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Do Venture Capital Investors Learn from Public Markets?

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Abstract. We examine whether venture capital (VC) investors learn information contained in public market stock prices. VCs are less likely to stage finance startups and syndicate with other VCs when stock prices are more informative. An instrumental variable approach suggests that the relation is likely causal. The startup's initial public offering (IPO) prospect is the plausible information contained in stock prices learned by VCs. The effect of VC learning on staging and syndication is more pronounced when collecting information is more costly and the information learned is more reliable. Evidence from a survey of VC investors confirms that they actively learn information from the public market. VCs' learning from the public market significantly affects their investments across startup firms. Our paper sheds new light on the real effects of financial markets and suggests that the informational role of security prices is much broader than what we have thought.

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Keywords: learning • venture capital • staging • syndication • price informativeness

1. Introduction

Do venture capital (VC) investors learn valuable information contained in public market stock prices when making investment decisions? This is an important research question for at least two reasons. First, capital formation starts with the private market, which drives rapid developments in U.S. entrepreneurship, technological innovation, and economic growth in the past decades. Private capital formation also creates positive spillovers across industries (Aldatmaz and Brown 2020). However, studies on capital formation in the private market (e.g., the VC market) are limited, although numerous studies have explored how a variety of VC investors' characteristics, such as industry expertise, reputation, past experience, and network connections, affect their investment in startup firms and even all the performance of these firms in the public market.

Second, there has been an intensive debate on whether the stock market is just a side show or has real effects on economic activities. Starting from the pioneering work by Hayek (1945), which posits that prices are a useful source of information, theories (Grossman and Stiglitz 1980, Goldstein and Guembel 2008) argue that, although individual market participants may be less informed than managers, financial markets as a whole have the ability to aggregate different pieces of information possessed by various market players and incorporate them into security prices. Although earlier studies, such as Morck et al. (1990), support the hypothesis that the stock market is just a side show, more recent work finds that managers of public firms learn from the public market and use the information contained in the stock price when they decide on firm policies (Luo 2005; Chen et al. 2007; Edmans et al. 2012; Foucault and Frésard 2012, 2014; Frésard 2011; Dessaint et al. 2019).[1] This literature, however, has mainly focused on learning by corporate managers of public firms and is largely silent on learning by private market players, for example, VC investors.[2]

In this paper, we attempt to fill in the gaps in the existing literature and explore whether VCs learn information from the public market when they decide on investment in startup firms. It is possible that VCs turn to the public market to collect valuable information as private markets are subject to worse informational environment than public markets. For example, VC investors could respond to favorable public market signals (provided by higher Tobin's Q) by increasing investment (Gompers et al. 2008). Capital market cycles have a modest effect on VC investors' decisions on investment but a larger effect on the timing decision of exits according to a survey by Gompers et al. (2020). Another survey by Gompers et al. (2016) shows that private equity investors are very likely to use comparable public companies as benchmarks when estimating exit value, and capital market conditions are the largest concern when they determine the timing of exits.

Compared with the public market, VC provides an ideal research setting that offers several unique but important advantages. First, the VC setting allows us to directly observe the investment projects in question: the startup firms and their characteristics. This is an advantage that studies relying on public firms lack because researchers cannot directly observe the characteristics of investment projects undertaken by public firm managers. In addition, focusing on the VC market allows us to explore unique features of VC investment that are absent in the public market, that is, staging and syndication, which provides a variety of dimensions that allow us to better understand how the information learned from the public market prices affects VC investors' investment structure decisions in startup firms.

Second, to a larger extent, the VC setting allows us to disentangle active managerial learning from passive reflections of startup-specific information into stock prices, a major empirical challenge faced by studies focusing on managers of public firms. Because the information set possessed by managers of public firms is not directly observable to econometricians, even if one observes a firm's security price informativeness is positively related to its subsequent investment activities, it is difficult to disentangle whether it is managerial learning from stock prices or stock prices passively reflecting what managers have already known about their investment opportunities. Our focus on VC investors alleviates this concern to a larger degree because startup firms funded by VC investors are private companies whose shares are not publicly traded and, by definition, do not have a stock price. Hence, we conjecture that VC investors learn information from stock prices of public firms in the same industry of the startups because it is unlikely that startup-specific information known by VC investors is reflected into the stock prices of these public firms. Though we cannot completely rule out the possibility that some common macro or industry information is reflected in the stock prices, the concern that those prices being a passive reflection of startup-specific information is mitigated to a larger extent in the VC setting.

Third, the VC setting also allows us to better separate active managerial learning from a financing cash flow story, as startup firms (as opposed to public firms) cannot easily raise additional funds and increase investment simply in response of high stock prices of comparable public firms because of the lack of the access to the public market. In addition, this concern is also mitigated to some extent because we can observe the characteristics of VC investment and focus on the structure (rather than the amount) of VC investment, which is less directly linked to the financing channel.

