Comparing Capital Allocation Efficiency in Public and Private Equity Markets*

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Abstract

Investors increasingly allocate capital outside of public equity markets through private equity investments. We evaluate capital allocation efficiency in the two markets by comparing the marginal revenue and innovation products of capital in firms receiving equity. Public markets allocate capital more efficiently than private markets, as public firms grow faster after receiving equity despite lower pre-deal growth rates. This efficiency gap is driven by lower efficiency in late-stage private investments, while early-stage private deals are as efficient as public markets. Specifically, a dollar allocated in late-stage private markets generates $0.44 less in annual revenue, and the average deal results in 1.97 fewer patent applications per year compared to similar size deals allocated in early-stage private or public markets. Using cross-sectional tests and quasi-natural experiments, we attribute the higher efficiency in public markets to superior information efficiency and governance mechanisms, crucial for larger and more complex firms like late-stage private and public companies. Our study highlights the essential role of public markets in improving capital allocation and the implications of private markets' expansion into late-stage financing.

Key Words: Capital allocation, stock markets, private equity, venture capital, growth equity, information efficiency, governance
JEL Classification: G14, G24, G32, G34, O16, O47

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Investors increasingly allocate capital outside of public equity markets through private equity investments. We evaluate capital allocation efficiency in the two markets by comparing the marginal revenue and innovation products of capital in firms receiving equity. Public markets allocate capital more efficiently than private markets, as public firms grow faster after receiving equity despite lower pre-deal growth rates. This efficiency gap is driven by lower efficiency in late-stage private investments, while early-stage private deals are as efficient as public markets. Specifically, a dollar allocated in late-stage private markets generates $0.44 less in annual revenue, and the average deal results in 1.97 fewer patent applications per year compared to similar size deals allocated in early-stage private or public markets. Using cross-sectional tests and quasi-natural experiments, we attribute the higher efficiency in public markets to superior information efficiency and governance mechanisms, crucial for larger and more complex firms like late-stage private and public companies. Our study highlights the essential role of public markets in improving capital allocation and the implications of private markets' expansion into late-stage financing.

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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). 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 capital allocation efficiency of public and private equity markets. We focus on equity deals that finance the issuing firms—SEOs for public firms and venture capital (VC) and growth equity investments for private firms—while excluding ownership transfer deals like mergers and buyouts. We present three major findings. First, on average, public markets allocate capital more efficiently than private markets, as public firms exhibit faster growth after receiving equity, despite having lower pre-deal growth rates than private firms. Second, this efficiency gap is concentrated in late-stage private investments. While early-stage private markets allocate capital as efficiently as public markets, late-stage private deals show significantly lower efficiency. This indicates that private markets perform well in early-stage deals—their traditional expertise—but their recent expansion into late-stage financing is characterized by lower allocation efficiency. Third, we find that the efficiency gap is likely not driven by differences in firm or deal characteristics, and potential selection biases would likely go against our findings. Instead, superior information efficiency and governance mechanisms in public markets enhance allocation efficiency by helping investors and managers identify and fund more productive projects. These mechanisms are more crucial for larger and more complex firms, such as late-stage private and public companies.

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 across 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

[1]VC investors emphasize 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. In Section 4.1, we provide some anecdotal evidence. For more empirical evidence, see Chemmanur et al.

prioritize innovation over revenue generation. Thus, we also use innovation outcomes and 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, on average, firms receiving equity in public markets have higher MRPK and MIPK than firms receiving equity in private markets, controlling for the effects of firm size, age, industry, and pre-issue growth rates. Crucially, this difference in allocation efficiency is driven by the low efficiency of late-stage private investments, which have become more prevalent in recent years, while early-stage private investments are as efficient as those in public markets. In other words, a dollar of equity allocated in public markets generates similar revenue and innovation growth as a dollar allocated in early-stage private markets. However, a dollar allocated in late-stage private markets generates \$0.44 less in annual revenue over the next three years compared to a dollar allocated in public or early-stage private markets. Moreover, the average deal in late-stage private markets results in 1.97 fewer patent applications per year than the same amount allocated in public or early-stage private markets. These differences in allocation efficiency persist over time and across sectors. This shows that private markets, while performing well in early-stage investments, are less efficient than public markets when it comes to their recent expansion into late-stage financing.

Importantly, the difference in output growth rates between public and private firms is created at the time of capital allocation, not from pre-trends. In fact, in the year leading up to raising equity, private firms have higher revenue and innovation growth rates than public firms. Our findings suggest that firms tend to raise equity in private markets after an exceptionally strong year of revenue and innovation growth. But, on average, they do not sustain those outcomes after raising capital. On the other hand, public firms, on average, tend to have higher growth rates after raising equity compared to the pre-deal period.

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. Recognizing that public firms may have easier access to debt financing and may hold higher cash reserves, we

(2011), Gompers, Kaplan, and Mukharlyamov (2016), Gompers, Gornall, Kaplan, and Strebulaev (2020), Maksimovic, Phillips, and Yang (2023).

compare subsamples of firms with no debt issuance around their equity-raising events and examine firms across different levels of cash holdings to isolate the effect of equity financing in the two markets. Additionally, we compare public issuers 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. Finally, we evaluate allocation efficiency at the market-portfolio level, emulating the perspective of investors who invest in all firms in a market.

Across all approaches, we consistently find similar estimates of the allocation efficiency gap when comparing average private and public equity deals. Importantly, consistent with our baseline results, we observe a monotonic decline in the MPK of private deals with respect to the funding round, confirming that the low allocative efficiency of late-stage VC deals drives the overall efficiency gap between private and public equity markets. This finding is particularly important because, in recent years, late-stage VC investments have increasingly replaced public equity issues for firms that delay going public and remain private longer (Ewens and Farre-Mensa, 2020, 2022).

While our nuanced group definitions improve the comparability of private and public firms, they may not fully eliminate biases from omitted variables or selection mechanisms. However, these factors likely bias our estimates in the opposite direction of our findings. According to our model, under efficient capital allocation and consistent with the law of diminishing returns to capital, the average MPK of smaller private firms should be greater–not lower–than that of larger public firms. Supporting this notion, the distribution of revenue growth for private firms in our sample skews to the right of that for public firms, suggesting that unconditional differences between the two groups likely work against the direction of our results. Recent studies corroborate this evidence, showing that firms typically 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 lower returns on assets than private firms (Ueda and Sharma, 2019). Therefore, observing the opposite result at equity-raising events suggests that the difference in allocation efficiency across the two markets is likely the underlying cause. We also verify that our results are not driven by differences in firms' exposure to aggregate risk (à la David, Schmid, and Zeke, 2022) or the rise of markups (à la De Loecker, Eeckhout, and Unger, 2020).

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 public 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.

Our findings invite the question of whether investors' turn to late-stage 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.

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

[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).

affect the real economy via the informational role of market prices (Bond, Edmans, and 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.

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

[3] Restuccia and Rogerson (2017) and Eisfeldt and Shi (2018) provide excellent reviews of this literature.
[4] Stulz (2020) and Lowry (2022) provide excellent reviews of this literature.

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 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, $\text{MRPK}_{it+1} = \dfrac{\partial Y_{it+1}}{\partial K_{it+1}}$, 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 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, $\mathbb{E}_t\big[M_{t+1}\big] = \beta$. 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

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

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 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 $\text{MRPK}_{it+1} = \frac{\partial Y_{it+1}}{\partial K_{it+1}}$ 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 and thus 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 of firms' beta across markets can affect the MRPK comparison. Assuming that the 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.

[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.

[6] In Section 5, we show the effect of firms' beta works against the 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 beta estimates in public and private markets).

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. Our baseline measure of equity issuance may include 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.[7] We exclude from our sample any public firm-year observations where acquisitions exceed 5% of the firm's total assets to mitigate the potential confounding effects of large acquisitions on firms' organic revenue growth (Eckbo, 2014). 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 Research 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.[8]

We do not exclude firms with multiple deals in consecutive years in either sample to avoid forward-looking bias. In our sample, having multiple equity issues in consecutive years is

[7]Our results are robust to using a 1% threshold. We apply this filter to mitigate the potential impact of small equity issuances, such as those related to employee stock options. We also use SEO data from SDC Platinum and find similar results, confirming that this treatment is not critical for our results. Note that this filter is not necessary for private deals because our data include only private deals with external investors and do not include equity compensation.

[8]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.

more common among private firms than public firms, so any potential bias is against our main results. We exclude private firms with zero sales (pre-revenue stage) and those exhibiting zero revenue growth from our sample. These filters ensure that our analysis focuses on private firms that have entered the commercialization stage and for which sales data are up-to-date and high-quality. The sample construction table in Appendix A describes the step-by-step process of constructing our final sample.

To ensure that 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 to 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). 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 the number of directorships for each company director and whether the company has a staggered board following Fos, Li, and Tsoutsoura (2018). Finally, we calculate the number of restrictions on shareholder rights of public firms using the G-index from Gompers, Ishii, and Metrick (2003).

