Comparing Capital Allocation Efficiency in Public and Private Equity Markets*

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Abstract

Investors increasingly allocate capital outside of public equity markets and through private equity investments. We evaluate capital allocation efficiency in public and private markets by comparing the marginal revenue and marginal innovation product of capital in similar firms that receive equity in each market. Public markets allocate financial capital substantially more efficiently than private markets. A dollar of equity allocated through public markets generates at least two times more revenue and patent applications than a dollar allocated to comparable firms in private markets. The difference in allocation efficiency is persistent over time and across industries. Using cross-sectional tests and quasi-natural experiments, we show that better information efficiency and governance mechanisms in public markets drive the allocation efficiency gap. Our study highlights the role of public markets in improving capital allocation in the economy, and points to a potential implication of the shrinking public equity and the growing private equity markets.

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"The Committee is concerned about the implications of private and quasi-public market growth on public markets and investors. The Committee believes public markets offer certain valuable benefits to investors that private and quasi-public markets do not provide, including more robust transparency, better pricing efficiency [...] and stronger accountability mechanisms."

U.S. House Committee on Appropriations,
Joint Explanatory Statement on Consolidated Appropriations Act, 2020

A primary job of the economy is to direct capital toward the most productive investment opportunities. Public equity markets have historically performed well in allocating capital efficiently (Wurgler, 2000; Levine, 2005). In recent years, however, private equity markets have grown significantly, supplying more capital to private firms in the form of late-stage financing than initial public offerings (IPOs) and seasoned equity offerings (SEOs) combined (U.S. SEC, 2020; Ewens and Farre-Mensa, 2022). Therefore, potential differences in public and private markets' ability to allocate capital efficiently suggest that this transition may affect the overall allocation efficiency in the U.S. economy.

In this study, we compare the efficiency of capital allocation in public and private equity markets and find that public markets allocate capital considerably more efficiently than private markets. Our results are based on comparing equity offerings of public firms with equity issues of similar private firms, including late-stage venture capital (VC) and growth equity investments, and excluding buyouts. We find that private markets allocate capital to firms with recent rapid growth, but their growth plateaus after receiving capital. However, public markets allocate capital to firms that, despite having lower growth before the deal, exhibit a steady increase in growth after capital injection. We examine potential explanations for the efficiency gap between the two markets. The gap is not driven by differences in firm or deal characteristics. Instead, we find that better information efficiency and governance mechanisms in public markets help investors and managers identify and direct capital to more productive projects.

It is not clear ex ante whether private or public markets allocate capital more efficiently. On the one hand, public equity markets improve allocation efficiency by aggregating private information and incorporating it into stock prices (Fama, 1970; Kyle, 1985; Subrahmanyam and Titman, 1999; Bond, Edmans, and Goldstein, 2012; Goldstein, 2023). Moreover, the information efficiency, and thus the allocation efficiency, in U.S. stock markets have increased over time (Bai, Philippon, and Savov, 2016). On the other hand, most private investments are intermediated, and intermediaries can improve allocation efficiency by screening out bad projects (Boyd and Prescott, 1986; Dow and Gorton, 1997). In fact, venture capitalists rate deal selection as the most important aspect of their value creation (Gompers, Gornall, Kaplan, and Strebulaev, 2020).

We use a standard neoclassical model of investment to motivate our empirical tests. In the model, the optimal capital allocation implies that firms with higher productivity should receive more capital. However, directly testing this relation in the data is not feasible because firm productivity is unobservable, especially in private firms. Therefore, we use the model to provide a framework for comparing the efficiency of capital allocation in public and private equity markets using observable data. In the model, the efficient allocation of capital equalizes the expected marginal product of capital (MPK) across firms, i.e., directs capital to the highest MPK firms and takes capital away from the lowest MPK firms. We show that, under standard assumptions, comparing the realized MPK—defined as output growth per unit of capital raised—in firms that receive equity in two markets is sufficient to assess the relative efficiency of capital allocation in those markets. We follow this approach in setting up our empirical tests. Moreover, the model illustrates how heterogeneity in firm characteristics across markets, such as firm size and exposure to systematic risk, influence the MPK comparisons. These insights inform our analysis of potential explanations for the observed allocation efficiency gap between public and private markets.

We measure MPK using two types of output. First, we use firms' revenue (i.e., top line) and define the marginal revenue product of capital (MRPK) as the average annual growth in revenue per dollar of raised equity in the three years following equity issuance. The use of MRPK is supported by evidence showing that private investors rely on revenue growth (not profit) to assess firms' performance and prospects.[1] Nonetheless, certain private firms may prioritize innovation over revenue generation. Thus, we also use innovation outcomes and

[1]In our private interviews, VC investors emphasized revenue growth as the predominant metric for gauging firms' performance and the demand prospects for their product or service, even in young firms with significant net operating losses. Refer to Section 4.1 for anecdotal evidence and Chemmanur, Krishnan, and Nandy (2011); Gompers, Kaplan, and Mukharlyamov (2016); Gompers, Gornall, Kaplan, and Strebulaev (2020); Maksimovic, Phillips, and Yang (2023) for systematic evidence.

define the marginal innovation product of capital (MIPK) as the three-year average annual number of new patent applications per million dollars of raised equity.

We find that the MRPK and MIPK of firms receiving equity in public markets are substantially larger than those of firms with similar size, age, and pre-issue growth rates receiving equity in private markets. A dollar of equity allocated in public markets generates $0.54 more in annual revenue over the next three years than a dollar allocated to a comparable firm via a private market deal. This estimate reflects a difference between an average MRPK of $0.34 in private investments and an average MRPK of $0.88 in public equity investments. Also, the median deal in public markets generates 0.40 more patent applications than the same amount allocated in private markets. This difference in allocation efficiency persists over time and across sectors. Overall, the results suggest that public markets allocate financial capital much more efficiently than private markets.

Importantly, the large difference in output growth rates between public and private firms is created at the time of capital allocation, not from pre-trends. In fact, private firms have higher revenue and innovation growth rates than public firms before raising capital. In the year leading up to raising equity, private firms' revenue growth and innovation output exceed public firms' by 61% and 28%, respectively. Our findings suggest that firms tend to raise equity in private markets after an exceptionally strong year of growth in revenue and innovation, but they do not sustain those outcomes after raising capital. This pattern is consistent with market timing in private markets. On the other hand, public markets are able to identify and direct capital to firms with high growth potential after the deal.

These findings invite the question of whether investors' turn to private markets is a mistake. Our analysis does not directly address this question because investor returns depend on unobservable valuations at the time of financing. If founders value staying private, for instance, due to their preference for control (à la Ewens and Farre-Mensa, 2020), they may agree to more favorable valuations for investors of late-stage private deals. This means that private market investors could still earn higher returns than public market investors, even when the allocation efficiency in private markets is lower than in public markets.

Comparing allocation efficiency in the two markets presents a few empirical challenges. First, an average public firm is different from an average private firm. Second, a typical SEO is different from an average VC deal. To address the first challenge, our analysis accounts for observable firm attributes, such as size, age, and industry. In addition, we compare a subsample of public and private firms matched based on industry and size. To account for the fact that the public status of firms may facilitate their access to debt financing, we compare subsamples of firms with no debt issuance around their equity-raising events to isolate the effect of equity financing in the two markets. Additionally, we compare public firms to a subsample of private firms that file for an IPO, later withdraw it, and go on to raise equity in private markets. Importantly, we also examine within-firm changes in allocation efficiency by comparing their MRPK and MIPK in equity-raising events pre- and post-IPO.

To address the second challenge, we focus on a subset of private deals that bear greater similarity to SEOs, including late-stage VC and growth equity deals. Also, recognizing the difference in average deal size between SEOs and VC investments, we sort deals into size groups and draw comparisons between public and private issues of comparable size. Furthermore, we compare private investments in public equity (PIPEs) with VC investments to mitigate the effects of differing placement processes between SEOs and VC investments.

In all approaches, we find similar estimates for the allocation efficiency gap. Additionally, we find a monotonic decline in the MPK of private deals with respect to the funding round, indicating that low allocative efficiency in late-stage VC deals drives most of the efficiency gap. This finding is important because, in recent years, late-stage VC is replacing public equity issues in firms that delay going public and stay private longer (Ewens and Farre-Mensa, 2020, 2022).

While the nuanced group definitions improve the comparability of private and public firms, they may still not eliminate biases from omitted variables or selection mechanisms. However, these forces likely bias our estimates in the opposite direction. Our model suggests that, under efficient capital allocation, the average MPK of smaller private firms should be greater, not lower, than the MPK of larger public firms. Consistent with this notion, the distribution of revenue growth for private firms in our sample skews to the right of that for public firms, suggesting that the unconditional differences between public and private firms are likely working against the direction of our findings. Recent studies corroborate this evidence, showing that firms grow faster before their IPO and slow down in the long term after going public (Maksimovic, Phillips, and Yang, 2023) and that publicly listed firms, on average, have a lower return on assets than private firms (Ueda and Sharma, 2019). Therefore, observing the opposite result at equity-raising events suggests that public markets are directly associated with allocating capital to the most productive firms. Furthermore, we verify that our results are not driven by the differences in firms' exposure to aggregate risk (i.e., firms' beta) (à la David, Schmid, and Zeke, 2022). Finally, our results are unlikely to be driven by the rise of markups in public firms relative to private firms. While there is a rise in the markups of large superstar firms over our sample period (De Loecker, Eeckhout, and Unger, 2020), the allocation efficiency gap is steady over time.

We further investigate possible mechanisms that could explain the improved allocation efficiency in public equity markets. First, we examine whether the allocation efficiency gap is driven by the disparity in the level of information efficiency between the two markets. By incorporating firm-specific information in stock prices, public markets may help investors and managers identify and allocate capital toward the most productive investment opportunities. We validate this hypothesis in the cross-section of firms using multiple proxies for stock price informativeness and in a quasi-natural experiment setting based on plausibly exogenous reductions in analyst coverage (Hong and Kacperczyk, 2010; Kelly and Ljungqvist, 2012; Chen, Harford, and Lin, 2015). Both tests confirm the hypothesis by showing that a decline in information efficiency leads to a drop in capital allocation efficiency.

Finally, we test whether the allocation efficiency gap arises from differences in the quality of corporate governance, a key determinant of firms' operational efficiency. We validate this hypothesis in the cross-section of public firms using multiple proxies for the quality of corporate governance and a quasi-natural experiment. We use large import tariff changes as an exogenous shock to the level of product market competition as an external governance mechanism (Hart, 1983; Fresard, 2010; Giroud and Mueller, 2010, 2011). The results from both sets of analyses underscore the importance of internal and external governance mechanisms in improving capital allocation decisions within firms.

The remainder of the paper is organized as follows. Section 1 discusses the paper's contribution to the related literature. Section 2 provides a theoretical framework to motivate our empirical tests. Section 3 provides information on data sources and describes the sample.

Section 4 presents the main results on the differences in allocation efficiency in public and private markets. Section 5 evaluates possible explanations for the documented differences. Section 6 concludes.

1. Contribution to the literature

This paper relates to multiple strands of the literature. First, it contributes to the literature studying the shrinkage of public equity and the growth of private equity markets. In the past 25 years, the US has experienced a significant decline in the number of IPOs, the number of publicly listed firms, and the aggregate contribution of listed firms to economic activity (Gao, Ritter, and Zhu, 2013; Doidge, Karolyi, and Stulz, 2017; Schlingemann and Stulz, 2022). Over the same period, the supply of private equity in the US has dramatically increased and surpassed the aggregate amount of capital raised in public equity markets every year since 2017 (Ewens and Farre-Mensa, 2022). Many factors contribute to this trend, including regulatory changes that facilitate the provision of large amounts of capital to private firms (Ewens and Farre-Mensa, 2020) and a sharp increase in allocations to private equity by institutional investors such as university endowments and various investment funds (Ivashina and Lerner, 2018; Kwon, Lowry, and Qian, 2020; Chernenko, Lerner, and Zeng, 2021; Aragon, Li, and Lindsey, 2018; Huang, Mao, Wang, and Zhou, 2021; Begenau, Liang, and Siriwardane, 2023).[2]

The shrinking role of stock markets can affect the economy in various ways. Stock markets have historically been the primary channel for firms to access external equity and have been linked to economic growth and capital accumulation (Levine and Zervos, 1998; Butler, Fauver, and Spyridopoulos, 2019; Frank and Sanati, 2021). Stock markets also improve capital allocation in the economy, as Wurgler (2000) shows that countries with developed markets invest more capital in growing industries and decrease investments in declining industries compared to those with undeveloped equity markets. In addition, stock markets affect the real economy via the informational role of market prices (Bond, Edmans, and

[2]Several studies evaluate the causes of the decline in the number of public firms and whether there is a causal relation between the two trends, for example, see Doidge, Kahle, Karolyi, and Stulz (2018); Ewens and Farre-Mensa (2020); Lattanzio, Megginson, and Sanati (2023); Eckbo and Lithell (2022); Chemmanur, He, Ren, and Shu (2022).

Goldstein, 2012; Goldstein, 2023). Also, Ljungqvist, Persson, and Tåg (2018) argue that the decline of public firms reduces citizen-investors' exposure to corporate profits, potentially leading to long-term reductions in aggregate investment and productivity. Our study highlights another channel whereby the decline of public equity markets negatively affects the economy through the decline in the allocation efficiency of invested capital. Our results suggest that the critical role of stock markets in capital allocation may not be easy to replace (e.g., by private markets) due to their advantages with respect to information efficiency and governance structures.

Our paper also relates to a large literature studying resource misallocation (see Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009, for seminal examples).[3] Our work is more closely related to recent papers exploring the role of financial frictions in causing misallocation, such as collateral constraints (Buera, Kaboski, and Shin, 2011; Midrigan and Xu, 2014; Moll, 2014), firm-specific borrowing costs (Gilchrist, Sim, and Zakrajšek, 2013), and the interaction of financial frictions and adjustment costs (Asker, Collard-Wexler, and De Loecker, 2014; Gopinath, Kalemli-Özcan, Karabarbounis, and Villegas-Sanchez, 2017; Kehrig and Vincent, 2017). More recently, Whited and Zhao (2021) extend the standard production-based misallocation model to study the misallocation of finance. They show that the misallocation of financial resources could significantly affect aggregate output and productivity. David, Hopenhayn, and Venkateswaran (2016) evaluate the role of imperfect information in resource misallocation when firms use a variety of noisy information sources to make input decisions. Compared to the extant literature, our study highlights the role of informational frictions in financial markets as a potential source of misallocation in the economy. While most of the misallocation literature studies cross-country differences, we compare allocation efficiencies between different segments of capital markets in the U.S. Our results suggest that public equity markets achieve a more efficient allocation of resources by reducing both adverse selection (via improving information efficiency for investors) and moral hazard (via governance mechanisms) compared to private markets.

[3] Restuccia and Rogerson (2017) and Eisfeldt and Shi (2018) provide excellent reviews of this literature.

Our paper also relates to a growing literature that compares private and public firms.[4] Asker, Farre-Mensa, and Ljungqvist (2015) find that public firms invest less and are less responsive to changes in investment opportunities than private firms. On the other hand, Mortal and Reisel (2013), Gilje and Taillard (2016), and Maksimovic, Phillips, and Yang (2023) find that public firms invest more in response to growth opportunities, in part due to better access to capital. This is consistent with the findings of Phillips and Sertsios (2017) that public firms raise more external financing than private firms in response to investment opportunities. Maksimovic, Phillips, and Yang (2023) suggest that the discrepancy in the literature may be driven by cross-sectional matching and selection issues. Larrain, Phillips, Sertsios, and Urzúa (2023) study the effect of going public on firms and show that IPO firms focus on commercialization and increasing profitability after going public. Also, Bias, Lochner, Obernberger, and Sevilir (2022) find that going public is associated with transforming firms' internal organization toward operating more efficiently. Our paper contributes to this literature by documenting a difference in the MPK of public and private firms that raise equity and providing potential explanations for the documented patterns.