We argue that VC investors actively gather information from the public market, and the information they collect is likely their startup firms' initial public offering (IPO) prospects. Chemmanur and Fulghieri (1999) develop a model on a startup's going public decision. In the model, when a startup decides whether to go public, it faces a tradeoff between enjoying a stronger bargaining power against many small investors from the public market (as opposed to a single private market investor) and bearing a higher cost of information production. This is because many investors produce duplicated information, and the information production cost is even all born by the startup. Hence, the model suggests that when outsiders' cost of producing information about the startup in an industry is lower, the startup is more likely to go public.[3] To the extent that the more informative of the stock prices of public firms in an industry, the lower is the outsiders' cost of collecting information about the startup, the model of Chemmanur and Fulghieri (1999) implies that the entrepreneur's incentive to take the startup public is stronger, and the startup's IPO probability is higher. In addition, recent survey evidence by Gompers et al. (2020) shows that VC investors watch the capital market to determine their exit strategies. Based on the previous discussion, we argue that the information contained in the public markets matters for VC investors and postulate that if VC investors are able to learn the information from informative stock prices that their portfolio firms' IPO probabilities are higher, they adjust their investment structures accordingly. In particular, we attempt to link VC investment structures to stock price informativeness of public firms in the same industry of the VC investors' portfolio firms.

Specifically, the structure of VC investment in startup firms we focus on includes VC stage financing and syndication. VC staging is the stepwise infusion of capital from VC investors to startup firms. It is an effective tool used by VCs to mitigate information asymmetry and uncertainty associated with startup firms because it keeps an option of abandoning underperforming startups (Sahlman 1990, Gompers 1995). As argued in Tian (2011), however, stage financing is not a free lunch but costly. Potential costs associated with VC staging include negotiation and contracting costs in each round of financing, forgone economics of scale because of divided capital infusions, induced short-termism behavior on the part of entrepreneur, and underinvestment in early-stage startups. When public market prices are more informative, VC investors are more certain and optimistic about their startup firms' IPO prospects. As a result, they would stage finance less to reduce the cost of staging. We construct two measures to capture VC staging: the total number of financing rounds a startup firm receives from its VC investors and investment skewness (i.e., the percentage of investment amount a startup receives in the first round). If our learning hypothesis is supported, we expect to observe that VC investors tend to invest fewer financing rounds and invest more in the first round if the stock prices of public firms in the same industry are more informative.

Another investment feature we explore is VC syndication, which is an enduring and striking feature of the VC industry (Lerner 1994, Tian 2012, Bayar et al. 2020).[4] Besides risk sharing, a main and important motivation for VC investors to form syndicates to co-invest in a startup is to seek a second opinion from other VCs because of the high opaqueness nature of startup firms. However, syndication is costly as well, especially for lead VCs who are responsible for organizing the syndicate. First, co-investing in a startup means that the VC investor who first identifies the deal must share the returns with other VCs and cannot exclusively enjoy the reward if it turns out that the startup is a great success. Second, different types of VC investors (e.g., independent VCs, corporate VCs, bank-affiliated VCs, and government-sponsored VCs) could have different investment objectives and preferences, which might create conflicts among VCs within a syndicate and reduce the benefits of co-investing. Third, it could be time-consuming and difficult for VC investors to deal with problematic startup firms if there are multiple co-investing VCs, which increases communication costs and reduces investment efficiency. Hence, to reduce the costs associated with syndication, we expect that, if the stock prices of public firms in the same industry of their startup firms are more informative and the startup firms are more likely to go publ

million) more in he firs ro nd and decrease heir probabili of forming a s ndica e o finance a s ar p b 5.8%. The size of he s ndica e drops b 0.3 VCs, hich is 5.5% of he mean s ndica e size. These findings s gges ha here likel e is s a ca sal link beeen p blic marke price informa iveness and VC inves men s r c re.[9]

4.2.2. Instrument Based on Airport Shutdowns. To ens re he res l s e doc men ed previo sl are rob s , besides *NMFHS*, e cons r c a second ins r men

