends on the number of warrants issued in SPAC IPOs (as part of the units). To produce the panel of SPAC deals in model simulation, we first solve the model for different numbers of warrants issued, w. Then we simulate the model to generate a panel of SPAC firms with their numbers of warrants w equal to the empirical distribution obtained from the data. As shown in Figure 2, the most common number of warrants issued in each unit is 1/3, 1/2, and 1, and there are also a few SPACs with no warrants, or 1/5, 1/4, or 3/4 warrants in each unit. Our simulated data replicates this empirical distribution in the model-simulated panel.

5.1 Identification

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

[17]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.

[18]Though cash is often an important consideration, some actual de-SPAC 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 $C = 0$.

captures the variation of latent demand shocks across SPAC shareholders' redemption decisions; σ_e that determines the extent of bounded rationality by SPAC shareholders, and η that represents the precision of the signal received by SPAC shareholders. In this section, we discuss what data features help us identify these parameters in estimating 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 convexity ϕ_2 makes it particularly expensive to raise a large amount of external capital and thus flattens the right tail 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 SPAC shareholders to himself 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 the merger. Thus, the larger the private target, the more shares (or a larger fraction) of the combined firm will be allocated to them 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 rate of either zero or one. If σ_δ is large, latent demand shocks across SPAC shareholders lead to more moderate redemption rates. We use the fraction of deals with a redemption rate falling between 10-90% to identify σ_δ: a higher fraction implies a greater value of σ_δ.

Sixth, the magnitude of information asymmetry between SPAC shareholders and the sponsor determines the correlation between the SPAC shareholders' redemption decision and their returns. Intuitively, as information asymmetry is low, SPAC shareholders can better infer the deal fundamentals and make more accurate and timely redemption decisions. But if information is very opaque, SPAC shareholders 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 η 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 $\eta = 0$. This benchmark corresponds to the case of SPAC shareholders who can perfectly assess the sponsor's and target's optimal decision rules but also receive no additional signal s. If the model-implied correlation is more negative than that in the data, we set η to be 0 and estimate σ_e; and if the model implied correlation is less negative than that in the data, we set σ_e to be 0 and estimate η.

The last two parameters are λ and γ which controls the likelihood of de-SPAC completion rate. To identify λ, the probability of deal completion when no cash is delivered to the target in de-SPAC (i.e., $C = 0$), we use the fraction of completed deals that deliver a low cash amount (lower than 50% of the SPAC IPO size). If λ is large, we expect to see a smaller fraction of deals with low cash, and vice versa. To identify γ, the sensitivity of deal completion rate with respect to the cash amount delivered, we include two additional moments: the fraction of completed deals that deliver a medium cash amount (130%-170%), and the fraction of completed deals that deliver a high cash amount (above 230%). Intuitively, the frequency of deals with medium and high cash amount, relative to the frequency of deals with low cash amount, is informative of the value of cash to increasing the deal completion rate.[19]

[19] The frequency of deals with different amount of cash is also influenced by other model parameters, including the distribution of z, u, and the cost of raising external capital ϕ_1 and ϕ_2. Given these parameters are mainly identified off other moments discussed above, λ and γ are important determinants remained. For instance, if we increases λ from its estimated value of 0.15 to a counterfactual value of 1, then the fraction of completed deals with low cash amount will be almost halved.

5.2 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 70% of the size of SPAC IPO, but the cross-sectional variation is also very large, with more than 20% of deals involving zero external capital.

Polarized redemption rate (below 10% or above 90%) is common, but there is also a substantial fraction (about 55%) 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 shareholders' redemption rate on the ex-post deal returns, the loading is significantly negative, as shown in Figure 3. The univariate regression produces an R-squared of 23%, indicating that the deal return alone can explain much of the variation in redemption. A prevalent explanation of this relation is that SPAC shareholders can, at least partly, infer deal fundamentals 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 shareholders 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.

Moreover, the model is able to match the average deal return to non-redeeming SPAC shareholders closely, and the model captures well the dispersion of their returns in the cross-section. Non-redeeming shareholders on average earn a slightly positive return, but the risk of this investment, measured by the standard deviation of return, is substantial.

Last, the model does a good job in matching the fraction of de-SPAC deals that deliver a low/medium/high amount of cash to the target. These three moments help pin down how the deal completion rate depends on the amount of cash brought to the table by the SPAC firms.

Overall, the model fits the data moments closely and it captures the main features present in the data. To further validate the model fit, we also compare the whole distribution of the observables, θ, K, $\frac{n}{N}$, δ, C, and R_{sh} in Figure 4.[20] 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. Our estimate of deal quality, z, shows that for the pool of SPAC targets, bringing them public increases their value by 5% on average. This average value creation appears low compared with most observed IPO deals and acquisitions of private targets in regular M&As. Recent studies suggest that private firms that choose to go public via merging with SPACs are on average weaker in fundamental than those that choose to go IPO. Also, unlike a private company acquired by a public firm, a target that merges with a shell company generates no operational synergies. Our estimate also suggests that the cross-sectional uncertainty in value creation is quite large, with a standard deviation of 27%. This high uncertainty, exposes SPAC shareholders to great risks, especially when information is asymmetric and incentives are likely to be a concern. Adding to this uncertainty, SPAC shareholders do not observe the target firm's reservation value u (i.e., the target's value as a private entity), and we find that variation in u is quite large.

Interestingly, even though the model specifies a quite flexible distribution (i.e., Beta distribution) to characterize the sponsor's agency cost, ℓ, our estimate suggests that the two parameters that govern the Beta distribution, α and β 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 and thus it is

[20]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 sets a much higher bar for the model to match the distribution of outcomes.

difficult to tell, ex ante, to what extent a sponsor cares about SPAC shareholders.

The cost of raising external capital is estimated to be highly convex. The marginal cost of raising an additional dollar externally is only 2 cents per dollar at the 25th percentile of K, but it climbs up to 10 cents per dollar as the dollar amount raised increases to the 75th percentile.

The parameter that controls the variation of latent demand shocks in SPAC shareholders' redemption decisions, σ_δ, is estimated to be 0.095. 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 shareholders' perceived return $E\left[R_{sh}|\mathcal{F}\right]$ is -2.63, suggesting that the redemption rate would increase by 2.63 percentage points for each percentage point decline in the perceived return.[21]

The parameter that drives the bounded rationality of SPAC shareholders, σ_e, is estimated to be 0.143. As σ_e is estimated to be positive, η must be set to zero, so SPAC shareholders rely only on observed deal terms, and there is no valuable private signal that helps refine their inference of deal quality in net. In fact, a positive value of σ_e implies that SPAC shareholders are unable to discern all information embedded in the observed deal terms. In this sense they have imperfect expectations regarding the sponsor's and target's policy function. This finding is consistent with anecdotal evidence that many retail SPAC shareholders may be unsophisticated.

Our estimate of the deal completion function shows that $\lambda = 0.15$ and $\gamma = 1.25$, which suggests that, if zero cash is delivered to the target at de-SPAC, the likelihood of closing the deal is only 45%, and this likelihood increases to almost 80% when the cash amount delivered in de-SPAC reaches the sample mean.

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 shareholders. SPAC shareholders seem to have some difficulty in fully anticipating the sponsor's and target's decision rules.

[21] This is derived by taking the derivative of δ^* in Equation (16) w.r.t. $E\left[R_{sh}|\mathcal{F}\right]$:

$$\frac{d\delta^*}{dE\left[R_{sh}|\mathcal{F}\right]} = -\delta^* \cdot (1-\delta^*) \cdot \frac{1}{\sigma_\delta}$$

and substituting in $\bar{\delta^*} = 0.5$ and $\sigma_\delta = 0.095$.

6 Model Implications

6.1 Agency cost

Using the estimated model as a laboratory, we investigate how agency costs affect the welfare of SPAC shareholders. In our model, sponsors in different deals have heterogeneous agency costs, captured by the parameter ℓ, with ℓ falling between 0 and 1 and a higher ℓ representing a higher agency conflict. We simulate the estimated model, generating 1,000 SPAC deals via simulation. We then partition the simulated sample into quintiles based on ℓ in each deal. Figure 5 compares the distribution of returns to SPAC shareholders in deals with low agency costs (bottom quintile) and high agency costs (top quintile). When agency cost is high, a large fraction of deals produce negative returns to SPAC shareholders and the losses can be substantial, with the 25th percentile of returns being -45% among the deals with top-quintile agency cost. When agency cost is low, most deals generate a positive return for SPAC shareholders, and the 25th percentile of returns is 3% for this subsample of deals with the bottom-quintile agency cost.

Next, we explore what drives the large gap in SPAC shareholders' returns from deals with different levels of agency costs. The conflict of interests between the sponsor and SPAC shareholders 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 shareholders 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 shareholders and internalizes their gains to a greater extent. As a result, we first compare the deal quality, z, in deals with low agency cost and deals with high agency cost. Panel A of Figure 6 shows that, deal quality, z, is significantly 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 the agency cost in observed deals is a manifestation of the endogenous selection effect: low-value deals are more likely to complete when their sponsors internalize less of the shareholders' welfare. 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 shareholders. In panel B of Figure 6, we plot the distribution of sponsor compensation, θ, for deals with top- and bottom-quintile agency costs. Sponsors with high agency cost 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 cost are more likely to give up large portions of their promote stake as needed. In fact, in almost 25% of deals, sponsors choose to reduce their θ from 0.25 to below 0.05.