Finally, our paper contributes to the literature that evaluates how the information efficiency of stock markets affects firms. Studies show that more informative stock prices facilitate more efficient corporate investments (Durnev, Morck, and Yeung, 2004; Bakke and Whited, 2010; Bond, Edmans, and Goldstein, 2012; Goldstein, 2023). Also, by mitigating information asymmetries and thus investors' uncertainty, public markets improve firms' access to capital (Gilje and Taillard, 2016; Phillips and Sertsios, 2017) and increase productivity (Butler and Cornaggia, 2011; Krishnan, Nandy, and Puri, 2015; Bennett, Stulz, and Wang, 2020). Our results add to this literature by highlighting the role of information efficiency in improving capital allocation in public markets by helping investors identify the most productive firms.

2. A Model for measuring allocation efficiency

In this section, we provide a theoretical framework to motivate our empirical tests. The model generates two sets of results that are useful for our purposes. First, we demonstrate

[4] Stulz (2020) and Lowry (2022) provide excellent reviews of this literature.

that, under standard assumptions, comparing the realized MPK (i.e., output growth per unit of capital raised) in firms that raise equity in two markets is sufficient to compare the efficiency of capital allocation in those markets. This result directly motivates the setup of our baseline tests in Section 4. Second, we illustrate how firm characteristics, such as pre-issue size and exposure to systematic risk, affect MPK comparisons. These results inform our analysis in Section 5, where we examine possible explanations for the allocation efficiency gap across public and private markets.

Our framework is based on a standard neoclassical model of investment. A representative investor owns all firms in the economy. Firms are equity-financed, and make dynamic investment and financing decisions to maximize their value. Each firm i uses capital and labor to generate revenue with a gross revenue function

$$Y_{it} = F(Z_{it}, K_{it}, N_{it}) = Z_{it} K_{it}^{\theta} N_{it}^{\nu}, \tag{1}$$

where $0 < \theta + \nu < 1$ and Z_{it} is the firm-specific productivity. Labor N_{it} is chosen period-by-period in a spot market at a competitive wage. At the end of each period, firms choose investment in new capital, which becomes available next period. Therefore, $K_{it+1} = (1 - \delta)K_{it} + I_{it}$, where δ is the depreciation rate, K_{it} the stock of capital, and I_{it} investment.

Firms can use both internal funds and external equity to finance their operations. Externally, firms can issue equity or distribute funds to shareholders. We define the net payout D_{it} as the available net cash flow in the firm at time t. Positive values of D_{it} represent the distribution of excess funds to shareholders, and negative values represent raising equity from shareholders.

Firms' objective is to maximize their equity value $V(.)$, which equals the sum of discounted future net payouts. Firm i's individual state is determined by its productivity Z_{it} and the stock of capital K_{it}. The aggregate states, are denoted by $\mathbb{S}_t$. Taking the stochastic discount factor (SDF) M_{t+1} and the competitive wage rate W_t as given, firm i chooses this period's labor input N_{it} and next period's capital K_{it+1} to maximize current equity value.

The firm's problem can be characterized recursively by the following Bellman's equation:

$$V(\mathbb{S}_t; Z_{it}, K_{it}) = \max_{N_{it}, K_{it+1}} \Big\{ D_{it} + \mathbb{E}_t\big[M_{t+1} V(\mathbb{S}_{t+1}; Z_{it+1}, K_{it+1})\big] \Big\} \tag{2}$$

$$\text{subject to} \qquad D_{it} + K_{it+1} + W_t N_{it} = Y_{it} + (1-\delta) K_{it}, \tag{3}$$

where $\mathbb{E}_t[.]$ denotes the firm's conditional expectations. Equation (3) is the firm's budget constraint, where the left-hand side shows the uses of funds, including the net payouts, purchases of new capital, and wage payments representing the cost of revenue. The right-hand side shows the sources of funds including the period's revenue and inherited stock of capital after depreciation.

Based on the first order condition for new capital K_{it+1}, the Euler equation is

$$1 = \mathbb{E}_t\Big[M_{t+1}\Big(\frac{\partial Y_{it+1}}{\partial K_{it+1}} + 1 - \delta\Big)\Big] \qquad \forall i, t. \tag{4}$$

This equation implies that, in equilibrium, the optimal capital allocation equates the expected discounted marginal revenue product of capital, $\text{MRPK}_{it+1} = \frac{\partial Y_{it+1}}{\partial K_{it+1}}$, across firms.

We evaluate the model implications in two cases. First, we assume that firm productivity is time-invariant, which allows us to derive closed-form solutions for optimal labor and capital choices and evaluate the model implications for the empirical analysis in a tractable way. Then, we evaluate the model's implications in a more general case with time-varying firm productivity (à la David, Schmid, and Zeke, 2022).

Case I: Time-invariant productivity

We assume that firm productivity is time-invariant, implying that each firm is born with a constant productivity Z_i. This could reflect time-invariant differences in managerial talent, proprietary technologies, or corporate culture across firms. Under this assumption, the Euler equation yields:

$$\text{MRPK}_{it+1} = \frac{\partial Y_{it+1}}{\partial K_{it+1}} = \frac{1}{\mathbb{E}_t\big[M_{t+1}\big]} - 1 + \delta \qquad \forall i, t. \tag{5}$$

This equation states that the optimal investment policy allocates capital across firms such that their MRPKs are equated and equal to the user cost of capital (the right-hand side).

As an example, we assume that the representative investor is well diversified and risk neutral, so that the SDF is a constant, $\mathbb{E}_t\left[M_{t+1}\right] = \beta$. Using the Euler equation (5) and the first order condition with respect to labor, we solve for the optimal levels of contemporaneous labor and new capital:

$$\hat{N}_{it} = \left(\frac{\nu Z_i}{\hat{W}_t}\right)^{\frac{1}{1-\nu}} \hat{K}_{it}^{\frac{\theta}{1-\nu}} \tag{6}$$

$$\hat{K}_{it+1} = \alpha \times Z_i^{\frac{\gamma}{1-\theta}} \tag{7}$$

where $\alpha = \left(\frac{\theta}{\frac{1}{\beta}-1+\delta}\right)^{\frac{1-\nu}{1-\nu-\theta}} \times \nu^{\gamma} \times \left(\frac{1}{\hat{W}_{t+1}}\right)^{\gamma}$ and $\gamma = \frac{\nu}{1-\nu-\theta}$.

Equation (7) shows that, under the optimal allocation, more capital should flow to firms with higher productivity Z_i. Therefore, to test whether the capital allocation process in a market is efficient, one must evaluate whether firms with the highest productivity are receiving more capital in that market.

However, we cannot empirically test this relation directly because firms' productivity is unobserved, especially for private US firms who do not disclose their balance sheet and capital stock. Thus, we use the model to propose an alternative approach to make this comparison based on observable data. In our data, we observe the size of the equity issue and revenue for all firms. We define the realized MRPK as the growth in revenue per unit of new capital $\frac{\Delta Y}{\Delta K}$. Let K_{i0} and N_{i0} be the stock of capital and labor in the firm before issuing equity. Under the assumption that firms use all of the issued equity ΔE to invest in new capital $\Delta K = K_{it+1} - K_{i0}$, the realized MRPK is

$$\frac{\Delta Y}{\Delta E} = \frac{\Delta Y}{\Delta K} = \frac{F(Z_i, \hat{K}_{it+1}, \hat{N}_{it+1}) - F(Z_i, K_{i0}, N_{i0})}{\hat{K}_{it+1} - K_{i0}} = \frac{Z_i(\hat{K}_{it+1}^{\theta}\hat{N}_{it+1}^{\nu} - K_{i0}^{\theta}N_{i0}^{\nu})}{\hat{K}_{it+1} - K_{i0}} \tag{8}$$

where $\hat{K}_{it+1}$ and $\hat{N}_{it+1}$ are the stock of capital and labor after the optimal level of investment, determined by equations (6) and (7).

Figure 1 uses Equation (8) to simulate the relation between MRPK $= \frac{\Delta Y}{\Delta E}$ and firm productivity Z_i when the allocation of capital is optimal. It shows this relation for two pre-issue capital levels ($k_0 = 1$ and $k_0 = 5$). There are two main takeaways from this figure:

Result 1: The realized MRPK is strictly increasing in firm productivity—i.e., there is a one-to-one mapping between this observable ratio and unobservable productivity. Therefore, assuming that two markets have the same distribution of firm productivity, one can compare the realized MRPK of firms receiving capital to compare the efficiency of capital allocation across these markets. The market that directs capital to firms with the highest MRPK allocates capital more efficiently. This result motivates the use of MRPK $= \frac{\Delta Y}{\Delta E}$ for assessing capital allocation efficiency across markets in our empirical tests in Section 4.

Result 2: Under the optimal capital allocation process, all else equal, firms that are smaller before raising capital have higher MRPK than larger firms with the same level of productivity. This result highlights how heterogeneity in firm size distribution across markets can affect the MRPK comparison. Assuming that two markets have the same distribution of firm productivity and that capital allocation is optimal, the average realized MRPK is higher in the market with smaller firms. This distinction is important in the context of our study because of the significant difference in the average firm size in public and private equity markets.[5]

Case II: Time-varying productivity

In this case, we evaluate the implications of a general model, in which firm productivity Z_{it} is time-varying and is correlated with broader economic conditions as in David, Schmid, and Zeke (2022). Under this assumption, firms' expected MRPK$_{it+1} = \frac{\partial Y_{it+1}}{\partial K_{it+1}}$ is correlated with the stochastic discount factor M_{t+1}, so the optimal investment policy is characterized by the Euler equation in Equation (4). To the extent that firms' MRPKs co-move differently with the SDF, their expected MRPK will differ under the optimal capital allocation process.
Result 3: Let a firm's beta β_{it} be the measure of its systematic risk, that is beta measures the exposure of a firm's MRPK to movements in the SDF. Under the optimal capital allocation process, all else equal, high-beta firms have higher MRPK than low-beta firms with the same level of productivity. This result highlights how heterogeneity in the distribution

[5] As we elaborate in Section 5, our main results are in the opposite direction, showing that the MRPK of public firms (i.e., larger firms) are larger than the MRPK of private firms (i.e., smaller firms), suggesting that our results are not driven by the differences in firm size.

of firms' beta across markets can affect the MRPK comparison. Assuming that two markets have the same distribution of firm productivity and that capital allocation is optimal, the average realized MRPK is higher in the market with high-beta firms. This distinction could be important in our study because of potential differences in the average beta between public and private firms.[6]

3. Data and sample construction

3.1. Data

Our main sample consists of equity-raising events for privately owned and publicly listed companies in the U.S. For public firms, financial and employment data come from Compustat. In the baseline tests, we use equity offerings data from Compustat and SDC Platinum to complement these data to identify IPO dates, IPO withdrawals, and private investments in public equities (PIPEs). We also use SDC data on seasoned equity offerings (SEOs) as an alternative measure of public equity offerings in robustness tests. One may be concerned that our baseline measure of equity issuance includes exercised equity-based compensation. The fact that firms use employee compensation contracts as a means of financing alleviates this concern (Sun and Xiaolan, 2019). However, we follow the literature (e.g., Frank and Sanati, 2021) and assume that only large values of measured equity issuance reflect equity offerings, so equity issuance values that are less than 5% of the firm's assets are set to zero. To obtain data on firms' age, we use firms' founding years from Jay Ritter's database (Field and Karpoff, 2002; Loughran and Ritter, 2004) and complement those with founding dates from Data Axle.

For private firms, we first gather VC equity financing deals from SDC Platinum's VentureXpert. Firms may go through multiple VC rounds in a given year, so we aggregate the total amount they raise at the firm-year level. We match firms that raise equity through VC deals to a dataset of private US businesses provided by Data Axle, available through Wharton Re-

[6] As we elaborate in Section 5, the effect of firms' beta goes in the opposite direction of our results. We find that private firms raising capital have lower MRPK than public firms, despite private firms' having higher beta than public firms (see Table OA.6 in the Online Appendix for estimates of beta in public and private markets in our sample).

search Data Services (WRDS). These data include business names, detailed establishment locations and hierarchy (i.e., headquarters, subsidiary, or branch), industry classifications, sales, age, and employment data for over 30 million U.S. private businesses in a panel format since 1997. Data Axle's extensive data collection procedures offer one of the most reliable publicly available resources for reproducible research on U.S. private firms.[7]

To ensure our results are not subject to systematic biases and data quality issues, we repeat our analysis using an alternative source of data on privately owned U.S. businesses from Mergent Intellect. These data also include millions of private businesses from Dun & Bradstreet and provide similar information as Data Axle. Our access to this dataset begins in 2010, and thus we relegate these results to the Online Appendix.

To measure the innovation output of firms, we compile data on patent applications. For private firms, we gather patent application data from the U.S. Patent and Trademark Office (USPTO) and match it to the baseline dataset via name and ZIP code at the establishment level. We aggregate this information at the firm-parent level. For public firms, we obtain patent application data from Kogan, Papanikolaou, Seru, and Stoffman (2017).

Finally, we compile several firm characteristics for public companies as proxies of stock price informativeness and quality of corporate governance in public firms. To measure the stock price informativeness of firms, we use the probability of informed trading (PIN) and the generalized version of this variable (GPIN) from Duarte, Hu, and Young (2020). We also calculate the number of analysts that cover a firm and the precision of their forecasts based on data from the Institutional Brokers' Estimate System (IBES). We calculate earnings announcements' cumulative abnormal returns (CAR) using earnings announcement dates from IBES and daily stock prices from CRSP. Lastly, data on brokerage house exits also come from IBES.

To measure the quality of corporate governance across public firms, we use institutional ownership data from Thomson-Reuters 13F files. We use data from BoardEx to calculate

[7] To collect the data, the provider aggregates 4,000 telephone directories and over 250 business sources such as secretaries of state, county courthouses and public records, annual reports, securities, SEC filings, articles, press releases, and other news feeds, internet research, industry and tourism directories, and feedback from users and other businesses. The information is collected over millions of calls annually and passes several quality checks. Data for small and mid-size businesses are collected and verified with each business at least once per year, and for large businesses (more than 100 employees) every three months.

the number of directorships for each company director and whether the company has a staggered board following Fos, Li, and Tsoutsoura (2018). We also calculate the number of restrictions on shareholder rights of public firms using the G-index from Gompers, Ishii, and Metrick (2003). Lastly, we use an annual update on firms' overall governance scores based on Morgan Stanley Capital International (MSCI) scores. To create the governance score, MSCI compiles and assesses several attributes regarding firms' boards (39 metrics), executive pay (23 metrics), ownership and control (26 metrics), and accounting (8 metrics).

3.2. Sample construction and summary statistics

To construct our final sample, we require public firms to have the US dollar as their native currency code. We also exclude highly regulated firms in the financial (SIC 6000-6799), utilities (SIC 4900-4999), and public administration (SIC 9100-9999) sectors.

The sample period starts in 1997, the first year that private firms' data are available on Data Axle. Our sample ends in 2019 because, starting in the first quarter of 2020, the COVID-19 pandemic had a large heterogeneous impact on firms' financial and real decisions. Our final sample covers the years from 1997 to 2019 and consists of 30,279 unique equity-raising events from 3,339 unique private firms and 6,486 unique public firms. Appendix A details the construction of all variables. We winsorize all variables at the 3rd and 97th percentiles to mitigate the impact of data errors and outliers.

Panel (a) of Table 1 describes the full sample. The unit of observation is a capital-raising event and public firms make up approximately 64% of the sample. The average firm raises approximately \$37 million in equity, has 421 employees, and \$86 million in sales, with an average annual sales growth of 19%. We calculate MRPK as the ratio of the three-year average of annual sales growth after raising equity divided by the total amount of equity raised. The average firm in the sample has an MRPK of 0.66, which implies a \$0.66 increase in annual sales in the next three years per dollar of raised equity. Similarly, MIPK is the three-year average of annual change in patent applications after raising equity, divided by the total amount of equity raised. The average MIPK is 0.21, suggesting that a million dollars in new equity generates approximately an additional 0.2 patents per year in the three years following an equity-raising event.