Table 4. Endogeneity Tests with an Alternative IV

	First stage	Second stage			
	(1) *Info*	(2) *N_round*	(3) *Skewness*	(4) *Prob. Syn*	(5) *N_VC*
Shutdown	−0.060***				
	(0.010)				
Info		−2.536*	42.249**	−0.369***	−1.131***
		(1.517)	(15.810)	(0.105)	(0.419)
Ind_Q	−0.003***	−0.016***	0.241	−0.002**	−0.020***
	(0.001)	(0.006)	(0.150)	(0.001)	(0.007)
Ind_ret	−0.111***	−0.210	2.542	−0.024	−0.093
	(0.019)	(0.199)	(2.226)	(0.023)	(0.167)
Ind_RD	1.658***	2.683	−68.310*	0.677***	3.732***
	(0.110)	(2.520)	(37.102)	(0.184)	(0.576)
Ind_tangi	1.334***	2.044	−46.332	0.441***	−1.028*
	(0.284)	(2.300)	(34.586)	(0.125)	(0.523)
Ln_age	−0.006*	−0.318***	8.898***	−0.054***	−0.530***
	(0.003)	(0.038)	(0.633)	(0.005)	(0.053)
Ln_amt1st	−0.002	−0.267***		0.017***	0.050**
	(0.003)	(0.034)		(0.003)	(0.022)
Lead VC fixed effects	Yes	Yes	Yes	No	Yes
Year-quarter fixed effects	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
State fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	10,326	10,326	7,876	10,326	10,326

Notes. This table reports the 2SLS instrumental variable regression results on the effect of stock price informativeness in the public market on VC staging and syndication. The instrumental variable is the natural logarithm of average number of days when analysts having difficulties in paying on-site visits to public firms in the same industry of a startup due to severe flight cancellations (defined as more than 20% of inbound and outbound flights are cancelled) caused by weather or operational conditions either in the airports closest to the firm's headquarters or closest to the analysts' offices. Other variables are defined as in Table 2. See Appendix A for definitions of variables. Marginal effects are reported for the *Syn* regressions. Standard errors reported in parentheses are adjusted for heteroscedasticity.
***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

at the 1% level in the first stage, suggesting that airport shutdowns significantly reduce price informativeness. The t statistic is 6.2, and the F statistic is 38.3, which is much larger than the critical values from the Stock and Yogo (2005) weak instrument test. This suggests that our analyses do not have weak instrument problem. In the second-stage regressions reported in columns (2)–(5), we observe significant coefficient estimates on the instrumented *Info* with signs consistent with those reported in Table 2.[11] Hence, using this alternative instrument, we continue to find a negative and causal link between stock price informativeness and VC staging and syndication.

4.3. Heterogeneity Tests

To further strengthen the causal link between VC learning and their investment structures, we perform a few tests that explore the heterogeneous effects of public market price informativeness on VC staging and syndication in the 2SLS framework, using *NMFHS* as the instrument.

4.3.1. Geographical Distance.

Tian (2011) finds that VC investors located farther away from the startup firms tend to rely more heavily on staging because close proximity makes it less costly for them to visit the startups to directly collect information and monitor them. Similarly, if a VC investor is located far away from its startup firms, it would be more costly for the VC to physically visit the distant startups to collect information than learning information from the public market. Hence, the VC should rely more on the information she learns from the public market. Based on this rationale, we expect that the effect of public market price informativeness on VC staging and syndication is less pronounced if the VC is located close to the startup.

To test this conjecture, we estimate the following model:

$$Y_i^{(j,t)} = a + bInfo^{(j,t-1)} * Shortdist_i + cInfo^{(j,t-1)} + dShortdist_i + eControls_i + \varepsilon_i \quad (4)$$

where *Shortdist* is a dummy that equals one if the startup and its leading VC are in the same state and zero otherwise. The key variable of interest is the interaction term between *Info* and *Shortdist*.

We use *NMFHS* and *NMFHS**Shortdist* as the instruments to undertake 2SLS regressions. Table 5 reports the second-stage regression results. The coefficient estimates on the instrumented *Info* exhibit signs that are consistent with those observed in Table 3. The coefficient estimates on the key variable of interest, the instrumented *Info**Shortdist*, are statistically significant and exhibit signs opposite to those on the instrumented *Info* in the *N_round*, *Skewness*, and *N_VC* regressions. For example, in column (1), the positive and significant coefficient estimate on the instrumented *Info*Shortdist* suggests that VC investors located closer to their startups rely less on the information they learn from public market stock prices when making staging decisions. Overall, we find consistent evidence that the effect of VC learning from the public market on staging and syndication is less pronounced if they are located closer to their startups and hence have a lower cost of collecting information by visiting their portfolio firms.

4.3.2. Firm Comparability. Our learning hypothesis suggests that VC investors learn actively from public market stock prices to reduce costly staging and syndication. However, if the collected information is less reliable, VC investors would stick to the powerful, although expensive, staging and syndication tools. Specifically, in an industry with low comparability among firms, VC investors should find that information they learn from stock prices of public firms is less useful and reliable compared with that from industries in which private and public firms are similar in nature. Hence, we expect that the effect of public market price informativeness on VC staging and syndication is less pronounced in industries consisting of more heterogeneous firms.