Overall, our analysis demonstrates that agency costs have a substantial impact on SPAC shareholders' returns from de-SPAC. When a sponsor suffers from high agency cost, 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 shareholders to earn negative returns, effectively subsidizing the sponsor and target in these deals.

6.2 Information asymmetry

In this section, we study the effect of information frictions. We measure the magnitude of information asymmetry between SPAC shareholders and the sponsor. We also examine how information asymmetry affects SPAC shareholders' returns.

The key role of information asymmetry in our model is that it influences SPAC shareholders' conjecture of de-SPAC return, or $E\left[R_{sh}|\mathcal{F}\right]$. If information is perfect, then this expectation equals the realized return, $R_{sh} = p - 1$. 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 shareholders 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:

$$
\begin{aligned}
Var\left(R_{sh}\right) &= Var\left(E\left[R_{sh}|\mathcal{F}\right]+\varepsilon\right) && (17)\\
&= Var\left(E\left[R_{sh}|\mathcal{F}\right]\right)+Var\left(\varepsilon\right)+2Cov\left(E\left[R_{sh}\right]|\mathcal{F},\varepsilon\right) && (18)
\end{aligned}
$$

where $\varepsilon = R_{sh} - E\left[R_{sh}|\mathcal{F}\right]$ is the SPAC shareholders' forecast errors of de-SPAC return. Intuitively, the LHS captures the total cross-sectional variation in realized returns, and the first term on the RHS is the variation explained by SPAC investors' conjecture. In this variance decomposition, the ratio $\frac{Var(\varepsilon)}{Var(R_{sh})}$ 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. SPAC shareholders' forecast errors explain 53% of the total variation in the realized returns, while their conjecture, together with the covariance term, explains the remaining 47%. This decomposition suggests that SPAC shareholders often make substantial mistakes in forecasting de-SPAC returns.

Next, we explore the sources of the forecast errors. Overall, forecast errors arise from two main sources. First, since SPAC shareholders can only observe the deal terms (θ, K, n), their forecast precision depends on how revealing these observables are regarding the deal fundamentals. In other words, if pooling is prevalent and deals with very different fundamentals are announced with similar terms, then it is hard for SPAC shareholders to discern good deals from bad deals. But if deal terms are strong signals of deal fundamentals, SPAC shareholders 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 shareholders are unable to extract all information embedded in the observed deal terms to infer deal fundamentals, and therefore their bounded rationality also creates forecast errors. We can further decompose the variance of forecast errors into:

$$Var(\varepsilon) = Var\left(R_{sh} - E^{PRE}\left[R_{sh}|\mathcal{F}\right]\right) + Var\left(E^{PRE}\left[R_{sh}|\mathcal{F}\right] - E\left[R_{sh}|\mathcal{F}\right]\right)$$
$$+ 2Cov\left(R_{sh} - E^{PRE}\left[R_{sh}|\mathcal{F}\right], E^{PRE}\left[R_{sh}|\mathcal{F}\right] - E\left[R_{sh}|\mathcal{F}\right]\right) \quad (19)$$

where $E^{PRE}\left[R_{sh}|\mathcal{F}\right]$ is the forecast of de-SPAC return based on deal terms if SPAC shareholders have perfect rational expectation of the sponsor's and target's policy function (i.e., when bounded rationality is absent). The first term on the RHS represents the first source we discussed above, that is, how revealing the deal terms are regarding deal fundamentals. The second term on the RHS represents the second source, that is, how much of the forecast errors can be attributed to SPAC shareholders making mistakes in anticipating the sponsor's and target's policy rule (i.e., bounded rationality), resulting from σ_e in Equation (14). 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 knows perfectly the sponsor's and target's policy rule. More specifically, we make his $\sigma_e \to 0$ in Equation (14). 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 also faces latent demand shocks as he makes redemption decisions and thus Equation (16) describes his likelihood of redemption given his expectation of de-SPAC returns. Sticking to these two constraints makes this hypothetical investor comparable to the regular SPAC shareholders in all aspects except his σ_e.

We first compare the conjecture of de-SPAC returns by SPAC shareholders in Figure 7. The left panel shows the de-SPAC return conjectured by regular SPAC shareholders, while the right panel shows the return conjectured by the hypothetical investor. We place the realized de-SPAC return R_{sh} on the x-axis and the conjectured returns $E\left[R_{sh}|\mathcal{F}\right]$ on the y-axis. The 45-degree dash line therefore marks the forecasts with 100% accuracy. The scattered points represent simulated deals. In general, expected de-SPAC returns are positively correlated with the realized returns in both panels, but the correlation is much higher for the hypothetical investor, suggesting that he is making a more accurate forecast. This figure also shows the concept of pooling: the same level of conjectured de-SPAC returns (i.e., fix a value of y and draw a horizontal line) maps to many possible realized returns on the x-axis. That means, investors are confused about the de-SPAC returns and often cannot tell apart good deals from bad deals. Pooling is particularly pronounced for regular SPAC shareholders and when their conjectured returns cluster around 0%. For instance, when the regular investors conjecture the return to be close to zero for a de-SPAC deal, the true return of the deal can swing in a large range from -60% to 60%. On the contrary, the hypothetical investor's conjecture is much more accurate: as he conjectures the de-SPAC return to be around zero, the realized return ranges from about -10% to 10%.

Using the hypothetical investor's conjectured return as $E^{PRE}\left[R_{sh}|\mathcal{F}\right]$, we are able to perform the decomposition of forecast errors in Equation (19). Panel B of Table 5 shows the results. About 61% of forecast errors can be attributed to regular SPAC shareholders making mistakes in anticipating the sponsor's and target's policy rule (i.e., due to σ_e), and the pooling equilibrium contributes to only 30% of the forecast errors. Combining our findings above that the total forecast errors are about 53% of the cross sectional variation in de-SPAC return, our estimate suggests that the fundamental information asymmetry explains about 16% of variation in cross-sectional de-SPAC return due to a pooling equilibrium in which even an investor with perfect rational expectation cannot fully tell deals apart ($53\% \times 0.30 = 16\%$), while investors' bounded rationality adds another 32% noise ($53\% \times 0.61 = 32\%$).

Last, we quantify the effect of bounded rationality on SPAC investor returns, and to do so, we compare the average return to the regular SPAC shareholders with that to the hypothetical investor. Panel C of Table 5 shows that the hypothetical investor, on average, earns an expected return that is 7 percentage-points higher than that of a regular SPAC shareholder. Intuitively, this return gap must be driven by their differential redemption decisions. Specifically, the hypothetical investor can earn a higher return because his redemption decision is more accurate, or equivalently, more negatively correlated with the de-SPAC return. We can further decompose this return gap into four components, including the gains from avoiding bad deals, the gains from catching good deals, the losses from falling into bad deals, and the losses missing out good deals. Among the four components, the hypothetical investor seems to benefit the most from avoiding more bad deals, leading to an increased return of 6.54 percentage-points. This happens in about 40% of deals (i.e., extensive margin), and the average gain from a higher redemption rate by the hypothetical investor in these bad deals amounts to 16.6 percentage-points (i.e., intensive margin).

In 26% of deals, the hypothetical investor is better at catching a positive return by reducing his redemption likelihood in good deals. Despite this sizeable extensive margin, the intensive margin seems much lower and the average gain from holding on to these good deals is only 3 percentage-points. Combining the extensive margin and intensive margin, we find that this component of catching good deals adds 0.76 percentage-point to the return improvement.

7 Policy Experiments

We made note earlier in the paper of the conflicts of interest embedded within the standard SPAC structure, and in fitting our model to the data, we found strong evidence of said conflict. Given the feverish pace of SPAC IPOs and business combinations of late, and with an eye toward improving the welfare of SPAC investors, the SEC released a series of policy proposals intended to address the sponsor-investor conflict of interest, as well as aligning the going-public process via a SPAC with the traditional fixed-price offering (SEC, March 30, 2022). As part of its Rules Changes and policy proposals, the SEC actively solicited commentary on its proposed changes, and have received a hundred or more to date from finance and law professors, corporate/securities lawyers and law firms, and assorted investors, both named and anonymous. And there are also a plethora of commentaries on the SEC's proposed rules changes, and the important aspects of SPACs to regulate.

In this section, we use our estimated model to evaluate the efficacy of potential changes to the SPAC structure that are in the spirit of the regulatory changes proposed by the SEC, that aim at reducing the conflicts of interest and information asymmetry in the SPAC market. We implement several policy experiments in the model and solve the new equilibrium with all agents re-optimizing their decisions. Since the goal is to improve outcomes for SPAC investors, we then analyze how the proposed policies change the welfare of SPAC shareholders. Specifically, we examine the following policy proposals: (1) subject the sponsor's promote shares to highly stringent earnouts; (2) reduce the number of warrants issued in SPAC IPOs.

7.1 Sponsor Earnouts

Earlier we noted that the misalignment of incentives between SPAC sponsors and investors is to the down side. As the risk of an eventual liquidation looms, sponsors facing the prospect of only poor deals to choose from are likely to prefer a badly-priced acquisition over a liquidation, while investors would unequivocally prefer a liquidation. Moreover, if SPAC investors understand that a deal is bad, they will redeem their shares and be made whole. This misalignment is primarily driven by the sponsor's promote shares, since they become worthless in a liquidation, but can still be lucrative in a bad deal. Therefore, the sponsor's promote shares push them to close deals regardless of deal quality.