Panel (b) of Table 1 compares the characteristics of public and private firms in the sample. The first three columns describe the full sample. On average, public firms have more sales and employees, and they are older than private firms. Also, an average equity issue in public markets (i.e., SEO) raises $48.34 million, which is approximately three times larger than the $16.89 million raised in an average equity issue in private markets.

We use a matching procedure to construct a subsample of public and private firms that are observably more similar. We use a caliper-based nearest-neighbor matching with replacement adapted to a panel setting, following Asker, Farre-Mensa, and Ljungqvist (2015). Starting in 1997, for each public firm, we find the private firm closest in size (i.e., the log of employees' count) in the same three-digit SIC industry, requiring that the private firm's size is within a 20% bandwidth around the public firm's size. If no match is found, we discard the observation and search for a match in the following year. Once a match is formed, the matched private firm is kept in subsequent years to ensure the panel structure remains intact. Our matched sample results are also robust to matching without replacement and alternative size bandwidths.

Columns 4 to 6 in Panel (b) of Table 1 describe the matched sample. The matched public and private firms are much more similar in sales, employment, age, and equity issuance size than the average public and private firms in the full sample. However, due to the matching procedure, in that we keep a private firm once it is matched to a public firm in at least one year, the average size and age of private firms over the 23-year sample period becomes smaller than those of public firms.

[Table 1 around here]

4. Allocation efficiency in public and private equity markets

4.1. Measuring allocation efficiency

As discussed in the introduction, our tests compare the MPK of firms receiving equity in public and private equity markets to infer their relative allocation efficiency. The true MPK, which is the derivative of the firm's production function with respect to capital raised, is unobservable. Therefore, we measure the realized MPK as the output growth following an equity issuance per unit of raised capital.

Our anecdotal interviews with a few private market investors reveal that private firm investors primarily use revenue growth (as opposed to profits) for gauging firms' performance and the demand prospects for their products or services. This holds true even for investors in early-stage firms that may not be profitable yet. For instance, in Appendix B, we present the revenue and net operating profit (loss) of six well-known startups with available data on both revenue and profits. The figures show that, despite sustained operating losses, these firms had significant revenue growth, enabling them to raise significant funding in private markets. Nevertheless, it is conceivable that certain private firms may prioritize innovation over bringing a product or service to market and generating sales. Therefore, we evaluate both the operational and innovation output of firms.

We consider revenue (i.e., top line) as the main measure of operational output and the number of patent applications as the main measure of innovation output. We measure the realized MRPK as the ratio of the average annual revenue growth in the three years after raising equity divided by the total amount of equity raised. Similarly, we measure the realized MIPK as the annual number of new patent applications in the three years after raising equity per million dollars of raised equity.

We also take an alternative market portfolio-approach to construct the MPK measures. This approach assigns greater weight to larger equity deals, representing the perspective of an investor who invests in all firms in a market. We present this discussion in Section 4.4.

4.2. Univariate differences

We start by evaluating the univariate differences in capital allocation efficiency in public and private equity markets. Table 1, Panel (b) presents a comparison of the MPK of firms that are receiving equity in public and private markets. In the full sample (columns 1-3), an average firm that receives equity in public markets has an MRPK of 0.83, whereas an average firm that receives equity in private markets has an MRPK of 0.34. This implies that a dollar of equity allocated through public markets generates $0.49 more in annual sales over the next three years than a dollar allocated through private markets. Similarly, comparing MIPKs suggests that a million dollars of equity allocated in public markets generates 0.01 more patent applications per year in the next three years than the same amount invested through private markets. Column 6 shows an economically and statistically significant difference in both MRPKs and MIPKs in the matched sample.

We also evaluate firms' output growth before equity issues to assess whether the MPK differences are driven from pre-trends. We construct pre-issue MRPK and MIPK, which measure the average annual revenue growth and number of new patents, respectively, in the three years *before* equity issuance, divided by the amount of equity raised. We used the same denominator as in the MRPK and MIPK to make comparing pre- and post-issue output growth easier. Comparing pre-issue MRPKs in columns 1-3 of Panel (b) in Table 1 shows that private firms have a higher revenue growth than public firms before raising capital. Columns 4-6 confirm similar pre-issue differences in the matched sample. Similarly, comparing pre-issue MIPKs shows that prior to equity issues, the number of new patent applications for private firms is approximately 20% larger than public firms' (0.24 vs 0.20). However, both revenue growth and the number of new patents in private firms decline considerably in the post-issue period compared to public firms.

Overall, the pre- and post-issue differences suggest that there might be a fundamental difference between the allocation efficiency in the public and private equity markets. Importantly, the differences seem to be created at the capital raising events, not from pre-trends. The evidence suggests that in private markets, firms with good recent performance tend to receive equity, but they do not sustain this performance after the deal. In public markets, firms with high growth potential tend to receive equity and increase output using the resources. We evaluate this conjecture more formally in Section 5.

The differences in the allocation efficiency of public and private equity markets persist over time. Figure 2 compares the average MRPK and MIPK for public and private firms that issue equity in each year from 1997 to 2016. The figure ends in 2016 because our measures of the MPK use three-year forward-looking measures of output, and our sample ends in 2019. Figure 2a uses the full sample and shows that public firms' MRPK and MIPK consistently exceed private firms'. We also compare the MPK of public issuers with those of private firms that issue equity via late-stage deals, which are presumably more similar to SEOs. We define late-stage deals as the fourth- or higher-round private VC deals. Figure 2b shows that the MRPK and MIPK of public issuers exceed that of private issuers every year in the sample. Figure 2c confirms that this pattern persists even after accounting for firms' size, age, and industry.

[Figure 2 around here]

Finally, we evaluate the differences in the efficiency of equity allocation across sectors of the economy. Figure 3 compares the MPK of public and private issuers in the six major sectors of the US economy, excluding the financial and government sectors. Despite heterogeneity across sectors, we find that public markets direct equity capital to firms with higher MRPK and MIPK than private markets in all sectors of the economy.

[Figure 3 around here]

4.3. Baseline tests

We compare patterns of output growth in public and private firms in an eight-year window around the capital-raising events in the spirit of an event-window DID test. For each year in the window ($t = -4, ..., +4$), Figure 4 plots the one-year output growth normalized by the size of the equity issue, that is $(\text{output}_t - \text{output}_{t-1})/\Delta\text{equity}$, where Δequity is the size of the equity issue at time $t = 0$. As before, we use both revenue (Figure 4(a)) and patent applications (Figure 4(b)) as the main measures of output.

Figure 4(a) shows that, before raising equity ($t = -4, ..., -1$), there are no significant pre-trends in either group. In the year of equity issuance ($t = 0$), both public and private firms have an increase in revenue growth, with private firms growing approximately 1.6 times faster than public firms. After raising equity ($t = +1, ..., +4$), the two groups diverge noticeably. Public firms nearly double their revenue growth in this period, whereas private firms experience a peak in growth in the issuance year and then revert to pre-issuance levels.

Figure 4(b) shows that firms' innovation outcomes follow similar relative trends around equity issues. There is a significant increase in private firms' patent applications in the year leading up to the capital-raising event, followed by a sharp decline in new patents during the post-issuance period. The innovation activities of public firms remain relatively stable around the equity issuance. The trends in revenue and innovation outcomes align with the notion that investors in public markets can identify and finance projects with high growth potential, not just those with good past performance, as in private markets.

[Figure 4 around here]

More formally, we examine the differences in the efficiency of capital allocation between public and private markets by evaluating the differences in the MPK of firms receiving equity in each market. We estimate the following regression:

$$\text{MPK}_{i,j,t} = \alpha_j + \alpha_t + \beta Public_{i,t} + \gamma \mathbf{C}_{i,j,t} + \epsilon_{i,j,t}, \tag{9}$$

where i, j, and t index the firm, industry (SIC-3), and year, respectively. The unit of observation in the regression is an equity issuance event. The dependent variable is the issuing firm's MRPK and MIPK, measured as the average annual change in firm i's revenue and patent applications, respectively, for every dollar of equity raised in the next three years after equity issuance. *Public*, is an indicator variable that equals one if the firm is publicly listed and raises equity in public markets, and zero if it is private. To account for pre-trends, the regressions also include average MPK in the three years before the equity-raising event, i.e., pre-issue MRPK and MIPK, respectively. In addition, $\mathbf{C}$ is a vector of firm-year control variables that capture time-varying firm characteristics that include the logarithm of employment as a measure of size, logarithm of age, and average Tobin's Q of the firm's industry in a given year. Because a proxy for Tobin's Q is not available for private firms, we measure industry Q for each three-digit SIC industry and year as the size-weighted average market-to-book ratio of all public firms in that industry. Finally, all regressions include SIC-3 industry (α_j) and year (α_t) fixed effects, which account for the effects of unobservable time-invariant industry attributes and macroeconomic shocks, respectively.[8]

Table 2 reports the estimated differences in allocation efficiency between public and private markets. Columns 1 and 2 compare the MRPK of firms receiving equity in the two

[8] To address time-varying, industry-specific shocks that affect firms' output, we include industry×year fixed effects and find similar results. We tabulate these results in the Online Appendix.

markets. In column 1, we estimate that every dollar of equity capital allocated through public markets generates \$0.56 more in annual sales than a dollar allocated in private markets. In column 2, the estimated difference in MRPK is \$0.54 after controlling for firm and industry characteristics. This estimate implies a difference between an average MRPK of 0.34 in private deals compared to an average MRPK of 0.88 in public equity investments in firms that are from the same industry and have similar size, age, and pre-issue growth rates. We find similar patterns based on firms' innovation output. Columns 3 and 4 of Table 2 compare the MIPK of firms receiving equity in each market. The estimates suggest that a million dollars of equity allocated in public markets generates 0.02-0.04 more patent applications than the same amount allocated in private markets. This difference translates to 0.20-0.40 more patents for the median deal (\$9.9 million). These estimates are equivalent to more than a quarter of the in-sample standard deviation of MRPK and MIPK, suggesting that public markets are considerably more efficient than private equity markets at allocating equity.

We note that prior to raising capital, private firms have higher growth rates in both revenue and innovation. Our findings suggest that private firms tend to raise equity after a period of high output growth, but they do not sustain those growth rates after raising capital. On the other hand, public markets can identify and direct capital to firms with high growth potential that can use the resources to grow at a high rate.

[Table 2 around here]

Figure 5 goes beyond mean estimates and plots the distribution of MRPKs (panel a) and MIPKs (panel b) for equity issuers in public and private markets, after accounting for firms' size, age, year, and industry characteristics. The goal is to evaluate whether the observed mean differences reflect the difference in the location of similar-shaped distributions or the difference in the shape of the distributions. For instance, VC investors' preference for large positive outliers could justify a lower average MPK in private markets. As Figure 5 illustrates, the MPK distribution of public issuers not only holds a larger average but also presents a better risk profile than that of private issuers. Both the MRPK and MIPK distributions of public firms are heavier on the right tails, while those of private firms carry more mass on the left tails. Private firms do not seem to have significantly more positive outliers, as both distributions exhibit similarly long right tails.

[Figure 5 around here]

Of course, there are many other dimensions in which public and private firms differ. We aim to make these comparison groups more homogeneous in Table 3. In columns 1 and 5, we restrict the private firm sample to those involved in late-stage VC deals. These firms usually have a proven track record of effectively exploiting market opportunities, scaling their business models, and generating sales. Thus, these private firms likely share more similarities with public firms than an average private firm. It's important to note that in recent years, a rising number of firms that would have typically gone public are instead staying private longer and seeking equity through late-stage VC financing (Ewens and Farre-Mensa, 2020). Interestingly, the proceeds from these deals are comparable to those of public firms' SEOs (Lowry, 2022).

For further precision, we apply the baseline regression to a sample of matched public and private firms in columns 2 and 6 of Table 3. These matched firms operate in the same industry and are paired based on size, following the procedure outlined in Section 3. In columns 3 and 7, we exclude public firms that issue debt within two years before raising equity. This filter aims to isolate the impact of equity financing on output growth and address potential concerns that public firms can access debt markets more easily, which could independently influence output growth. In the most restrictive comparison in columns 4 and 8, we focus on matched firms and late-stage VC private deals while excluding public firms that issue debt.

Across all specifications, we find an economically large difference in MRPK and MIPK between firms that receive equity in public and private markets. We estimate that the MRPK of firms receiving equity in public markets is, on average, 0.44–0.69 higher than those in private markets. Similarly, the average MIPK of firms raising equity in public markets is 0.03–0.06 higher than those in private markets. The similarity of the subsample estimates in Table 3 with the full-sample estimates in Table 2 provide reassurance that these differences are less likely driven by unobserved differences between public and private firms, and more likely to reflect the discrepancies in the efficiency of capital allocation in the two markets.

[Table 3 around here]

In Table 4, we further refine the capital allocation comparison between public and private markets by considering firms' going-public decisions. In columns 1-4, we restrict the private firm sample to those that have filed for an IPO, subsequently withdrawn it, and then raised equity through a private VC deal. As one of the most pivotal choices in a firm's life cycle, the decision to go public implies these private firms are likely larger and more comparable to public firms. This filter reduces our sample to 16,671 equity-raising events. Our findings indicate that public issuers demonstrate a higher MRPK (columns 1-2) and MIPK (columns 3-4) than private issuers with a withdrawn IPO.[9] As one might expect, these results are economically comparable to those from late-stage VC deals (see Table 3, columns 1 and 5).

In columns 5-8 of Table 4, we focus on firms with completed IPOs to compare the MPK of public and private issuers. These specifications incorporate firm and year fixed effects to enable within-firm comparisons of MRPK and MIPK from pre- and post-IPO capital-raising events. The positive coefficients on *Public* suggest that the MRPK and MIPK of IPO firms are higher at post-IPO equity issues than their pre-IPO issues in private markets. These results are reassuring because the fixed effects remove the cross-sectional firm differences from the estimates.

[Table 4 around here]

Next, we consider deal characteristics to further align the comparison groups. In columns 1-4 of Table 5, we compare the MPK of private equity issues of private firms with the MPK of private equity issues of public firms (i.e., PIPEs). PIPEs allow public firms to raise equity by negotiating directly with a single or small group of investors without registering with the Securities and Exchange Commission. Compared to SEOs, the placement process of

[9] We also use an instrumental variable (IV) for firms' decision to complete or withdraw an IPO using the two-month Nasdaq returns following Bernstein (2015). We verify that post-filing market returns increase the probability of a firm completing its IPO. However, the K–P F-statistics in the first stage regression in our sample are between 4 and 6, suggesting that we cannot reject the null of a weak instrument based on conventional thresholds (Stock and Yogo, 2002; Lee, McCrary, Moreira, and Porter, 2022).

PIPEs is more similar to VC deals (Hertzel, Lemmon, Linck, and Rees, 2002; Gomes and Phillips, 2012). Also, PIPE investors are more likely to overlap with investors who regularly participate in VC investments (Lim, Schwert, and Weisbach, 2021). The estimates in columns 1-2 show that a dollar of privately issued equity that goes to public firms generates \$0.36–\$0.40 more in annual sales over the next three years. Columns 3-4 do not show a statistically significant difference in the MIPK. This could be because PIPE deals likely target mature public companies focused on commercializing existing innovations rather than generating new patents. This analysis highlights that the gap in allocation efficiency is likely driven by the public status of the firm, rather than investor type or the differences in placement processes between SEOs and VC deals.

In columns 5-8 of Table 5, we evaluate the effect of deal size on our primary results. There is a significant size difference between average equity issues in public and private markets. In our sample, the average SEO size is \$48.34 million, whereas the average VC deal size is \$16.89 million. In the presence of certain frictions, such as fixed costs, larger equity issues may be more effective in facilitating the growth of revenue and innovation outcomes.[10] To test whether the larger size of public issues drives the observed differences in allocation efficiency, we evaluate the interaction between the variables *Public* and *Large deal*. The indicator *Large deal* is set to one for the top tercile of equity issues in the annual distribution of deals in the sample. From the 30,279 total capital-raising events in our sample, 1,668 private deals and 8,404 public issues are classified as large deals.