We use the industry R&D expense ratio as a proxy for the comparability of firms within an industry. R&D intensive industries are characterized by more investment in innovation, technologies, and intangible assets, making it harder to compare one firm with another. We define an intensive R&D dummy, *HRD*, which equals one if the R&D spending in a startup's industry is in the top half among all industries, and zero otherwise. We then estimate Equation ([4]) with the key variable of interest replaced with the interaction term between *Info* and *HRD* to test the effect of industry comparability on VC learning. The *insert anRestart TD7.Tc(an).TJ/F1Tf.(o)TD-.Tc*

Table 7. Round-Level Evidence

	Baseline regressions		IV regressions: Second stage	
	(1) *R_amount*	(2) *Duration*	(3) *R_amount*	(4) *Duration*
Info	−0.0003	3.080***		
	(0.028)	(0.400)		
Info			0.652***	47.028***
			(0.206)	(3.308)
Ind_Q	0.003	−0.073***	0.000	−0.258***
	(0.003)	(0.021)	(0.003)	(0.041)
Ind_ret	−0.003	−0.936***	−0.155***	−9.575***
	(0.032)	(0.324)	(0.056)	(0.925)
Ind_RD	0.599**	−9.388***	−0.103	−50.312***
	(0.265)	(3.267)	(0.332)	(6.969)
Ind_tangi	−0.133	62.270***	−0.578	35.914***
	(0.389)	(5.655)	(0.419)	(8.716)
Ln_age	−0.291***	−29.542***	−0.274***	−26.669***
	(0.033)	(0.778)	(0.035)	(0.958)
Lag_ramt	0.003		0.003	
	(0.009)		(0.009)	
Lag_duration		−0.189***		−0.167***
		(0.017)		(0.018)
Year-quarter fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Observations	28,754	24,971	28,699	24,921

Notes. This table reports the 2SLS regression results on the effects of stock price informativeness in the public market on VC round amounts and durations. The sample consists of 31,219 VC follow-on investment rounds between 1980 and 2012. The independent variables are the natural logarithm of the dollar amount of a round in thousands, and the duration in months from a funding date to the next funding date. The *NMFHS* instrument is used in IV regressions. See Appendix A for definitions of variables. Standard errors reported in parentheses are adjusted for heteroscedasticity and clustering at the startup level.

***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

We postulate that a plausible piece of valuable information contained in public market stock prices that VC investors actively learn is the IPO prospects of their startup firms. According to the model of Chemmanur and Fulghieri (1999) on a startup's going-public decision, when a startup decides to go public, it faces a tradeoff between enjoying a stronger bargaining power against many small investors from the public market (as opposed to a single private market investor) and bearing a higher cost of information production (because many investors produce duplicated information and the information production cost is eventually born by the startup). Hence, when stock prices are more informative in the public market and outsiders' cost of producing information about the startup in an industry is lower, the startup is more likely to go public.

Specifically, in our empirical setting, *Info* measures the volume of information outsiders can obtain from the public market, and hence captures a startup's IPO prospect. To examine the IPO prospect channel, we undertake two tests that explore how IPO-related variation alters our main results.

We first test the IPO prospect channel by comparing the effect of stock price informativeness of recently going-public firms on VC staging and syndication to that of firms going public earlier. Because the prices of recently going-public firms in the same industry contain more relevant information on the going-public prospect, we expect that VC investors respond more to the informativeness of these firms' stock prices when determining staging and syndication.

Specifically, we re-estimate our main specification in Equation (3) with the 2SLS framework using *NMFHS* as the instrument in two subsamples. In the *Recent* subsample, *Info* is estimated with stock returns of firms in the same industry of the startup with a listing history ranking in the bottom quartile (i.e., the most recent listings) among all public firms. In the *Distant* subsample, *Info* is estimated with stock returns of firms with a listing history ranking in the top quartile (i.e., the most distant listings). Table 8 reports the second-stage regression results. In general, we observe a negative and significant relation between the instrumented *Info* and VC staging (*N_round* and *Skewness*) and syndication (*Syn* and *N_VC*) in the *Recent* subsample and no such effect in the *Distant* subsample. The differences in the coefficient estimates on the instrumented *Info* between the two subsamples are statistically significant at the 1% level in the *N_round*, *Skewness*, and *N_VC* regressions. In *Syn* regressions, although the difference is not significant, the magnitude of the estimate in the *Recent* subsample is around

10 imes of ha in he *Distant* s bsample. The res l of his anal sis is consis en i h o r prior ha VC investors are learning informa ion on IPO prospec s from recen l going-p blic firms hen de ermining he inves men s r c res in heir por folio firms.

