Options Trading Activity and the Efficiency of Corporate Investment

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CRETE 2021 Conference

July 12, 2021

Motivation - Why associate firm-level investment efficiency with options trading activity?

In **frictionless markets** firms make their **financing** and **investment** decisions **independently** (Modigliani and Miller, 1958), undertaking projects with **positive net present value** (Modigliani and Miller, 1958; Hayashi, 1982; Biddle et al., 2009).

With **capital market frictions**, as a result of **conflicts of interest** arising between firm **insiders** and **outsiders** and **financing constraints** (Jensen and Meckling, 1976; Myers and Majluf, 1984), firms **deviate** from **optimal** levels of investment by **over-** or **under-investing.**

Prior literature has identified **information asymmetries (adverse selection)** and **moral hazard** frictions as triggering factors for **sub-optimal levels of investing** (e.g. Biddle et al., 2009; Jung et al., 2014, among many others).

This research has suggested that **investment inefficiency** in terms of **deviations** from **optimal levels** of **investment** can be **mitigated** by **enhancing** firms' **informational efficiency,** which should further **reduce moral hazard concerns** through **more effective monitoring** by **shareholders** and **other stakeholders** (Cheng et al., 2013; Chen et al., 2017b).

Motivation - Why associate options trading activity with firm-level investment efficiency? (1)

- We examine the association between **options trading** activity and the **efficiency of corporate investment** in terms of **deviation** from **optimal investment** levels.

- Research on the effects of **options trading activity** has mainly focused on **stock market outcomes** (Chen et al., 2020), with recent work to provide insights into its **effects** on **corporate decision-making** and firm **policies** (Gao, 2010; Cao et al., 2020b; Chen et al., 2020; Blanco and Wehrheim, 2017).

- **Options trading** facilitates the **transfer of information** from the **options** to the **stock market**, enhancing **price discovery** and improving **informational efficiency** and firms' overall **information environment** (Chakravarty et al., 2004; Pan and Poteshman, 2006; Ge et al., 2016; Blanco and Wehrheim, 2017; Ali et al., 2020; Chen et al., 2020).

- **Options trading** stimulates **information production** and **acquisition,** leading to more **informed trades** (Cao et al., 2020b), **reduces the cost of capital** and **information asymmetries** between firm **managers** and **outsiders** (Ross, 1976; Kumar et al., 1998; Pan and Poteshman, 2006; Naiker et al., 2013; Hu, 2014; Blanco and Wehrheim, 2017; Chen et al., 2020) and **increases firm value** (Roll et al., 2009).

- **Options trading** also increases the **participation rate** of **informed traders** (Chakravarty et al., 2004; Hu, 2018), helping make markets more **complete**: these benefits accrue mainly to firms with **options trading activity**, and **increase** with **higher volume** of options trading (Chen et al., 2020).

Motivation - Research hypotheses - *H1*

- ✓ This paper **examines** whether the **volume** of **options trading**, a factor that **reduces firm-level information asymmetry** and **differential access** to firm-specific **information** by **outsiders** compared to the firm's management, is associated with **improvement** in the **efficiency** of **investments** made by the firm.

- ✓ **Investment efficiency**, defined as **minimal deviation** from optimal **investment levels**, is **influenced** by **firm-level informational efficiency** and by **discrepancies** in the amount of **investment-related information** between firm **insiders and outsiders** (e.g. Biddle et al., 2009, Chen et al., 2017a, 2017b).

- ✓ We **expect** that a **higher intensity** or volume of options **trading activity,** by improving the firm's **information environment** should have a **positive association** with the **efficiency** of corporate **investment,** or **reduction of deviations** from **optimal** investment levels.

- ✓ **Information benefits** from **options trading** depend on whether the **market** for options has **sufficient volume** so as to make **informed traders** more **active** (Admati and Pfleiderer, 1988; Chowdhry and Nanda, 1991; Pagano, 1989; Blanco and Wehrheim, 2017): such **benefits** should be **directly associated** with the **intensity** or **volume** of traded options, reflecting the **degree** of **activity** of **market participants** in relevant markets.

H1: More active options trading manifested through higher trading volumes is positively associated with the efficiency of firm-level investment and lower deviation from optimal investment levels.

Hypotheses - *H1a*

- **Higher options trading volume** should help **alleviate information asymmetry** and **moral hazard** concerns for **external providers** of **capital** when the latter are **main drivers** of **under-investment**.

- **Over-investment**, on the other hand, is **not so much driven** by the **reluctance** of **external capital providers** to **supply funding** at **reasonable cost**; it occurs mainly when **managers** make **excess capital investment** in the presence of **information asymmetries** or do so to **gratify** their **private objectives** in the presence of **abundant resources.**

- Thus, the **hypothesized positive association** of **options trading volume** with **investment efficiency** should be **stronger** when it is **most sensitive** to addressing the **concerns** of **capital providers** for **supplying funding,** and **less** so when managerial **entrenchment motives** give rise to **over-investment.**

H1a: More active options trading is more strongly (negatively) associated with under-investment, compared to over-investment.

Hypotheses - *H2*

- The posited effects should be **more pronounced** for **more uncertain** and **intangible** or **growth-option type investments**, because of the **limited degree** of **certainty** with which the **anticipated profitability** from such investments can be **reliably forecasted**.

- Anticipated outcomes can **vary significantly**, given that **most growth options** are **staged** and provide **opportunities** for **contraction, exit, or abandonment** (Trigeorgis and Lambertides, 2014): **different** for two **components** of **total investment**, **Capex** and **NonCapex.**

- **NonCapex** consists of **R&D** and **acquisition-related outlays,** which are more related to the **exercise** of **growth options**, whereas tangible **Capex** merely **expands** firm AIP.

- **NonCapex** is **more inherently uncertain** in nature, referring to the **difficulty** in **predicting possible future outcomes**, compared to the **more concrete** and **tangible Capex**.

- **Information asymmetry** between managers/capital providers should be **larger** for investment that is **more uncertain** in terms of **potential success;** repercussions for **efficient investment.**

- **Capital providers** are **more prone** to **constraining** the **supply** of **capital** for **investments** they consider **particularly uncertain** with less **predictable outcomes**, **triggering under-investment** for more **uncertain**, **growth-option type investments**.

H2: More active options trading is more strongly associated with the efficiency of firm-level investment when the latter takes the form of NonCapex rather than Capex investment.

Hypotheses - *H3*

- Further consider how the **strength** and **efficiency** of **external monitoring moderates** the **association** between **options trading** and firm **investment efficiency**.

- On one hand, **more active options trading** may better **enable investors** to **uncover private information** by managers, as there may be **repercussions** in terms of **reputation loss** and **managerial career concerns** in **hiding information** from investors (Cao et al., 2020a).

- Thus, an **improved information environment** due to **active options trading** could **enhance** the **efficiency** of **governance mechanisms** already **in place** that involve **better monitoring**, **mitigate managerial entrenchment** and **induce managerial behaviors** that **support** the **interests** of investors, making the **anticipated reduction** in **investment inefficiency** due to options trading activity **more pronounced** for firms with a **stronger information environment** attributable to **more effective external monitoring**.

However, if the **strength** and **effectiveness** of **external monitoring** helps **reduce investment inefficiencies** by **enhancing** firms' **information environment**, the **negative** association between **option volumes** and **investment inefficiency** may actually be **less strong** when the **quality** of such **monitoring** is **better:**

- **Stronger external monitoring** should provide **managerial discipline**, and thus work as a **substitutive mechanism** for **information advantages** offered by **more options trading activity**.

- *H3: More active options trading is less strongly associated with the efficiency of firm-level investment when substitutive mechanisms of external monitoring are stronger.*

Main findings

- Examine research question for US firms with options in Optionmetrics during **1996-2019** and find that the **volume of options trading** (in dollars or in units) is **positively** associated with firm-level **investment efficiency.**

- Measure **investment inefficiency** as **firm-specific residuals** from a model **predicting** the **level of investment** in growth opportunities based on **sales growth** as per Biddle et al. (2009) - also via **extended models** that better account for **growth opportunities** in line with **growth option variables** and **evidence** in Trigeorgis and Lambertides (2014).

- Results are **stronger** for **under-investment,** and are mostly driven by **NonCapex expenditure** mainly consisting of **R&D investments** and **acquisitions** that mostly involve **growth options**, rather than **Capex** investment mostly focused on assets in place (AIP).

- Results support the notion that a **higher options trading volume** is **mitigating** information **asymmetry** and **moral hazard** concerns for **external capital providers,** with a **stronger** effect on mitigating **under-investment** which is driven by this **type of concerns**.

- Options volume mainly has an **alleviating** effect on **investment inefficiency** when investment outcomes are **more uncertain** and involve more **growth options,** that is for **NonCapex vs.** more **concrete** and **tangible Capex**, in support of the information enriching role of options trading.

- Results are **robust** to alternative models to measure **investment efficiency** and measures of **options volume** activity, controls for **endogeneity** (2 Stage GMM using moneyness and open interest as IVs, PSM)

Main findings (1)

Further investigate the **underlying mechanisms** that may drive our results.

- Regarding the **efficacy** of **external monitoring**, **options trading** should **improve** firms' **information environment** and thus help **alleviate adverse selection** and **moral hazard problems** that trigger **investment inefficiency**.