Columns 5-8 of Table 5 present the results. The coefficients on the interaction terms are indistinguishable from zero in columns 5-7 and negative in column 8, suggesting that the MRPK and MIPK of firms involved in large public issues are not higher than those in small public issues. Moreover, the negative coefficients on *Large deal* suggest that larger issues are indeed associated with smaller increases in revenue and patent applications per unit of raised capital. These outcomes affirm that the allocation efficiency gap between public and private issuers is driven more by the public status of issuing firms than by the differences in issuance size.

[10]Note that we do not include issue size as a control in the regressions because it is in the denominator of the dependent variable.

[Table 5 around here]

Finally, we focus only on the private equity market and study the heterogeneity in allocation efficiency of firms raising capital from private markets across different funding rounds. Figure 6 shows the average MRPK (panel a) and MIPK (panel b) of private investments by VC round number. The dark-color bars show the realized MPK of the equity investments, and the light-color bars show the pre-issue MPKs, defined as the pre-issue growth rates normalized by the amount of equity raised. Panel (a) shows that the pre-issue revenue growth of private firms is not only sizable but also relatively stable across different funding stages. More importantly, however, it shows that the MRPK declines monotonically with the funding round. Panel (b) shows similar patterns for pre- and post-issue MIPK of private equity investments.

In Figure 6, the pre-issue MPK patterns suggest that firms consistently tap the private equity market after good recent performances. The post-issue MPK patterns show that private market investors' ability to identify firms with the highest post-issue potential declines with the funding round, reducing the allocative efficiency in late-stage deals (i.e., rounds four and higher) compared to early-stage deals. The observed patterns indicate that the low efficiency in late-stage deals drives a big part of the efficiency gap. A likely reason is that firms seeking late-stage deals are larger, more mature, and more complex than those in early-stage deals. This environment makes it harder for investors to overcome information asymmetries and impose control over firm operations. Such an environment increases the possibility of market timing by private issuers in late-stage deals more than early-stage deals. Notably, this finding is important because, in recent years, late-stage VC is replacing public equity issues in firms that delay going public and stay private longer (Ewens and Farre-Mensa, 2020, 2022).

[Figure 6 around here]

Given these results, one may question the rapid growth of late-stage VC investments from the perspective of investor returns. Our results do not directly address this question because unobserved valuations that investors get in each funding round determine their returns. In other words, investor returns in private deals are determined by the division of rents between the founders and investors. If founders derive utility from staying private, such as retaining full control of their firm, i.e., voting rights (à la Ewens and Farre-Mensa, 2020), they might be willing to give up more cash flow rights per dollar of raised equity in late-stage private deals, resulting in more favorable valuations for investors. This means that, although the allocation efficiency in private markets is lower than in public markets, private market investors could still earn higher returns than public market investors.

4.4. A market portfolio approach to measuring allocation efficiency

While our main analysis focuses on firm-level measures of MRPK and MIPK, it is important to consider whether these patterns hold when examining markets as a whole. This approach is informative for evaluating allocative efficiency from the perspective of an investor who invests in all firms in a market—hence, the portfolio approach. We construct the portfolio-level MRPK (MIPK) in each market as the ratio of the sum of the three-year revenue (patent) growth divided by the total equity raised in each market (see Appendix A for more details).

The portfolio approach weights each firm's MRPK by its equity issue size, potentially yielding different results than averaging firm-level MRPKs that are equally weighted. This approach could reveal efficiency differences when deal sizes vary significantly within public and private markets. To illustrate this point, consider two public firms with equity issues of $100 and $150, generating an additional $200 and $300 in revenue post issue, respectively. In private markets, suppose four firms raise $1, $1, $1, and $10, generating an additional -$1, -$1, -$1, and $30 in post-issue revenue, respectively. The portfolio-level MRPK for private firms exceeds that of public firms (2.1 vs. 2), even though the average of firm-level MRPKs are 0 and 2.[11]

We investigate whether such discrepancies exist in our data, and calculate portfolio-level MRPK and MIPK measures for public and private markets each year. Figure 7 presents these results. Interestingly, we find that the firm-level patterns persist when examining portfolio-level measures. Public markets consistently demonstrate higher portfolio-level MRPK and

[11]The portfolio level MRPK for public firms is $(200 + 300)/(100 + 150) = 500/250 = 2$ and for private firms is $(-1 - 1 - 1 + 30)/(1 + 1 + 1 + 10) = 27/13 = 2.1$. The average of firm-level MRPKs for public firms is $\frac{1}{2}(2 + 2) = 2$, and for private firms is $\frac{1}{4}(-1 - 1 - 1 + 3) = 0$.

MIPK compared to private markets throughout our sample period. The consistency between firm-level and portfolio-level results provides additional confidence in the robustness of our findings.

[Figure 7 around here]

4.5. Robustness tests

We perform additional tests to confirm the robustness of our main results. First, we use an alternative definition for the main dependent variable. In the baseline tests, MRPK and MIPK are calculated based on three-year forward-looking changes in revenue and innovation output after equity issuance. Alternatively, we compute the MPK measures as the one-year and five-year increase in output per dollar of raised equity. These results, presented in the Online Appendix, confirm the consistency of our primary findings with the modified MPK definitions.

Next, we modify the baseline regression to account for time-varying industry-specific shocks that may affect firms' sales by including three-digit SIC industry×year fixed effects in the regressions. We tabulate these results in the Online Appendix and confirm that the observed allocation efficiency gap is similar to the baseline findings.

Finally, we use an alternative source for data on the equity issuance of public firms. Our baseline measures of public firms' equity come from Compustat, which includes exercised equity-based compensation of employees. Alternatively, we use data on SEOs from SDC Platinum and show the results in the Online Appendix. The results are similar to our baseline findings and confirm that the estimated allocation efficiency gap between the public and private markets is not sensitive to the SEO data source.

5. Explaining the gap in capital allocation efficiency

In this section, we focus on understanding factors contributing to the large difference in the allocation efficiency in public and private equity markets. We start by investigating the impact of selection issues and unobservable variables on the estimates and show that they are unlikely to be the main driver of the results. Then, we evaluate two other hypotheses, namely information efficiency and corporate governance, as potential drivers of the allocation efficiency gap.

5.1. Selection and unobservables

Our baseline results document a large gap in the MRPK and MIPK of firms that receive capital in public and private equity markets. The gap is persistent over time, across industries, and in various subsamples that improve the comparison of public and private firms and deals. Nonetheless, these specifications may still not eliminate all biases from selection mechanisms or unobservable characteristics.

We argue, however, that these effects most likely bias our estimates in the opposite direction. Naturally, the unconditional growth rate of young small private firms declines as they mature and transition from private to public markets (Maksimovic, Phillips, and Yang, 2023; Ueda and Sharma, 2019). Our model shows that, under the optimal capital allocation process, all else equal, firms that are smaller before raising capital have higher MRPK than larger firms with the same level of productivity (see Result 2 in Section 2). Therefore, comparing two markets with similar distributions of firm productivity, the average realized MRPK should be higher in the market with smaller firms, implying that private firms should, on average, have a higher MPK than public firms. Thus, observing the opposite results further indicates the superior ability of public markets to allocate capital to the most productive firms.

More formally, we investigate the hypothesis that public firms have unconditionally higher revenue and innovation growth rates, regardless of raising capital, which would mechanically increase their realized MPK after issuing equity. We evaluate this hypothesis in three ways and find the opposite pattern, i.e., public firms have lower unconditional growth rates than private firms. First, in Panel B of Table 1, we compare the growth patterns of equity issuers before capital raising events. We use the pre-issue MRPK and MIPK, i.e., the average annual change in revenue and patent applications, respectively, in the three years before equity issuance, normalized by the amount of equity raised. In the pre-issue period, private firms' revenue and innovation growth exceed public firms' by \$0.26 per dollar and 0.51 patent applications per million dollars of equity raised, respectively. As previously discussed, this pattern is also shown in Figure 4, where the plot illustrates the lack of pre-trends in revenue and innovation growth in both groups of firms and the role of capital allocation in increasing public firms' output relative to private firms.

Second, we also show that, among non-issuers, private firms have a higher growth rate than public firms. Table 6 describes the sales growth rate, defined as $\frac{\text{sales}_t - \text{sales}_{t-1}}{\text{sales}_{t-1}}$, for public and private firms that never issue equity during our sample period. On average, private firms grow 0.6 percentage points or 8.22% faster than public firms, consistent with diminishing returns to capital, since private firms are younger and smaller than public firms on average.

[Table 6 around here]

We also examine the full distribution of sales growth rates for public and private non-issuers. Figure 8 illustrates the comparison and visually rules out the hypothesis that public firms' unconditional average growth rate is larger than that of private firms.

[Figure 8 around here]

Third, we use a difference-in-differences (DID) setting to examine the trends in revenue and innovation growth rates of private and public firms around the time of the capital-raising events. We perform an event-window DID test based on a four-year window before and after equity issuance. Specifically, we estimate the following model:

$$MPK_{i,j,t} = \alpha_j + \alpha_t + \beta_1 Public_{i,t} * Post_{i,t} + \beta_2 Public_{i,t} + \beta_3 Post_{i,t} + \gamma \mathbf{C}_{i,t} + \epsilon_{i,t}. \qquad (10)$$

Table 7 shows the results. The dependent variable in columns 1-3 is the MRPK, and in columns 4-6 the MIPK. For each set of regressions, the first column shows the results for a model with no controls and fixed effects. The second column includes all the firm-level controls as well as industry and year fixed effects that absorb industry differences and macro trends. The third column adds firm and year fixed effects to exploit within-firm variations in output growth from before to after equity issuance. The negative coefficients on *Public* show that the growth rates of revenue and innovation in public firms are, on average, lower than those in private firms, consistent with our previous findings. Across all specifications, we find large and positive coefficients on the interaction terms, confirming that the increase in MRPK and MIPK of public firms relative to private firms takes place after the capital-raising event.

[Table 7 around here]

Furthermore, motivated by David, Schmid, and Zeke (2022), we investigate whether the observed MPK gap between public and private firms is driven by differences in their exposure to aggregate risk, i.e., firm beta. Result 3 in our model shows that, under the optimal capital allocation process, all else equal, high-beta firms have higher MRPK than low-beta firms with the same level of productivity. Therefore, comparing two markets with similar productivity distributions, the average realized MRPK should be higher in the market with high-beta firms. This channel could drive the observed MPK gap, if public firms on average had higher beta than private firms. However, we show in Table OA.6 in the Online Appendix that the opposite is true—that is, private firms in our sample have higher beta than public firms, when beta is measured as the elasticity of revenue growth rate to aggregate GDP. Therefore, the effect of differences in firms' beta goes in the opposite direction of our main results.

Finally, De Loecker, Eeckhout, and Unger (2020) find a steady rise in the markups and economic activity of large superstar firms, which most likely include the largest public firms. This pattern could potentially contribute to the documented MPK gap between the public and private equity issuers. However, our results suggest that the efficiency gap is unlikely to be driven by a heterogeneous rise in markups. First, our findings are based on within industry and year comparisons while controlling for firm characteristics that are correlated with markups, such as size, age, and market-to-book ratio. Also, as Figure 2 shows, the MPK gap (i.e., the distance between the two trend lines) remains relatively steady over our sample period, while there is a steady rise in markups.

Overall, these analyses rule out the hypothesis that the observed differences in the MPK of public and private issuers are driven by pre-issue differences or pre-trends in sales or innovation growth of the two groups. The evidence is more consistent with the premise that investors in public markets can identify companies with higher MPK better than investors in private markets. In the rest of this section, we investigate whether the observed allocation efficiency gap relates to the fact that private firms are not subject to the same information transparency and price efficiency, as well as auditing and monitoring mechanisms as public firms.

5.2. Information efficiency

A fundamental difference between public and private markets is the availability of information that managers and investors can access. An established view in financial economics is that financial market prices provide useful and important information about firms' fundamentals. The idea is that financial markets collect the private information and beliefs of many different investors who trade firms' securities and hence provide an efficient mechanism for information production and aggregation (Fama, 1970; Kyle, 1985; Goldstein and Yang, 2015). Moreover, over the years, market prices have arguably become more informative (Bai, Philippon, and Savov, 2016).

Nonetheless, the relation between information efficiency and capital allocation efficiency in public and private equity markets is not trivial (Dow and Gorton, 1997). On the one hand, public firms' stock prices provide investors with valuable information and inform the allocation of resources toward firms with the most productive uses for capital (Wurgler, 2000). Also, managers of public firms could benefit from the "feedback effect," whereby informative financial market prices guide production and investment decisions after raising capital (Subrahmanyam and Titman, 1999; Durnev, Morck, and Yeung, 2004; Chen, Goldstein, and Jiang, 2007a; Bakke and Whited, 2010; Bond, Edmans, and Goldstein, 2012; Goldstein and Yang, 2015; Bennett, Stulz, and Wang, 2020; Goldstein, 2023). On the other hand, private markets may provide an environment where firms and VC intermediaries can privately share information, which leads to better screening and a more efficient allocation of capital in private markets (Boyd and Prescott, 1986; Doidge, Kahle, Karolyi, and Stulz, 2018).

We test the effect of information efficiency on capital allocation efficiency in the cross section of firms and a quasi-natural experiment:

Cross-sectional analysis. First, we examine the relation between the MPK of equity issuers and standard measures of stock price informativeness in the cross section of public firms. We follow the literature and measure the stock price informativeness by calculating the probability of informed trading (PIN), the generalized PIN (GPIN), the number of analysts following the firm, analysts' forecast accuracy, and earnings announcement surprises (Easley, Kiefer, O'hara, and Paperman, 1996; Chen, Goldstein, and Jiang, 2007a; Duarte, Hu, and Young, 2020; Goldstein, Yang, and Zuo, 2022). Appendix A provides detailed definitions for all variables.

Table 8 shows the results. Panel (a) shows that higher levels of price informativeness are associated with an increase in the MRPK of firms receiving equity. In particular, a one standard deviation increase in price informativeness measured by PIN and GPIN is associated with \$0.45 and \$0.18 increases in revenue growth per dollar of invested equity, respectively. Also, a one standard deviation increase in the log of the number of analysts following the firm and analysts' forecast precision are associated with an additional \$0.12 and \$0.06 in sales per dollar of allocated equity, respectively. In the Online Appendix, we show that the results are similar when firm fixed effects are included to partial out time invariant firm differences and effectively make the inference based on the comparison between different equity issues within a firm. Panel (b) evaluates the association between price informativeness and the MIPK of public firms receiving equity. We find that a greater number of analysts is associated with a higher MIPK of equity issuers. However, the other proxies for information efficiency are not related to the MIPK of firms receiving equity. Overall, the results suggest that a better information environment, proxied by higher price informativeness, is associated with the more efficient allocation of capital.

[Table 8 around here]

Quasi-natural experiment. Our second analysis employs a quasi-natural experiment to test the information efficiency hypothesis. We consider shocks that result in lost analyst coverage due to brokerage mergers and closures as plausibly exogenous variation in the quality of the information environment of a firm. Studies show that brokerage exits are motivated by business strategy rather than by the characteristics of the firms they cover, so these events reduce firms' analyst coverage for exogenous reasons (Hong and Kacperczyk, 2010; Kelly and Ljungqvist, 2012; Chen, Harford, and Lin, 2015).

To identify treated firms, we use the IBES Recommendations database that identifies brokerage houses with unique IDs (item *estimid*). We find the exit year for a brokerage house as the last year they produce a recommendation on any firm. Next, we identify firms as treated if 1) they have been covered by a broker that exits, and 2) the total number of brokers covering the firm drops in the next year following an exit. In other words, we do not consider the firm to be treated if a broker stops and another starts covering it in the same year. Due to the nature of the experiment, this analysis focuses only on public firms.