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. After dropping deals involving firms with missing three-year sales growth data, our final sample covers the years from 1997 to 2019 and consists of 20,887 unique equity-raising events from 6,617 private and 14,270 public market deals. 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 equity issues make up 68% of the sample. The rest of the sample consists of private deals, including both early- and late-stage investments. Late-stage private deals (round 4+) constitute 13% of the full sample. The average firm raises approximately $32 million in equity, has 327 employees, and $66 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 0.54, which implies a $0.54 increase in annual sales in the next three years per dollar of raised equity. Similarly, MIPK is the three-year average annual change in patent applications per million dollars of raised equity. The average MIPK is 0.21, suggesting that a million dollars in new equity generates approximately an additional 0.21 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 $38.95 million, which is approximately twice as large as the $17.83 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 re-

placement 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 become smaller than those of public firms.

[Table 1 around here]

4. Allocation efficiency in public and private equity markets

4.1. Measuring allocation efficiency

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, guided by the model in Section 2, we measure the realized MPK as the output growth following an equity issuance per unit of raised capital.

Anecdotal evidence suggests 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 the Online Appendix, we present the revenue and net operating profit (loss) of six well-known startups with available data on both revenue and profits. We 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 0.59, whereas an average firm that receives equity in private markets has an MRPK of 0.43. This implies that a dollar of equity allocated through public markets generates \$0.16 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 0.03 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, before raising capital, private firms have considerably higher revenue growth than public firms. 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 similar to public firms'. However, both revenue growth and the number of new patents in private firms decline 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, we find that these differences appear after capital raising events, not from pre-trends or pre-deal differences across the two groups. 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.

Finally, we evaluate the differences in the efficiency of equity allocation across sectors of the economy. Figure 2 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 compared to private markets in all sectors of the economy, except for the agriculture and mining sectors, which has a small number of observations in our sample.

[Figure 2 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 3 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 3(a), and patent applications, Figure 3(b), as the main measures of output.

Figure 3(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 two times faster than public firms. After raising equity ($t = +1, ..., +4$), the two groups diverge

noticeably. Public firms double their revenue growth in this period, whereas private firms' growth peaks in the issuance year and then revert to pre-issuance levels.

Figure 3(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. For public firms, there is also an increase in the innovation growth rate in the year leading up to equity issuance. However, public firms retain the elevated innovation growth rate after issuance. The trends in revenue and innovation outcomes align with the notion that public markets are more successful than private markets in identifying and financing projects with high growth potential after raising equity—not just those with good past performance.

[Figure 3 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 equity-raising events, 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.[9]

Table 2 reports the estimated differences in allocation efficiency between public and private markets. We begin by comparing the MRPK (columns 1–2) and MIPK (columns 4–5) of an average equity deal in private markets with those of an average deal in public markets. Column 1 shows that every dollar of equity capital allocated through public markets generates \$0.37 more in annual sales than a dollar allocated in private markets. In column 2, the estimated difference in MRPK is \$0.35 after controlling for firm and industry characteristics, such as pre-issue growth rates, size, age, and industry q. We observe similar patterns when examining firms' innovation output. Columns 4 and 5 indicate that a million dollars of equity allocated in public markets generates 0.03–0.04 more patent applications than the same amount allocated in private markets. This difference translates to 0.96–1.28 more patents per year for the average deal (\$32.26 million). These estimates are economically significant, suggesting that public markets are, on average, more efficient than private equity markets at allocating equity.

Motivated by the recent expansion of private markets into late-stage investments, we also conduct a three-way comparison among early-stage private, late-stage private, and public equity investments. In columns 3 and 6 of Table 2, we include an indicator for late-stage private deals on the right-hand side. In these specifications, the *Private early-stage* deals serve as the baseline group, and the estimated coefficients on *Public* and *Private late-stage* represent the marginal effects for firms in these categories. In columns 3 and 6, the estimated coefficients on *Public* are not significantly different from zero, suggesting that a dollar of equity allocated in public markets generates similar revenue and innovation growth as a dollar allocated in early-stage private markets. The negative coefficients on *Private late-stage* indicate that a dollar of equity allocated in late-stage private markets generates \$0.44 less in annual revenue, and a million dollars of equity results in 0.06 fewer patent applications per year over the next three years compared to the same amounts allocated in early-stage private or public markets. The latter estimate implies that the average deal in late-stage private markets results in 1.97 ($= -0.061 \times \$32.26$) fewer patent applications per year than the same amount allocated in the other two markets. These estimates suggest that the

[9] 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.

efficiency gap documented earlier is concentrated in late-stage private investments, whereas early-stage private markets allocate capital as efficiently as public markets.

[Table 2 around here]

Figure 4 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. Alternatively, the documented mean differences could be driven by outliers in public markets. As Figure 4 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 or public firms do not seem to have significantly more positive outliers, as both distributions exhibit similarly long right tails.

[Figure 4 around here]

Of course, there are many other dimensions in which public and private firms differ. In Table 3, we aim to make these comparison groups more homogeneous to ensure that MPK differences reflect market-level allocation efficiency rather than differences in the characteristics of the issuers. First, in columns 1 and 5, we keep all public firms and restrict the private firm sample to those involved in late-stage VC deals. This test is motivated by our baseline results above and the fact that, in recent years, a rising number of firms that would have typically gone public, stay private longer and seek equity through late-stage VC financing (Ewens and Farre-Mensa, 2020). These firms usually have a proven track record of effectively exploiting market opportunities, scaling their business models, and generating sales. Interestingly, the proceeds from late-stage VC deals are comparable to those of public firms' SEOs (Lowry, 2022). Thus, these private firms likely share more similarities with public firms than an average private firm.

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 around 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, 0.23–0.62 higher than those in private markets. Similarly, the average MIPK of firms raising equity in public markets is 0.04–0.08 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 12,324 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.[10] As one might expect, these results are economically more similar 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

[10]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).

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. The effects are statistically less significant, likely due to the demanding specification that includes firm fixed effects given that each firm has a limited number of equity raising events. Nonetheless, 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 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 \$0.15–\$0.20 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 \$38.95 million, whereas the average VC deal size is \$17.83 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.[11] To test whether the larger size of public issues drives the observed differences in allocation efficiency,

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

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 20,887 total capital-raising events in our sample, 1,566 private deals and 5,369 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.

[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 5 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 5, 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. 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 5 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 (= 2.1) exceeds that of public firms (= 2), even though the average of firm-level MRPKs are lower in private firms (= 0) than public firms (= 2).[12]

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 6 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 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 6 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. Also, we test whether differences in firms' cash reserves drive the allocation efficiency gap between public and private markets. We split our sample of public firms into high- and low-cash groups and analyze the allocation efficiency in each group. The results, presented in the Online Appendix, show that public markets exhibit higher allocation efficiency in both subsamples, indicating that differences in cash reserves do not drive our main findings.

[12]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 $\frac{1}{4}(-1-1-1+3) = 0$.

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 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 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 that these effects most likely bias our estimates in the opposite direction. We begin by emphasizing the fact that 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 indicates the higher 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 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 growth exceed public firms' by \$0.68 per dollar of raised equity and their innovation growth rates are essentially similar. As previously discussed, this pattern is also shown in Figure 3, where the plot illustrates the lack of pre-trends in revenue and innovation growth in both groups of firms, emphasizing 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 7 illustrates the comparison and visually rules out the hypothesis that public firms' unconditional average growth rate is larger than that of private firms.

[Figure 7 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:

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

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, *Public*×*Post issue*, confirming that the increase in MRPK and MIPK of public firms relative to private firms takes place after capital-raising events.

[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, in untabulated results, we confirm that the MPK gap remains relatively steady over our sample period, with a slight decline in the MPK of private deals, while the MPK of public deals remains steady (and does not increase) throughout the sample period.

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. In these tests, we use revenue as the primary measure of output, making the outcome variable the MRPK. We do not report results for the marginal innovation product of capital (MIPK), as the sample of firms with data on both price informativeness proxies and patent applications is too limited.[13]

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, and analysts' forecast accuracy (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.

Columns 1-4 of Table 8 shows the results. We find 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 are associated with \$0.52 (0.044×11.87) and \$0.36 (0.019×19.09) increase 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 \$0.07 and \$0.06 in sales per dollar of allocated equity, respectively. Overall, the results suggest that a better information environment, proxied by higher price informativeness, is associated with the more efficient allocation of capital.

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

[13]Depending on the price informativeness proxy, the sample size for MIPK tests ranges from 10% to 25% of the corresponding MRPK tests. Results of the MIPK tests are similar to those in the corresponding MRPK tests, but they are less statistically significant.

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. Columns 5-6 of Table 8 present the results. Column 5 includes industry and year fixed effects. The coefficient on the interaction between *Treated* and *Post Exit* suggests that the treatment has a negative impact on the MRPK of allocated equity. Column 6 includes firm fixed effects, which limit the sample to firms with at least one brokerage exit, and equity raising events before and after the brokerage exit. This setup allows us to compare the MRPK 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. Overall, the estimated coefficients suggest that the exogenous decline in information efficiency causes a minimum \$0.21 drop in the marginal revenue per dollar of allocated equity. These results confirm the information efficiency hypothesis.