- The **improved information environment** associated with **options** trading may help **enhance** the **efficiency** of **alternative governance mechanisms**, **reducing managerial entrenchment;** however, when **external monitoring** performs a **similar** role in **reducing investment inefficiency** as options **trading activity**, our **baseline** result should be **less** strong as the **quality** of such monitoring and **information-enhancing mechanisms increase.**

- When the **strength** of **monitoring** and **information-enriching mechanisms** increases (in terms of **size of institutional block holdings; existence** of **credit ratings** for **firms' long-term debt**), the **positive association** of **options trading** with investment **efficiency** is **weaker.**

- So, **options trading activity** may **substitute** for or **work in the same direction** as the **aforementioned factors** and is thus **negatively** related with **investment inefficiency** as these factors allow **more accurate inference** of **firms' investment opportunities**.

Contribution

Our study takes the effect of **options trading** on price **informativeness** as given (Blanco and Wehrheim, 2017); builds on research on the **effect** of **information production** on **corporate investment decisions** with focussing on the **efficiency** of **firm-level investment**:

- focus on the relation of **information production** associated with **active options trading** with **important corporate outcomes** driven by the **efficiency** of the **information environment** of firms and the **effectiveness** of external **monitoring** by capital providers.

- Study follows a recent stream of research examining whether **financial markets affect corporate decision-making** or whether they are simply a **sideshow** with **no real economic consequences** (Cao et al., 2020b).

- **Price informativeness** can **discipline managers**, providing them with **incentives** for **optimizing firm-value** (Holmström and Tirole, 1993; Faure-Grimaud and Gromb, 2004); at the same time, **information** incorporated in **stock prices** can **better guide** firms' **investment decisions** as firm **managers** are **compensated** based on **future stock market performance** (Dow and Gorton, 1997):

- We show that the **volume of options trading** is **positively associated** with attaining **more optimal levels** of investment at the **firm level** and that **active options trading** helps **alleviate** concerns related to **information asymmetry** and **moral hazard**.

- Our findings provide insight into the positive association between **enhanced informational efficiency** associated with **options trading** and **firm-level performance outcomes** associated with **more efficient investing**.

Sample selection

- Initial **sample** consists of **all Compustat firms** matched to **IvyDB Optionmetrics US** during the period **1996-2019** (1996 is the first year of data in Optionmetrics).

- **274,593** unique firm-year observations, of which **69,503** have data available on options volumes from Optionmetrics.

- Apply the **Fama and French (1997) 48** industry breakdown (hereafter **FF48**).

- **Measurement** of **investment efficiency** made at the **level** of the **population** and **before** any matching of data from **Compustat** to **Optionmetrics**; number of firms with usable firm-year observations are subsequently reduced due to data availability constraints

- Obtain a **maximum** of **34,090** firm-year observations for our **baseline model**, corresponding to **4,860 unique sample firms.**

- Use **returns** data from **CRSP**, Institutional Shareholder Services (**ISS**) for **corporate governance data**, **Thomson Reuters** for **institutional holdings**, and **I/B/E/S** for **analyst** data.

- All continuous variables **winsorized** annually at **1** and **99** percentiles at the Compustat population level.

Research methodology - investment efficiency

We measure **investment inefficiency** as **deviations** from **predicted levels** of **investment** from a **normative model** that **predicts optimal levels** of **investment** based on **growth opportunities**.

In our **baseline** specification, the optimal (normal) level of investment is based on **sales growth**, following Biddle et al. (2009) (Chen et al., 2011; Benlemlih and Bitar, 2018; Gao and Sidhu, 2018):

$$INV_{i,t} = \alpha_0 + \alpha_1 Sales\ Growth_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

Deviations from the **predicted optimal (normal) levels** of investment represent **investment inefficiency** (denoted ***INV_INEFF***), which can take the form of **over(under)-investment** for **positive (negative) residuals,** captured via the **error terms** of regressions, estimated **each year** (at the **level** of the **population**) **cross-sectionally** using OLS for each **FF48** industry separately (with at least 20 observations in an industry-year).

Investment (*INV*): the sum of research and development expenditure **(R&D**), capital expenditure **(Capex),** and **acquisition expenditure**, **less cash receipts** from sale of property, plant, and equipment **(PPE),** multiplied by 100, scaled by lagged total assets (Biddle et al., 2009).

INV is decomposed into **Capex** and **NonCapex** (= **R&D** and **acquisition** expenditures, both multiplied by 100, and scaled by lagged total assets; Biddle et al., 2009).

Also measure **Capex** (respectively **NonCapex) investment inefficiency,** denoted ***Capex_INEFF*** (***NonCapex_INEFF***), by using the **firm-specific residuals** from the above regression model when the **dependent variable** investment takes only the form of **Capex** (**NonCapex**).

Research methodology - investment efficiency (1)

- The **different approaches** used in the literature to measure **investment efficiency** (e.g., based on investment-cash flow sensitivity or deviations from expected levels of investment) often come with **method-specific advantages** and **criticism** regarding the **theory** underpinning them or their **empirical operationalization** (Gao and Yu, 2018).

- Roychowdhury et al. (2019) note that: **investment efficiency** is **not actually observable** with researchers often using **imperfect proxies**, each with their **own limitations**; the **economics** and **finance** literature discusses the **various challenges** that arise due to **measurement error** in using **imperfect proxies** for **growth opportunities**; **conflicting** evidence about the **validity** of proxies for **financing constraints**; **misspecification** issues in empirical **investment models**.

- We measure **investment efficiency** based on estimating **deviations** from **expected levels** of **investment** founded on **accelerator theory**, which assumes that the **level** of **capital** is **proportional** to the **level** of **output** and **models net investment** as a **function** of **past output growth** (Gao and Yu, 2018).

- Such models often have **low explanatory power** because **output growth** relates **weakly** to **optimal investment; other factors** related to **future growth opportunities** are **not considered**.

- Recognizing that the **"true" financial performance** of a firm is **integrally linked** to its **investment opportunities** (Roychowdhury et al., 2019) both at **present** and in the **future**, we **extend** the **baseline model** of equation (1) by considering **two additional specifications** aimed at **better capturing firms' future growth opportunities**.

Research methodology - investment efficiency (2)

Our approach in this extension is based on the **measurement** of **growth opportunities** proposed by **Trigeorgis and Lambertides (2014).**

We develop two **alternative investment inefficiency measures,** estimated via **extensions** of the model in **Biddle et al. (2009),** by **augmenting** this **baseline** model with **more explanatory variables** that better **capture future growth opportunities**. The first alternative measure uses **firm-specific residuals** from an investment model predicting the level of investment based on **sales growth** and a **number** of **other variables affecting growth opportunities**.

These are:
(i) market leverage (Lev), or long-term debt divided by the sum of long-term debt and the market value of equity,
(ii) cash flow coverage (CFC), or a variable that captures the **firm's ability** to **generate excess cash**, **beyond covering** its **interest expense** and **debt repayment** obligations,
(iii) an R&D binary variable, indicating whether a firm **reports R&D expenses** or **not**, as follows:

$$INV_{i,t} = \beta_0 + \beta_1 Sales\ Growth_{i,t-1} + \beta_2 Lev_{i,t-1} + \beta_3 CFC_{i,t-1} + \beta_4 R\&D Dummy_{i,t-1} + e_{i,t} \qquad (2)$$

Research methodology - investment efficiency (3)

Our **second extension** of **the model** in **Biddle et al. (2009)** adds an **empirical proxy** for the **value** of **growth opportunities** implied from the **market, GO**, as used in **Cao et al. (2008)** and **Trigeorgis and Lambertides (2014).**

Deviations from the **predicted** level of **investment,** as reflected in the **error terms** of the model (*INV_INEFF*^{GO,M}) signify **investment inefficiency**:

$$INV_{i,t} = \gamma_0 + \gamma_1 Sales\ Growth_{i,t-1} + \gamma_2 GO_{i,t-1} + u_{i,t} \qquad (3)$$

***GO*$_{i,t-1}$** captures the **percentage** of a **firm's market value** arising from **future growth opportunities**, estimated by **subtracting** from the **current market value** of the firm the **perpetual discounted stream** of firm **operating cash flows** under a **no-growth policy**.

Research methodology - baseline regression equation

To estimate the association of o**ptions trading volume** in year ***t*** with **investment efficiency** in **year *t+1***, we estimate the following baseline model for the full sample period:

$$INV\_INEFF_{i,t+1}\ (or\ Capex\_INEFF_{i,t+1}, or\ NonCapex\_INEFF_{i,t+1}) = \delta_0 + \delta_1 LnOptVol_{i,t} + \sum_p \xi_p Controls_{p,i,t} + \sum_m \varphi_m Year\ Fixed\ Effects_m + v_{i,t} \quad (4)$$

The dependent variable can take the form of **total signed investment inefficiency** $\boldsymbol{INV\_INEFF_{i,t+1}}$ or **signed investment inefficiency** in terms of **Capex** and **NonCapex** separately.

In extensions based on equations (2) and (3), alternative measures $\boldsymbol{INV\_INEFF^{GO}_{i,t+1}}$ and $\boldsymbol{INV\_INEFF^{GO,M}_{i,t+1}}$ (and their subcomponents) are obtained in separate estimations.

Independent variable of interest: $\boldsymbol{LnOptVol_{i,t}}$, or the **natural logarithm** of **one plus** the **total annual dollar options** volume (in $000) in a fiscal year (for each stock, we multiply the daily trading volume with the midpoint of the end-of-day bid-ask spread for each options contract on the stock, and then aggregate all listed options contracts on the particular stock across all trading days during a fiscal year; Roll et al., 2009).

The **coefficient** for $\boldsymbol{LnOptVol_{i,t}}$ should be **negative (positive)** and **significant** in the case that the **volume** of **options** trading **attenuates (accentuates)** investment inefficiency.