We use a standard DID setting to test how shocks to firms' information environment due to brokerage exits affect capital allocation efficiency. Table 9 presents the results. Columns 1 and 3 include industry and year fixed effects to partial out time-invariant industry differences and macroeconomic conditions across years. The coefficients on the interaction between *Treated* and *Post Exit* suggest that the treatment has a negative impact on the MRPK and MIPK of allocated equity. Columns 2 and 4 limit the sample to firms with at least one brokerage exit and include firm fixed effects. This setup allows us to compare the MRPK and MIPK of capital-raising events before and after the shock in treated firms. Similar to the previous case, we estimate a negative treatment effect on the efficiency of capital allocation. The estimated coefficients suggest that the exogenous decline in information efficiency causes a minimum $0.23 drop in the marginal revenue per dollar of allocated equity and a 0.05 drop in new patent applications per million dollars of invested equity. Overall, the results confirm the information efficiency hypothesis.

[Table 9 around here]

5.3. Corporate governance

Public markets may influence firms' investment and capital allocation choices by monitoring and advising firms' management. Several studies associate corporate governance mechanisms, such as executive compensation, board supervision, shareholder rights, and strict regulatory oversight, with higher equity values, efficiency, and productivity.[12] Better

[12] For an inexhaustive list of studies consistent with this view see: Shleifer and Vishny (1997); Bertrand and Mullainathan (2001, 2003); Gompers, Ishii, and Metrick (2003); Cremers and Nair (2005); Chhaochharia and Grinstein (2007); Cohen and Wang (2013); Edmans (2014).

governance mechanisms may discipline managers to use issuance proceeds more productively and prevent wasteful uses and bad investments. Therefore, the differences in the realized MPK of equity issuers after raising capital may be due to differences in the quality of governance among firms. We test this hypothesis using two different identification approaches.

Cross-sectional analysis. First, we test whether higher quality of corporate governance is associated with improved capital allocation efficiency in the cross-section of firms. To test this hypothesis, we adopt standard metrics of internal and external governance quality from the literature (Cremers and Nair, 2005). This analysis is limited to public firms due to the lack of data on governance measures for private firms. Therefore, the estimates represent the intensive margin of the effect of corporate governance on allocation efficiency.

Among public firms, the quality of corporate governance and the level of monitoring increases with institutional ownership (Chen, Harford, and Li, 2007b; Edmans, 2014), and decreases with busy board members (Fich and Shivdasani, 2012), staggered boards (Cohen and Wang, 2013), and the G-index, which is based on the number of restrictions on shareholder rights (Gompers, Ishii, and Metrick, 2003). We also measure the quality of firms' governance based on MSCI's ESG ranking methodologies. Appendix A provides the details on variable definitions.

Panel (a) of Table 10 shows the estimates from regressing the MRPK of equity issuers on the proxies for the quality of corporate governance at the firm level. Column 1 shows that firms with high institutional ownership, which improves governance quality, increase annual revenue by an additional \$0.25 per dollar of issued equity compared to other firms. Columns 2 to 4 show that firms that have busy directors who sit on three or more boards, high G-index, and staggered boards have lower revenue growth after raising capital, as their annual revenue per dollar of issued equity is lower by \$0.59, \$0.52, and \$0.17, respectively. Finally, column 5 shows that firms that earn a high governance score on MSCI's ESG rankings have an additional \$0.30 in annual revenue for every dollar of equity raised. Panel (b) of Table 10 evaluates the relation between the quality of corporate governance and the MIPK of equity issuers. The results suggest that high institutional ownership (column 1) and MSCI governance score (column 5) are associated with more patent applications after raising equity. However, the other proxies of governance quality are not significantly related to firms' innovation output. Overall, the results are consistent with the view that strict governance mechanisms and regulatory and market oversight in public markets increase the efficiency of capital allocation.

[Table 10 around here]

An important caveat for interpreting these results as a contributing factor to the allocation efficiency gap is that comparing the level of governance quality in public and private firms is not trivial (Lowry, 2022). It is unclear ex ante which group of firms has better governance mechanisms. On the one hand, public firms face corporate governance requirements imposed by the SEC and the exchanges that are not necessary for unlisted firms. On the other hand, the concentrated ownership of private firms may prevent agency conflicts associated with public companies (Jenson and Meckling, 1976). Also, most VC investments are intermediated, and intermediaries monitor the firms (Diamond, 1984; Bernstein, Giroud, and Townsend, 2016). Moreover, private VC-backed companies tend to benefit from professionalization induced by the VC investors (Hellmann and Puri, 2002) and increase boards' size and independence as they age (Ewens and Malenko, 2022). Nonetheless, several recent scandals in high-profile private firms, such as Theranos Inc.[13] and FTX Trading Ltd.[14], offer anecdotal evidence that private firms may not be immune to moral hazard.

Quasi-natural experiment. In the second analysis, we use a quasi-natural experiment to test the effect of governance quality on allocation efficiency in both private and public markets. Product market competition can discipline managers and affect the allocation of resources within the firm (Hart, 1983; Giroud and Mueller, 2010, 2011). We exploit changes in import tariffs to get exogenous variation in the intensity of competition in firms' product markets (Tybout, 2003; Fresard, 2010). Large tariff cuts (increases), which are arguably outside the control of individual firms, are associated with increased (reduced) competition in a product market and thus exogenously increase (reduce) the need for high-quality governance. We follow prior studies and define large tariff changes if the four-year change in tariff rates in the SIC-3 industry is at the top and bottom 5% of the annual distribution.

[13] See Wall Street Journal (2018)
[14] See Economist (2022)

Table 11 presents the results of regressions of equity issuers' MRPK on large tariff changes interacted with an indicator for private and public status. Columns 1 and 2 suggest that, among private firms, the MRPK of equity investments is significantly larger in industries that experience large tariff cuts, and vice versa. These findings are consistent with the idea that, by increasing product market competition, lower import tariffs strengthen an external governance mechanism, which increases the allocation efficiency at affected firms.[15]

Importantly, Table 11 suggests that the changes in tariffs do not affect the MPK of public firms. These results highlight that governance mechanisms in public firms make the impact of tariff changes less salient, consistent with the idea that alternative governance mechanisms substitute for each other (Cremers and Nair, 2005). Overall, these findings further support the hypothesis that better governance improves the allocation efficiency of equity investments, and they provide new insights into the relationship between industry competitiveness and operational efficiency.

[Table 11 around here]

6. Conclusion

Allocating capital to firms with the most productive investment opportunities is vital for a well-functioning economy. Traditionally, public equity markets have been effective in allocating capital efficiently and held the lion's share of new equity investments. Over the last two decades, however, private equity markets have substantially grown and now allocate more capital to firms than IPOs and SEOs combined. The gradual eclipse of public markets has been alarming because of the potential implications of this transition for the overall allocation efficiency in the U.S. economy.

This study compares the efficiency of capital allocation in public and private equity markets. Our analysis suggests that public equity markets allocate capital much more efficiently than private equity markets. While private firms' revenue and innovation output grow at least 1.6 times faster than public firms' prior to raising capital, this pattern completely re-

[15] Product market competition influences firms' innovation activities in complex ways, potentially counteracting governance's positive effects (Aghion, Bloom, Blundell, Griffith, and Howitt, 2005; Gu, 2016). This interaction complicates using tariff changes as a clean shock to product market competition.

verses after the event. We find that a dollar of equity capital allocated to firms through public markets generates at least two times more in annual sales and patent applications than a dollar invested through private markets.

We investigate economic factors that may explain this gap. Using cross-sectional tests and quasi-natural experiments, we find evidence that higher levels of information efficiency and more robust corporate governance systems in public equity markets contribute to the differences in allocation efficiency.

These findings naturally invite the question of whether investors' turn to private markets is a misstep. Investor returns depend critically on unobservable valuations they receive at the time of financing, so we cannot make any conclusions in that regard. This study's primary focus is on allocation efficiency, specifically investigating how efficiently private and public markets allocate capital to projects with the highest growth potential. The observed differences in allocation efficiency may have significant economic implications, particularly when firms with promising investment opportunities face capital constraints.

Overall, our results emphasize the importance of stock markets in efficiently allocating capital and promoting economic growth. The findings also emphasize a potential risk associated with the shrinkage of public markets and the growth of private equity markets.

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Figure 1: $\frac{\Delta Y}{\Delta K}$ versus firm productivity Z_i in the model. This figure illustrates the relationship between the revenue growth per unit of capital raised ($\frac{\Delta Y}{\Delta K}$) and firm productivity (Z_i) for two different initial capital levels ($k_0 = 1$ and $k_0 = 5$). The model parameters are set to $\theta = 0.30$, $\nu = 0.55$, $\beta = 0.96$, $\delta = 0.08$, and $W = 1$.

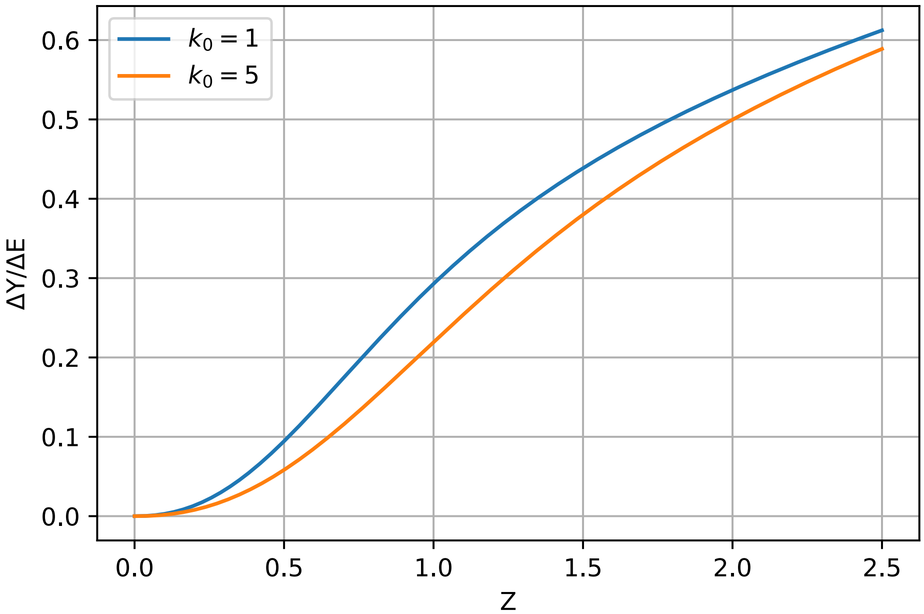
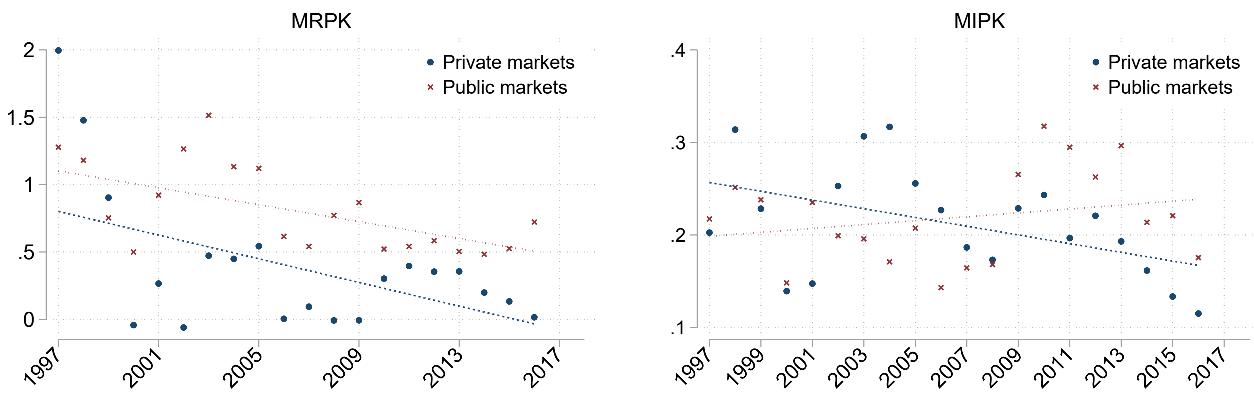


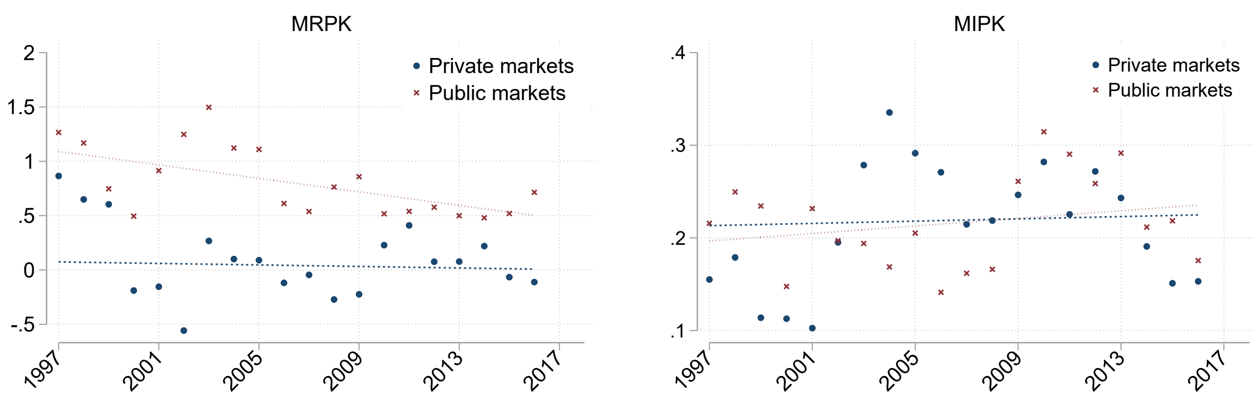
Figure 2: Capital allocation efficiency in public and private markets by year

These figures compare the average MRPK and MIPK of equity-issuing firms in public and private markets in each year. Appendix A provides variable definitions.

(a) Average MRPK and MIPK for public and private firms by year



(b) Average MRPK and MIPK for public and late-stage private firms by year



(c) Average MRPK and MIPK for public and private firms by year, controlling for age, size, and SIC-3 industry

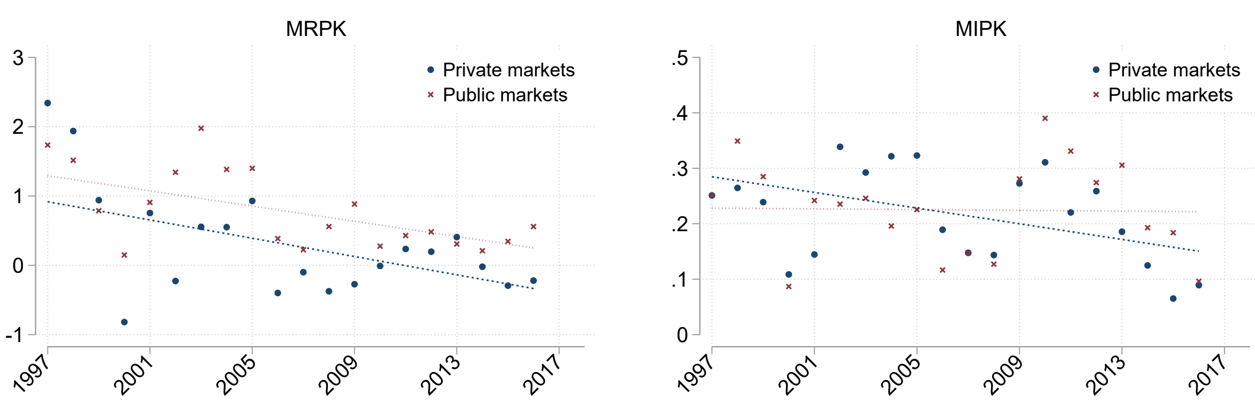
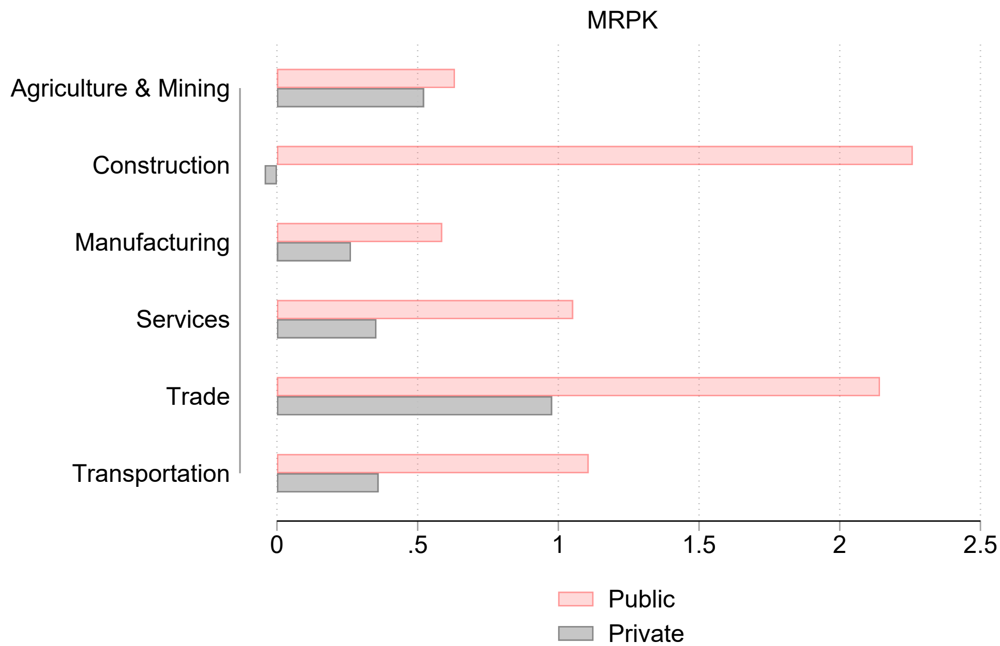


Figure 3: Capital allocation efficiency in public and private markets by sector

These figures compare the average MRPK (panel a) and MIPK (panel b) of equity-issuing firms in public and private markets in each of the six major non-financial and non-government sectors of the U.S. economy. Appendix A provides variable definitions.