Sponsor earnouts have been touted as a new, innovative way to align sponsor and shareholder interests, because they tie sponsor compensation to post-merger share price performance.[22] Specifically, an earnout requires that a SPAC's post-merger share price reaches a specified threshold before the sponsor receives those shares. If the post-merger share price does not reach the threshold, the corresponding promote shares are canceled. A typical threshold is set to be \$12.5 or \$15, or higher, which requires the share price to appreciate 25% or 50% (or more) post-merger relative to the IPO price before the sponsor's earnout shares are awarded. In their January ruling in the MPLN case (2022 WL 24060, Del. Ch., January 3, 2022), the Delaware Chancery Court suggested that tying the entire sponsor promote to an earnout might well eliminate the apparent conflicts of interest between sponsors and SPAC investors.

In a recent study, Klausner and Ohlrogge (2022) document that the current structure of earnouts has a minimal impact on mitigating the agency costs in the standard SPAC structure. They use simulations to show that the value of earnouts is very close to the

[22]In fact, earnouts are fairly standard fare in traditional M&A deals involving private targets, specifically for the purpose of overcoming asymmetric information and agency problems (Cadman and Faurel, 2014).

value of promote shares when their maturity is long and the volatility of post-merger stock prices is high, as is common. In contrast, we value the earnouts in our sample with binomial trees using the method of Cox, Ross, and Rubinstein (1979), and we similarly find that most earnouts have limited impact on sponsor compensation. For example, assuming an underlying annualized volatility of 60%, a 5-year earnout with a trigger price of \$12.50 is worth \$8.98 if the underlying promote share is worth \$10. A 3-year earnout only reduces that value slightly to \$8.30.

Klausner and Ohlrogge (2022) propose to improve the efficacy of earnouts by reducing their maturity. Since our model relies on the share price 3-month post de-SPAC to measure performance, our policy experiment considers the impact of 3-month earnouts. As a preliminary means of comparison, a binomial model with monthly time-steps (and 60% annualized volatility values a 3-month earnout with a trigger price of \$12.50 at \$3.00 relative to a \$10 promote share. In other words, these appear to have substantial bite.

Our policy experiment using earnouts involves forcing sponsors to tie a certain fraction, χ, of their promote to earnouts (with trigger price of \$12.50 and effectively T = 3 months). For instance, if $\chi = 0.4$, then the sponsor's compensation contains 0.1 share of earnouts ($0.1 = 0.25 \times 0.4$) and 0.15 promote shares. In solving the model, we still allow the sponsor to forfeit his promote shares as in the baseline model, but we assume that they do not alter their compensation tied to earnouts. In this policy experiment, we vary the value of χ and investigate how increasing the fraction of earnouts in sponsor compensation helps improve SPAC shareholders' welfare.

Panel A of Figure 8 shows the results. As χ increases, the average return to non-redeeming shareholders rises monotonically. Quantitatively, we find that for every 10% increase in the fraction of compensation tied to earnouts, the average return to SPAC shareholders increases by 1.8 percentage points. As a result, tying sponsors' promote shares to an earnout indeed improves shareholders' welfare substantially. These findings are in line with the suggestions put forth in Klausner and Ohlrogge (2022), regarding the potential efficacy of usingg short-term earnouts.

If earnouts help mitigate the agency costs and better align the interest of the sponsor and shareholders, then we should expect the results to be stronger among SPACs that suffer from more severe agency problems. To examine the heterogeneous effects of earnouts, we contrast the average return to non-redeeming shareholders across SPACs with the top/bottom quintile agency costs. We track how the average returns to the shareholders in these two groups of SPACs vary as the fraction of earnouts, χ, in the sponsor's compensation structure, changes. In Panel B of Figure 8, we confirm that as a larger fraction of sponsor compensation is tied to earnouts, the average returns to shareholders increase for both groups, but the increase is much more pronounced for SPACs facing severe agency problems. Specifically, for every 10 percentage-point increase in χ, the average return to shareholders in SPACs with low agency costs improves by 0.7 percentage points while the average return in SPACs with high agency costs improves by 2.2 percentage points. This finding suggests that sponsor earnouts are effective devices in mitigating agency costs, thereby leveling the playing field for outside investors, in line with the SEC's objectives. The heterogeneous effects of earnouts shrink the gap between the returns to shareholders in the two groups. The red dotted line in Panel B of Figure 8 indicates that the gap is reduced from about 20% to 5% as we increase χ from 0% to 100%. The remaining gap is due to the fact that, even though none sponsors have incentive to push through bad deals when all their compensations are tied to earnouts, sponsors with high agency costs still tend to allocate a larger fraction of the combined firm's value to targets in good deals. This is because, as they internalize shareholders' gains to a lesser extent, they tend to overpay targets in Nash bargaining.

Overall, we find that sponsor earnouts, when implemented with short maturity, can dramatically reduce incentive conflicts and substantially improve the welfare of SPAC shareholders.

7.2 Public warrants

Units issued in SPAC IPOs typically contain warrants. Warrants are like call options in that they can be exercised and converted to shares if the post-merger stock price is above the strike price. However, unlike call options, when warrants are exercised, new shares are created and sold to the exercising party at the strike price, resulting in dilution. At some point after the SPAC IPO, the warrants and shares that comprise a unit begin to trade separately, and some studies show that, at the time of the redemption decision, SPAC shareholders are often not the warrant holders. Klausner et al. (2022) and

Gahng et al. (2022) document that warrants are costly to non-redeeming shareholders, because they dilute the combined firm's value when exercised, transferring wealth from non-redeeming shareholders to warrant holders, and this problem is exacerbated when redemptions are high. Both the SEC and commentators propose reducing the number of warrants issued in units, in the hope of curtailing the dilution caused by the presence of SPAC warrants, and thereby retain more value for non-redeeming shareholders.

Our baseline model includes warrants, and we use the empirical distribution of warrants in our estimation (the distribution of warrants in our sample is given in Figure 2). To implement a policy experiment related to warrant issuance, we assume that existing SPACs cut back their use of warrants issued in IPO by a fraction of ψ, in response to a regulatory change. For instance, if a SPAC issues 0.5 warrants per unit in the baseline model, then we assume it now issues $0.5(1-\psi)$ in this policy experiment. $\psi = 0$ nests the baseline case and $\psi = 1$ represents the case in which warrants are completely abandoned.

We examine how the returns to SPAC shareholders change as we gradually reduce the number of warrants by moving from $\psi = 0$ to $\psi = 1$. Panel A of Figure 9 depicts the trajectory. We observe that average returns to SPAC shareholders increase as warrants are reduced, but the improvement appears substantially smaller than that obtained from the policy experiment based on sponsor earnouts. In particular, we find that for every 10% reduction in the average amount of warrants issued, returns to non-redeeming shareholders increase by about 0.28%. This gain is only a small fraction of that achieved through sponsor earnouts (1.8%).

Should eliminating warrants help reduce agency costs, in the same way that the imposition of sponsor earnouts does? To answer this question, we contrast the returns to shareholders in SPACs with high/low agency costs, as we did above for the experiment using sponsor earnouts. Panel B of Figure 9 suggests that, reducing warrants indeed improves shareholder value for both groups, but the gain does not seem to arise from curbing agency costs. In fact, the gap between the returns to shareholders in the high vs. low agency costs group widens rather than shrinks. In other words, eliminating warrants makes SPACs with low agency costs better, but it does not help SPACs with high agency costs as much. Intuitively, warrants would be exercised only when the proposed deals are good and they become irrelevant when the deals perform poorly. Our analyses show that for the SPAC investors, the primary source of the losses in welfare come from the staying with the poorly-performing deals. In those deals, the warrants are more likely to remain under-the-water, and thus their existence has little impact on the sponsor's decisions or shareholder welfare. Overall, we find that warrants are not the main driving force of poor returns to SPAC shareholders in the current market. Even though cutting back on warrants could further improve the returns to SPAC shareholders with low agency costs, it has very limited power in curbing agency costs, or leveling the playing field of SPAC investors. The sponsor's incentive to push through bad deals is not mitigated by reducing warrant issuance.

8 Conclusion

The recent boom in SPACs has attracted considerable attention from both researchers and practitioners. The unique structure and business model of SPACs call into question the specific incentives of SPAC sponsors and the associated welfare of their 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 19% 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 sizeable mistakes in inferring the underlying deal quality. This costs them, in terms of return, 7% percentage points, 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 M&A rules."[23] Our results shed light on this policy debate by quantifying the incentive conflicts between SPAC sponsors and SPAC shareholders, as well as the potential welfare impact on SPAC shareholders that results from an improvement of the information transparency. Our policy experiments show that tying the sponsor promote to earnouts can potentially improve the shareholders' welfare significantly, while cutting back warrant issuance in SPAC IPOs is likely much less effective in that regard.

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.