Also estimate **Capex (and NonCapex) investment inefficiency** for the two alternative measures, denoted ***Capex_INEFF^{GO}*** and ***Capex_INEFF^{GO,M}*** (***NonCapex_INEFF^{GO}*** and ***NonCapex_INEFF^{GO,M}***), by using the firm-specific residuals from equations (2) and (3), respectively, when investment takes the form of **Capex (NonCapex).**

Research methodology - baseline regression equation (1)

Control variables are based on the **determinants** of **investment** employed by **past research** (e.g., Biddle et al., 2009; García Lara et al., 2016; Benlemlih and Bitar, 2018):

- financial leverage ($\boldsymbol{Lev_{i,t}}$);
- firm size ($\boldsymbol{LogTA_{i,t}}$);
- the market-to-book ratio ($\boldsymbol{MB_{i,t}}$);
- a negative profit indicator ($\boldsymbol{Loss_{i,t}}$);
- firm age ($\boldsymbol{LogAge_{i,t}}$);
- cash flow from operations to sales ($\boldsymbol{CFOSales_{i,t}}$);
- tangibility based on net PPE over assets ($\boldsymbol{Tangibility_{i,t}}$);
- the length of the operating cycle ($\boldsymbol{OperCycle_{i,t}}$);
- an indicator variable of whether a firm distributes dividends or not ($\boldsymbol{Dividend_{i,t}}$);
- an indicator for financial slack based on the intensity of cash over net PPE ($\boldsymbol{Slack_{i,t}}$);
- a proxy for bankruptcy risk based on Altman (1968) ($\boldsymbol{ZScore_{i,t}}$);
- controls for the standard deviations of cash flow from operations ($\boldsymbol{\sigma(CFO)_{i,t}}$), sales ($\boldsymbol{\sigma(Sales)_{i,t}}$) and investment ($\boldsymbol{\sigma(I)_{i,t}}$).

Equation (4) is estimated with **year fixed effects** and **standard errors double-clustered** at the **firm** and the **industry level** (FF48 sectors).

Research methodology - alternative model specification

- **Biddle et al. (2009)-type models** are **criticized** for the **assumption** that firms can **adjust** their **capital fully within one period**, whereas **capital investment** typically requires **substantial planning, installation** and **delivery time** (Gao and Yu, 2018).
- We use **more than one** specification for measuring **investment (in)efficiency** for robustness.
- **Estimate investment inefficiency** using **firm-specific levels** of **cash** and **leverage** as **ex ante firm-specific characteristics** may affect the **likelihood** of a firm to **over-** or **under-invest,** (Biddle et al., 2009); Cheng et al., 2013; Chen et al., 2017b).
- Calculate the **ranked variable** $\boldsymbol{OverFirm_{i,t}}$ as the **average** of **ranked decile measures** of **cash** and **leverage**, calculated according to **year** and **FF48 industry** sectors (Chen et al., 2017b), and **rescaled** from **0 to 1**.
- **Underlying** premise is that **firms without cash** are **more likely** to be **financially constrained** and thus **prone to under-invest**, while **firms** with **high cash balances** are more **vulnerable** to **agency problems** (Jensen, 1986) and **more prone** to **over-invest** (Biddle et al., 2009).
- **Firms** with **high leverage** should be **more prone** to **under-investing** in case they are **more financially constrained**, thus **more vulnerable** to **debt overhang problems** (Biddle et al. 2009).
- Under this premise, a **firm's likelihood** to **over(under)-invest increases (decreases)** with **cash** and **decreases (increases)** with **leverage.**
- For $\boldsymbol{OverFirm_{i,t}}$ **measurement**, **leverage** is **multiplied** by **minus one** so that it **increases** with the **likelihood** of **over-investment,** while a **high (low)** value of $\boldsymbol{OverFirm_{i,t}}$ is indicative of a firm **prone** to **over(under)-investment.**

Research methodology - alternative model specification (1)

To estimate the association of **options trading** volume in **year *t*** with **investment efficiency** in **year *t+1***, we follow the methodology of **Chen et al. (2017b)** based on Biddle et al. (2009) (also Cheng et al, 2013; García Lara et al., 2016) and estimate the following equation:

$$Inv_{i,t+1}\ (or\ Capex_{i,t+1}, or\ NonCapex_{i,t+1}) = \zeta_0 + \zeta_1 LnOptVol_{i,t} + \zeta_2 OverFirm_{i,t} + \zeta_3 LnOptVol_{i,t} \times OverFirm_{i,t} + \sum_n \theta_n Controls_{n,i,t} + \sum_m \psi_m Year\ Fixed\ Effects_m + e_{i,t} \quad (5)$$

Our **independent variables** of **interest** are $\boldsymbol{LnOptVol_{i,t}}$ and the **multiplicative term** with $\boldsymbol{OverFirm_{i,t}}$.

- If **options trading volume** is **negatively** associated with **under-investment**, then coefficient $\boldsymbol{\zeta_1}$ should be **positive** and **significant.**
- $\boldsymbol{\zeta_1}$ measures the relation between **options trading volume** and **investment** when **under-investment** is **most likely.**
- As $\boldsymbol{\zeta_3}$ measures the **incremental** relation between **options trading volume** and **investment** as **over-investment** becomes **more likely,** the **sum** of the **coefficients** $\boldsymbol{\zeta_1 + \zeta_3}$ measures the relation between **options trading activity** and **investment** when **over-investment** is **most likely** (Biddle et al., 2009).
- If **options trading volume** is **negatively** associated with **over-investment,** $\boldsymbol{\zeta_1 + \zeta_3}$ should be **negative**.

Research methodology - alternative model specification (2)

Control variables include proxies for **monitoring** and **governance mechanisms** and **standard determinants** of **investment** (Biddle et al. 2009; Cheng et al., 2013; García Lara et al., 2016; Chen et al., 2017b).

- Controls for **monitoring/governance**: **institutional holdings ($INST_{i,t}$)** and **coverage** by **financial analysts ($LogAnalysts_{i,t}$).**
- Also include a proxy for **accounting quality ($AQ_{i,t}$)** (Chen et al., 2017b).
- These **variables** are **interacted** with $OverFirm_{i,t}$ to control for their **association** with **over-** and **under-investment**.

Controls for **investment drivers:**

leverage at the **industry level** ($Ind\ K - structure_{i,t}$), and other standard controls: firm size ($LogTA_{i,t}$), the market-to-book ratio ($MB_{i,t}$), cash flow from operations ($CFOSales_{i,t}$), a tangibility indicator ($Tangibility_{i,t}$), a binary dividend payment indicator ($Dividend_{i,t}$), the firm's operating cycle ($OperCycle_{i,t}$), a negative profit indicator ($Loss_{i,t}$), Altman's (1968) Z score for bankruptcy risk ($ZScore_{i,t}$), firm age ($LogAge_{i,t}$), and the standard deviations of cash flow from operations ($\sigma(CFO)_{i,t}$), sales ($\sigma(Sales)_{i,t}$) and investment ($\sigma(I)_{i,t}$**).**

Equation (5) estimated with year **fixed effects** and **standard errors double-clustered** at the **firm** and **industry** levels (FF48 sectors).

Table 2, Effect of options volume on investment inefficiency, panel OLS estimates, **baseline model results - Equation (3)**

Table 2, Panel A Effect of options volume on investment inefficiency, panel OLS estimates

	Dependent variable: $INV\_INEFF_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF_{i,t+1}$	$NonCapex\_INEFF_{i,t+1}$
$LnOptVol_{i,t}$	**-0.9161*** **	**-0.2107**	**-0.9402*** **	**-0.2028**	**-0.6861*** **
	(0.2703)	**(0.3837)**	**(0.2208)**	**(0.1380)**	**(0.2409)**
$Lev_{i,t}$	-4.5977***	0.9557	0.6345	-2.4537***	-1.7502***
	(0.6639)	(1.4692)	(0.4481)	(0.3911)	(0.5641)
$LogTA_{i,t}$	-0.4518***	-1.2217***	0.2382***	-0.1254**	-0.3533***
	(0.1137)	(0.1918)	(0.0879)	(0.0572)	(0.0988)
$MB_{i,t}$	1.1528***	0.9204***	-0.2302***	0.4756***	0.6886***
	(0.1374)	(0.1878)	(0.0735)	(0.0363)	(0.1262)
$\sigma(I)_{i,t}$	1.1570***	2.5392***	-1.3235***	0.2528	0.9712***
	(0.4275)	(0.5522)	(0.2822)	(0.1752)	(0.3757)
$\sigma(CFO)_{i,t}$	3.6277	7.9775*	-5.7600***	2.4708***	1.0622
	(2.9139)	(4.2109)	(1.5193)	(0.8324)	(2.6406)
$\sigma(Sales)_{i,t}$	2.0893***	-0.0863	0.8252**	-0.5263*	2.4614***
	(0.7086)	(1.1177)	(0.3935)	(0.2983)	(0.6235)
$Tangibility_{i,t}$	6.6162***	-3.1477***	3.1341***	7.6218***	-0.7313
	(0.6011)	(0.9986)	(0.4182)	(0.4288)	(0.4615)
$OperCycle_{i,t}$	-0.4531***	-0.9828***	0.4803***	0.5049***	-0.9333***
	(0.1460)	(0.2525)	(0.0946)	(0.0514)	(0.1293)
$Loss_{i,t}$	-2.4560***	-3.2707***	-0.8234***	-0.8024***	-1.5129***
	(0.3229)	(0.6430)	(0.1602)	(0.1148)	(0.2927)
$CFOSales_{i,t}$	-0.0499	-0.0444	-0.0001	0.0406***	-0.0894*
	(0.0564)	(0.0610)	(0.0190)	(0.0092)	(0.0515)
$Dividend_{i,t}$	-0.2100	-0.3753	0.8670***	-0.9133***	0.6377**
	(0.3058)	(0.5336)	(0.2142)	(0.1437)	(0.2707)
$Slack_{i,t}$	-0.0042***	-0.0012	-0.0034***	-0.0003	-0.0040***
	(0.0012)	(0.0009)	(0.0006)	(0.0002)	(0.0012)
$ZScore_{i,t}$	-1.0203***	-1.4134***	0.3006***	0.3031***	-1.3257***
	(0.2265)	(0.2949)	(0.0862)	(0.0438)	(0.2086)
$LogAge_{i,t}$	-0.0132*	-0.0120	-0.0031	-0.0177***	0.0054
	(0.0073)	(0.0126)	(0.0057)	(0.0043)	(0.0065)
Intercept	-0.2310	27.0659***	-14.9751***	-5.0623***	4.6594***
	(1.4011)	(2.5029)	(0.8177)	(0.5333)	(1.2462)
Year FE	YES	YES	YES	YES	YES
N	34,090	10,441	23,649	34,090	34,090
R-square	0.0622	0.0915	0.1117	0.1207	0.0452
No of firms	4,860	3,121	4,306	4,860	4,860