[Table 8 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.[14] Better governance mechanisms may discipline managers to use issuance proceeds more productively

[14]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).

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 detailed below. Similar to before, we focus on the MRPK as the main outcome variable due to the small sample size of the MIPK tests.

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). Appendix A provides the details on variable definitions.

Columns 1-4 of Table 9 show 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 \$0.15 per dollar of issued equity compared to other firms. Columns 2 and 3 show that firms that have busy directors who sit on three or more boards and those with high G-index have \$0.51 and \$0.42 lower revenue growth, respectively, after raising capital compared to other firms. In column 4, we do not find a significant impact from having staggered boards on the MRPK of issuing firms. 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.

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.[15] and FTX Trading Ltd.[16], 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.

Column 5 of Table 9 presents the results of the regression of equity issuers' MRPK on large tariff changes interacted with an indicator for private and public status. The estimates suggest that, among private firms, the MRPK of equity investments is significantly larger in industries that experience large tariff cuts, and smaller in industries with large tariff increases. These findings are consistent with the idea that, by increasing product market competition, lower (higher) import tariffs strengthen (weaken) an external governance mechanism, which increases (decreases) the allocation efficiency at affected firms.

Importantly, Table 9 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

[15] See Wall Street Journal (2018)
[16] See Economist (2022)

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 9 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.

Our analysis shows that public equity markets, on average, allocate capital more efficiently than private equity markets. Public firms exhibit faster growth after receiving equity funding, despite having lower growth rates prior to capital raising compared to private firms. Importantly, this efficiency difference is mainly concentrated in late-stage private investments. While early-stage private markets allocate capital just as effectively as public markets, late-stage private deals tend to be less efficient. This indicates that private markets perform well in early-stage financing—the area of their traditional expertise—but their recent expansion into late-stage funding is associated with diminished allocation efficiency.

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.

References

Aragon, G. O., Li, E., Lindsey, L. A., 2018. Exploration or exploitation? Hedge funds in venture capital. Working Paper, Arizona State University.

Asker, J., Collard-Wexler, A., De Loecker, J., 2014. Dynamic inputs and resource (mis) allocation. Journal of Political Economy 122, 1013–1063.

Asker, J., Farre-Mensa, J., Ljungqvist, A., 2015. Corporate investment and stock market listing: A puzzle? Review of Financial Studies 28, 342–390.

Bai, J., Philippon, T., Savov, A., 2016. Have financial markets become more informative? Journal of Financial Economics 122, 625–654.

Bakke, T.-E., Whited, T. M., 2010. Which firms follow the market? An analysis of corporate investment decisions. Review of Financial Studies 23, 1941–1980.

Begenau, J., Liang, P., Siriwardane, E., 2023. The rise in alternatives .

Bennett, B., Stulz, R., Wang, Z., 2020. Does the stock market make firms more productive? Journal of Financial Economics 136, 281–306.

Bernstein, S., 2015. Does going public affect innovation? Journal of Finance 70, 1365–1403.

Bernstein, S., Giroud, X., Townsend, R. R., 2016. The impact of venture capital monitoring. Journal of Finance 71, 1591–1622.

Bertrand, M., Mullainathan, S., 2001. Are CEOs rewarded for luck? The ones without principals are. Quarterly Journal of Economics 116, 901–932.

Bertrand, M., Mullainathan, S., 2003. Enjoying the quiet life? Corporate governance and managerial preferences. Journal of Political Economy 111, 1043–1075.

Bias, D., Lochner, B., Obernberger, S., Sevilir, M., 2022. Going public and the internal organization of the firm. Working Paper, Vanderbilt University.

Bond, P., Edmans, A., Goldstein, I., 2012. The real effects of financial markets. Annu. Rev. Financ. Econ. 4, 339–360.

Boyd, J. H., Prescott, E. C., 1986. Financial intermediary-coalitions. Journal of Economic Theory 38, 211–232.

Buera, F. J., Kaboski, J. P., Shin, Y., 2011. Finance and development: A tale of two sectors. American economic review 101, 1964–2002.

Butler, A. W., Cornaggia, J., 2011. Does access to external finance improve productivity? Evidence from a natural experiment. Journal of Financial Economics 99, 184–203.

Butler, A. W., Fauver, L., Spyridopoulos, I., 2019. Local economic spillover effects of stock market listings. Journal of Financial and Quantitative Analysis 54, 1025–1050.

Chemmanur, T. J., He, J., Ren, X., Shu, T., 2022. The disappearing IPO puzzle: New insights from proprietary US Census data on private firms. Working Paper, Boston College.

Chemmanur, T. J., Krishnan, K., Nandy, D. K., 2011. How Does Venture Capital Financing Improve Efficiency in Private Firms? A Look Beneath the Surface. Review of Financial Studies 24, 4037–4090.

Chen, Q., Goldstein, I., Jiang, W., 2007a. Price informativeness and investment sensitivity to stock price. Review of Financial Studies 20, 619–650.

Chen, T., Harford, J., Lin, C., 2015. Do analysts matter for governance? Evidence from natural experiments. Journal of Financial Economics 115, 383–410.

Chen, X., Harford, J., Li, K., 2007b. Monitoring: Which institutions matter? Journal of Financial Economics 86, 279–305.

Chernenko, S., Lerner, J., Zeng, Y., 2021. Mutual funds as venture capitalists? Evidence from unicorns. Review of Financial Studies 34, 2362–2410.

Chhaochharia, V., Grinstein, Y., 2007. Corporate governance and firm value: The impact of the 2002 governance rules. Journal of Finance 62, 1789–1825.

Cohen, A., Wang, C. C., 2013. How do staggered boards affect shareholder value? Evidence from a natural experiment. Journal of Financial Economics 110, 627–641.

Cremers, K., Nair, V. B., 2005. Governance mechanisms and equity prices. Journal of Finance 60, 2859–2894.

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

David, J. M., Schmid, L., Zeke, D., 2022. Risk-adjusted capital allocation and misallocation. Journal of Financial Economics 145, 684–705.

De Loecker, J., Eeckhout, J., Unger, G., 2020. The rise of market power and the macroeconomic implications. The Quarterly Journal of Economics 135, 561–644.

Diamond, D. W., 1984. Financial intermediation and delegated monitoring. The Review of Economic Studies 51, 393–414.

Doidge, C., Kahle, K. M., Karolyi, G. A., Stulz, R. M., 2018. Eclipse of the public corporation or eclipse of the public markets? Journal of Applied Corporate Finance 30, 8–16.

Doidge, C., Karolyi, G. A., Stulz, R. M., 2017. The US listing gap. Journal of Financial Economics 123, 464–487.

Dow, J., Gorton, G., 1997. Stock market efficiency and economic efficiency: Is there a connection? Journal of Finance 52, 1087–1129.

Duarte, J., Hu, E., Young, L., 2020. A comparison of some structural models of private information arrival. Journal of Financial Economics 135, 795–815.

Durnev, A., Morck, R., Yeung, B., 2004. Value-enhancing capital budgeting and firm-specific stock return variation. Journal of Finance 59, 65–105.

Easley, D., Kiefer, N. M., O'hara, M., Paperman, J. B., 1996. Liquidity, information, and infrequently traded stocks. Journal of Finance 51, 1405–1436.

Eckbo, B. E., 2014. Corporate takeovers and economic efficiency. Annu. Rev. Financ. Econ. 6, 51–74.

Eckbo, B. E., Lithell, M., 2022. Merger-driven listing dynamics. Working Paper, Tuck School of Business at Dartmouth.

Economist, 2022. The spectacular fall of FTX and Sam Bankman-Fried. Available at https://www.economist.com/finance-and-economics/2022/11/09/the-spectacular-fall-of-ftx-and-sam-bankman-fried.

Edmans, A., 2014. Blockholders and corporate governance. Annual Review of Financial Economics 6, 23–50.

Eisfeldt, A. L., Shi, Y., 2018. Capital reallocation. Annual Review of Financial Economics 10, 361–386.

Ewens, M., Farre-Mensa, J., 2020. The deregulation of the private equity markets and the decline in IPOs. Review of Financial Studies 33, 5463–5509.

Ewens, M., Farre-Mensa, J., 2022. Private or public equity? The evolving entrepreneurial finance landscape. Annual Review of Financial Economics .

Ewens, M., Malenko, N., 2022. Board dynamics over the startup life cycle. Working Paper, NBER.

Fama, E. F., 1970. Efficient capital markets: A review of theory and empirical work. Journal of Finance 25, 383–417.

Fich, E. M., Shivdasani, A., 2012. Are busy boards effective monitors? In: *Corporate governance*, Springer, pp. 221–258.

Field, L. C., Karpoff, J. M., 2002. Takeover defenses of IPO firms. Journal of Finance 57, 1857–1889.

Fos, V., Li, K., Tsoutsoura, M., 2018. Do director elections matter? Review of Financial Studies 31, 1499–1531.