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

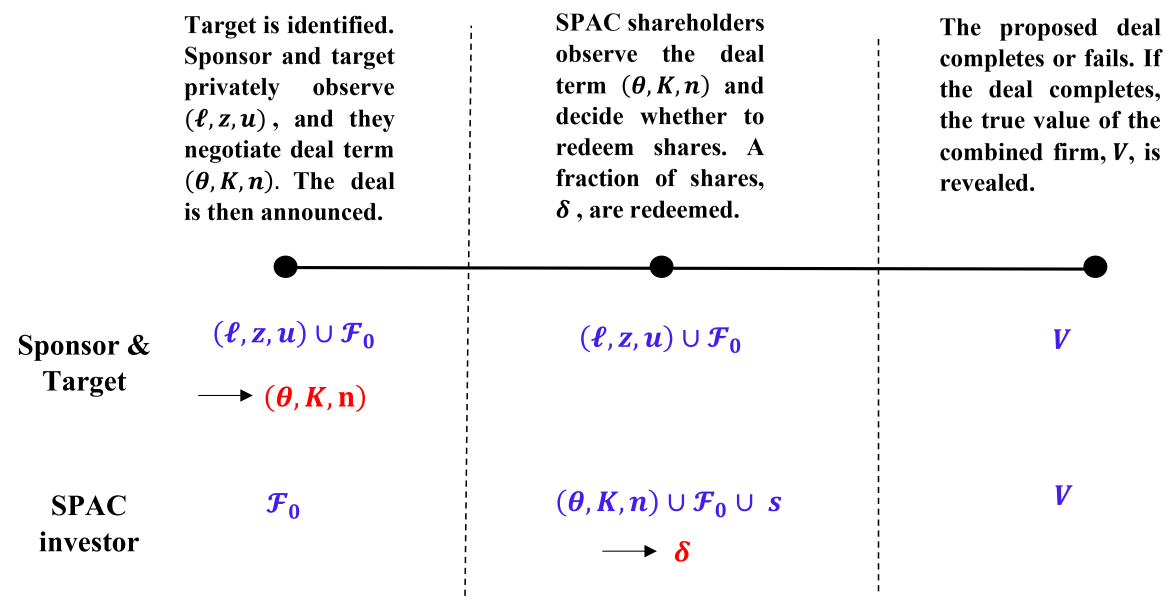

Figure 1. Model timeline.

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 (ℓ), value creation (z), and the target's reservation value as a private entity (u). Anticipating the SPAC shareholders' 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 shareholders 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.

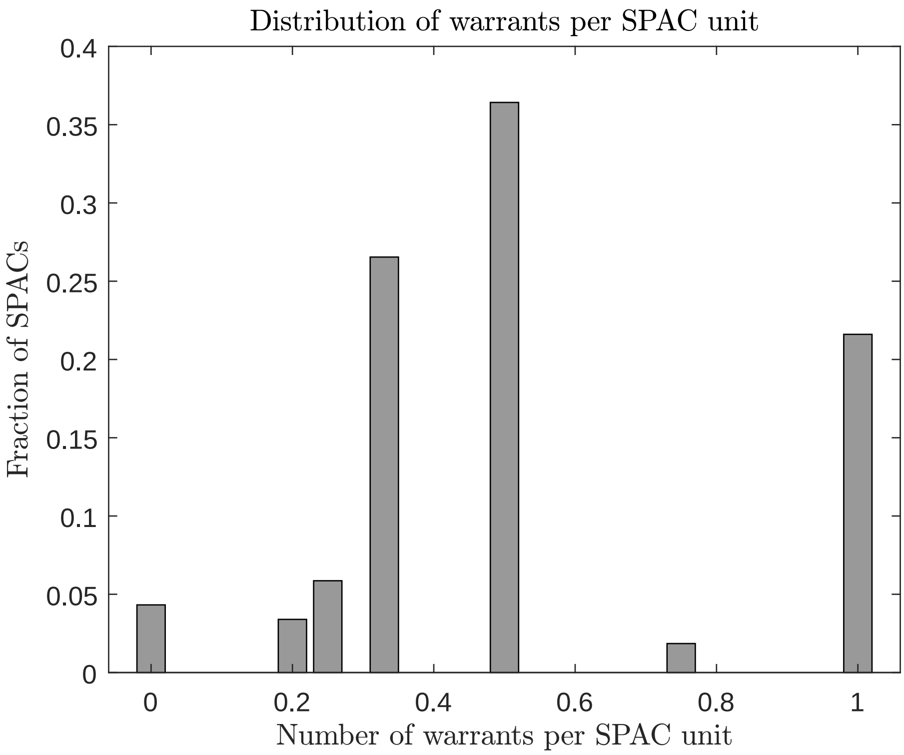

Figure 2. Distribution of warrants per SPAC unit.

This figure shows the distribution of SPACs that issue different numbers of warrants in their IPO units. Each IPO unit is composed of one share and w warrant and the common choice of w is 0, $\frac{1}{5}$, $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1. x-axis represents w and y-axis represents the fraction of SPACs that issue w warrants in each of their IPO unit.

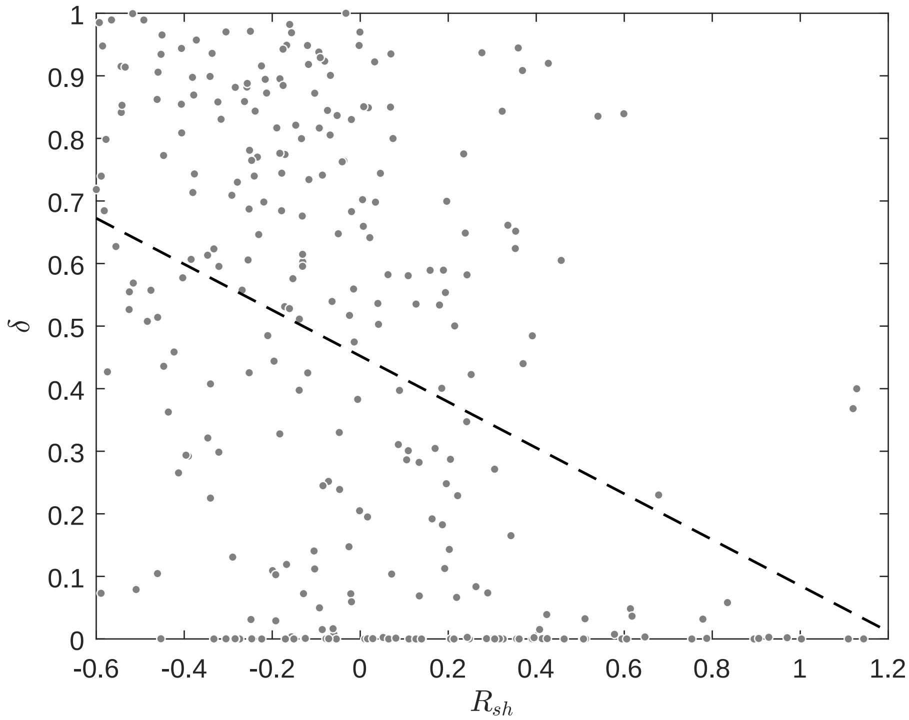

Figure 3. Redemption rate and returns to SPAC shareholders

This figure shows the relation between the aggregate redemption rate and returns to non-redeeming shareholders. Return to non-redemming shareholders is measured as the share price 3-month post deal completion relative to the face value of the shares at IPO $10, benchmarked against the Russell 2000 Growth ETF (IWO). The scattered points represent individual deals and the dash line depicts the best fit of a linear relation between redemption and returns. There exists a significant, negative association between the redemption rate and return to non-redeeming shareholders in the data.

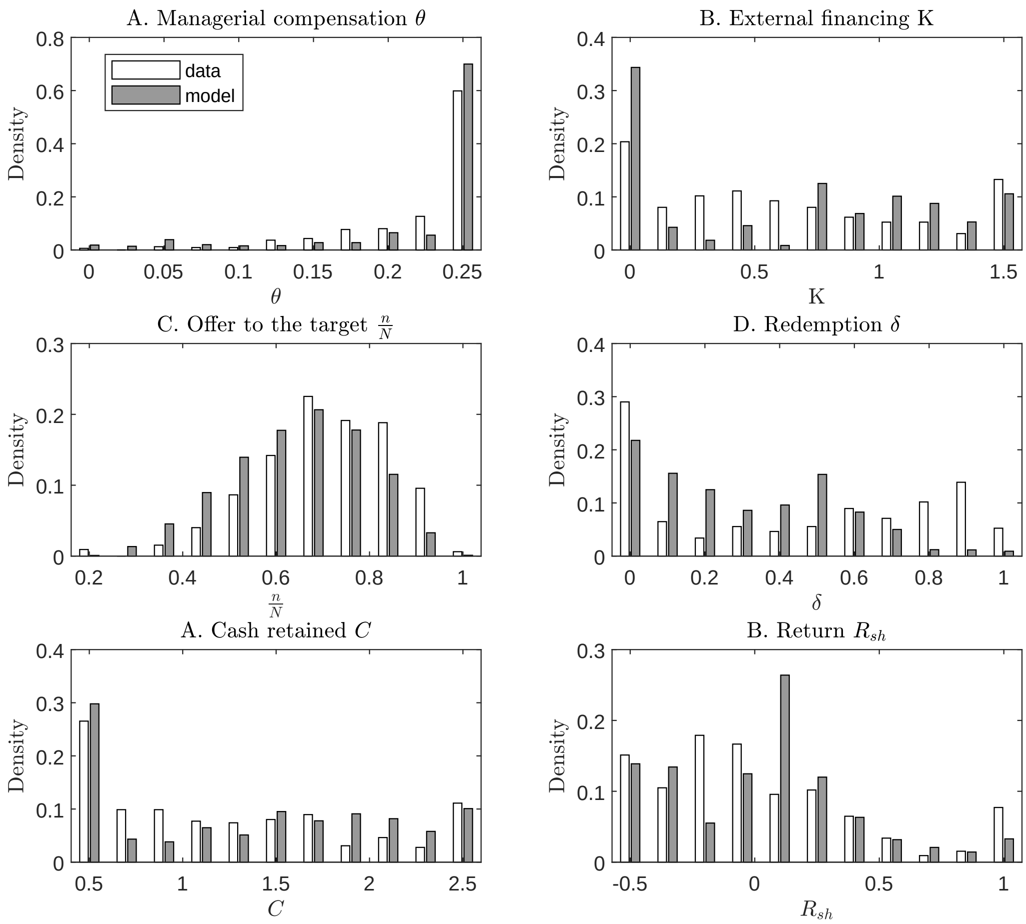

Figure 4. Model fit on variable distributions

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 return to SPAC shareholders R_{sh}.