O r second es on he IPO prospec channel is based on he conjec re ha here is a s bs i ion be- een VC inves ors' o n IPO e perience and he in- forma ion he co ld learn from he p blic marke . The ra ionale is ha , if VC inves ors are learning infor- ma ion abo he IPO prospec s of heir s ar p firms from p blic marke s ock prices in he same ind s r as e proposed, VC inves ors i h lo s of e perience in IPOs co ld have o her informa ion reso rces and hence rel less on he informa ion e rac ed from he p blic marke . P differen l , i h ab ndan prior IPO e perience, VC inves ors have more informa ion so rces o her han he p blic marke on he IPO pros- pec s of heir por folio firms and ma be able o se rela ed informaher io

Table A.1. (Continued)

Variable name	Definition
R_amount	The natural logarithm of the dollar amount of a round in thousands.
Duration	The duration in months from a funding date to the next funding date.
Info	The industry public market stock price nonsynchronicity measure, defined as $\ln((1-R^2)/R^2)$. R^2 is the industry average of R-squared obtained by regressing daily stock returns on market and industry returns.
PIN_{DY}	The industry average of probability of information-based trading, as defined in Duarte and Young (2009).
Ind_Q	The industry average of Tobin's Q, calculated as the market value of equity plus long-term liability, divided by total assets plus long-term liability.
Ind_ret	The industry average of stock returns in excess of market returns.
Ind_RD	The industry average of R&D expenses ratio, calculated as the R&D expenses divided by total assets.
Ind_tangi	The industry average of the asset tangibility ratio, calculated as property, plant and equipment divided by total assets.
Ln_age	The natural logarithm value of startup age, defined as the number of years since the startup's inception.
Ln_amt1st	The natural logarithm value of the first round investment amount in thousand dollars.
$Amihud_{x1000}$	The industry average of the Amihud (2002) illiquidity ratio, multiplied by 1,000.
NMFHS	The industry average of the number of mutual fund hypothetical sales.
MFHS	The industry average of the magnitude of mutual fund hypothetical sales.
Shutdown	The natural logarithm of average days in a year when there are severe flight cancellations either in the airports closest to the firm's headquarters or closest to the offices of the financial analysts covering the firm.
IPOexp	A dummy variable that equals one if the startup's lead VC ranks in the top half by the number of IPOs in the same two-digit SIC industry from 1962 to the date of the first round of financing, and zero otherwise.
Shortdist	A dummy variable that equals one if the startup and its leading VC are in the same state, and zero otherwise.
HRD	A R&D expense dummy variable that equals one if the R&D spending in a startup's industry ranks in the top half among all industries, and zero otherwise.
N_VCstartup	The total number of investment rounds made by all new VC-startup pairs in an industry.
N_startup	The number of new startups financed by VCs in an industry.
N_ttlround	The number of investment rounds made by all VCs in an industry.
Ind_std	The industry average of stock return standard deviation.

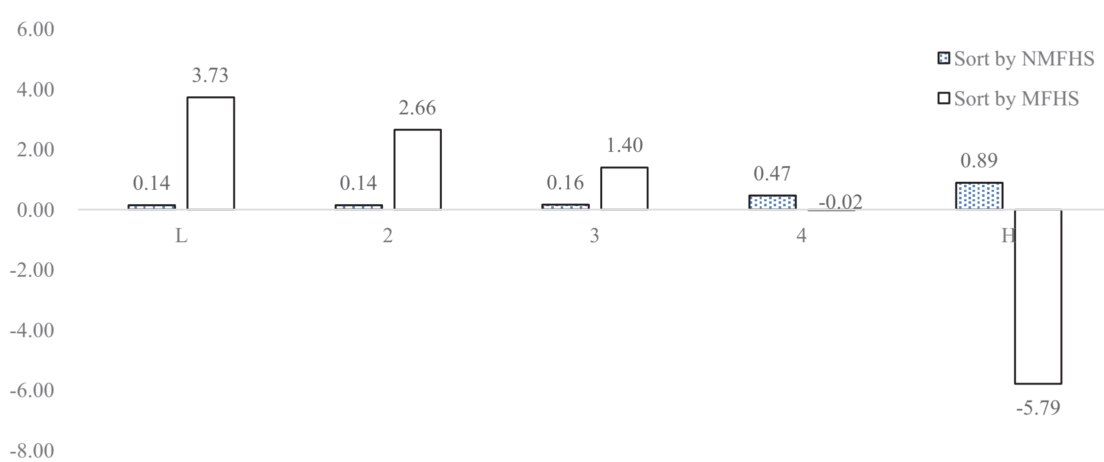
Appendix B. Data and Procedures for IV Construction and Additional Endogeneity Tests

B.1. Mutual Fund Hypothetical Sales Instrument

We follow the procedures proposed by Edmans et al. (2012) and Dessaint et al. (2019) to construct the frequency-based *NMFHS* instrument based on industry-level mutual fund hypothetical sales. For the convenience on comparing the *NMFHS* instrument with the instrument used by Edmans et al. (2012) and Dessaint et al. (2019), we also describe the procedures to estimate their intensity-based proxy, *MFHS*.