Frank, M. Z., Sanati, A., 2021. Financing corporate growth. Review of Financial Studies 34, 4926–4998.

Fresard, L., 2010. Financial strength and product market behavior: The real effects of corporate cash holdings. Journal of Finance 65, 1097–1122.

Gao, X., Ritter, J. R., Zhu, Z., 2013. Where have all the IPOs gone? Journal of Financial and Quantitative Analysis 48, 1663–1692.

Gilchrist, S., Sim, J. W., Zakrajšek, E., 2013. Misallocation and financial market frictions: Some direct evidence from the dispersion in borrowing costs. Review of Economic Dynamics 16, 159–176.

Gilje, E. P., Taillard, J. P., 2016. Do private firms invest differently than public firms? taking cues from the natural gas industry. Journal of Finance 71, 1733–1778.

Giroud, X., Mueller, H. M., 2010. Does corporate governance matter in competitive industries? Journal of Financial Economics 95, 312–331.

Giroud, X., Mueller, H. M., 2011. Corporate governance, product market competition, and equity prices. Journal of Finance 66, 563–600.

Goldstein, I., 2023. Information in financial markets and its real effects. Review of Finance 27, 1–32.

Goldstein, I., Yang, L., 2015. Information diversity and complementarities in trading and information acquisition. Journal of Finance 70, 1723–1765.

Goldstein, I., Yang, S., Zuo, L., 2022. The real effects of modern information technologies: Evidence from the EDGAR implementation. Working Paper, NBER.

Gomes, A., Phillips, G., 2012. Why do public firms issue private and public securities? Journal of Financial Intermediation 21, 619–658.

Gompers, P., Ishii, J., Metrick, A., 2003. Corporate governance and equity prices. Quarterly Journal of Economics pp. 107–155.

Gompers, P., Kaplan, S. N., Mukharlyamov, V., 2016. What do private equity firms say they do? Journal of Financial Economics 121, 449–476.

Gompers, P. A., Gornall, W., Kaplan, S. N., Strebulaev, I. A., 2020. How do venture capitalists make decisions? Journal of Financial Economics 135, 169–190.

Gopinath, G., Kalemli-Özcan, Ş., Karabarbounis, L., Villegas-Sanchez, C., 2017. Capital allocation and productivity in south europe. The Quarterly Journal of Economics 132, 1915–1967.

Hart, O. D., 1983. The market mechanism as an incentive scheme. The Bell Journal of Economics pp. 366–382.

Hellmann, T., Puri, M., 2002. Venture capital and the professionalization of start-up firms: Empirical evidence. Journal of Finance 57, 169–197.

Hertzel, M., Lemmon, M., Linck, J. S., Rees, L., 2002. Long-run performance following private placements of equity. Journal of Finance 57, 2595–2617.

Hong, H., Kacperczyk, M., 2010. Competition and bias. Quarterly Journal of Economics 125, 1683–1725.

Hsieh, C.-T., Klenow, P. J., 2009. Misallocation and manufacturing tfp in china and india. The Quarterly journal of economics 124, 1403–1448.

Huang, S., Mao, Y., Wang, C., Zhou, D., 2021. Public market players in the private world: Implications for the going-public process. Review of Financial Studies 34, 2411–2447.

Ivashina, V., Lerner, J., 2018. Looking for alternatives: Pension investments around the world, 2008 to 2017. In: *Harvard University and NBER. See at: https://www. bostonfed. org/-/media/Images/research-conference-2018/papers/lookingfor-alternatives-pension-investments-around-the-world-2008-to-2017. pdf* .

Jenson, M. C., Meckling, W. H., 1976. Theory of the firm: Managerial behavior, agency costs and ownership structure. Journal of Financial Economics 3, 305–360.

Kehrig, M., Vincent, N., 2017. Do firms mitigate or magnify capital misallocation? evidence from plant-level data. US Census Bureau Center for Economic Studies Paper No. CES-WP-17-14, CESifo Working Paper Series .

Kelly, B., Ljungqvist, A., 2012. Testing asymmetric-information asset pricing models. Review of Financial Studies 25, 1366–1413.

Kogan, L., Papanikolaou, D., Seru, A., Stoffman, N., 2017. Technological innovation, resource allocation, and growth. Quarterly Journal of Economics 132, 665–712.

Krishnan, K., Nandy, D. K., Puri, M., 2015. Does financing spur small business productivity? Evidence from a natural experiment. Review of Financial Studies 28, 1768–1809.

Kwon, S., Lowry, M., Qian, Y., 2020. Mutual fund investments in private firms. Journal of Financial Economics 136, 407–443.

Kyle, A. S., 1985. Continuous auctions and insider trading. Econometrica: Journal of the Econometric Society pp. 1315–1335.

Larrain, B., Phillips, G. M., Sertsios, G., Urzúa, F., 2023. The Effects of Going Public on Firm Profitability and Strategy. Working Paper, NBER.

Lattanzio, G., Megginson, W. L., Sanati, A., 2023. Dissecting the listing gap: Mergers, private equity, or regulation? Journal of Financial Markets p. 100836.

Lee, D. S., McCrary, J., Moreira, M. J., Porter, J., 2022. Valid t-ratio inference for IV. American Economic Review 112, 3260–3290.

Levine, R., 2005. Chapter 12 finance and growth: Theory and evidence. Handbook of economic growth 1, 865–934.

Levine, R., Zervos, S., 1998. Stock markets, banks, and economic growth. American Economic Review 88, 537–558.

Lim, J., Schwert, M., Weisbach, M. S., 2021. The economics of PIPEs. Journal of Financial Intermediation 45, 100832.

Ljungqvist, A., Persson, L., Tåg, J., 2018. The incredible shrinking stock market: On the political economy consequences of excessive delistings. Working Paper, ECGI.

Loughran, T., Ritter, J., 2004. Why has IPO underpricing changed over time? Financial Management pp. 5–37.

Lowry, M., 2022. The blurring lines between private and public ownership. Working Paper, Drexel University.

Maksimovic, V., Phillips, G., Yang, L., 2023. Do IPO firms become myopic? Review of Finance 27, 765–807.

Midrigan, V., Xu, D. Y., 2014. Finance and misallocation: Evidence from plant-level data. American economic review 104, 422–458.

Moll, B., 2014. Productivity losses from financial frictions: Can self-financing undo capital misallocation? American Economic Review 104, 3186–3221.

Mortal, S., Reisel, N., 2013. Capital allocation by public and private firms. Journal of Financial and Quantitative Analysis 48, 77–103.

Phillips, G. M., Sertsios, G., 2017. Financing and new product decisions of private and publicly traded firms. Review of Financial Studies 30, 1744–1789.

Restuccia, D., Rogerson, R., 2008. Policy distortions and aggregate productivity with heterogeneous establishments. Review of Economic dynamics 11, 707–720.

Restuccia, D., Rogerson, R., 2017. The causes and costs of misallocation. Journal of Economic Perspectives 31, 151–174.

Schlingemann, F. P., Stulz, R. M., 2022. Have exchange-listed firms become less important for the economy? Journal of Financial Economics 143, 927–958.

Shleifer, A., Vishny, R. W., 1997. A survey of corporate governance. Journal of Finance 52, 737–783.

Stock, J. H., Yogo, M., 2002. Testing for weak instruments in linear IV regression.

Stulz, R. M., 2020. Public versus private equity. Oxford Review of Economic Policy 36, 275–290.

Subrahmanyam, A., Titman, S., 1999. The going-public decision and the development of financial markets. Journal of Finance 54, 1045–1082.

Sun, Q., Xiaolan, M. Z., 2019. Financing intangible capital. Journal of Financial Economics 133, 564–588.

Tybout, J. R., 2003. Plant-and firm-level evidence on "new" trade theories. Handbook of International Trade pp. 388–415.

Ueda, K., Sharma, S., 2019. Listing advantages around the world. Working Paper, NBER.

U.S. SEC, 2020. Report to Congress on Regulation A / Regulation D Performance As Directed by the House Committee on Appropriations in H.R. Rept. No. 116-122 Available at https://www.sec.gov/files/report-congress-regulation-a-d.pdf.

Wall Street Journal, 2018. Theranos Inc.'s Partners in Blood. Available at https://www.wsj.com/articles/theranos-inc-s-partners-in-blood-1526662047.

Whited, T. M., Zhao, J., 2021. The misallocation of finance. Journal of Finance 76, 2359–2407.

Wurgler, J., 2000. Financial markets and the allocation of capital. Journal of Financial Economics 58, 187–214.

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 $W = 1$.