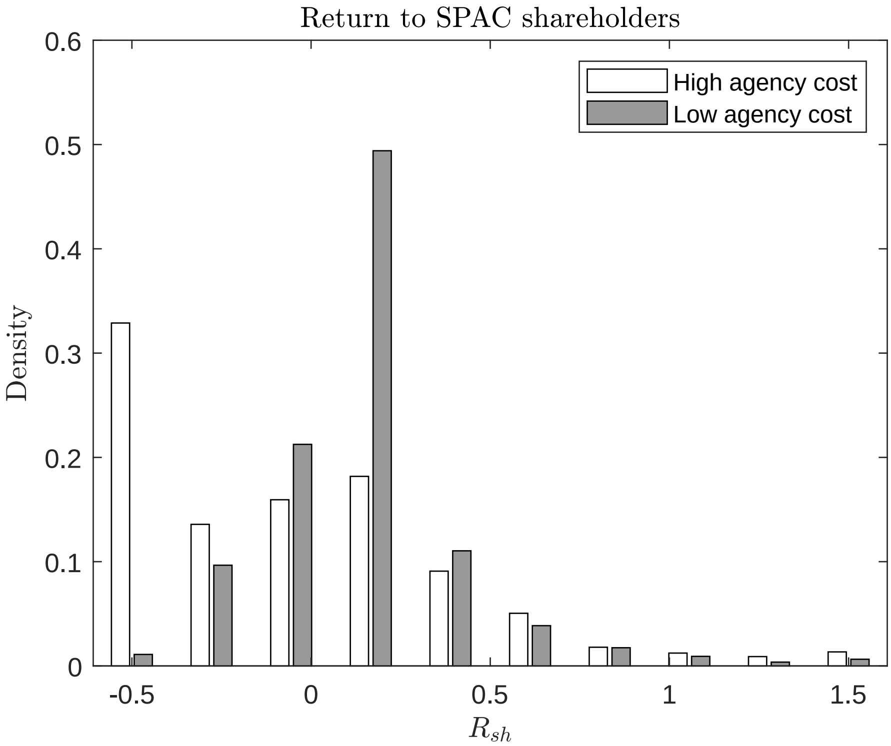

Figure 5. Returns to SPAC shareholders: low vs. high agency cost

This figure compares the distribution of returns to SPAC shareholders, R_{sh}, 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.

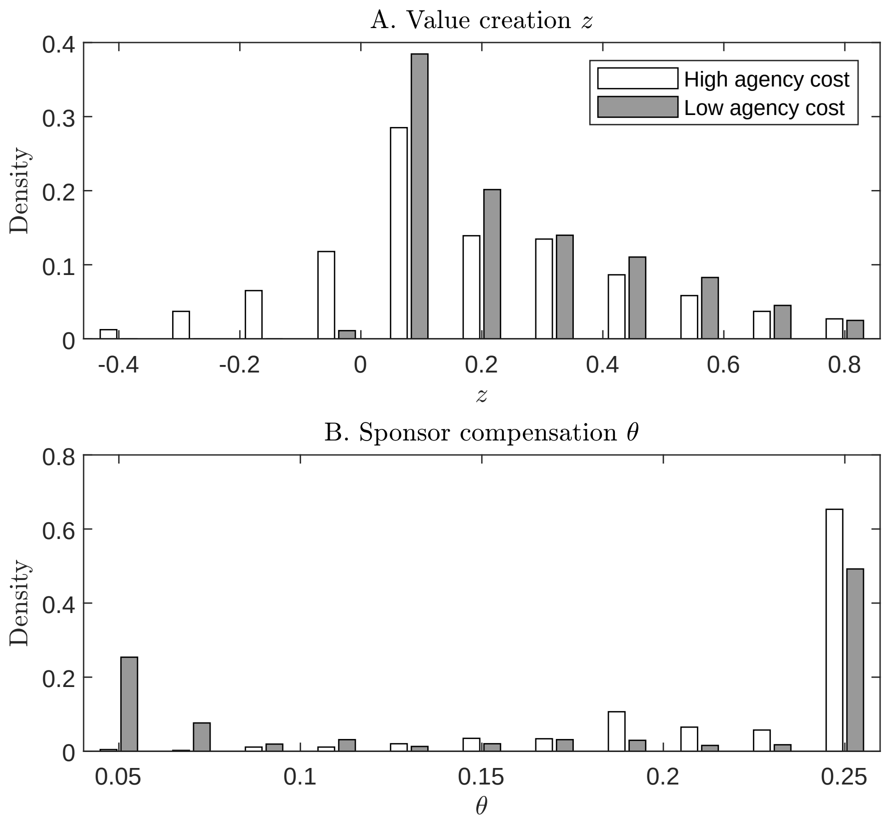

Figure 6. Deal quality and sponsor compensation: low vs. high agency cost

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 variable z and θ in deals with high agency cost and the gray bars show that for low agency cost.

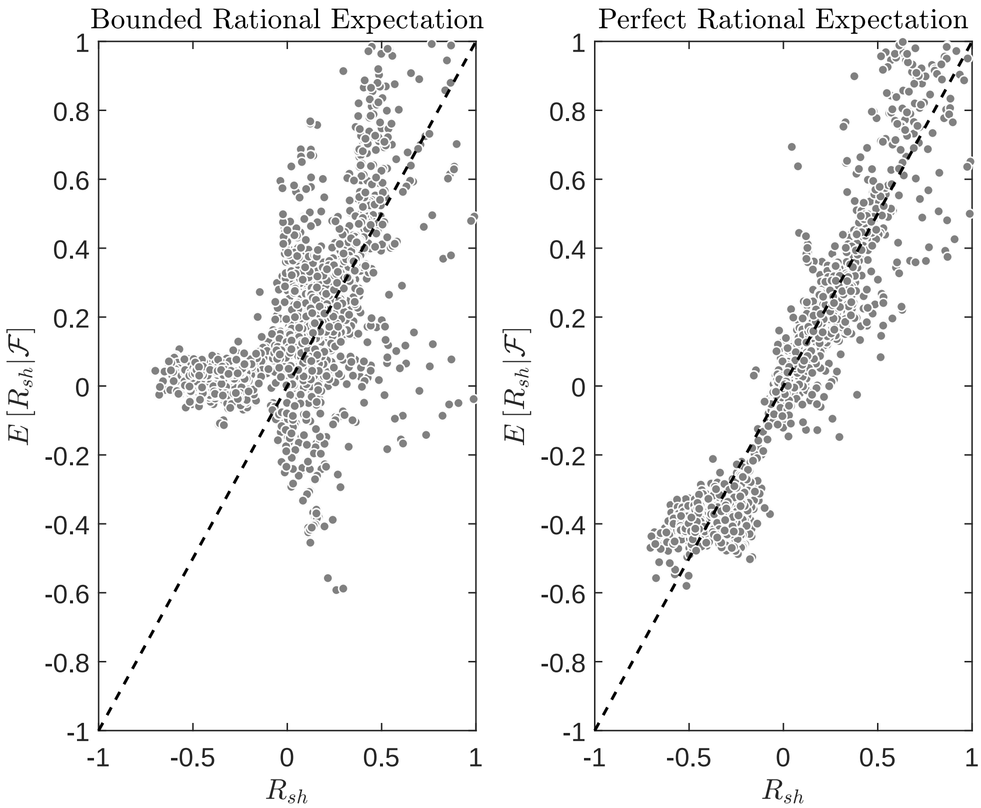

Figure 7. Forecast of deal returns: bounded vs. perfect rational expectation

This figure compares the forecast of returns to SPAC shareholders by a regular SPAC investor with bounded rationality as in the baseline model (panel A) and a hypothetical investor with perfect expectation (panel B). x-axis represents the true return to shareholders in a given deal, R_{sh}, and y-axis represents the expected return of the deal perceived by the investors, $E[R_{sh}|\mathcal{F}]$. The dash line (45-degree line) represents the accurate forecast. We simulate the model and plot the simulation results in scattered points. A better forecast, or a more accurate expectation of deal returns, implies that the points cluster closely to the dash line.