(a) Average MRPK of public and private equity issuers by sector



(b) Average MIPK of public and private equity issuers by sector

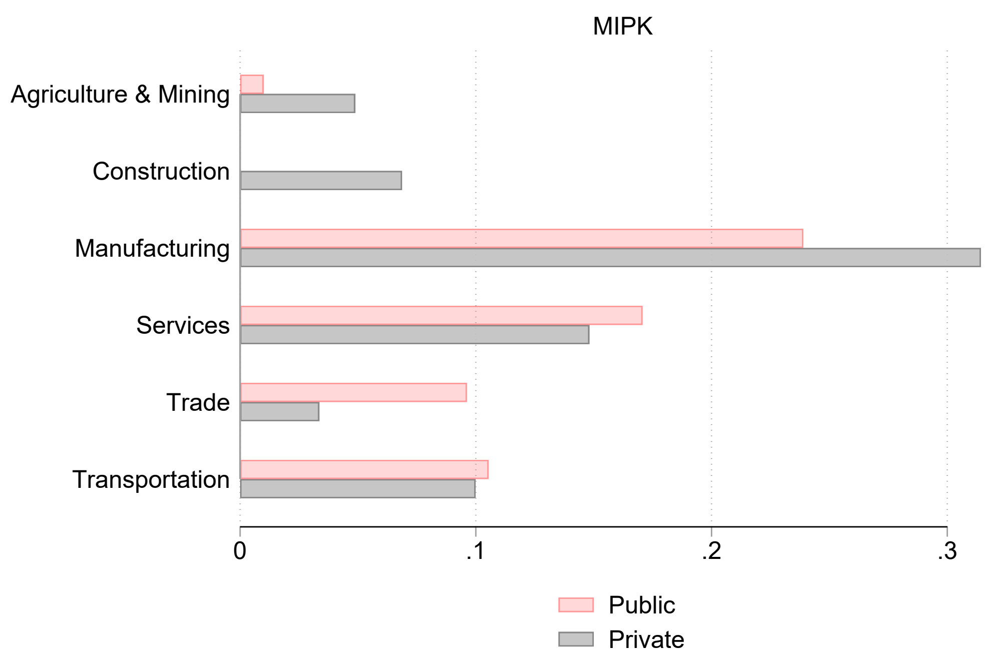
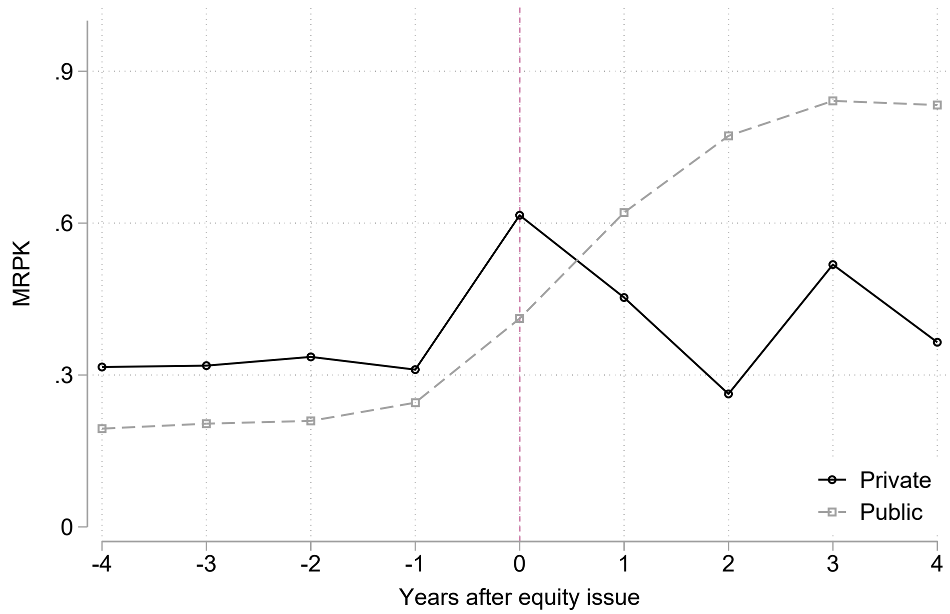


Figure 4: Pre- and post-issue trends in output growth of capital raising firms

These figures show the pre- and post-issue annual change in output per dollar of equity financing in private and public firms. That is, for each $t = -4, ..., +4$, we plot $(\text{output}_t - \text{output}_{t-1})/\Delta\text{equity}$ in each market, where Δequity is the size of the equity issue at time $t = 0$. Panel (a) evaluates revenue and panel (b) evaluates the number of patent applications as the measure of output. Appendix A provides variable definitions.

(a) Pre- and post-issue trends in revenue growth (MRPK)



(b) Pre- and post-issue trends in innovation output growth (MIPK)

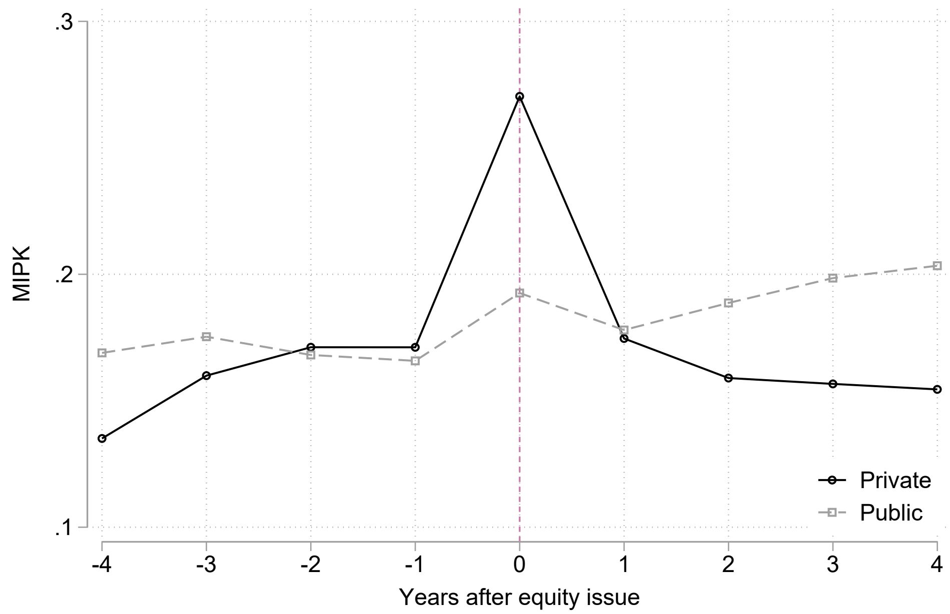
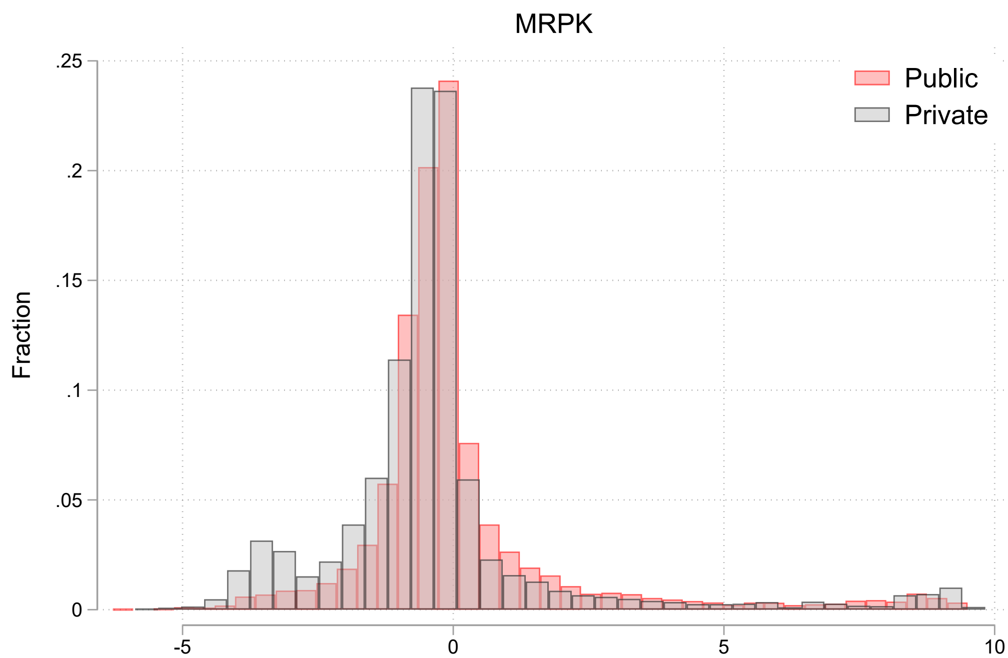


Figure 5: Distribution of MRPK and MIPK of equity issuers in public and private markets

These figures show the distribution of MRPK (panel a) and MIPK (panel b) of equity issuers in public and private markets. The MPK estimates are after controlling for firm size, age, industry Q, and industry and year fixed effects. The masses at the end of each tail reflect the winsorized observations. Appendix A provides variable definitions.

(a) Distribution of MRPK of equity issuers in public and private markets



(b) Distribution of MIPK of equity issuers in public and private markets

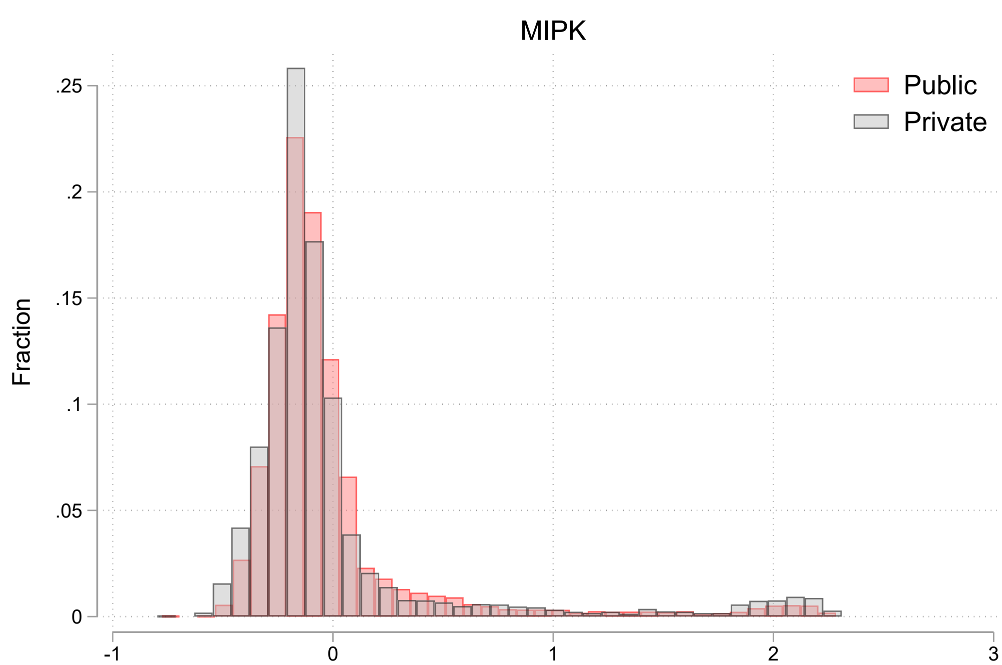
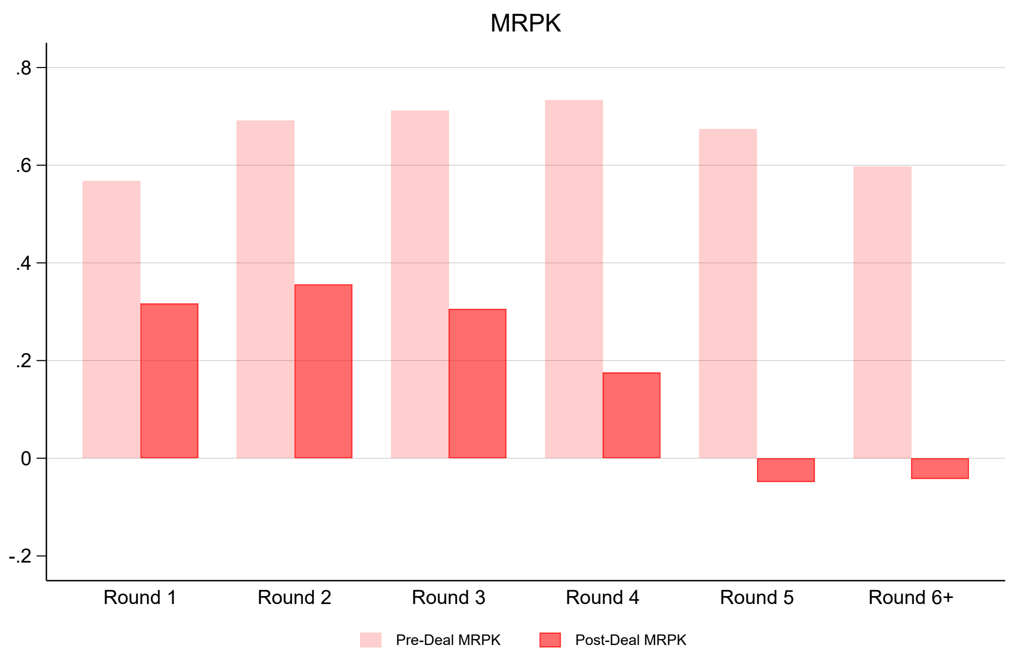


Figure 6: Capital allocation efficiency across VC funding rounds

These figures show the average MRPK (panel a) and MIPK (panel b) of equity issuers in private markets across VC funding rounds. The pre-deal and post-deal MPK measure the output growth rates in the three years before and after raising equity, respectively. Appendix A provides variable definitions.