Table 2, Effect of options volume on investment inefficiency, panel OLS estimates, **alternative investment inefficiency measure - Equation 3 with** $INV\_INEFF^{GO}_{i,t+1}$

Table 2, Panel B Effect of options volume on investment inefficiency, panel OLS estimates

	Dependent variable: $INV\_INEFF^{GO}_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF^{GO}_{i,t+1}$	$NonCapex\_INEFF^{GO}_{i,t+1}$
$LnOptVol_{i,t}$	**-0.7802*** **	**0.0033**	**-1.0044*** **	**-0.2154**	**-0.5524** **
	(0.2796)	**(0.4443)**	**(0.2161)**	**(0.1339)**	**(0.2501)**
$Lev_{i,t}$	-0.1542	-2.1688*	2.9279***	-1.8475***	1.7966***
	(0.7275)	(1.2250)	(0.4786)	(0.3960)	(0.6134)
$LogTA_{i,t}$	-0.6558***	-1.3388***	0.2359***	-0.0670	-0.6217***
	(0.1155)	(0.1984)	(0.0891)	(0.0538)	(0.1033)
$MB_{i,t}$	1.1103***	0.8406***	-0.2279***	0.5310***	0.5931***
	(0.1698)	(0.2467)	(0.0785)	(0.0487)	(0.1544)
$\sigma(I)_{i,t}$	0.6949	3.2232***	-1.2118***	0.2340	0.4827
	(0.4567)	(0.7383)	(0.2862)	(0.1885)	(0.3852)
$\sigma(CFO)_{i,t}$	6.5919**	5.9403	-3.0303*	4.4631***	2.3806
	(3.2223)	(4.8030)	(1.7488)	(1.1786)	(2.9306)
$\sigma(Sales)_{i,t}$	2.0894***	-0.5862	1.1106**	-0.9164***	2.8552***
	(0.6923)	(1.1245)	(0.4457)	(0.3419)	(0.5868)
$Tangibility_{i,t}$	5.8797***	-4.0547***	2.5263***	6.3930***	-0.3792
	(0.5989)	(1.0297)	(0.4336)	(0.4400)	(0.4589)
$OperCycle_{i,t}$	-0.8811***	-0.8266***	-0.2303*	0.3828***	-1.2438***
	(0.1888)	(0.2972)	(0.1348)	(0.0754)	(0.1655)
$Loss_{i,t}$	-2.2677***	-3.7541***	-0.4956***	-0.5489***	-1.6370***
	(0.3021)	(0.6349)	(0.1735)	(0.1248)	(0.2668)
$CFOSales_{i,t}$	-0.1050**	0.0131	-0.0420	0.0423***	-0.1479***
	(0.0516)	(0.0402)	(0.0256)	(0.0140)	(0.0474)
$Dividend_{i,t}$	-0.3359	-0.1552	0.6713***	-1.0549***	0.7046**
	(0.3088)	(0.5538)	(0.2136)	(0.1555)	(0.2728)
$Slack_{i,t}$	-0.0019	0.0007	-0.0013***	-0.0005**	-0.0014
	(0.0012)	(0.0012)	(0.0003)	(0.0002)	(0.0011)
$ZScore_{i,t}$	-0.3088*	-1.4584***	0.5812***	0.3455***	-0.6848***
	(0.1876)	(0.2410)	(0.1126)	(0.0532)	(0.1693)
$LogAge_{i,t}$	-0.0061	-0.0218*	0.0086	-0.0114***	0.0055
	(0.0069)	(0.0121)	(0.0054)	(0.0039)	(0.0062)
Intercept	2.2880	28.1268***	-11.9992***	-4.2456***	6.6152***
	(1.6116)	(2.7489)	(1.0171)	(0.6405)	(1.4414)
Year FE	YES	YES	YES	YES	YES
N	29,050	8,851	20,199	29,050	29,050
R-square	0.0455	0.0790	0.1063	0.0945	0.0310
No of firms	4,290	2,843	3,811	4,290	4,290

Table 2, Effect of options volume on investment inefficiency, panel OLS estimates, **alternative investment inefficiency measure (1) - Equation 3 with** $\boldsymbol{INV\_INEFF^{GO,M}_{i,t+1}}$

Table 2, Panel C Effect of options volume on investment inefficiency, panel OLS estimates

	Dependent variable: $INV\_INEFF^{GO,M}_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF^{GO,M}_{i,t+1}$	$NonCapex\_INEFF^{GO,M}_{i,t+1}$
$\boldsymbol{LnOptVol_{i,t}}$	**-0.7407*** **	**-0.1757**	**-0.7591*** **	**-0.1929**	**-0.5179*** **
	(0.2361)	**(0.3571)**	**(0.1600)**	**(0.1395)**	**(0.1972)**
$Lev_{i,t}$	-5.3518***	0.4494	-0.4464	-2.1569***	-2.7165***
	(0.6353)	(1.3276)	(0.4010)	(0.3926)	(0.5257)
$LogTA_{i,t}$	-0.3276***	-1.1486***	0.3259***	-0.1578***	-0.2071**
	(0.1034)	(0.1806)	(0.0701)	(0.0577)	(0.0865)
$MB_{i,t}$	1.3963***	0.8992***	0.0081	0.4849***	0.9170***
	(0.1408)	(0.1762)	(0.0627)	(0.0367)	(0.1298)
$\sigma(I)_{i,t}$	1.4783***	2.5573***	-0.9544***	0.1791	1.3520***
	(0.4292)	(0.5441)	(0.2443)	(0.1745)	(0.3769)
$\sigma(CFO)_{i,t}$	3.2472	9.2613**	-6.4197***	2.5007***	0.9284
	(2.9175)	(3.8720)	(1.4520)	(0.8343)	(2.6574)
$\sigma(Sales)_{i,t}$	1.2508*	-0.2997	0.1728	-0.3503	1.4542**
	(0.6802)	(1.0013)	(0.3902)	(0.2970)	(0.5937)
$Tangibility_{i,t}$	5.6978***	-2.6583***	2.4005***	7.1811***	-1.3592***
	(0.5749)	(0.9527)	(0.3751)	(0.4284)	(0.4268)
$OperCycle_{i,t}$	-0.2690**	-1.0764***	0.6559***	0.4859***	-0.7078***
	(0.1341)	(0.2274)	(0.0793)	(0.0518)	(0.1173)
$Loss_{i,t}$	-2.5706***	-3.1012***	-1.0229***	-0.6845***	-1.7474***
	(0.3135)	(0.5807)	(0.1549)	(0.1152)	(0.2803)
$CFOSales_{i,t}$	-0.0053	-0.0351	0.0561**	0.0310***	-0.0337
	(0.0602)	(0.0627)	(0.0222)	(0.0088)	(0.0546)
$Dividend_{i,t}$	-0.8414***	-0.3999	0.4383**	-0.9015***	0.0116
	(0.2842)	(0.5042)	(0.1741)	(0.1435)	(0.2452)
$Slack_{i,t}$	-0.0033**	-0.0007	-0.0030***	-0.0003	-0.0027*
	(0.0016)	(0.0016)	(0.0006)	(0.0002)	(0.0016)
$ZScore_{i,t}$	-0.7062***	-1.5327***	0.4331***	0.2328***	-0.9464***
	(0.2182)	(0.2497)	(0.0973)	(0.0449)	(0.1989)
$LogAge_{i,t}$	-0.0176***	-0.0063	-0.0057	-0.0186***	0.0023
	(0.0067)	(0.0121)	(0.0046)	(0.0043)	(0.0056)
Intercept	-0.4237	26.8658***	-15.1316***	-4.4683***	3.8595***
	(1.3352)	(2.2705)	(0.7002)	(0.5350)	(1.1777)
Year FE	YES	YES	YES	YES	YES
N	34,044	10,964	23,080	34,044	34,044
R-square	0.0657	0.0913	0.1169	0.1207	0.0437
No of firms	4,857	3,230	4,286	4,857	4,857

Table 3 Effect of options volume on over and under-investment, panel OLS estimates for **alternative model specification when measuring investment efficiency - Equation (4)**

Table 3 Effect of options volume on over and under-investment, panel OLS estimates