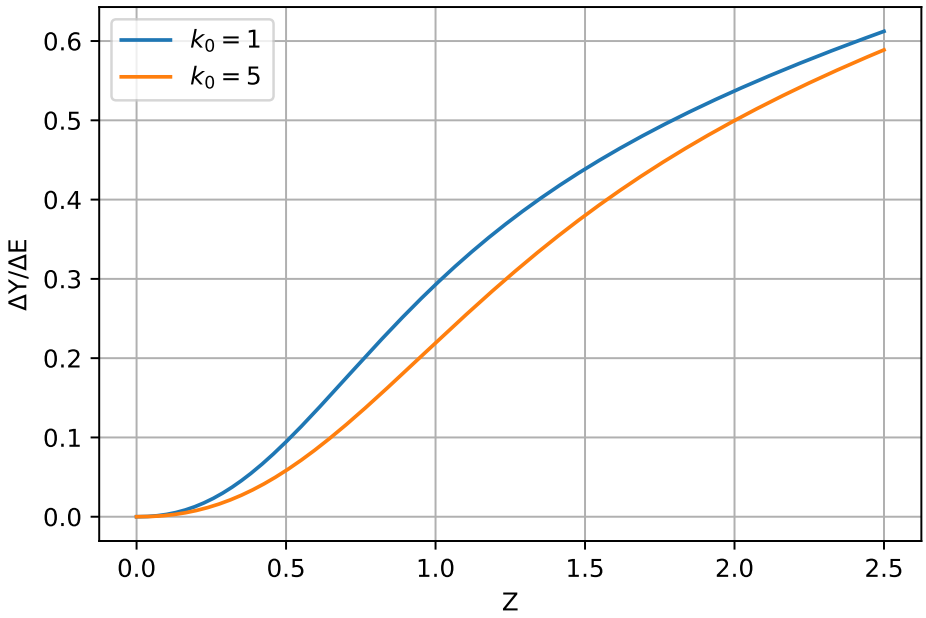
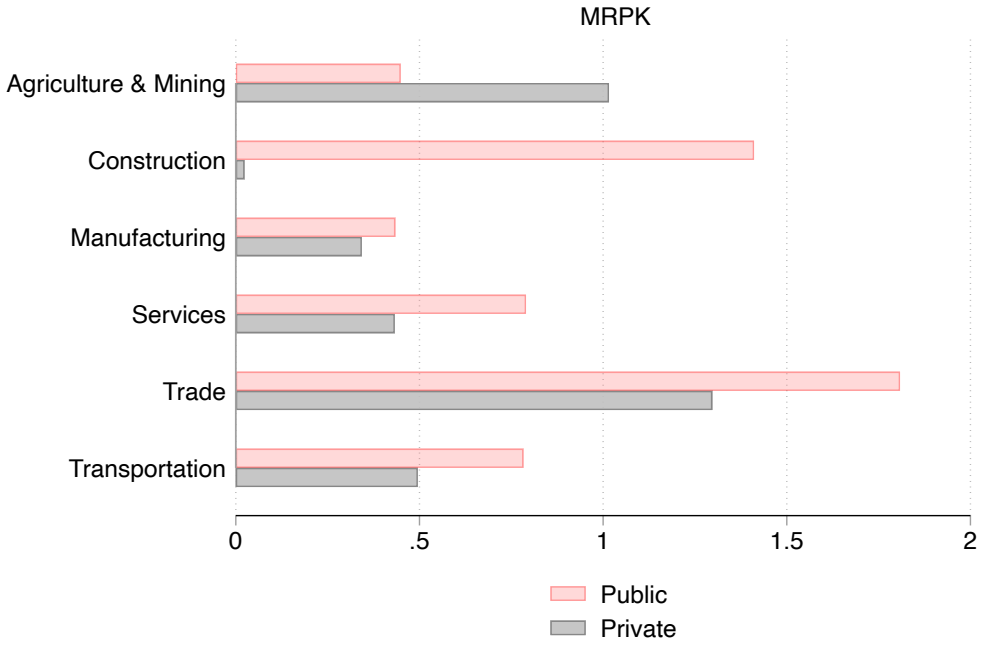


Figure 2: Capital allocation efficiency in public and private markets by sector

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

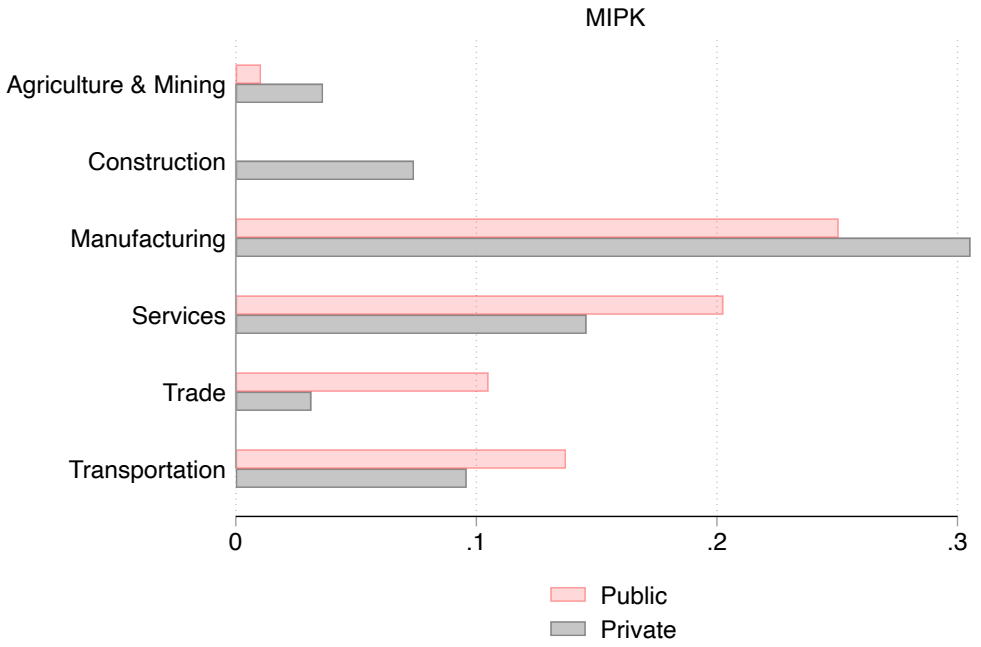
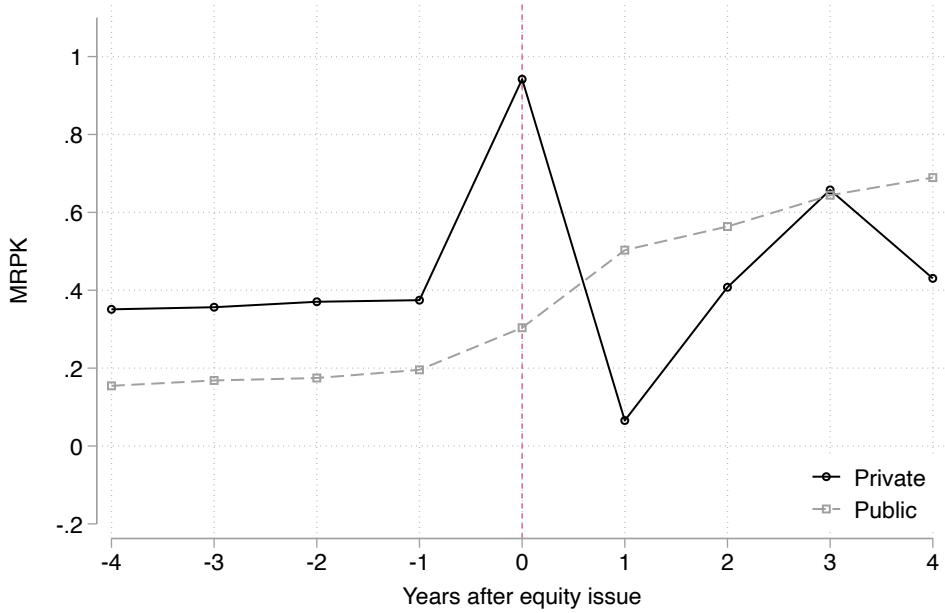


Figure 3: Pre- and post-issue trends in output growth of capital raising firms

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)