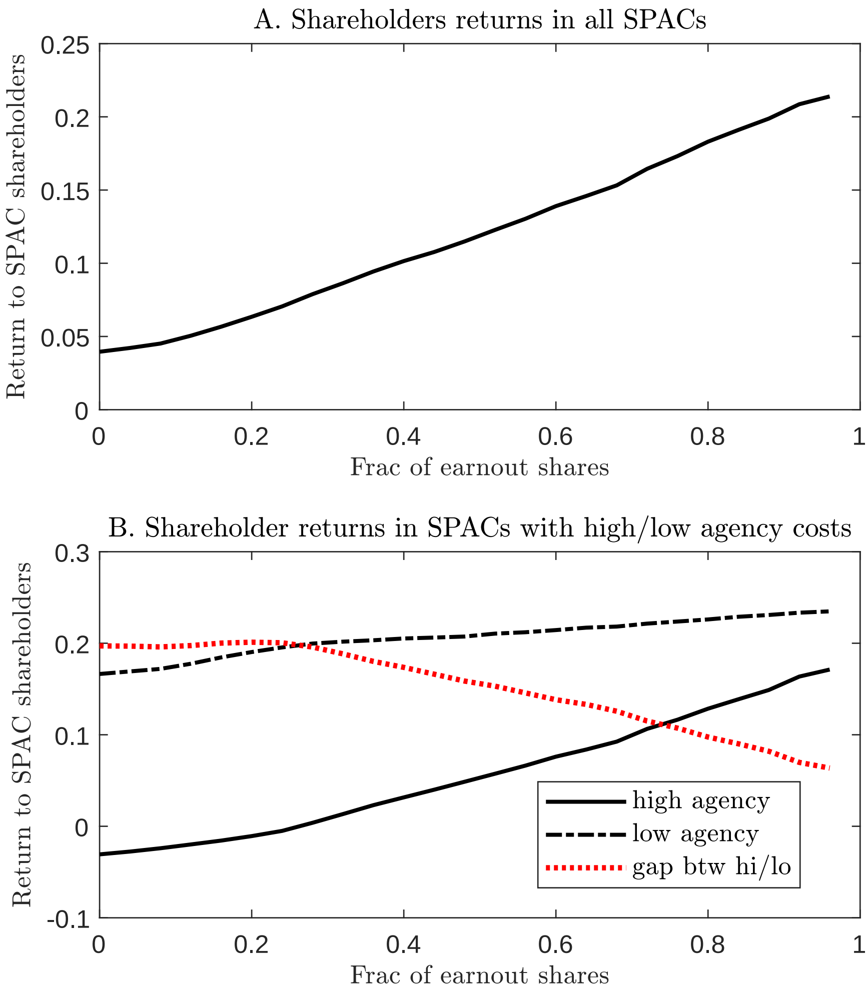

Figure 8. Policy experiment: sponsor earnouts

This figure illustrates the effects of a policy experiment that ties a certain fraction of sponsor compensation to earnouts. x-axis represents the fraction of sponsor compensation tied to earnouts, and y-axis is the average return to non-redeeming SPAC shareholders. Panel A shows the effects on the full sample of simulated SPACs, and Panel B shows the effects on the simulated SPACs with low agency cost (bottom quintile) and high agency cost (top quintile) as well as the gap between them.

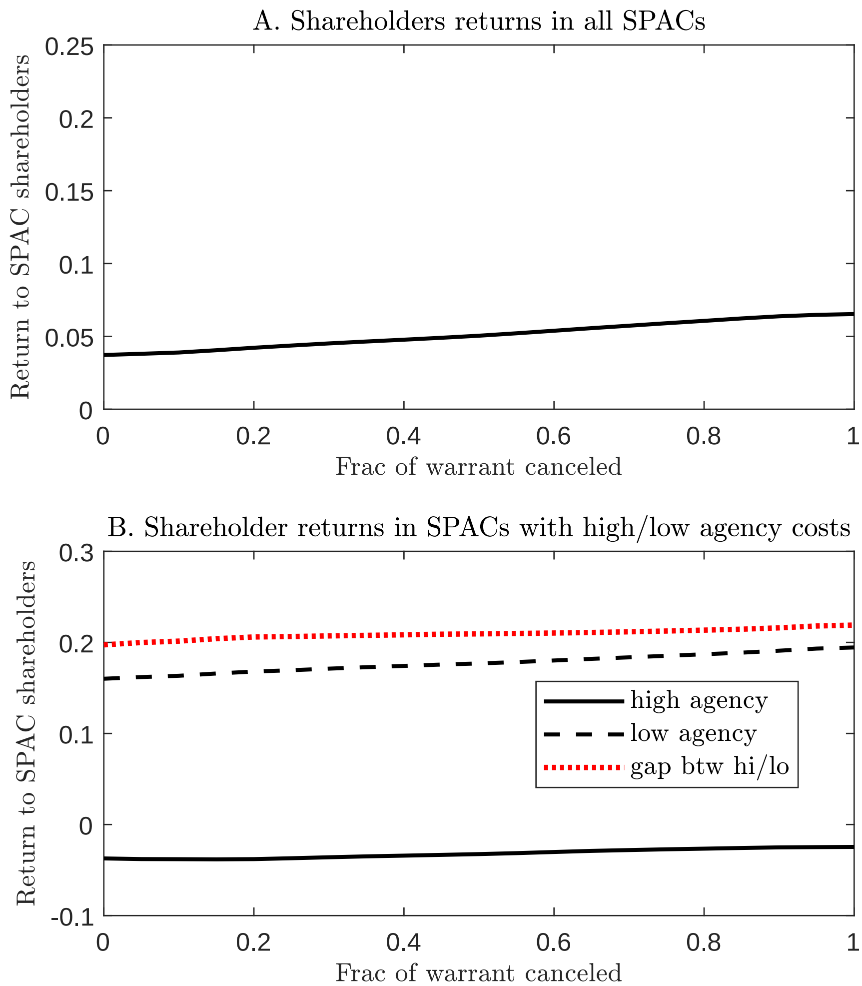

Figure 9. Policy experiment: public warrants

This figure illustrates the effects of a policy experiment that cuts back a certain fraction of public warrants issued in SPAC IPO. x-axis represents the fraction of warrants reduced in the policy experiment, and y-axis is the average return to non-redeeming SPAC shareholders. Panel A shows the effects on the full sample of simulated SPACs, and Panel B shows the effects on the simulated SPACs with low agency cost (bottom quintile) and high agency cost (top quintile) as well as the gap between them.

Table 1. Number of SPACs over Time

This table reports registered number of SPACs and the deal outcomes in our sample. 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. "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. This is based on the status as of April 30, 2022.

	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	2	0	0
2019	57	40	3	1	2
2020	318	165	0	33	120
Totals	548	364	28	34	122

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, benchmarked against IWO; Private Placement refers to any funds raised via unregistered equity sales and are used to supplement the SPAC's cash trust; Total redemption 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. 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	272	230	345	138	214	n/a	n/a
Sponsor Earn-outs	0.92	0	0.3	0	5.24	3.66	88
Target Earn-outs	5.60	0	6.00	0	19.30	15.30	131
Performance (in %)	2.82	-7.00	24.03	-28.38	47.29	n/a	n/a
Private Placement (FPA, PIPE, Backstop)	236	109	275	9.2	616.00	296	286
Total Redemptions	7.055	7.580	18.980	0.0.094	12.55	n/a	n/a
Promote Shares Forfeited	0.648	0	0.710	0	1.59	1.732	134
Priv Plac Warrants Forfeited	0.419	0	0	0	4.095	3.96	39
Total Consideration	1300.5	771.1	1427.5	300.0	2428.0	n/a	n/a

Panel B. Relative to IPO Cash/Shares

	Mean	Median	75th %ile	25th %ile	Std Dev
Private Placement (FPA, PIPE, Backstop)	0.76	0.53	1.01	0.17	1.06
Redemption (% of IPO Shares)	0.44	0.48	0.80	0.01	0.37
Promote Stake Retained (0.25 is Max)	0.22	0.25	0.25	0.21	0.05
Offer to Target (% of Total Shares)	0.71	0.71	0.81	0.61	0.14

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

This table reports the model fit. The first column lists the 13 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 FPA 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; C is the total cash delivered to the target by the SPAC upon merger, including the non-redeemed shares $1-\delta$ and the cash raised externally K; $\frac{n}{N}$ is the offer made to the target, expressed as the ownership in the combined firm post deal completion; R_{sh} is the return to non-redeeming SPAC shareholders, and it is calculated as the share price 3-month post deal completion divided by the face price of shares at IPO $10 minus one in the data, benchmarked against the Russell 2000 growth ETF (IWO), and in the model, it corresponds to $R_{sh} = p - 1$ as in Equation **??**.

Moment	Definition	Empirical value	Simulated value
Mean(K)	Avg. external capital raised	0.764	0.639
Std(K)	Stdev. of external capital raised across deals	1.060	0.560
Frac($0.1 < \delta < 0.9$)	The fraction of deals with redemption ratio between 10% and 90%	0.549	0.679
RegCoef(δ, R_{sh})	Regression coefficient of regressing delta on returns to SPAC shareholders	-0.367	-0.326
Mean(θ)	Avg. compensation to sponsor	0.219	0.217
Std(θ)	Stdev. of compensation to sponsor across deals	0.054	0.067
Mean($\frac{n}{N}$)	Avg. fraction of the combined firm's shares offered to the target	0.707	0.643
Std($\frac{n}{N}$)	Stdev. of the fraction of the combined firm's shares offered to the target	0.143	0.145
Mean(R_{sh})	Avg. return to non-redeeming SPAC shareholders	0.028	0.042
Std(R_{sh})	Stdev. of returns to non-redeeming SPAC shareholders	0.473	0.428
Frac($C < 0.5$)	The fraction of SPACs that deliver less than 50% of cash raised in IPO to targets	0.265	0.298
Frac($1.3 < C < 1.7$)	The fraction of SPACs that deliver 130% to 150% of cash raised in IPO to targets	0.080	0.095
Frac($C > 2.3$)	The fraction of SPACs that deliver more than 230% of cash raised in IPO to targets	0.111	0.101

Table 4. Parameter value estimation

This table reports the estimated 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 estimated parameter values.