Independent variables	Dependent variable: $INV_{i,t+1}$	Dependent variable: $Capex_{i,t+1}$	Dependent variable: $NonCapex_{i,t+1}$
$\boldsymbol{LnOptVol_{i,t}}$	**1.8798*** **	**-0.2530**	**2.1217*** **
	(0.5821)	**(0.2836)**	**(0.5021)**
$\boldsymbol{LnOptVol_{i,t} \times OverFirm_{i,t}}$	**-3.3961*** **	**0.6758**	**-4.0242*** **
	(1.0374)	**(0.5028)**	**(0.9029)**
Wald test, sum of coefficients $LnOptVol_{i,t}$ and $LnVOptol_{i,t} \times OverFirm_{i,t}$, F-statistic	**7.06**	**2.50**	**14.22**
p-value	**[0.0079]**	**[0.1143]**	**[0.0002]**
$INST_{i,t}$	0.0880	0.1153	-0.1277
	(0.3373)	(0.1516)	(0.2523)
$INST_{i,t} \times OverFirm_{i,t}$	-0.2294	-0.2272	0.2062
	(0.6915)	(0.3059)	(0.5258)
$LogAnalysts_{i,t}$	2.2249**	0.9971*	1.3693*
	(0.9419)	(0.5102)	(0.8050)
$LogAnalysts_{i,t} \times OverFirm_{i,t}$	1.9496	-0.7514	2.4776
	(1.7463)	(0.8784)	(1.5298)
$AQ_{i,t}$	-8.0281	-2.6513	-5.5463
	(9.3854)	(3.5143)	(8.7549)
$AQ_{i,t} \times OverFirm_{i,t}$	21.1154	5.1670	16.5933
	(14.2530)	(5.4930)	(13.3441)
$OverFirm_{i,t}$	4.3797**	3.4920***	0.7168
	(1.6971)	(0.8003)	(1.4854)
$Ind\ K-structure_{i,t}$	-17.1003***	-6.4683***	-10.4941***
	(1.4247)	(0.8154)	(1.1962)
$LogTA_{i,t}$	-1.2597***	-0.1512**	-1.1417***
	(0.1291)	(0.0634)	(0.1114)
$MB_{i,t}$	1.9113***	0.4159***	1.4619***
	(0.1836)	(0.0323)	(0.1792)
$\sigma(I)_{i,t}$	2.5848***	1.0968***	1.5515***
	(0.5284)	(0.2883)	(0.4590)
$\sigma(CFO)_{i,t}$	27.0123***	5.4243***	21.4581***
	(3.5073)	(1.1974)	(3.2017)
$\sigma(Sales)_{i,t}$	-1.5971**	0.1111	-1.7414**
	(0.8063)	(0.2227)	(0.7489)
$Tangibility_{i,t}$	6.3732***	19.0932***	-11.8630***
	(0.7474)	(0.5984)	(0.5521)
$OperCycle_{i,t}$	-0.6234***	0.2281***	-0.8584***
	(0.2228)	(0.0744)	(0.2095)
$Loss_{i,t}$	-2.3503***	-0.9984***	-1.1488***
	(0.4303)	(0.1260)	(0.3886)
$CFOSales_{i,t}$	-0.0963**	0.0464***	-0.1416***
	(0.0429)	(0.0105)	(0.0411)
$Dividend_{i,t}$	-1.6768***	-0.9815***	-0.7319***
	(0.3175)	(0.1527)	(0.2806)
$Slack_{i,t}$	-0.0023***	-0.0005*	-0.0017***
	(0.0007)	(0.0003)	(0.0005)
$ZScore_{i,t}$	-2.2712***	0.3114***	-2.5379***
	(0.3108)	(0.0505)	(0.2852)
$LogAge_{i,t}$	-0.0067	-0.0197***	0.0133**
	(0.0068)	(0.0035)	(0.0063)
Intercept	23.9225***	0.2541	24.1218***
	(2.0805)	(0.7761)	(1.9037)
Year FE	YES	YES	YES
N	30,059	30,059	30,059
R-square	0.1900	0.3730	0.2256
No of firms	4,206	4,206	4,206

Results - Controlling for endogeneity

- **Baseline** results **consistent** with our main **hypothesis**, but **potential endogeneity concerns** could muddy this association.

- This could be the case if **both options trading volume** and **firm-level investment efficiency** are **jointly affected** by factors **unobservable** to the **empiricist** but **observable** to **traders** (Blanco and Wehrheim, 2017), as may be the case, for example, if **traders adjust** their **trading patterns** in light of **anticipated efficient investing** by **firms**.

- If such **factors correlate positively** with the **level** of **options trading**, model **inferences** could be **biased.**

- In a similar vein, **options volume** could be **endogenously determined** by the **efficiency** of firm **investment** or **efficient investment** and **options trading volumes** may be **simultaneously determined** by the **informational efficiency** of **firms**.

Following previous research, we use **two main methods** to **mitigate** such **potential endogeneity** concerns.

Results - Controlling for endogeneity (1)

1. Following Roll et al. (2009) (also Blanco and Werheim, 2017; Cao et al., 2020a; Cao et al., 2020b, Chen et al., 2020), we employ a **two-stage GMM estimation** with **instrumental variables**.

We use **option moneyness** and **option open interest** as **IVs** for options trading volume.

- The two instruments for the **volume** of options trading should **satisfy** a **relevance condition** (**correlated** with **options trading volume**), and also **satisfy** the **exclusion** criterion (**uncorrelated** with firm-level **investment efficiency**)
- **Moneyness** is related to **options trading** because of a **preference** of **informed** (**uninformed) traders** for **OTM (ITM)** options, and because **volatility traders** tend to avoid **deep ITM and OTM options** (Roll et al., 2009; Blanco and Wehrheim, 2017) in preference for **ATM** options (Chakravarty et al., 2004).
- **Open interest** indicates **unsettled option contracts** (Chen et al., 2020) and should be **higher** when **more open positions** for **option calls-puts** exist and when **options volumes** are **higher** (Ali et al., 2020).

Option moneyness: annual average absolute difference between a firm's **stock price** and the **strike price** of **traded options** as in Chen et al. (2020) and Ni et al. (2005); **Open interest: average open interest across all options** on a **firm's stock** throughout the **fiscal year** as in Cao et al. (2020b).

- option exchanges periodically list new options with **strike prices close** to the stock's **market price** (Blanco and Wehrheim, 2017), so there is **no reason** to expect that the degree of **moneyness** of **traded options** should be **linked intrinsically** to **investment efficiency; open interest (with both call and put options)** will be **higher** when there are **more open positions** for **calls** and **puts**, and this should **not** be **intrinsically** linked to **efficient investing**.

Results - Controlling for endogeneity (2)

2. We apply **PSM** among firms with **high vs. low options trading activity** to test whether **otherwise similar matched firms** that differ **only** in the **volumes** of their **traded option contracts** exhibit **distinctly different** levels of **firm-level investment inefficiency.**

High (low) options trading activity firms are defined as those with **options trading volume above (below)** their **industry** (based on FF48 sectors)-**year median**.

The **former ("high")** group represents our **treatment** firms, while firms with **"low" options trading activity** represent the **control firms.**

Perform **PSM** between our **treatment** and **control** firms based on one to one, nearest-neighbor matching with replacement where **all** the **control variables** used in equation (4) are employed to produce the **propensity scores**, following Ali et al. (2020).

Table 4, Effect of options volume on investment efficiency, two-step GMM IV estimates **baseline model results - Equation (3)**

Table 4, Panel A Effect of options volume on investment efficiency, two-step GMM IV estimates

Effect on investment inefficiency, two-step GMM IV estimates					
	Dependent variable: $INV\_INEFF_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF_{i,t+1}$	$NonCapex\_INEFF_{i,t+1}$
$\boldsymbol{LnOptVol_{i,t}}$	**-1.3424** **(0.5663)**	**-0.3242** **(0.5439)**	**-1.4874*** **(0.4880)**	**-0.0669** **(0.2346)**	**-1.1420**** **(0.4791)**
$Lev_{i,t}$	-4.8670*** (0.7329)	0.8562 (1.5184)	0.3411 (0.5008)	-2.3802*** (0.4043)	-2.0391*** (0.6188)
$LogTA_{i,t}$	-0.3465** (0.1615)	-1.1899*** (0.2282)	0.3671*** (0.1311)	-0.1560** (0.0731)	-0.2386* (0.1381)
$MB_{i,t}$	1.1833*** (0.1420)	0.9270*** (0.1873)	-0.1803** (0.0830)	0.4642*** (0.0386)	0.7094*** (0.1293)
$\sigma(I)_{i,t}$	1.1641*** (0.4264)	2.5381*** (0.5513)	-1.3130*** (0.2794)	0.2571 (0.1751)	0.9893*** (0.3748)
$\sigma(CFO)_{i,t}$	4.0749 (2.9622)	8.0714* (4.2178)	-5.0914*** (1.6105)	2.2983*** (0.8622)	1.4250 (2.6681)
$\sigma(Sales)_{i,t}$	2.1780*** (0.7122)	-0.0607 (1.1165)	0.9325** (0.3973)	-0.5296* (0.3010)	2.5530*** (0.6281)
$Tangibility_{i,t}$	6.6509*** (0.6020)	-3.1474*** (0.9971)	3.1914*** (0.4200)	7.6400*** (0.4286)	-0.6512 (0.4623)
$OperCycle_{i,t}$	-0.4673*** (0.1471)	-0.9847*** (0.2517)	0.4613*** (0.0959)	0.5164*** (0.0518)	-0.9482*** (0.1302)
$Loss_{i,t}$	-2.3910*** (0.3313)	-3.2518*** (0.6420)	-0.7419*** (0.1732)	-0.8132*** (0.1170)	-1.4507*** (0.2990)
$CFOSales_{i,t}$	-0.0508 (0.0563)	-0.0446 (0.0609)	-0.0012 (0.0189)	0.0408*** (0.0092)	-0.0912* (0.0514)
$Dividend_{i,t}$	-0.2865 (0.3119)	-0.3951 (0.5363)	0.7739*** (0.2178)	-0.9165*** (0.1466)	0.5358* (0.2754)
$Slack_{i,t}$	-0.0042*** (0.0012)	-0.0012 (0.0009)	-0.0034*** (0.0006)	-0.0003 (0.0002)	-0.0040*** (0.0012)
$ZScore_{i,t}$	-1.0207*** (0.2258)	-1.4146*** (0.2934)	0.2961*** (0.0855)	0.3013*** (0.0439)	-1.3038*** (0.2075)
$LogAge_{i,t}$	-0.0123* (0.0072)	-0.0120 (0.0125)	-0.0014 (0.0056)	-0.0173*** (0.0043)	0.0058 (0.0064)
Intercept	-0.9123 (1.5618)	26.8712*** (2.6031)	-15.8473*** (1.0217)	-4.8898*** (0.6035)	3.9089*** (1.3759)
Year FE	YES	YES	YES	YES	YES
Hansen's J statistic *p-value*	0.024 [0.8764]	0.001 [0.9795]	0.015 [0.9036]	5.274 [0.0216]	1.405 [0.2360]
N	34,090	10,441	23,649	34,090	34,090
R-square	0.0621	0.0915	0.1101	0.1205	0.0449
No of firms	4,860	3,121	4,306	4,860	4,860