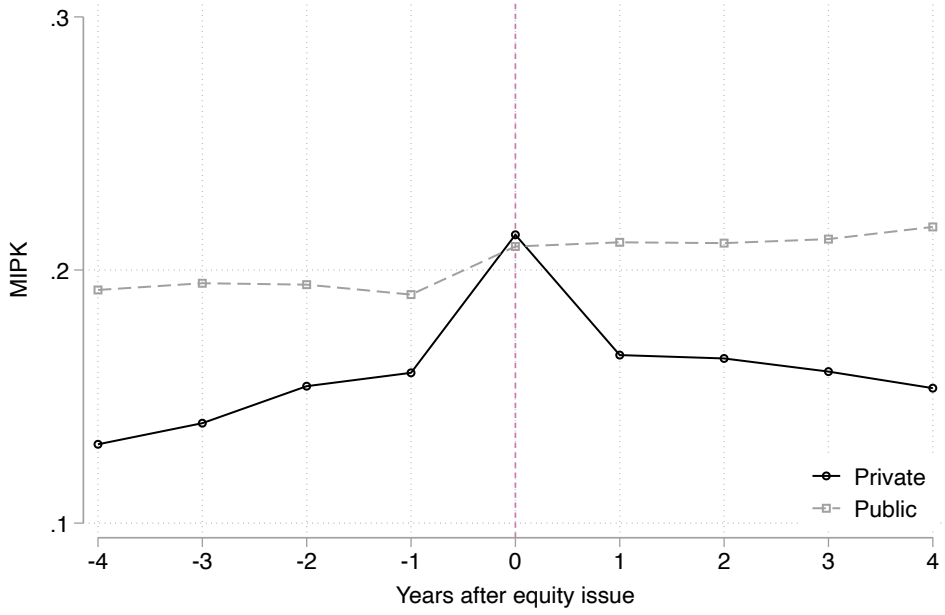
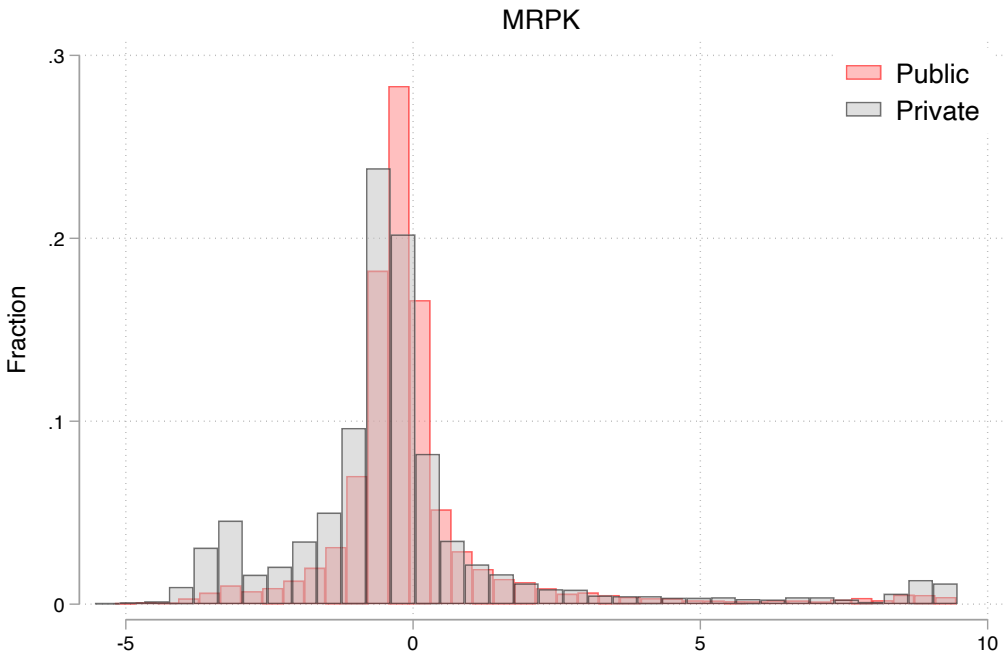


Figure 4: Distribution of MRPK and MIPK of equity issuers in public and private markets

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

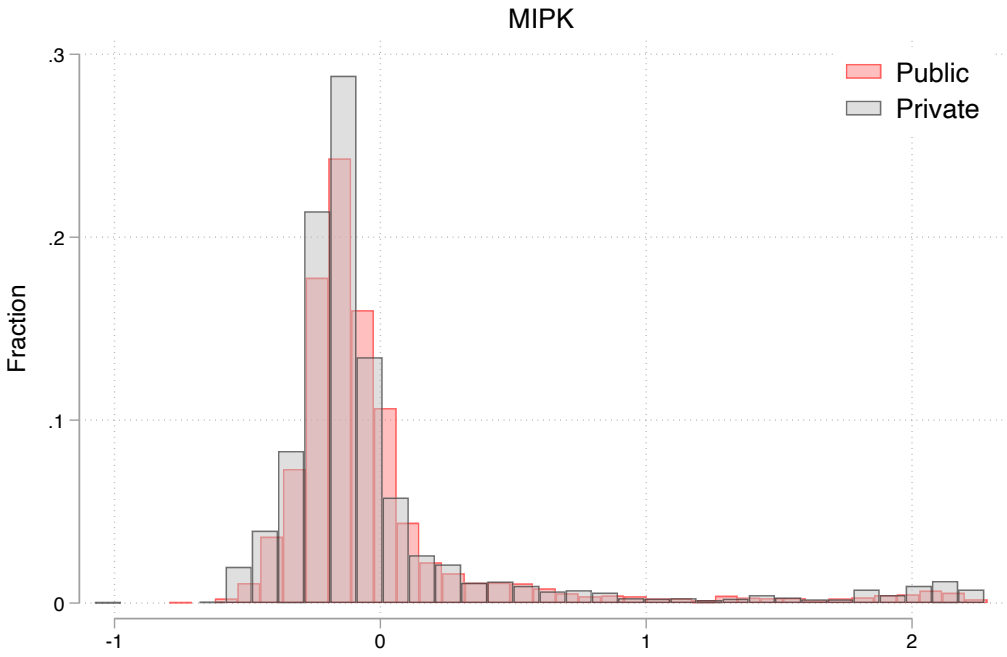
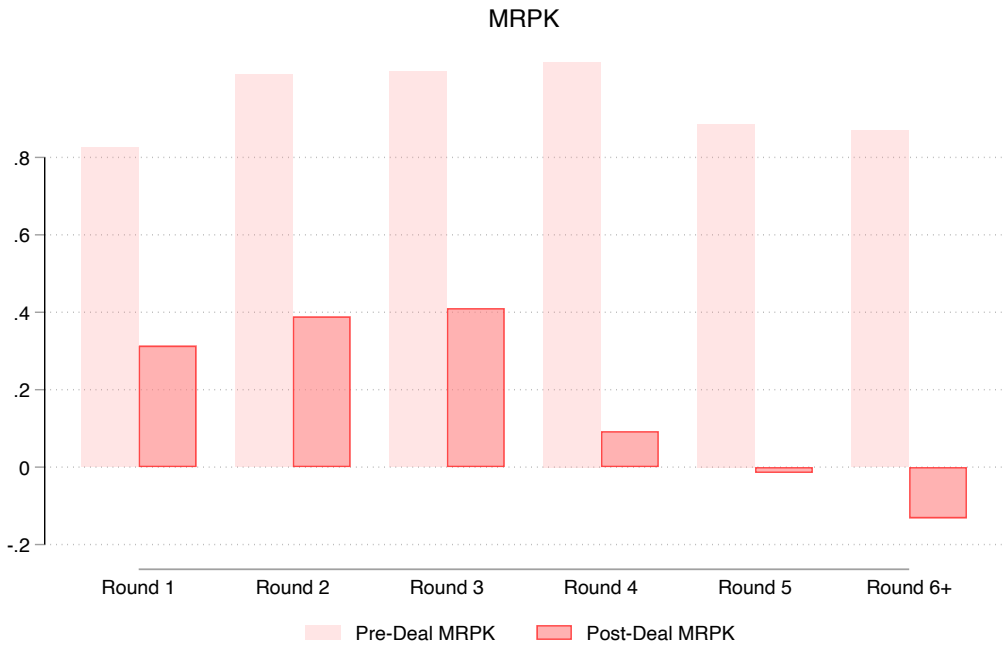