(a) Pre- and post-issue revenue growth across funding rounds



(b) Pre- and post-issue innovation output growth across funding rounds

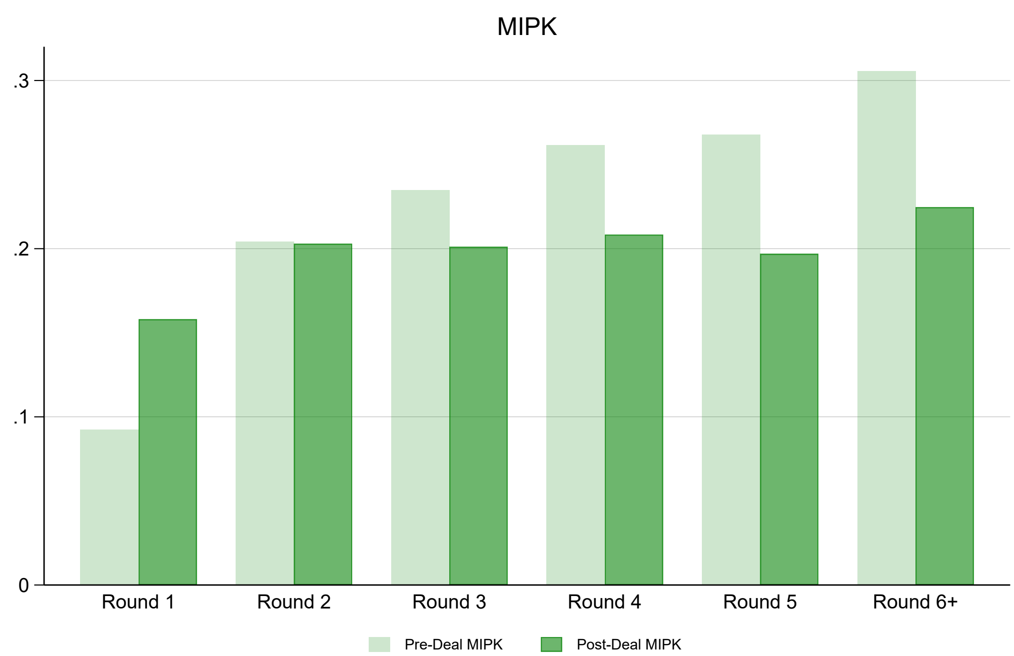
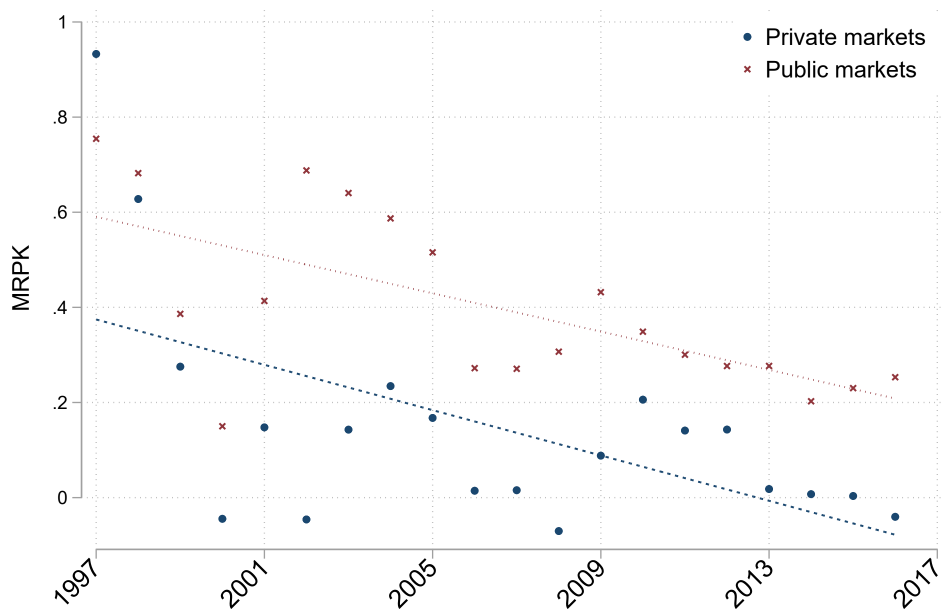


Figure 7: Portfolio-level measures of MRPK and MIPK

These figures compare the average aggregate MRPK (panel a) and aggregate MIPK (panel b) of equity-issuing firms in public and private markets each year. Aggregate MRPK (MIPK) is the ratio of the sum of the three-year sales (patent) growth divided by the sum of total equity raised in each market. Appendix A provides detailed variable definitions.

(a) Aggregate MRPK



(b) Aggregate MIPK

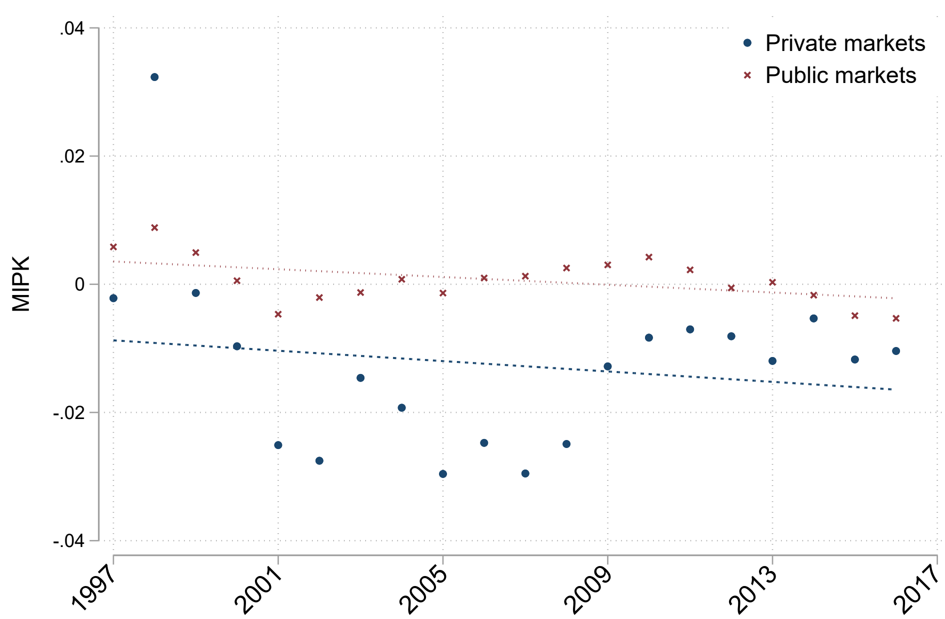


Figure 8: Distribution of sales growth for non-equity-issuing firms

This figure shows the distribution of sales growth for non-equity-issuing public and private firms. Table 6 provides the summary statistics and mean comparisons.

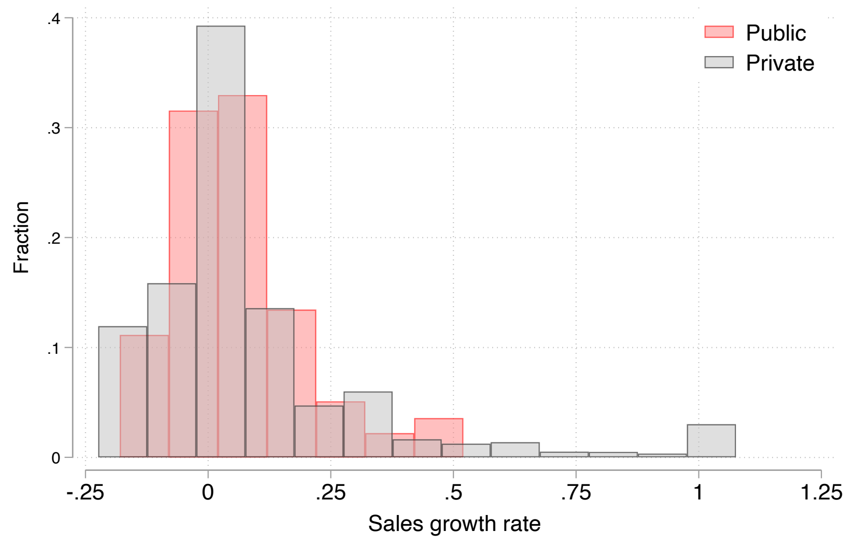


Table 1: Summary statistics

Panel (a) presents summary statistics for the full sample over the period 1997-2019. Panel (b) presents summary statistics and univariate differences between public and private firms in the full sample and the matched sample, that matches public and private firms based on industry and size following the procedure outlined in Section 3. Panel (c) presents summary statistics for the measures of stock price informativeness and corporate governance for public firms. Appendix A provides variable definitions.

(a) Full Sample

	N	Mean	SD	P10	P50	P90
Public	30,279	0.64	0.48	0.00	1.00	1.00
MRPK	30,279	0.66	2.21	-0.66	0.03	2.62
MIPK	16,946	0.21	0.51	0.00	0.00	0.61
MRPK (late-stage)	24,029	0.68	2.15	-0.63	0.05	2.66
MIPK (late-stage)	11,292	0.22	0.49	0.00	0.01	0.64
Equity raised ($ mil.)	30,279	37.12	66.92	0.61	9.99	108.03
Sales ($ mil.)	30,279	85.95	204.39	0.00	6.76	245.42
Employment	27,785	421.73	988.17	3.00	54.00	1,127.00
Age	26,318	17.52	23.59	1.00	10.00	41.00
Industry Q	30,002	2.81	1.87	1.50	2.52	4.15
Patents	16,946	2.96	7.10	0.00	0.00	10.00

(b) Univariate differences

				Matched sample		
	Public	Private	Difference	Public	Private	Difference
	(1)	(2)	(1)-(2)	(4)	(5)	(4)-(5)
Pre-issue MRPK	0.44	0.71	-0.26***	0.32	0.83	-0.51***
Post-issue MRPK	0.83	0.34	0.49***	0.63	0.15	0.48***
Pre-issue MIPK	0.18	0.23	-0.04***	0.20	0.24	-0.04*
Post-issue MIPK	0.22	0.21	0.01	0.25	0.22	0.04*
Equity raised ($ mil.)	48.34	16.89	31.45***	27.05	15.54	11.51***
Sales ($ mil.)	119.42	25.59	93.83***	38.88	26.95	11.93***
Employment	597.42	110.71	486.72***	182.10	112.66	69.44***
Age	18.56	14.62	3.94***	14.69	12.14	2.56***
Industry Q	2.84	2.77	0.06**	3.19	2.96	0.23***
Investors #		2.94			3.10	
Rounds #		4.07			4.32	
Observations	19477	10802	30279	4538	6038	10576

(c) Stock price informativeness & governance measures

	N	Mean	SD	P10	P50	P90
PIN	359	38.91	11.87	25.01	38.65	55.13
GPIN	359	37.33	19.09	15.93	34.13	58.92
Analyst count	4,193	2.78	0.93	1.54	2.79	3.98
Forecast precision	9,960	-0.54	1.16	-1.05	-0.21	-0.05
Earnings ann. return (CAR-3)	5,964	2.15	1.85	0.27	1.66	4.68
Total inst. ownership	9,909	0.39	0.33	0.00	0.33	0.91
Ln(block ownership)	9,909	0.80	0.68	0.00	0.69	1.79
Busy directors	604	0.38	0.49	0.00	0.00	1.00
High G-index	368	0.28	0.45	0.00	0.00	1.00
Staggered board	470	0.64	0.48	0.00	1.00	1.00
High governance score	1,519	0.38	0.49	0.00	0.00	1.00

Table 2: Comparing capital allocation efficiency in public and private equity markets

This table presents regressions of equity issuers' MRPK (columns 1-2) and MIPK (columns 3-4) on firm characteristics over the period 1997-2019. *Public* is an indicator variable that equals one if the firm issues equity in the public markets and zero if it raises equity in private markets. The regressions include industry (SIC-3) and year fixed effects. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	Full Sample			
	MRPK		MIPK	
	(1)	(2)	(3)	(4)
Public	0.558***	0.537***	0.021**	0.040***
	(0.054)	(0.058)	(0.011)	(0.013)
Pre-issue MRPK	-0.010	0.028**		
	(0.013)	(0.014)		
Pre-issue MIPK			0.444***	0.491***
			(0.012)	(0.014)
Ln(Employment)		-0.010		-0.011***
		(0.011)		(0.003)
Ln(Age)		0.064***		-0.004
		(0.019)		(0.005)
Industry Q		-0.029***		-0.004*
		(0.010)		(0.002)
SIC-3, year FE	Yes	Yes	Yes	Yes
Observations	23766	19257	13221	9890
Adjusted R^2	0.067	0.073	0.360	0.413

Table 3: Comparing allocation efficiency in different subsamples (late-stage, matched, and no-debt-issues)

This table presents regressions of equity issuers' MRPK (columns 1-4) and MIPK (columns 5-8) on firm characteristics in different subsamples that include more comparable public and private firms. *Public* is an indicator variable that equals one if the firm issues equity in the public markets and zero if it raises equity in private markets. Columns 1 and 5 restrict private issues to late-stage deals (i.e., round 4 and higher VC deals). Columns 2 and 6 uses the sample of public and private firms that are matched on industry and size using the procedure outlined in Section 3. Columns 3 and 7 exclude public firms that issue debt within two years before raising equity. Columns 4 and 8 apply the three filters at the same time. The regressions include industry (SIC-3) and year fixed effects. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	MRPK				MIPK			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public	0.687***	0.437***	0.528***	0.538***	0.059***	0.033**	0.035***	0.027
	(0.073)	(0.067)	(0.060)	(0.084)	(0.015)	(0.017)	(0.013)	(0.019)
Pre-issue MRPK	0.084***	-0.069***	-0.005	-0.053**				
	(0.015)	(0.018)	(0.016)	(0.021)				
Pre-issue MIPK					0.503***	0.463***	0.478***	0.461***
					(0.015)	(0.020)	(0.016)	(0.024)
Ln(Employment)	-0.007	-0.060***	-0.010	-0.061**	-0.013***	-0.012***	-0.009***	-0.011**
	(0.011)	(0.021)	(0.013)	(0.024)	(0.003)	(0.004)	(0.003)	(0.005)
Ln(Age)	0.062***	0.082**	0.061***	0.071**	0.004	-0.014**	-0.003	0.006
	(0.018)	(0.035)	(0.023)	(0.035)	(0.006)	(0.007)	(0.005)	(0.011)
Industry Q	-0.027**	-0.008	-0.039**	0.001	-0.006**	-0.004	-0.004	-0.003
	(0.011)	(0.023)	(0.016)	(0.027)	(0.003)	(0.006)	(0.003)	(0.006)
Late-stage deals	✓			✓	✓			✓
Matched sample		✓		✓		✓		✓
No-debt-issues			✓	✓			✓	✓
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17099	6892	13692	4214	7851	4553	7853	2703
Adjusted R^2	0.088	0.039	0.069	0.044	0.450	0.372	0.396	0.396

Table 4: Comparing allocation efficiency: Using withdrawn IPOs, and pre- and post-IPO comparisons

This table presents regressions of equity issuers' MRPK (columns 1-2, 5-6) and MIPK (columns 3-4, 7-8) on firm characteristics over the period 1997-2019. *Public* is an indicator variable that equals one if the firm issues equity in the public markets and zero if it raises equity in private markets. In columns 1-4, we limit the sample of private firms to those that file for an IPO, withdraw the filing, and issue equity in private markets. In columns 5-8, we use firms that complete an IPO and compare their pre-IPO private issues with post-IPO public issues.The regressions include industry (SIC-3) and year fixed effects in columns 1-4, and firm and year fixed effects in columns 5-8. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	Public vs Private (withdrawn IPOs)				Public vs Private (completed IPOs)			
	MRPK		MIPK		MRPK		MIPK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public	0.910***	0.927***	0.079**	0.054	0.454***	1.115***	0.032	0.172***
	(0.178)	(0.228)	(0.038)	(0.048)	(0.083)	(0.140)	(0.031)	(0.045)
Pre-issue MRPK	0.183***	0.186***			-0.055***	-0.006		
	(0.017)	(0.018)			(0.017)	(0.021)		
Pre-issue MIPK			0.582***	0.598***			0.326***	0.369***
			(0.017)	(0.019)			(0.024)	(0.029)
Ln(Employment)		0.007		-0.013***		-0.400***		-0.056***
		(0.011)		(0.004)		(0.044)		(0.010)
Ln(Age)		0.033*		0.008		0.334***		-0.005
		(0.019)		(0.006)		(0.056)		(0.014)
Industry Q		-0.035***		-0.004*		-0.023		-0.009**
		(0.012)		(0.003)		(0.019)		(0.004)
SIC-3, year FEs	Yes	Yes	Yes	Yes	No	No	No	No
Firm, year FEs	No	No	No	No	Yes	Yes	Yes	Yes
Observations	16671	15142	6239	5891	18920	15502	9745	7665
Adjusted R^2	0.113	0.115	0.482	0.502	0.260	0.298	0.488	0.530