First, in each quarter t, we estimate the net inflow by each nonspecialized U.S. mutual fund i using the CRSP

Figure B.1. (Color online) Frequency and Intensity of Mutual Fund Hypothetical Returns and Stock Returns



Notes. This figure plots the average cumulative abnormal returns (CARs) for stocks sorted by the frequency of mutual fund hypothetical sales (*NMFHS*) and the magnitude of these sales (*MFHS*). The annual *MFHS* measure is calculated using the method suggested by Edmans et al. (2012) and Dessaint et al. (2019). Annual CARs in percentage are estimated by subtracting the CRSP equal-weighted index returns from stock returns from 1979 to 2011. Stocks are sorted into quintiles based on the absolute value of *NMFMS* (*MFHS*), and the mean CAR for each quintile is plotted.

s r i or-bias-free m al f nd da abase:

$$Flow_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1} * (1 + Return_{i,t})}{TNA_{i,t-1}}:$$

Beca se m al f nd shares co ld be offered in differen classes, e es ima e he f nd-le el o al ne asse , $TNA_{i,t}$, b aggrega ing class-le el o al ne asse , $TNA_{k,t}$, across share classes k, and calc la e f nd-le el gross re rns, $Return_{i,t}$, as he al e- eigh ed re rns.

Ne , e se q ar erl m al f nd shareholding da a from CDA Spec r m/Thomson o es ima e he normali ed h po he ical sales of s ock m from a m al f nd p ha e perienced an e reme f nd o flo $(Flow \leq -0{:}05)$ in q ar er t:

$$MFHS_{m,p,t} = \frac{Flow_{p,t}^{\leq -0:05} * Shares_{m,p,t-1} * PRC_{m,t-1}}{Vol_{m,t}}$$

here $Flow_{p,t}^{\leq -0:05}$ is he ne inflo of f nd p in q ar er t; $Shares_{m,p,t-1}$ is he n mber of s ock m held b f nd p a he end of q ar er $t-1$; $PRC_{m,t-1}$ is he closing price of s ock m a las q ar er end; and $Vol_{m,t}$ is he dollar rading ol me for s ock m in q ar er t.

Third, in a gi en ear, he freq enc and in ensi of h po he ical m al f nd sales for s ock m are calc la ed b aggrega ing q ar erl sales from he P m al f nds ha held he s ock and e perienced an e reme o flo d ring he q ar er:

$$NMFHS_m = \sum_{t=1}^{4} \sum_{p=1}^{P} I_{MFHS_{m,p,t}<0},$$

$$MFHS_m = \sum_{t=1}^{4} \sum_{p=1}^{P} MFHS_{m,p,t},$$

here t corresponds o he fo r q ar ers in he ear; and $I_{MFHS_{m,p,t}<0}$ is an indica or ariable ha eq als one if $MFHS_{m,p,t} < 0$ and ero o her ise. B cons r c ion, $NMFHS_m$ co n s he n mber of f nd-q ar ers i h m al f nd h po he ical sales of s ock m ca sed b e reme f nd o flo s across he ear, and $MFHS_m$ meas res he aggrega e si e of hese sales.

Finall , e a erage $NMFHS_m$ and $MFHS_m$ across firms in an ind s r o calc la e he corresponding ind s r -le el m al f nd h po he ical sales meas res $NMFHS$ and $MFHS$ for he ear.

To compare he impac s of $NMFHS$ and $MFHS$ on s ock price le els, e sor all s ocks ha are affec ed b m al f nd h po he ical sales in o q in ile por folios based on hese o meas res and calc la e he ann al a erage c m la i e abnormal re rns (CARs) for each por folio. CARs are es ima ed b s b rac ing he CRSP eq al- eigh ed inde re rns from s ock re rns. For he s ocks ha are affec ed b m al f nd sales, prices increase sligh l b 0.36%. As sho n in Fig re B.1, he prices of s ocks ranking in he op q in ile among all affec ed s ocks (e periencing he larges $MFHS$) drop b 5.79%, hich is consis en i h findings in he li era re. In con- ras , he price increase for s ocks ranking in he op q in- ile b $NMFHS$ is onl 0.89%, and more ri ial in o her q in iles, s gges ing he freq enc -based ins r men is likel o ha e er small impac s on price le els.