Table 4, Effect of options volume on investment efficiency, two-step GMM IV estimates, **alternative investment inefficiency measure - Equation 3 with** $\boldsymbol{INV\_INEFF^{GO}_{i,t+1}}$

Table 4, Panel B Effect of options volume on investment efficiency, two-step GMM IV estimates

Effect on investment inefficiency, two-step GMM IV estimates					
	Dependent variable: $INV\_INEFF^{GO}_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF^{GO}_{i,t+1}$	$NonCapex\_INEFF^{GO}_{i,t+1}$
$LnOptVol_{i,t}$	**-1.2392****	**-0.3496**	**-1.8037*****	**-0.1479**	**-1.0504****
	(0.5979)	**(0.6509)**	**(0.4993)**	**(0.2351)**	**(0.5080)**
$Lev_{i,t}$	-0.4188	-2.3266*	2.5042***	-1.8501***	1.4823**
	(0.7936)	(1.2641)	(0.5310)	(0.4035)	(0.6709)
$LogTA_{i,t}$	-0.5409***	-1.2594***	0.4304***	-0.0825	-0.4939***
	(0.1690)	(0.2415)	(0.1374)	(0.0723)	(0.1468)
$MB_{i,t}$	1.1500***	0.8763***	-0.1477	0.5216***	0.6226***
	(0.1753)	(0.2468)	(0.0902)	(0.0507)	(0.1586)
$\sigma(I)_{i,t}$	0.7046	3.2350***	-1.1959***	0.2295	0.4936
	(0.4562)	(0.7367)	(0.2828)	(0.1883)	(0.3846)
$\sigma(CFO)_{i,t}$	7.2021**	6.3559	-1.9453	4.3523***	2.9489
	(3.2863)	(4.8453)	(1.8641)	(1.2109)	(2.9702)
$\sigma(Sales)_{i,t}$	2.1854***	-0.5289	1.2675***	-0.9016***	2.9639***
	(0.6986)	(1.1190)	(0.4501)	(0.3459)	(0.5933)
$Tangibility_{i,t}$	5.9121***	-4.0464***	2.6113***	6.4216***	-0.3088
	(0.5987)	(1.0286)	(0.4350)	(0.4400)	(0.4593)
$OperCycle_{i,t}$	-0.8814***	-0.8223***	-0.2373*	0.3857***	-1.2430***
	(0.1883)	(0.2969)	(0.1343)	(0.0753)	(0.1652)
$Loss_{i,t}$	-2.1935***	-3.7304***	-0.3743**	-0.5549***	-1.5616***
	(0.3121)	(0.6440)	(0.1877)	(0.1282)	(0.2752)
$CFOSales_{i,t}$	-0.1053**	0.0141	-0.0428*	0.0421***	-0.1486***
	(0.0514)	(0.0400)	(0.0257)	(0.0139)	(0.0472)
$Dividend_{i,t}$	-0.4073	-0.2143	0.5444**	-1.0639***	0.6163**
	(0.3148)	(0.5564)	(0.2202)	(0.1590)	(0.2775)
$Slack_{i,t}$	-0.0019	0.0007	-0.0013***	-0.0005**	-0.0014
	(0.0012)	(0.0012)	(0.0003)	(0.0002)	(0.0011)
$ZScore_{i,t}$	-0.3152*	-1.4621***	0.5777***	0.3437***	-0.6754***
	(0.1872)	(0.2401)	(0.1108)	(0.0533)	(0.1686)
$LogAge_{i,t}$	-0.0049	-0.0211*	0.0106**	-0.0113***	0.0061
	(0.0068)	(0.0121)	(0.0052)	(0.0039)	(0.0060)
Intercept	1.4490	27.5627***	-13.4546***	-4.1242***	5.6820***
	(1.8081)	(2.9167)	(1.2336)	(0.7273)	(1.5950)
Year FE	YES	YES	YES	YES	YES
Hansen's J statistic	0.043	0.422	0.328	0.070	0.626
p-value	[0.8350]	[0.5158]	[0.5669]	[0.7920]	[0.4288]
N	29,050	8,851	20,199	29,050	29,050
R-square	0.0452	0.0789	0.1028	0.0944	0.0442
No of firms	4,290	2,843	3,811	4,290	4,290

Table 4, Panel C Effect of options volume on investment efficiency, two-step GMM IV estimates

Table 4, Effect of options volume on investment efficiency, two-step GMM IV estimates, **alternative investment inefficiency measure (1) - Equation 3 with** $INV\_INEFF^{GO,M}_{i,t+1}$

Effect on investment inefficiency, two-step GMM IV estimates					
	Dependent variable: $INV\_INEFF^{GO,M}_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF^{GO,M}_{i,t+1}$	$NonCapex\_INEFF^{GO,M}_{i,t+1}$
$\boldsymbol{LnOptVol_{i,t}}$	**-1.0630****	**-0.2089**	**-1.2619*****	**0.0031**	**-0.7757****
	(0.4811)	**(0.5462)**	**(0.3626)**	**(0.2368)**	**(0.3695)**
$Lev_{i,t}$	-5.5692***	0.4261	-0.7081	-2.0569***	-2.9186***
	(0.6868)	(1.3620)	(0.4333)	(0.4048)	(0.5621)
$LogTA_{i,t}$	-0.2439*	-1.1410***	0.4417***	-0.2015***	-0.1307
	(0.1426)	(0.2225)	(0.0991)	(0.0735)	(0.1150)
$MB_{i,t}$	1.4115***	0.9020***	0.0528	0.4691***	0.9074***
	(0.1439)	(0.1772)	(0.0695)	(0.0391)	(0.1312)
$\sigma(I)_{i,t}$	1.4977***	2.5580***	-0.9562***	0.1871	1.3865***
	(0.4283)	(0.5431)	(0.2427)	(0.1743)	(0.3762)
$\sigma(CFO)_{i,t}$	3.5148	9.2890**	-5.8362***	2.2446***	0.9683
	(2.9526)	(3.9056)	(1.5071)	(0.8624)	(2.6694)
$\sigma(Sales)_{i,t}$	1.3266*	-0.2933	0.2657	-0.3588	1.5132**
	(0.6817)	(0.9982)	(0.3915)	(0.2999)	(0.5955)
$Tangibility_{i,t}$	5.7344***	-2.6579***	2.4578***	7.2025***	-1.2812***
	(0.5754)	(0.9510)	(0.3763)	(0.4281)	(0.4275)
$OperCycle_{i,t}$	-0.2819**	-1.0779***	0.6369***	0.5010***	-0.7142***
	(0.1349)	(0.2266)	(0.0798)	(0.0522)	(0.1177)
$Loss_{i,t}$	-2.5260***	-3.0991***	-0.9606***	-0.7007***	-1.7162***
	(0.3199)	(0.5858)	(0.1610)	(0.1172)	(0.2843)
$CFOSales_{i,t}$	-0.0063	-0.0351	0.0549**	0.0315***	-0.0355
	(0.0601)	(0.0626)	(0.0221)	(0.0088)	(0.0545)
$Dividend_{i,t}$	-0.9054***	-0.4054	0.3483*	-0.9028***	-0.0592
	(0.2898)	(0.5096)	(0.1785)	(0.1471)	(0.2491)
$Slack_{i,t}$	-0.0032**	-0.0007	-0.0029***	-0.0003	-0.0026*
	(0.0016)	(0.0016)	(0.0006)	(0.0002)	(0.0016)
$ZScore_{i,t}$	-0.6973***	-1.5342***	0.4303***	0.2302***	-0.9069***
	(0.2175)	(0.2489)	(0.0968)	(0.0449)	(0.1978)
$LogAge_{i,t}$	-0.0171**	-0.0062	-0.0046	-0.0181***	0.0024
	(0.0066)	(0.0120)	(0.0045)	(0.0044)	(0.0056)
Intercept	-0.9577	26.8247***	-15.8912***	-4.2121***	3.3546***
	(1.4657)	(2.4034)	(0.8261)	(0.6044)	(1.2717)
Year FE	YES	YES	YES	YES	YES
Hansen's J statistic	0.626	0.005	1.769	0.494	0.061
p-value	[0.4287]	[0.9411]	[0.1835]	[0.4823]	[0.8053]
N	34,044	10,964	23,080	34,044	34,044
R-square	0.0656	0.0915	0.1152	0.1118	0.0435
No of firms	4,857	3,230	4,286	4,857	4,857

Table 5 Effect of options volume, **propensity score matching**

Panel A: **average treatment effects** from **PSM**. **Panel B**: results of the **PSM** estimation of equation (4) for **treatment** and **control** firms, estimated for the entire **sample**, for the **over-investment (under-investment)** subsamples separately.