Figure 5: Capital allocation efficiency across VC funding rounds

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

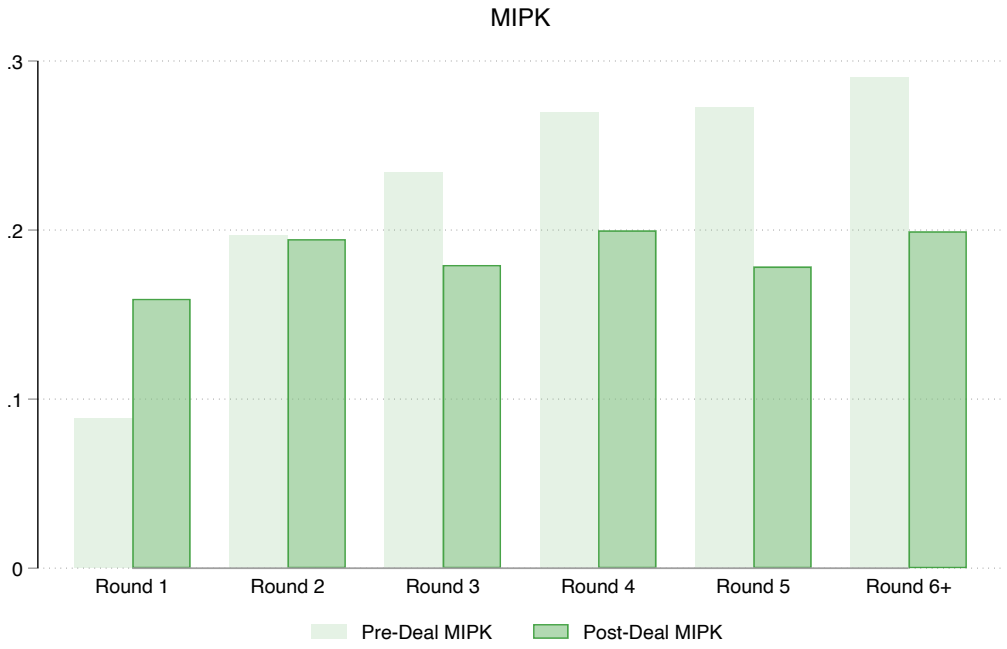
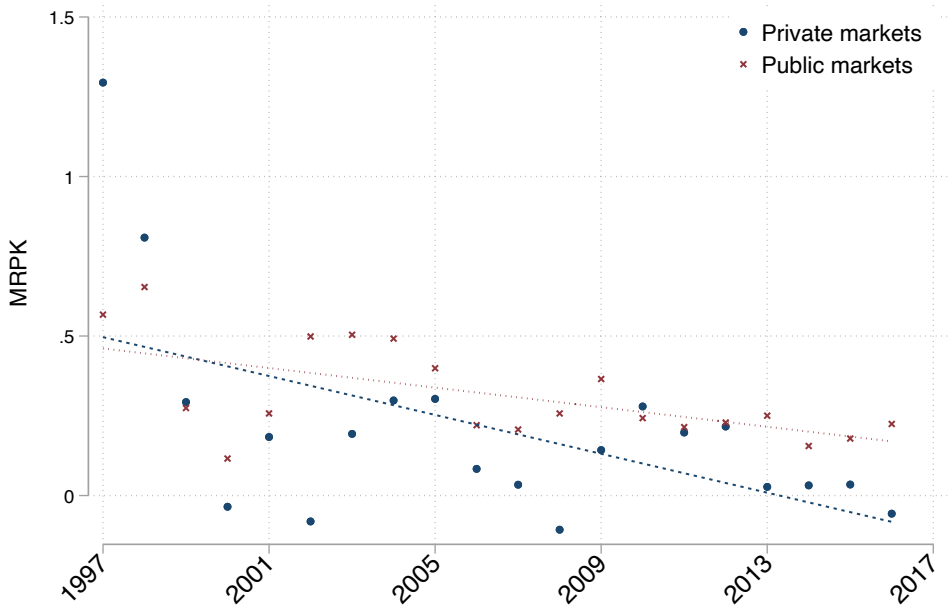


Figure 6: Portfolio-level measures of MRPK and MIPK

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

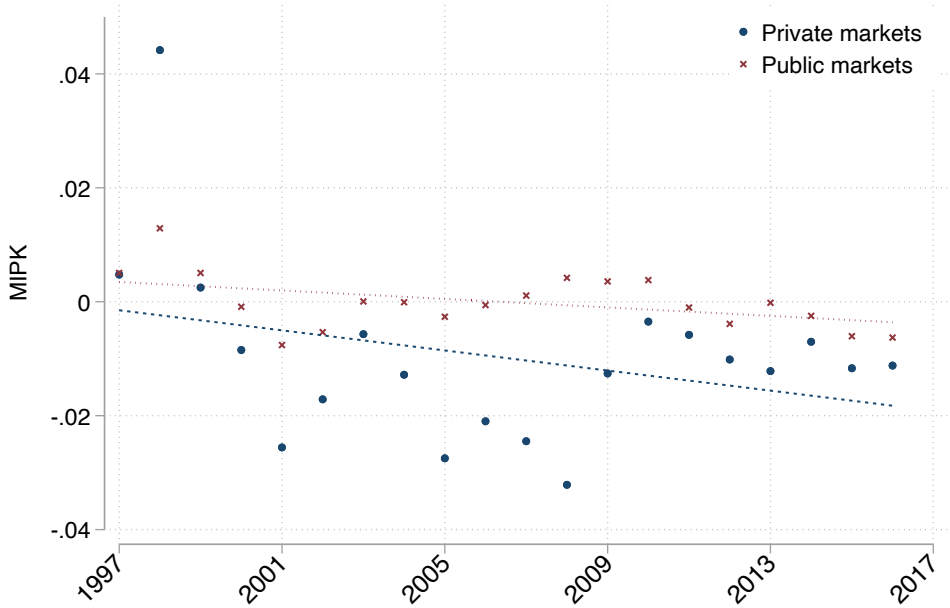


Figure 7: Distribution of sales growth for non-equity-issuing firms

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.

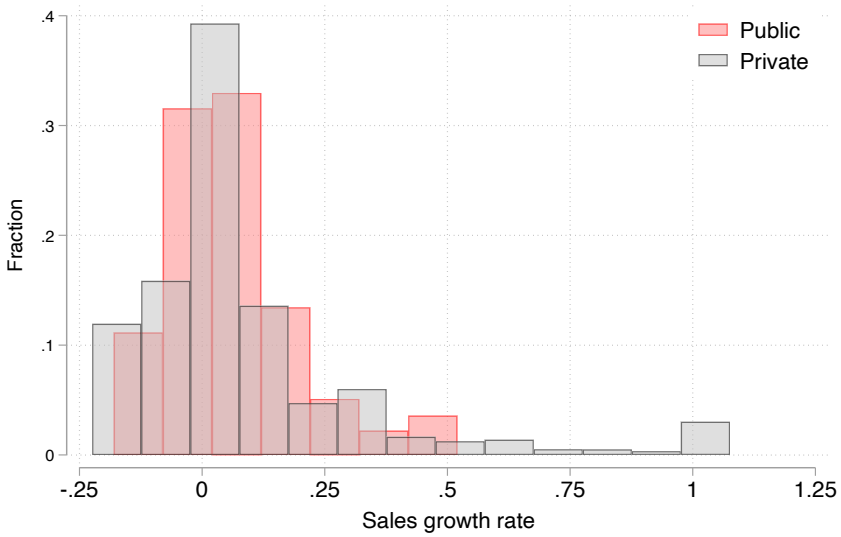


Table 1: Summary statistics

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	20,887	0.68	0.47	0.00	1.00	1.00
Private	20,887	0.32	0.47	0.00	0.00	1.00
Private (late-stage)	20,887	0.13	0.34	0.00	0.00	1.00
MRPK	20,887	0.54	2.13	-0.76	0.02	2.25
MIPK	11,397	0.21	0.50	0.00	0.00	0.64
Equity raised ($ mil.)	20,887	32.26	59.85	0.59	9.04	89.28
Sales ($ mil.)	20,887	65.89	169.19	0.00	6.15	162.00
Employment	19,011	326.51	826.52	4.00	50.00	700.00
Age	18,439	15.56	20.03	2.00	9.00	33.00
Industry Q	20,397	5.34	2.42	2.56	5.00	7.71
Patents	11,397	3.11	7.23	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	0.31	0.98	-0.68***	0.23	1.10	-0.86***
Post-issue MRPK	0.59	0.43	0.16***	0.47	0.14	0.33***
Pre-issue MIPK	0.20	0.21	-0.01	0.23	0.24	-0.01
Post-issue MIPK	0.23	0.20	0.03***	0.27	0.21	0.07***
Equity raised ($ mil.)	38.95	17.83	21.12***	24.52	16.25	8.27***
Sales ($ mil.)	80.68	34.00	46.67***	30.73	33.42	-2.69
Employment	415.98	132.79	283.19***	143.57	126.32	17.25*
Age	16.09	13.78	2.31***	14.07	11.45	2.62***
Industry Q	5.27	5.52	-0.25***	5.66	5.78	-0.12**
Investors #		3.26			3.43	
Rounds #		4.02			4.25	
Observations	14270	6617	20887	3626	3848	7474

(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	10,271	2.39	1.20	0.69	2.48	3.87
Forecast precision	9,965	-0.54	1.16	-1.05	-0.21	-0.05
Total inst. ownership	9,916	0.39	0.33	0.00	0.33	0.91
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
Tariff cut	16,608	0.03	0.16	0.00	0.00	0.00
Tariff increase	16,608	0.01	0.09	0.00	0.00	0.00

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

This table presents regressions of equity issuers' MRPK (columns 1-3) and MIPK (columns 4-6) 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. *Private (late-stage)* is an indicator variable that equals one if the firm raises equity in private markets for round four or greater. 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)	(5)	(6)
Public	0.375***	0.350***	0.141	0.028**	0.045***	0.015
	(0.063)	(0.070)	(0.090)	(0.014)	(0.018)	(0.020)
Private (late-stage)			-0.437***			-0.061***
			(0.100)			(0.019)
Pre-issue MRPK	-0.035**	0.014	0.016			
	(0.015)	(0.018)	(0.018)			
Pre-issue MIPK				0.434***	0.483***	0.486***
				(0.014)	(0.016)	(0.016)
Ln(Employment)		-0.006	-0.006		-0.008**	-0.007**
		(0.013)	(0.013)		(0.003)	(0.003)
Ln(Age)		0.019	0.015		-0.012*	-0.013*
		(0.022)	(0.022)		(0.007)	(0.007)
Industry Q		0.016	0.016		0.002	0.002
		(0.010)	(0.010)		(0.003)	(0.003)
SIC-3, year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	16643	13594	13594	9035	6787	6787
Adjusted R^2	0.052	0.052	0.054	0.357	0.417	0.418