Parameter	Definition	Value
μ_z	Avg. of deal quality $\ln(1+z)$	0.013
σ_z	Stdev. of deal quality across deals $ln(1+z)$	0.28
μ_u	Avg. of $\ln(u)$, u is the target value as a private entity	0.85
σ_u	Stdev. of $\ln(u)$, u is the target value as a private entity	1.21
α	Parameter of Beta distribution $Beta(\alpha, \beta)$ for sponsor agency cost ℓ	1.00
β	Parameter of Beta distribution $Beta(\alpha, \beta)$ for sponsor agency cost ℓ	1.00
ϕ_1	The linear component of variable cost of raising external capital	0.004
ϕ_2	The quadratic (convex) component of variable cost of raising external capital	0.098
σ_δ	Heterogeneous preference of SPAC shareholders in redemption decision	0.095
σ_e	SPAC shareholders' bounded rationality regarding sponsors' policy	0.143
η	The precision of additional signal SPAC shareholders receive	0
λ	Constant term in deal completion rate $q(C) = \frac{1}{1+e^{-\gamma(C-\lambda)}}$	0.15
γ	Slope term in deal completion rate $q(C) = \frac{1}{1+e^{-\gamma(C-\lambda)}}$	1.25

Table 5. The effect of information asymmetry

This table reports our estimate of the magnitude of information asymmetry between SPAC shareholders and the sponsor as well as the effect of information asymmetry on SPAC shareholders' returns. Panel A decomposes the total variance of the cross-sectional deal return into the variance of the expected return 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' bounded rationality. Panel C shows the improvement in average returns for an investor when his bounded rationality is eliminated. It also breaks down the improvement into four components to demonstrate the main sources of the improvement.

Panel A. Variance decomposition of deal value	
$Var(R_{sh})$	1
$Var(\epsilon)$	0.53
$Var(E[R_{sh}\|F]) + 2Cov(E[R_{sh}\|F], \epsilon)$	0.47

Panel B. Variance decomposition of forecast errors	
$Var(R_{sh} - E[R_{sh}\|F])$	1
$Var(R_{sh} - E^{PRE}[R_{sh}\|F])$	0.303
$Var(E^{PRE}[R_{sh}\|F] - E[R_{sh}\|F])$	0.605
$2Cov(R_{sh} - E^{PRE}[R_{sh}\|F], E^{PRE}[R_{sh}\|F] - E[R_{sh}\|F])$	0.092

Panel C. Gains from perfect expectation

	Total	Extensive Margin	Intensive Margin
Avoid bad deals	6.54%	0.394	16.61%
Catch good deals	0.76%	0.256	2.99%
Miss good deals	-0.31%	0.338	-0.93%
Fall in bad deals	-0.004%	0.013	-0.34%
Return gap (total)	7.00%		

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Appendix

A Numerical algorithm

To solve the model numerically, we first discretize the state variable tuple (ℓ, z, u) into grids with the number of grids to be N_ℓ, N_z and N_u. We then discretize the policy function (θ, K, n) and δ into grids with the number of grids of N_θ, N_K, N_n and N_δ, respectively.

Since the shareholders' redemption rate δ is a function of the deal terms (θ, K, n) in equilibrium, we initialize its value on each grid of (θ, K, n) as:

$$\delta = \delta^{(0)}(\theta, K, n)$$

where $\delta^{(0)}(\cdot)$ is our initial guess of the redemption function $\delta(\theta, K, n)$. We then follow the steps below in each iteration $g \geq 1$:

1. Given the redemption function obtained in iteration $g-1$, $\delta^{(g-1)}(\theta, K, n)$, for each grid on the state variable tuple (ℓ, z, u), we search for the corresponding optimal deal terms, (θ, K, n), on the their grids that solve the sponsor's and target's value maximization problem in Equation 10;

2. The above step produces the optimal deal terms in the gth iteration:

$$\theta = \theta^{(g)}(\ell, z, u)$$
$$K = K^{(g)}(\ell, z, u)$$
$$n = n^{(g)}(\ell, z, u)$$

   Using the updated deal terms $(\theta^{(g)}, K^{(g)}, n^{(g)})$, we solve the shareholders' optimal redemption decision, as shown in Equation 12 and 16.

3. The above step produces the solution to the redemption rate in the the gth iteration:

$$\delta = \delta^{(g)}(\theta, K, n)$$

4. We compute the distance between the deal terms in the $(g-1)$th iteration and the gth iteration and the distance between the redemption rate in the two iterations.

5. We repeat step 1 to 4 above until the distance of policy functions between the last two iterations falls below a predetermined threshold.

The above numerical algorithm solves the model for a given set of model parameters. Once the model is solved, we use the model to simulate a cross-section of SPACs and the associated mergers. Specifically, to simulate a SPAC and its proposed merger, we draw a realization of its state variable tuple (ℓ, z, u) from the joint distribution $f(\ell, z, u)$. Then we obtain the optimal deal terms that the sponsor and target will choose in the deal based on the optimal deal terms (θ^*, K^*, n^*) we solved in the model. We can also obtain the redemption rate by the SPAC shareholders, δ^*. Based on this set of information, we are able to compute the characteristics and outcomes for this deal.

To perform SMM estimation, we simulate a cross-section of SPAC deals, and compute the aggregate moments from them. We then compare the model-implied moments with the data moments to evaluate the model's fit. We search for the model parameters that minimize the distance between the model-implied moments and the data moments.

B Data and Sample

B.1 Variable construction

We provide various cross-sectional data on our sample of SPACs/de-SPACs. These values are presented in Table 2, with raw values presented in Panel A and scaled values presented in Panel B.

IPO Proceeds is fairly self-explanatory, representing the total dollar value of proceeds raised in the SPAC IPO (in millions of $s), and also represents the value of the SPAC's cash trust if it is fully funded, which essentially they all are. This is the sum of the sought-after proceeds listed in the SPAC's IPO prospectus (Form 424B4), and any additional shares sold via the over-allotment (Green Shoe) option.[24] Sponsor earn-outs are the number of sponsor promote shares tied to earn-out provisions (in millions of shares), while Target earn-out shares are similarly defined for the number of contingent shares given as a portion of the merger consideration paid to the target owners.

In terms of performance metrics, our focus is on the investor's redemption decision, wherein he/she has the choice to exchange their shares for approximately $10 each, or stick with the SPAC shares, in the hope of increasing the payoff. For this reason, we compare the price of the de-SPACed firm 3 months post business combination with the $10 that investors could have had had he redeemed his shares. Call this the return relative to redemption. Then, in addition to the return relative to redemption, we consider that return in excess of two ETF-based benchmarks: IWO (I-shares Russell 2000 Growth ETF) and IPOS (Renaissance International IPO ETF). These are straight returns (not annualized).

Private Placement is the amount raised via PIPE, FPA, or Backstop agreement, in millions of dollars, while total redemptions are the total number of shares redeemed by SPAC IPO investors (in millions). Promote Shares Forfeited is the number of shares of the sponsor's promote stake that were voluntarily forfeited by the sponsor to push the deal through (in millions), while Private Placement Warrants Forfeited represent the number of private placement warrants that the sponsor offered to forfeit in order to enable the completion of a deal (in millions of warrants). And finally, the total consideration is the total dollar value of consideration paid to the target firm's owners in the business combination (in millions of $).

Panel B shows statistics on a subset of our cross-sectional variables, scaled by IPO shares or promote stake. Private Placement is the size of the PIPE or similar as a percentage of IPO shares sold. Redemption represents the fraction of IPO shares redeemed by IPO investors, Shares Granted and Total Shares are similarly defined for shares given to the target owners in consideration, and total shares outstanding. Finally, Promote Stake Retained gives a reading on the fraction of the promote retained by the sponsor, where IPO shares are redefined in our model as 1, and the baseline promote is then 0.25 shares.

[24] The SPAC promote is typically constructed under the assumption that the Green Shoe option is exercised. In the event the this option is not exercised, the sponsor will forgo the requisite number of shares

B.2 Method of payment

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, some deals in our sample involve some cash consideration. 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.

To provide some context, 38.8% of deals that we study involve cash, meaning that nearly 62% of SPAC business combinations involve only shares. Focusing on the 38.8% of business combinations that involve some cash, just 3 deals are done with 100% cash, and only 33 deals (less than 10% of our sample) are majority financed with cash. Finally, only 27.9% of deals utilize more than 10% cash, and only 22% of deals utilize more than 20% cash.

B.3 Sponsor compensation

We gather information on SPAC sponsor compensation from the Super 8-K that is typically filed a few days after the closing of the proposed business combination. SPACs that are foreign-domiciled (typically in the Carribean) file a Form 20-F in lieu of a Super 8-K.

In nearly every SPAC, the sponsor's main source of compensation is the sponsor's *promote shares*. The sponsor's promote is designed so that he/she holds 20% of the sum of IPO shares and promote shares, which means the sponsor's promote is defined as 25% of the IPO shares. The sponsor also purchases securities (usually warrants, but occasionally SPAC units in lieu of warrants). in a private placement coinciding with the SPAC IPO.

Sponsors understand that they can make any proposed deal more palatable to the other parties in the deal (PIPE investors, IPO investors, and target shareholders) if they forfeit, or make contingent, a portion of their compensation. Any such arrangements are typically reported in the Super 8-K and/or an attachment to the Super 8-K, and they are often also reported in the investor presentation that the SPAC/target put together to try to sell the deal to investors.