Table 5 Effect of options volume, propensity score matching analysis

Panel A Propensity score matching

Variables	Treatment (Firms with high options volume)	Control (Firms with low options volume)	*t-test*
$\boldsymbol{INV\_INEFF_{i,t}}$	**-0.2481**	**-1.8921**	**6.91*****
$\boldsymbol{Capex\_INEFF_{i,t}}$	**0.4124**	**-0.4174**	**8.80*****
$\boldsymbol{NonCapex\_INEFF_{i,t}}$	**-0.7017**	**-1.3991**	**3.38*****
$Lev_{i,t}$	0.2024	0.2024	-0.00
$LogTA_{i,t}$	8.2267	8.2269	0.01
$MB_{i,t}$	2.2540	2.2528	0.04
$\sigma(I)_{i,t}$	0.1253	0.1268	-0.18
$\sigma(CFO)_{i,t}$	0.0556	0.0559	-0.02
$\sigma(Sales)_{i,t}$	0.2084	0.2080	0.09
$Tangibility_{i,t}$	0.2538	0.2538	0.00
$OperCycle_{i,t}$	4.7537	4.7550	-0.08
$CFOSales_{i,t}$	-0.2120	-0.2187	0.00
$ZScore_{i,t}$	1.0547	1.0547	0.00

Panel B Propensity score matching panel OLS

	Dependent variable: $INV\_INEFF_{i,t+1}$			Dependent variable:	
Independent variables	Entire sample	Over-investment sample	Under-investment sample	$Capex\_INEFF_{i,t}$	$NonCapex\_INEFF_{i,t}$
$\boldsymbol{LnOptVol_{i,t}}$	**-0.7151***** **(0.2737)**	**-0.2080** **(0.3853)**	**-0.8108***** **(0.2261)**	**-0.1651** **(0.1422)**	**-0.5268**** **(0.2436)**
Controls	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES
N	25,670	8,374	17,138	25,670	25,670
R-square	0.0655	0.0895	0.1131	0.1214	0.0426

Results - The role of external monitoring

To examine whether the **volume** of **options trading relates** to **investment efficiency** through an **external monitoring channel,** as **predicted** by ***H3*:**

Estimate equation (4) by **interacting** $\boldsymbol{LnOptVol_{i,t}}$ with **measures** for the **strength** of **external monitoring**, as follows:

1. $\boldsymbol{LnOptVol_{i,t}}$ is **interacted** with a **variable** indicating the **magnitude** of **institutional blockholder ownership** (taking the value of **one (zero)** if a firm is **above (below)** the **sample-year median** for **institutional blockholder ownership (>= 5%,** as percentage of **fiscal year-end market capitalization**) using data from Thomson Reuters 13F)

2. Equation is **estimated** for firms **with** and **without** an **S&P credit rating** of their **long-term debt separately**.

Larger blockholder institutional ownership should **increase** the **strength** of **external monitoring** on the firm, while the **presence** or **absence** of **S&P credit rating** provides evidence of an **independent external assessment** (or **lack** of it) of the firm's **long-term survivability** prospects.

Table 6 Effect of options volume on investment efficiency, **external monitoring channel**

Table 6 Effect of options volume on investment efficiency, external monitoring channel

Independent variables	Dependent variable: $INV\_INEFF_{i,t+1}$ (1)	(2a) Firms with credit rating	(2b) Firms without credit rating
$\boldsymbol{LnOptVol_{i,t}}$	**-1.0438*** **	**-0.5519**	**-1.1360*** **
	(0.2812)	**(0.3425)**	**(0.3521)**
$\boldsymbol{InstitOwn.-top\ five\_H-L_{i,t}}$	**-1.0810*** **		
	(0.3062)		
$\boldsymbol{LnVol_{i,t} \times InstitOwn.-top\ five\_H-L_{i,t}}$	**0.9092***		
	(0.5075)		
$Lev_{i,t}$	-4.1806***	-6.2912***	-6.5775***
	(0.6738)	(1.0891)	(0.8737)
$LogTA_{i,t}$	-0.5864***	-1.5765***	-0.1940
	(0.1224)	(0.1936)	(0.1481)
$MB_{i,t}$	1.0883***	0.6941***	1.1973***
	(0.1413)	(0.2611)	(0.1537)
$\sigma(I)_{i,t}$	1.1350***	0.5723	1.1845**
	(0.4266)	(0.8061)	(0.4917)
$\sigma(CFO)_{i,t}$	3.5961	20.6012***	0.9020
	(2.9195)	(6.4012)	(3.1621)
$\sigma(Sales)_{i,t}$	2.0469***	-0.1423	2.6712***
	(0.7076)	(1.0197)	(0.9159)
$Tangibility_{i,t}$	6.4903***	7.7176***	6.2652***
	(0.6009)	(0.8761)	(0.7687)
$OperCycle_{i,t}$	-0.4450***	0.1431	-0.6246***
	(0.1463)	(0.2497)	(0.1742)
$Loss_{i,t}$	-2.3427***	-2.3066***	-2.1651***
	(0.3217)	(0.4203)	(0.4467)
$CFOSales_{i,t}$	-0.0482	0.2234	-0.0474
	(0.0566)	(0.1560)	(0.0576)
$Dividend_{i,t}$	-0.2741	-0.5586	0.0133
	(0.3062)	(0.4640)	(0.3875)
$Slack_{i,t}$	-0.0042***	0.0605*	-0.0043***
	(0.0012)	(0.0336)	(0.0012)
$ZScore_{i,t}$	-1.0144***	0.0794	-1.3410***
	(0.2263)	(0.2231)	(0.2854)
$LogAge_{i,t}$	-0.0134*	-0.0061	-0.0339***
	(0.0073)	(0.0087)	(0.0120)
Intercept	1.2370	4.2292*	0.4995
	(1.4878)	(2.3790)	(1.7914)
Year FE	YES	YES	YES
N	34,090	13,943	20,147
R-square	0.0630	0.0651	0.0782
No of firms	4.860	1.937	4.026

Results - Supplementary Analyses

Estimate **equation (4)** separately:

(a) for firm-year observations with **unexpected investment above/below sample-year median**,

(b) for firm-year observations with **number** of **business** and **geographical segments above/ below sample-year median** (i.e. more **complex operational** and **informational environments**).

(c) for firms **with** and **without CDS trading** (**user demand** for **one derivative instrument** can affect the **pricing** of **other derivatives** with **correlated unhedgeable risks** (Gârleanu et al., 2009; Chen et al. 2019)).

(a) Unexpected investment (**deviation** of a firm's **investment** from **expected levels** through estimating a regression of **total investment** on **growth opportunities** (Chen et al., 2017b) is considered an **indicator** of **poor firm performance** (Chen et al., 2017b):

- Firms with **high levels** of **unexpected investment** should be **in great need** of **any factor** with a **positive** effect on **efficient investing** due to their **poorer-than-average performance, compared** to firms with **low unexpected investment**.

(b) For **more informationally-obscure** firms, there is likely **more private information** to be **discovered** by **option market participants**, so **options market activity** may be ***more*** **important for information asymmetry mitigation** for **more informationally obscure** firms

- however, **multi-segment operations** have been associated with **capital allocation inefficiency /lower firm value** (Anagnostopoulou et al., 2021; Stein, 1997; Lamont and Polk, 2002; Denis et al., 2002), so they may **negatively *moderate*** the **association** between **options trading activity** and **inefficient firm investment**.

(c) Firms with **both traded options** and **CDSs** have **improved informational efficiency**, making the relation of **options trading volumes** and firm **investment efficiency *less* significant**.