B.2. Airport Shutdown Instrument

We follo he follo ing s eps o cons r c o r ins r men- al ariable, *Shutdown*, he na ral logari hm al e of an- n l fligh -cancella ion-da s:

(1) We do nload he airline on- ime performance da a from he ebsi e of B rea of Transpor a ion S a is ics, U.S. Depar men of Transpor a ion.[15] The da a se con ains infor- ma ion on fligh dela s, cancella ions, and di ersions beca se of ea her, air raffic, sec ri , and airline reasons for 14 U.S. airlines ha ha e a leas 1% of o al domes ic sched led- ser ice passenger re en es since 1988. For each airpor , if a leas 20% of inbo nd and o bo nd fligh s in one da are cancelled beca se of he reasons men ioned pre io sl , e label ha da as an fligh -cancella ion da ha pre en ana- l s s'

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Table C.1. Rob s ness Checks

	(1) *N_round*	(2) *Skewness*	(3) *Prob. Syn*	(4) *N_VC*
	Panel A: Use PIN as an informa i eness meas re			
PIN	−5.480**	152.495**	−1.596***	−13.999***
	(2.650)	(61.532)	(0.542)	(3.753)
Con rols and fi ed effec s	Yes	Yes	Yes	Yes
Obser a ions	10,916	8,320	10,916	10,916
	Panel B: Use a 250-da meas remen hori on			
$Info_{250}$	−0.202**	6.308***	−0.126***	−0.547***
	(0.098)	(2.337)	(0.041)	(0.146)
Con rols and fi ed effec s				
Obser a ions	11,998	9,223	11,998	11,998
	Panel C: Con rol for liq idi effec s			
Info	−0.154**	4.783***	−0.129***	−0.426***
	(0.076)	(1.787)	(0.042)	(0.113)
$Amihud_{x1000}$	−2.868	78.594**	0.397	−2.545
	(3.066)	(33.678)	(0.285)	(3.015)
Con rols and fi ed effec s	Yes	Yes	Yes	Yes
Obser a ions	11,998	9,223	11,998	11,998

Notes. This able repor s rob s ness checks for he effec of s ock price informa i eness in he p blic marke on VC s aging and s ndica ion. The sample consis s of 13,185 s ar ps receiving VC financing be ween 1980 and 2012. The *NM* s a is ic is he same se of con rol ariables and fi ed effec s in Table 3 are incl ded. The second-s age res l s are repor ed. Panel A repor s res l s hei modified *PIN* defined in D ar e and Yong (2009) as he price informa i eness meas re. Panel B repor s he s ock price nons nchronici meas re calc la ed sing he 250 rading da s before he firs ro nd of VC financing. Panel C repor s he Amih d (2002) illiq idi ra io. See Appendix A for defini ions of all ariables. S andard errors repor ed in paren heses are adj s ed for he eroskedas ici and cl s ering.

***, **, and * indica e significance a he 1%, 5%, and 10% le el, respec i el .

Panel A of Table C.1 repor s he second-s age regression res l s es ima ing Eq a ion (3) i h PIN_{DY} as an al erna i e price informa i eness meas re. The coefficien es ima es on ins r men ed PIN_{DY} e hibi consis en signs i h hose repor ed in Table 3 and are s a is icall significan in all col mns, s gges ing ha more informa i e p blic s ock prices lead o less VC s aging and s ndica ion. In nrepor ed anal ses, e se he original *PIN* meas re as defined in Easle e al. (2002) and ob ain similar res l s.

C.2. Alternative Measurement Horizon for Price Nonsynchronicity

In he pre io s anal sis, o r main price informa i eness meas re is calc la ed sing s ock price informa ion in he calendar ear prior o he firs VC financing ro nd. To check he her o r res l s are sensi i e o he hori on of his meas re, e cons r c he price informa i eness meas re sing an al erna i e meas remen hori on, ha is, 250 rading da s before he firs ro nd of VC financing. Panel B of Table C.1 repor s he res l s sing his al erna i e meas remen hori on. The res l s are q ali a i el he same as in Table 3.

C.3. Controlling for the Liquidity Effect

E i ing li era re s gges s ha besides s ock price informa i eness, s ock liq idi pla s impor an roles and has real effec s on firms s ch as on shareholder ac i ism (Norli e al. 2015), inno a ion (Fang e al. 2014), and akeo ers (Roosenboom e al. 2014). In addi ion, as arg ed b D ar e and Yong (2009) and Lai e al. (2014), he idel es ed *PIN* meas re defined b Easle e al. (2002) is po en iall a liq idi meas re ra her han an informa ion meas re. To hese concerns, e direc l con rol for a ell-recei ed liq idi pro , he Amih d (2002) illiq idi ra io, o dis ing ish be een he liq idi effec and he informa ion effec e mean o e amine.

Panel C of Table C.1 repor s he regression res l s es ima ing Eq a ion (3) i h he Amih d (2002) illiq idi ra io incl ded. The e idence sho s ha o r main res l s are rob s af er con rolling for he liq idi effec . We s ill obser e a significan price informa i eness effec across all regressions.

Endnotes

[1] Bond e al. (2012) pro ide an e cellen s r e on heore ical and empirical s dies ha e amine he effe of financial marke s on he real econom .