Table 5: Comparing allocation efficiency: Using PIPEs and assessing the effects of issue size

This table presents regressions of equity issuers' MRPK (columns 1-2, 5-6) and MIPK (columns 3-4, 7-8) on firm characteristics over the period 1997-2019. *Public* is an indicator variable that equals one if the firm issues equity in the public markets and zero if it raises equity in private markets. Columns 1-4 limit the sample of public issues to PIPE deals. In columns 5-8, *Large deal* is an indicator that equals one if the issue size is in the top tercile of the sample's yearly distribution of equity issues. The regressions include industry (SIC-3) and year fixed effects. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	PIPEs vs private				Interaction with large deal			
	MRPK		MIPK		MRPK		MIPK	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public	0.362***	0.404***	-0.034	-0.012	0.597***	0.547***	0.069***	0.067***
	(0.068)	(0.083)	(0.026)	(0.026)	(0.062)	(0.069)	(0.015)	(0.016)
Pre-issue MRPK	-0.258***	-0.237***			-0.011	0.021		
	(0.014)	(0.021)			(0.013)	(0.014)		
Pre-issue MIPK			0.402***	0.432***			0.436***	0.480***
			(0.017)	(0.021)			(0.012)	(0.014)
Large deal					-0.225***	-0.307***	-0.066***	-0.059***
					(0.047)	(0.065)	(0.010)	(0.013)
Public × Large deal					0.015	0.018	-0.050***	-0.045***
					(0.053)	(0.072)	(0.015)	(0.017)
Ln(Employment)		-0.134***		-0.013***		0.036***		0.002
		(0.025)		(0.004)		(0.013)		(0.003)
Ln(Age)		0.052		-0.013*		0.054***		-0.009*
		(0.040)		(0.007)		(0.019)		(0.005)
Industry Q		-0.018		0.003		-0.026**		-0.002
		(0.027)		(0.005)		(0.011)		(0.002)
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8512	5395	7800	4734	23766	19257	13221	9890
Adjusted R^2	0.146	0.154	0.288	0.324	0.070	0.076	0.367	0.419

Table 6: Revenue growth rates in non-equity-issuing private and public firms

This table shows the summary statistics of the annual revenue growth rate, measured as $(\text{revenue}_t - \text{revenue}_{t-1})/\text{revenue}_{t-1}$, separately for public and private firms that do not issue equity during our sample period 1997-2019. The full distribution is shown in Figure 8. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	Public	Private	Public−Private
Mean	0.073	0.079	-0.006***
Std. Deviation	0.227	0.244	
Observations	28,404	115,600,846	

Table 7: Differences-in-differences regressions

This table presents differences-in-differences estimates based on a four-year window before and after equity-raising events. The dependent variable in columns 1-3 is the MRPK and in columns 4-6 is the MIPK. *Public* is an indicator variable that equals one if the firm issues equity in the public markets and zero if it raises equity in private markets. *Post* is an indicator variable that equals one for the years after equity issuance. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	MRPK			MIPK		
	(1)	(2)	(3)	(4)	(5)	(6)
Public × Post issue	0.745***	0.705***	0.583***	0.060***	0.049***	0.051***
	(0.056)	(0.064)	(0.048)	(0.011)	(0.010)	(0.011)
Post issue	-0.327***	-0.359***	-0.311***	-0.021**	-0.014	-0.024***
	(0.041)	(0.059)	(0.045)	(0.009)	(0.009)	(0.008)
Public	-0.240***	-0.213***		-0.053*	-0.084***	
	(0.060)	(0.043)		(0.030)	(0.027)	
Ln(Employment)		0.118***	-0.044***		0.000	-0.018***
		(0.007)	(0.015)		(0.004)	(0.006)
Ln(Age)		-0.088***	0.025		-0.027***	-0.015
		(0.017)	(0.026)		(0.006)	(0.015)
Industry Q		-0.024***	-0.026***		-0.006*	-0.011**
		(0.005)	(0.009)		(0.003)	(0.004)
SIC-3, Year FEs	No	Yes	No	No	Yes	No
Firm, Year FEs	No	No	Yes	No	No	Yes
Observations	62910	47991	45834	34717	23766	22721
Adjusted R^2	0.011	0.064	0.202	0.001	0.047	0.435

Table 8: Information efficiency and capital allocation efficiency: Evidence from the cross section

This table presents regressions of equity issuers' MRPK (panel a) and MIPK (panel b) on firm-level measures of stock price informativeness. The analysis is limited to publicly listed firms over the period 1997-2019. In columns 1-5, the measure of stock price informativeness is, respectively, the probability of informed trading (*PIN*), the generalized probability of informed trading (*GPIN*), the number of analysts following the firm's stock, analysts' forecast precision, and earnings' announcement surprises measured as the three-day cumulative abnormal return (CAR) after earnings announcements. The regressions control for firm size (log of employment and log of total assets), age, Tobin's q, profitability (ROA), and book leverage, as well as industry (SIC-3) and year fixed effects. Appendix A provides variable definitions. We report clustered standard errors at the industry and year levels in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***.

(a) The effects of information efficiency on MRPK

	MRPK				
	(1)	(2)	(3)	(4)	(5)
PIN	0.045**				
	(0.018)				
GPIN		0.018**			
		(0.007)			
Analyst count			0.122**		
			(0.047)		
Forecast precision				0.055***	
				(0.017)	
Earnings ann. return (CAR-3)					-0.017
					(0.017)
Firm Controls	Yes	Yes	Yes	Yes	Yes
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes
Observations	287	287	3819	8798	5473
Adjusted R^2	0.382	0.380	0.202	0.222	0.258

(b) The effects of information efficiency on MIPK

	MIPK				
	(1)	(2)	(3)	(4)	(5)
PIN	0.004*				
	(0.002)				
GPIN		-0.001			
		(0.001)			
Analyst count			0.010		
			(0.008)		
Forecast precision				-0.005	
				(0.004)	
Earnings ann. return (CAR-3)					-0.002
					(0.002)
Firm Controls	Yes	Yes	Yes	Yes	Yes
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes
Observations	171	171	2538	4589	3419
Adjusted R^2	0.925	0.921	0.695	0.640	0.661

Table 9: Information efficiency and capital allocation efficiency: Evidence from brokerage exits

This table presents difference-in-differences estimates of the MRPK (columns 1-2) and MIPK (columns 3-4) using brokerage firm exits as an exogenous shock to the information environment of equity issuing firms. The analysis is limited to publicly listed firms from 1997-2019. *Treated* is an indicator variable that equals one if the firm experiences a drop in analyst coverage due to a brokerage house exit. *Post Exit* is an indicator variable that equals one during the period following a brokerage closure. The regressions in columns 1 and 3 include industry (SIC-3) and year fixed effects, and in columns 2 and 4 include firm and year fixed effects. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	MRPK		MIPK	
	(1)	(2)	(3)	(4)
Treated × Post Exit	-0.228**	-0.269**	-0.045**	-0.021
	(0.095)	(0.122)	(0.016)	(0.024)
Treated	0.268***		0.038**	
	(0.083)		(0.015)	
Pre-issue MRPK	0.276***	0.199*		
	(0.023)	(0.101)		
Pre-issue MIPK			0.806***	0.851***
			(0.028)	(0.049)
Ln(Employment)	0.093***	0.053	-0.003	-0.037*
	(0.027)	(0.084)	(0.007)	(0.021)
Ln(Age)	0.060**	0.395	-0.002	0.046
	(0.026)	(0.285)	(0.008)	(0.049)
Industry Q	-0.046***	-0.139***	-0.001	-0.015**
	(0.015)	(0.040)	(0.002)	(0.007)
Ln(assets)	-0.084***	-0.392***	-0.000	-0.033
	(0.017)	(0.109)	(0.005)	(0.025)
ROA	0.001*	0.000	0.000	0.000
	(0.000)	(0.003)	(0.000)	(0.000)
Book leverage	0.002	0.443	-0.043*	-0.004
	(0.014)	(0.256)	(0.024)	(0.042)
Market-to-book	0.000**	0.028	0.001*	0.004
	(0.000)	(0.016)	(0.001)	(0.003)
Year FEs	Yes	Yes	Yes	Yes
SIC-3 FEs	Yes	No	Yes	No
Firm FEs	No	Yes	No	Yes
Observations	14346	1471	5443	1007
Adjusted R^2	0.120	0.462	0.567	0.684

Table 10: Corporate governance and capital allocation efficiency: Evidence from the cross section

This table presents regressions of equity issuers' MRPK (panel a) and MIPK (panel b) on firm-level measures of governance quality. The analysis is limited to publicly listed firms over the period 1997-2019. *High inst. ownership* equals one if the firm's institutional ownership is at the top tercile of the annual distribution. *Busy directors* equals one if the firm's directors hold more than three directorships. *High G-index* equals one if the firm's governance index is at the top tercile of the annual distribution. *Staggered board* equals one if the firm's board is staggered. Column 5 uses MSCI's firm-level ESG scores. The regressions control for firm size, age, Tobin's q, profitability (ROA), and book leverage, as well as industry (SIC-3) and year fixed effects. Appendix A provides variable definitions. We report clustered standard errors at the industry and year levels in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***.

(a) The effects of governance mechanisms on MRPK

	MRPK				
	(1)	(2)	(3)	(4)	(5)
High inst. ownership	0.254***				
	(0.066)				
Busy directors		-0.589**			
		(0.259)			
High G-index			-0.519*		
			(0.237)		
Staggered board				-0.172	
				(0.141)	
High governance score					0.301**
					(0.098)
High social score					0.527**
					(0.235)
High environmental score					-0.179
					(0.128)
Firm Controls	Yes	Yes	Yes	Yes	Yes
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes
Observations	9155	518	320	422	4095
Adjusted R^2	0.101	0.181	0.275	0.179	0.079

(b) The effects of governance mechanisms on MIPK

	MIPK				
	(1)	(2)	(3)	(4)	(5)
High inst. ownership	0.016				
	(0.017)				
Busy directors		0.041			
		(0.083)			
High G-index			0.066		
			(0.034)		
Staggered board				-0.081	
				(0.073)	
High governance score					0.040*
					(0.022)
High social score					-0.020
					(0.032)
High environmental score					0.046
					(0.029)
Firm Controls	Yes	Yes	Yes	Yes	Yes
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes
Observations	4114	345	217	217	3701
Adjusted R^2	0.067	0.145	0.120	0.196	0.069

Table 11: Corporate governance and capital allocation efficiency: Evidence from import tariffs

This table presents difference-in-differences estimates of the MRPK (columns 1-2) and MIPK (columns 3-4) using large import tariff shocks. The sample includes all public and private equity issues over the period 1997-2019. *Tariff cut (increase)* is an indicator that equals one if the four-year change in the tariff rate in the firm's SIC-3 industry is in the 5% left (right) tail, and zero otherwise. *Public (Private)* is an indicator variable that equals one if the firm issues equity in public (private) markets and zero if it raises equity in private markets. The regressions include industry (SIC-2) and year fixed effects. Appendix A provides variable definitions. We cluster standard errors at the industry and year levels and report them in parentheses. Significance at the 10%, 5%, and 1% level is indicated by *, **, and ***, respectively.

	MRPK	
	(1)	(2)
Private × Tariff cut	0.397	0.724*
	(0.315)	(0.429)
Private × Tariff increase	-0.567	-1.281**
	(0.474)	(0.513)
Public × Tariff cut	-0.054	-0.045
	(0.161)	(0.141)
Public × Tariff increase	0.294	0.211
	(0.298)	(0.294)
Pre-issue MRPK	-0.046***	-0.012
	(0.014)	(0.017)
Ln(Employment)		0.029**
		(0.011)
Ln(Age)		0.082***
		(0.021)
Industry Q		-0.020*
		(0.010)
SIC-2, year FE	Yes	Yes
Observations	17354	14180
Adjusted R^2	0.022	0.024

Appendix A. Variables Definitions

Variable	Definition
Public	Indicator that equals one if the firm is publicly listed
MRPK	The marginal revenue product of capital, calculated as the average annual change in revenue in the three years after a capital raising event divided by the total amount of equity raised (in dollars)
MIPK	The marginal innovation product of capital, calculated as the average annual new patent applications in the three years after a capital raising event divided by the total amount of equity raised (in million dollars)
MRPK (pre-issue)	The average annual change in revenue in the three years prior to a capital raising event divided by the total amount of equity raised (in dollars)
MIPK (pre-issue)	The average annual new patent applications in the three years prior to a capital raising event divided by the total amount of equity raised (in million dollars)
Portfolio-level MRPK	The ratio of the sum of the three-year sales growth divided by the sum of total equity raised in each market, i.e., portfolio-level MRPK $= \frac{\sum_{\forall i \in M} \text{Sales}_{t+3} - \sum_{\forall i \in M} \text{Sales}_t}{\sum_{\forall i \in M} \text{Equity}_i}$, where M represents the market (private vs public)
Portfolio-level MPIK	The ratio of the sum of the three-year patent growth divided by the sum of total equity raised in each market, i.e., portfolio-level MIPK $\frac{\sum_{\forall i \in M} \text{Patents}_{t+3} - \sum_{\forall i \in M} \text{Patents}_t}{\sum_{\forall i \in M} \text{Equity}_i}$, where M represents the market (private vs public)
Employment	Total firm employment
Sales	Total firm sales ($ millions)
Age	Firm founding age (For public firms, we use Ritter's database and when missing complement with information from Data Axle. For private firms we use the company's founding year provided by Data Axle
Industry Q	The average Q in the firm's SIC-3 industry
Ln(assets)	Natural log of a the firm's assets
ROA	Net income over total (lagged) assets
Market-to-book	Total market value of equity over total value of book assets
Book leverage	Total (long-term) debt over total (lagged) assets
PIN	Probability of informed trading by Easley, Kiefer, O'hara, and Paperman (1996)
GPIN	Generalized probability of informed trading by Duarte, Hu, and Young (2020)
Analyst count	Log(3-year moving average of # of analysts following the stock of a firm)
Forecast precision	$-1\times$ 3-year moving average of EPS forecast error, where forecast error$= \frac{\lvert \text{actual EPS} - \text{forecast EPS} \rvert}{\text{actual EPS}}$
CAR-3	Cumulative abnormal return following firms' earnings announcements
High inst. ownership	An indicator that equals one if the firm's total institutional ownership is at the top tercile of the annual sample distribution
Busy director	A director in the firm's board occupying at least three different directorships
Busy directors (high)	An indicator variable that equals one for firms with at least one busy director
G-index	Governance index based on 24 governance provisions by Gompers et al. (2003)
G-index (high)	Indicator variable that equals one if the firm's G-index is at the top tercile of the distribution of the G-index
Staggered board	Indicator variable that equals one if the firm's board is staggered
High governance score	An indicator variable that equals one if the firms' MSCI governance score is at the top tercile of the annual distribution

High social score	An indicator variable that equals one if the firms' MSCI social score is at the top tercile of the annual distribution
High environmental score	An indicator variable that equals one if the firms' MSCI environmental score is at the top tercile of the annual distribution
Tariff cut (increase)	An indicator variable that equals one if the four-year % change in the tariff rate is in the 5% (95%) of the distribution

Appendix B. Anecdotes on Revenue and Profits in Young Firms

Figure B.1: Revenue and Net Operating Profit (Loss) In Well-known Startups

This figure shows the revenue (i.e., top line) and net operating profit (loss) in six well-known startups. The data are from PitchBook. We use all available data for each firm. The plots show that these firms had significant revenue growth, which allowed them to raise large sums of money in private markets, despite having operating losses.