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 around 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	0.623***	0.229***	0.339***	0.437***	0.083***	0.046**	0.040**	0.069**
	(0.085)	(0.079)	(0.071)	(0.097)	(0.021)	(0.023)	(0.018)	(0.027)
Pre-issue MRPK	0.068***	-0.078***	-0.011	-0.059**				
	(0.018)	(0.025)	(0.020)	(0.025)				
Pre-issue MIPK					0.499***	0.448***	0.472***	0.449***
					(0.016)	(0.022)	(0.019)	(0.025)
Ln(Employment)	-0.002	-0.061**	-0.009	-0.071**	-0.009**	-0.011**	-0.007**	-0.007
	(0.013)	(0.024)	(0.015)	(0.028)	(0.004)	(0.006)	(0.004)	(0.006)
Ln(Age)	0.022	0.088**	0.008	0.062	-0.002	-0.033***	-0.010	-0.014
	(0.022)	(0.041)	(0.027)	(0.043)	(0.007)	(0.010)	(0.007)	(0.012)
Industry Q	0.012	0.038	0.008	0.037	0.000	-0.019*	0.007**	-0.003
	(0.011)	(0.026)	(0.012)	(0.032)	(0.004)	(0.011)	(0.003)	(0.011)
Late-stage deals	✓			✓	✓			✓
Matched sample		✓		✓		✓		✓
No-debt-issues			✓	✓			✓	✓
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	12371	4933	9753	3066	5675	3121	5254	1857
Adjusted R^2	0.064	0.031	0.051	0.039	0.459	0.369	0.400	0.406

Table 4: Comparing allocation efficiency: Withdrawn IPOs and pre/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 by industry and year in columns (1)–(4) and by firm in columns (5)–(8), 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	0.960***	0.972***	0.181***	0.194**	0.037	0.447**	0.002	0.037
	(0.263)	(0.376)	(0.054)	(0.075)	(0.130)	(0.181)	(0.021)	(0.031)
Pre-issue MRPK	0.158***	0.162***			-0.125***	-0.055*		
	(0.020)	(0.020)			(0.028)	(0.032)		
Pre-issue MIPK			0.566***	0.585***			0.363***	0.397***
			(0.019)	(0.020)			(0.023)	(0.026)
Ln(Employment)		0.019		-0.007*		-0.323***		-0.032***
		(0.012)		(0.004)		(0.045)		(0.009)
Ln(Age)		0.001		0.005		0.275***		-0.004
		(0.022)		(0.008)		(0.075)		(0.018)
Industry Q		0.020*		-0.001		0.025		0.004
		(0.012)		(0.004)		(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	12324	11221	4809	4522	13031	10773	6645	5232
Adjusted R^2	0.091	0.094	0.487	0.512	0.135	0.158	0.447	0.483

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	0.199**	0.148	-0.043	0.003	0.379***	0.338***	0.075***	0.073***
	(0.083)	(0.103)	(0.034)	(0.034)	(0.076)	(0.085)	(0.019)	(0.022)
Pre-issue MRPK	-0.273***	-0.247***			-0.036**	0.010		
	(0.017)	(0.029)			(0.015)	(0.018)		
Pre-issue MIPK			0.361***	0.401***			0.424***	0.471***
			(0.021)	(0.026)			(0.014)	(0.016)
Large deal					-0.180**	-0.212**	-0.052***	-0.061***
					(0.072)	(0.090)	(0.013)	(0.018)
Public × Large deal					0.045	0.058	-0.068***	-0.050**
					(0.076)	(0.093)	(0.018)	(0.022)
Ln(Employment)		-0.146***		-0.011**		0.019		0.007*
		(0.033)		(0.005)		(0.016)		(0.004)
Ln(Age)		0.062		-0.033***		0.011		-0.019***
		(0.054)		(0.011)		(0.023)		(0.007)
Industry Q		0.008		0.006		0.016		0.003
		(0.019)		(0.005)		(0.010)		(0.003)
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	5392	3382	4832	2836	16643	13594	9035	6787
Adjusted R^2	0.169	0.164	0.256	0.305	0.053	0.053	0.366	0.425

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 (revenue$_t$ − revenue$_{t-1}$)/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 7. 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	0.850***	0.804***	0.688***	0.047***	0.044***	0.049***
	(0.066)	(0.075)	(0.067)	(0.009)	(0.011)	(0.013)
Post issue	-0.564***	-0.577***	-0.509***	-0.017*	-0.021*	-0.028**
	(0.059)	(0.077)	(0.064)	(0.009)	(0.011)	(0.011)
Public	-0.677***	-0.547***		-0.011	-0.059***	
	(0.057)	(0.057)		(0.027)	(0.022)	
Ln(Employment)		0.098***	-0.087***		0.001	-0.028***
		(0.011)	(0.020)		(0.008)	(0.010)
Ln(Age)		-0.082***	0.067*		-0.024***	0.013
		(0.022)	(0.034)		(0.006)	(0.020)
Industry Q		0.007	0.015*		0.004	0.004
		(0.007)	(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	37359	29163	28406	20364	14561	14155
Adjusted R^2	0.012	0.051	0.192	0.001	0.042	0.437

Table 8: Information efficiency and capital allocation efficiency

This table presents two sets of results on the impact of information efficiency on capital allocation efficiency. The analysis is limited to publicly listed firms over the period 1997-2019. Columns 1-4 present cross-sectional regressions of equity issuers' MRPK on firm-level measures of stock price informativeness. In columns 1-4, respectively, the measure of stock price informativeness is the probability of informed trading (*PIN*), the generalized probability of informed trading (*GPIN*), the number of analysts following the firm's stock, and analysts' forecast precision. Columns 5-6 present difference-in-differences estimates of the MRPK using brokerage firm exits as an exogenous shock to the information environment of equity issuing firms. *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. All regressions control for firm size (log of employment and log of total assets), age, Tobin's q, profitability (ROA), and book leverage. Columns 1-5 include industry (SIC-3) and year fixed effects. Column 6 include firm 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 ***.

	MRPK					
	Cross-sectional tests				Brokerage closures	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated × Post Exit					-0.262***	-0.208*
					(0.094)	(0.120)
Treated					0.269***	
					(0.078)	
PIN	0.044**					
	(0.018)					
GPIN		0.019***				
		(0.007)				
Analyst count			0.055**			
			(0.025)			
Forecast precision				0.049**		
				(0.022)		
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
SIC-3, year FEs	Yes	Yes	Yes	Yes	Yes	No
Firm, year FEs	No	No	No	No	No	Yes
Observations	287	287	9070	8798	19247	1794
Adjusted R^2	0.371	0.370	0.231	0.235	0.123	0.346

Table 9: Corporate governance and capital allocation efficiency

This table presents two sets of results on the impact of corporate governance on capital allocation efficiency. Columns 1-4 present cross-sectional regressions of equity issuers' MRPK on firm-level measures of governance quality. This 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 presents difference-in-differences estimates of the MRPK 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. Columns 1-4 control for firm size, age, Tobin's q, profitability (ROA), and book leverage, as well as industry (SIC-3) and year fixed effects. Column 5 controls for firm size, age, and industry q, as well as industry (SIC-2) 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 ***.

	MRPK				
	Cross-sectional tests				Tariff shocks
	(1)	(2)	(3)	(4)	(5)
High inst. ownership	0.153***				
	(0.054)				
Busy directors		-0.515**			
		(0.214)			
High G-index			-0.424*		
			(0.220)		
Staggered board				0.013	
				(0.187)	
Private × Tariff cut					0.773*
					(0.432)
Private × Tariff increase					-1.161**
					(0.494)
Public × Tariff cut					0.012
					(0.141)
Public × Tariff increase					0.313
					(0.286)
Firm Controls	Yes	Yes	Yes	Yes	Yes
SIC-3, year FEs	Yes	Yes	Yes	Yes	No
SIC-2, year FEs	No	No	No	No	Yes
Observations	9102	518	320	422	13812
Adjusted R^2	0.181	0.319	0.281	0.298	0.028

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 $= \frac{\sum_{\forall i \in M} \text{Sales}_{it+3} - \sum_{\forall i \in M} \text{Sales}_{it}}{\sum_{\forall i \in M} \text{Equity}_{it}}$, 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 $\frac{\sum_{\forall i \in M} \text{Patents}_{it+3} - \sum_{\forall i \in M} \text{Patents}_{it}}{\sum_{\forall i \in M} \text{Equity}_{it}}$, 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 it 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 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(# of analysts following the stock of a firm)
Forecast precision	$-1\times$ 3-year moving average of EPS forecast error, where forecast error$= \frac{\lvert\text{actual EPS} - \text{forecast EPS}\rvert}{\text{actual EPS}}$
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
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

Sample construction process

Filter	Dropped	Count
Initial sample		44,402
Missing 1-year MRPK	694	43,708
Missing industry	788	42,920
Private deals with zero/stagnant sales	6,505	36,415
Public deals involving acquisitions	6,940	29,475
Missing 3-year MRPK	8,588	20,887
Final sample		20,887
Private market deals		6,617
Public market deals		14,270