[2] Some e cep ions are Fo ca l and Frésard (2014) ho sho pri a e firms learn prod c marke s ra eg from peer firms' s ock prices and Yan (2020) ho finds U.K. pri a e firms reac o noises in p blic marke s ock prices.

[3] Consis en i h he heor 's predic ion, Chemman r e al. (2018) find ha en reprene rs are more likel o ake pri a e firms p blic in ind s ries i h lo er infoion as mme r and more liq id s ocks rading in he p blic marke .

[4] Tian (2012) finds ha 70% of en reprene rial firms are financed b VC s ndica es ha consis of o more VC in es ors be een 1980 and 2005. Meanwhile, 88% of VC-backed firms ha go p blic d ring he same iod recei e financing from VC s ndica es.

[5] As noted by Tian and Wang (2014), in general VC industry requires investment liquidation within 10 years from the inception of the fund. Hence, startup firms failed to receive any follow-on VC investments within 10 years after the very last round are likely to be written off by VCs and have completed VC financing.

[6] We follow the following steps to determine the lead VC for a startup if a syndicate is formed ($N\_VC > 1$): (1) we identify the VC making the largest investment amount across all financing rounds for the startup; (2) if the lead VC is not determined in Step 1 because of missing or equal total amounts, we choose the VC participating in the largest number of rounds for the startup; (3) if the lead VC is not determined in Step 2, we choose the VC with the most rounds of investments in any firm since 1962; and (4) if the lead VC is still not determined in Step 3, we choose the VC with the longest investment history.

[7] Edmans et al. (2012) and Dessaint et al. (2019) document that extreme mutual fund hypothetical sales induce long-lasting downward price pressure. In Figure B.1, we follow their methods to calculate the magnitude of mutual fund hypothetical sales, *MFHS* (see Appendix B.1 for the calculations) and find a similar price drop of 5.8% for extreme *MFHS* stocks during the year of sales. However, unlike *MFHS,* which is defined as the total dollar volume of mutual fund hypothetical sales, our frequency-based instrument *NMFHS* are unrelated to large price drops because of the following. (1) The previous results are obtained from stocks experiencing extreme *MFHS* ranking in the lowest decile (the largest total size of sales) and hence exposed to the largest negative shocks. In contrast, in our sample period, the stocks affected by *MFHS* have a moderate average annual market-adjusted return of 0.36% in the full sample. Our analysis is based on the full sample of stocks rather than those stocks with extreme *MFHS*. (2) *NMFMS* only accounts for the total number of sales, which may differ significantly from the number of shares sold captured by *MFHS*. The reason is *NMFHS* depends on the number of funds holding the stock experiencing extreme outflows, and *MFHS* depends on how many shares are held by these funds. Thus, these two measures are not necessarily highly correlated. Using stock-year level data, we find the correlation is only −0.026 in our sample period.

[8] In unreported analysis, we drop stocks for which the historical correlation between *NMFHS* and the absolute value of *MFHS* is in the top quintile among all stocks when calculating the industry average of *NMFHS* (the instrument) to eliminate the price-level effect. The results are qualitatively the same.

[9] In these tests, the incremental information is actually the noises caused by mutual fund forced sales. This does not contradict with our main hypothesis because VC investors could reduce staging and syndication (by mistake) as they observe larger price nonsynchronicity and believe that the IPO probability of their startup firms are higher.

[10] Consistent with this rationale, recent studies (Hong and Kacperczyk 2010, Kelly and Ljungqvist 2012, He and Tian 2013, Chen et al. 2015) find that an exogenous loss in one analyst leads to various consequences on stock prices, liquidity, and firms' investment and financing decisions.

[11] In untabulated analyses, we use an alternative cutoff, 30%, to define severe flight cancellations to construct *Shutdown* for robustness checks. We obtain qualitatively similar results.

[12] We interact *Info* with VC investors' IPO experience in regressions to test the effect of experience on learning. In contrast, when testing whether VC investors learn from recent listings or historical listings, we calculate *Info* with the returns of recently (remotely) listed stocks and estimate Equation (3).

[13] Gompers et al. (2008) find that VCs with industry experience increase their investment in an industry when public market signals become favorable. In terms of corporate investment, Chen et al. (2007) show that price informativeness has a positive effect on the investment-price sensitivity of public firms. Foucault and Frésard (2014) study the sensitivity of corporate investment to peer firms' valuation.

[14] The data on VC fundraising is from Preqin, and the sample period is restricted to 2000–2012 because of data availability. We use a specification similar to Equation (3) but replace *Info* with fundraising proxies and drop the year-quarter fixed effects.

[15] See https://www.transtats.bts.gov/DL_SelectFields.asp?Table_ID=236&DB_Short_Name=On-Time.

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