Sponsors can also potentially improve the economics of a transaction for the other parties by agreeing to tie a portion of their promote shares to performance of the de-SPACed firm in what is known as an earnout. Earnouts are also typically disclosed in the Super 8-K and/or the investor presentation. Figure B.1 shows a snippet form the Super 8-K describing the business combination between Switchback Energy Acquisition Corp (the SPAC) and Chargepoint Holdings (the target company in the EV charging industry):

This information is also sometimes available in an attachment to the Super 8-K, especially the Unaudited Condensed Pro-Forma Information, as shown in Figure B.2.

Earnouts In our sample, 88 of our SPACs tie significant portions of the Sponsor promote to performance targets, utilizing what are known as "earnouts" (or sometimes written earn-outs, hereafter, EOs). This is approximately one quarter of the sample of

From the Super 8-K filed by Switchback Energy Acquisition Corp/Chargepoint Holdings

Filed on March 1, 2021

In addition, pursuant to a letter agreement (the "Founders Stock Letter") entered into by the holders of the Founder Shares (the "initial stockholders") and the Company in connection with the execution of the Business Combination Agreement, immediately prior to the Closing, the initial stockholders (i) **surrendered to the Company, for no consideration and as a capital contribution to the Company, 984,706 Founder Shares held by them (on a pro rata basis), whereupon such shares were immediately cancelled**, and (ii) **subjected 900,000 Founder Shares (including Common Stock issued in exchange therefor in the Merger) held by them to potential forfeiture in accordance with the terms of the Founders Stock Letter.** Upon the Closing, all outstanding Founder Shares converted into Common Stock on a one-for-one basis and the Founder Shares ceased to exist.

Forfeited shares highlighted in **yellow**, earnout shares in **green**

Figure B.1. Super 8-K

This figure illustrates an example of source where we identify the sponsor's compensation using Super 8-K. Forfeited promote shares are highlighted in yellow and earnout shares are highlighted in green.

From the Unaudited Condensed Pro-Forma Information attached to the Super 8-K

The following summarizes the New ChargePoint Common Stock issued and outstanding immediately after the Business Combination:

	Pro Forma Combined (Shares)	%
Switchback Class A stockholders	31,378,754	11.3
Switchback Class B stockholders(1)	6,868,235	2.5
Former ChargePoint stockholders(2)(3)	217,021,368	78.1
PIPE Financing	22,500,000	8.1
Total	**277,768,357**	100.0

(1) Amount excludes the **984,706 Founder Shares surrendered to Switchback** and **includes 900,000 shares of New ChargePoint Common Stock subject to forfeiture until the Founder Earn Back Triggering Event has occurred.**

Forfeited shares highlighted in **yellow**, earnout shares in **green**

Figure B.2. Super 8-K

This figure illustrates an example of source where we identify the sponsor's compensation using the unaudited condensed Pro-Forma information attached to the Super 8-K. Forfeited promote shares are highlighted in yellow and earnout shares are highlighted in green.

SPACs. Among these 88 SPACs, the average sponsor ties about 40% of their promote stake to an EO.

By agreeing to tie a portion of their compensation to performance targets (usually, but not necessarily, a price target), clearly the sponsor is giving up something, the question is how much? In this appendix, we describe our implementation of the binomial model of Cox et al. (1979), including any simplifying assumptions made specifically for the purpose of valuing EOs.

Structure of a Typical EO

In an EO, the sponsor offers to tie a portion of their promote stake to the performance of the target company post de-SPAC. In a typical de-SPAC transaction, the sponsor's promote stake (set to be 25% of the SPAC's original IPO shares) vests upon the consummation of a business combination. But with an EO clause, a portion of the promote is tied to an EO and does not vest unless the provisions of the EO are met. Though performance targets are sometimes set based on accounting goals (i.e., revenues, EBITDA, etc.) or non-financial performance (e.g., approval of a drug), by far the most common structure uses share price as the relevant performance benchmark. Recall that in a SPAC, shares have a par or book value of $10 each. EO price targets are typically set noticeably or considerably above $10, implying that the sponsor only retains ownership of any EO shares if post de-SPAC performance is decent or exceptional, depending on the price target and time dimension. In our sample, price targets are as low as $11 per share and as high as $50 per share.[25] In terms of timing, we see EOs as short as 6 months out to as long as 10 years. Moreover, EOs can be complex, with multiple price targets and expiry dates. Most EOs have price targets of $12.50 to $15.00, and maturities of two to five years. In order to avoid incentives to manipulate the share price, most EO clauses insist that the post de-SPAC share price must surpass the EO target share price on 20 or more days in any given 30-day period prior to the expiry date of the EO, meaning that a performance target need not only to be met, but *maintained* to qualify for vesting.

The following example of an EO has a structure that is typical of those we see in our sample. A SPAC sponsor creates a SPAC to raise $200M. As such, his promote stake is 5,000,000 shares with a par value of $50M. Suppose that in order to make the SPAC more palatable to all parties, the sponsor agrees to tie half the promote stake to an EO. The EO has 2 triggers, one at $12.50/shr and the other at $15.00/shr. The $12.50 trigger has to be reached within 1 year, while the $15 trigger has to be reached within 2 years. Suppose that half the EO is associated with each price target and each expiry date. Thus, 1,250,000 shares are released to the sponsor if the share price exceeds $12.50 in the first year following the de-SPAC, and another 1,250,000 shares will be released to the sponsor if the share price exceeds $15.00 in the first two years following the de-SPAC. A reminder that in our example, the sponsor retains 2,500,000 worth of promote shares that vest immediately upon the consummation of a business combination. Remember too that though option-like, the EOs are different from options, in that if the trigger price is breached for the requisite number of days the shares vest immediately w/o payment, whereas call options would require payment of an exercise price.

Our Approach

To evaluate our EOs, we follow Cox et al. (1979), hereafter CRR, and construct binomial trees to evaluate the EOs in our sample of SPACs. We evaluate each EO contract based on its terms (trigger price(s) and EO duration(s)) and based on a set of universal assumptions. Specifically, we assume an underlying volatility of the ongoing (de-SPACed) firm of $\sigma = 60\%$ per year and a risk-free rate of 2%. We construct binomial

[25] Note: one firm has several EO triggers (actually 8 in total, running from a low of $15 to a high of $200/share) that exceed $50, but this is the only firm with a trigger over $50, so not representative. We feel that stating the max as $50 is more informative, though technically not 100% accurate.

trees with semi-annual periods if the maturity of EO, T_{EO}, is within 5 years, and annual time-step if $T_{EO} > 5$ years.

Following CRR, and with the above assumptions, we define u and d, the returns in the "up" and "down" states, respectively, as: $u = e^{\sigma\sqrt{t}}$ and $d = e^{-\sigma\sqrt{t}}$, with $\sigma = 60\%$ and t equal to either 0.5 years or 1 year, depending on T_{EO}.[26] In this setting, CRR showed that the risk-neutral probability in such a case is given by: $q = \frac{e^{rt}-d}{u-d}$. We treat reaching a given price as equivalent to staying there for 30+ consecutive days, and therefore satisfying the "price maintenance" portion of the EO's payment clause. We use the usual iterative procedure to evaluate the EO, beginning at the EO expiration and working backwards. Additionally we note that vesting (early exercise of the EO "option") will always occur immediately upon breaching a price trigger.[27]

In this framework, the value at any node, t, where the share price is denoted, P_t, the EO value by $V_{EO,t}$, and the value of the EO in the following period denoted as $V_{EO,u}$ with risk neutral probability q, and $V_{EO,d}$ with risk neutral probability $(1-q)$, the value of the EO at node t will be given by:

$$V_{EO,t} = \begin{cases} P_{t,} & if\ P_t \geq P_{EO} \\ \left[qV_{EO,u} + (1-q)\,V_{EO,d}\right] e^{-rt}, & if\ P_t < P_{EO} \end{cases} \tag{20}$$

By definition, $V_{EO,0} < P_0$ because the manager would always prefer a "free" share to an EO share. We value each EO according to it's fundamentals (trigger price and expiry date) and our simplifying assumptions, with the goal of determining the equivalent amount of promote stake that the sponsor has voluntarily given up by tying a portion of their promote stake to an EO. As a means of benchmarking, and to give an example, a 5-year EO with a trigger price of \$15.00, a fairly typical structure, has a value of \$8.98/share when the share price is \$10. This represents a 10.2% reduction in value. Suppose further that the sponsor has tied half of her promote stake to such an EO, we would characterize this sponsor as having given up 5.1% of her promote stake.

As mentioned earlier, among the 88 SPACs who's sponsors agree to tie a portion of their promote to an EO, the average sponsor agrees to tie 40% of their promote to an EO, with the range running from a low of 4.5% to a high of 100% (there are 6 SPACs whose sponsors agree to tie their entire promote to an EO). Based on our volatility assumptions, we estimate that this willingness of the sponsors to tie an average of 40% of their promote to EOs, results in a value loss of about 6.8% of their promote stake, relative to simply retaining the shares.

[26]Note that in our comprehensive dataset of SPACs, the average volatility of post de-SPAC 3-month returns is about 57% , which is considerably higher than a 60% annualized volatility. However, our performance data cover the initial 3-month window immediately following the de-SPAC, which is a particularly volatile period for the newly de-SPACed shares.

[27]Unlike in the case of a call option, the EO does not sustain any "insurance value", in the sense that owning the shares always strictly dominates retaining the EO.