Supplementary analysis

Table 7 Effect of options volume on investment efficiency, supplementary analysis

Independent variables	Dependent variable: $INV\_INEFF_{i,t+1}$							
	(1a) Unexpected investment above median	(1b) Unexpected investment below median	(2a) Business segments above median	(2b) Business segments below median	(3a) Geographical segments above median	(3b) Geographical segments above median	(4a) Firms with CDS trading	(4b) Firms without CDS trading
$LnOptVol_{i,t}$	**-0.5787** **(0.2639)**	**-0.4335** **(0.3213)**	**-0.3341** **(0.3294)**	**-1.2670*** **(0.3998)**	**-0.1592** **(0.3960)**	**-0.8381**** **(0.3575)**	**-0.0316** **(0.4970)**	**-1.2163*** **(0.3444)**
$Lev_{i,t}$	-7.5815*** (0.7490)	-0.2256 (0.7264)	-2.3720*** (0.8359)	-9.1025*** (1.0745)	-2.8269*** (1.0412)	-5.8604*** (0.9340)	-0.4835 (1.9075)	-5.4252*** (0.7109)
$LogTA_{i,t}$	-0.5482*** (0.1110)	-0.5742*** (0.1398)	-0.7597*** (0.1427)	-0.3684* (0.1906)	-1.0938*** (0.1782)	-0.1763 (0.1605)	-1.3858*** (0.3752)	-0.3748*** (0.1248)
$MB_{i,t}$	1.6598*** (0.1685)	0.4258*** (0.1184)	0.7607*** (0.1986)	1.3568*** (0.1680)	0.9021*** (0.1640)	1.3920*** (0.2194)	0.3978 (0.2926)	1.1972*** (0.1475)
$\sigma(I)_{i,t}$	1.1232** (0.5212)	0.7864 (0.5104)	0.7683 (0.7027)	1.3340** (0.5630)	1.1953* (0.6649)	0.3236 (0.4742)	-1.6344 (2.0977)	1.2643*** (0.4367)
$\sigma(CFO)_{i,t}$	5.1288 (3.4929)	-4.7628* (2.7620)	13.5215*** (4.8340)	-1.5562 (3.4926)	10.2191** (5.1475)	1.1695 (3.8836)	12.3626 (10.2384)	2.7695 (2.9935)
$\sigma(Sales)_{i,t}$	2.1090*** (0.7954)	0.6529 (0.7791)	0.2160 (0.8599)	2.8146*** (1.0467)	0.1795 (1.0764)	2.4584*** (0.9126)	-0.7791 (1.8788)	2.2639*** (0.7601)
$Tangibility_{i,t}$	6.3658*** (0.6617)	4.2473*** (0.6877)	5.3777*** (0.7574)	9.7352*** (0.9275)	4.0610*** (0.9587)	8.4923*** (0.8610)	6.9046*** (1.3514)	6.7433*** (0.6718)
$OperCycle_{i,t}$	-0.3554** (0.1423)	-0.8935*** (0.2128)	-0.6022** (0.2571)	-1.7511*** (0.2506)	-1.6846*** (0.3702)	-0.9036*** (0.2554)	-0.2504 (0.4331)	-0.4637*** (0.1564)
$Loss_{i,t}$	-1.6267*** (0.4223)	-2.6851*** (0.3031)	-3.1300*** (0.3300)	-1.0876* (0.5648)	-1.7650*** (0.4121)	-2.3944*** (0.4562)	-1.7920*** (0.6212)	-2.5060*** (0.3549)
$CFOSales_{i,t}$	-0.0824 (0.0674)	-0.0043 (0.0281)	-0.0895 (0.1315)	-0.0613 (0.0593)	-0.0365 (0.0883)	-0.1254 (0.1041)	1.5365 (2.2189)	-0.0454 (0.0566)
$Dividend_{i,t}$	-0.7204** (0.3364)	0.4453 (0.3594)	-0.2424 (0.3957)	-0.8159* (0.4658)	-0.2926 (0.4564)	-0.5816 (0.4260)	-0.3191 (0.8085)	-0.2827 (0.3284)
$Slack_{i,t}$	-0.0012 (0.0014)	-0.0049*** (0.0006)	-0.0033*** (0.0009)	-0.0046*** (0.0015)	-0.0038*** (0.0005)	-0.0045** (0.0018)	0.0977*** (0.0366)	-0.0042*** (0.0012)
$ZScore_{i,t}$	-1.5947*** (0.2687)	0.0959 (0.1368)	-0.3134 (0.2501)	-1.1173*** (0.3119)	-0.5807* (0.3079)	-0.9402*** (0.2487)	0.7551 (0.5085)	-1.1239*** (0.2415)
$LogAge_{i,t}$	-0.0117 (0.0071)	0.0026 (0.0089)	-0.0001 (0.0081)	-0.0462*** (0.0155)	-0.0069 (0.0110)	-0.0070 (0.0100)	-0.0171 (0.0129)	-0.0190* (0.0100)
Intercept	4.3700*** (1.6752)	-1.7736 (1.6994)	0.6394 (2.0702)	6.0975*** (2.1736)	10.1496*** (2.6682)	-0.4640 (2.1223)	4.0036 (4.4122)	-0.1843 (1.5303)
Year FE	YES	YES	YES	YES	YES	YES	YES	YES
N	17,684	15,889	19,403	13,784	15,165	13,400	5,551	28,539
R-square	0.1275	0.0340	0.0436	0.1015	0.0622	0.0690	0.0620	0.0638
No of firms	3,911	3,530	2,846	2,843	2,194	2,611	403	4,457

Results - Robustness tests

Estimate baseline **equation (4)** when **options trading activity** is measured **differently**:

Use total **number** of **option contracts** rather than their **dollar value** (Ali et al., 2020), employ **call** and **put option volumes separately** (Cao et al., 2020a), use the **absolute delta-weighted option volume,** based on Lakonishok et al. (2007).

(the **majority** of **trading** takes place in **ATM options** yet trading **ITM** or **OTM** options might convey **different** information, so **trading activity** measured using **all options** might be an **imperfect proxy** about **trading activity** that **incentivizes information gathering** by **investors** (Cao et al., 2020a)).

Robustness controls

Table 8 Effect of options volume on investment efficiency, robustness controls

	Dependent variable: $INV\_INEFF_{i,t+1}$			
Independent variables	(1)	(2)	(3)	(4)
$LnOptNon\$Vol_{i,t}$	**-0.1165***			
	(0.0612)			
$LnVolCalls_{i,t}$		**-1.0590*** **		
		(0.3339)		
$LnVolPuts_{i,t}$			**-1.0576*** **	
			(0.3718)	
$LnOptVolDelta_{i,t}$				**-0.1138** **
				(0.0498)
$Lev_{i,t}$	-4.2234***	-4.5517***	-4.3524***	-4.2820***
	(0.6662)	(0.6659)	(0.6667)	(0.7157)
$LogTA_{i,t}$	-0.5602***	-0.4698***	-0.5343***	-0.6430***
	(0.1165)	(0.1129)	(0.1100)	(0.1169)
$MB_{i,t}$	1.1199***	1.1504***	1.1204***	1.1331***
	(0.1363)	(0.1375)	(0.1349)	(0.1404)
$\sigma(I)_{i,t}$	1.1589***	1.1703***	1.0986***	1.0915**
	(0.4280)	(0.4279)	(0.4203)	(0.4353)
$\sigma(CFO)_{i,t}$	3.2871	3.4781	3.8520	2.6865
	(2.9211)	(2.9146)	(2.9096)	(3.0497)
$\sigma(Sales)_{i,t}$	1.9897***	2.0610***	1.7561**	2.0328***
	(0.7099)	(0.7085)	(0.6978)	(0.7548)
$Tangibility_{i,t}$	6.5862***	6.6213***	6.6356***	6.7313***
	(0.6019)	(0.6015)	(0.6009)	(0.6389)
$OperCycle_{i,t}$	-0.4542***	-0.4547***	-0.4353***	-0.5488***
	(0.1468)	(0.1465)	(0.1469)	(0.1567)
$Loss_{i,t}$	-2.5139***	-2.4777***	-2.4091***	-2.5385***
	(0.3240)	(0.3229)	(0.3217)	(0.3554)
$CFOSales_{i,t}$	-0.0504	-0.0491	-0.0450	-0.0532
	(0.0566)	(0.0566)	(0.0572)	(0.0588)
$Dividend_{i,t}$	-0.1569	-0.1960	-0.1959	0.0056
	(0.3075)	(0.3063)	(0.3056)	(0.3269)
$Slack_{i,t}$	-0.0042***	-0.0042***	-0.0042***	-0.0045***
	(0.0012)	(0.0012)	(0.0012)	(0.0012)
$ZScore_{i,t}$	-1.0156***	-1.0197***	-0.9565***	-1.0227***
	(0.2265)	(0.2271)	(0.2268)	(0.2435)
$LogAge_{i,t}$	-0.0148**	-0.0133*	-0.0141*	-0.0158**
	(0.0075)	(0.0073)	(0.0074)	(0.0078)
Intercept	1.5946	-0.0961	0.1976	2.3066
	(1.3596)	(1.3967)	(1.3954)	(1.4375)
Year FE	YES	YES	YES	YES
N	34,090	34,021	33,865	29,735
R-square	0.0616	0.0622	0.0611	0.0643
No of firms	4,860	4,855	4,836	4,760

Discussion - Conclusions

- ✓ Examine the **association** between **options trading activity** and firm **investment efficiency** measured as **deviation** from **optimal investment levels**.
- ✓ Examine whether **options trading volume,** a factor that **reduces information asymmetries** and **improves access** to **internal firm information** for **outsiders**, is associated **positively** with improved firm-level **investment efficiency** or lower **deviations from optimal** levels of firm investment.
- ✓ Use **US firms** with **options trading activity** during **1996-2019** and find that **options trading volumes positively** and **significantly** associate with **firm-level investment efficiency**.
- ✓ Main findings more prevalent in the case of **under**-, rather than **over-investment,** and are mostly **driven** by **NonCapex** rather than **Capex**-type investment, suggesting that the **volume** of **options trading** helps **mitigate information asymmetry** and **moral hazard concerns** particularly related to **under-investment**, and when the **outcome** of **investment** is **more uncertain** and primarily entails **NonCapex,** consisting of **R&D** and **acquisitions** that involve **more growth options**, compared to more **tangible Capex** investment that merely **adds** to a firm's **AIP**.
- ✓ Results **robust** under **alternative** model specifications, **different** ways of measuring options **trading activity**, and **endogeneity** controls (**two-stage GMM** estimation, using option **contract moneyness** and **open interest** as **IVs** for options trading volume, also use **PSM** between firms with **high** vs. **matched firms** with **low options trading volumes**).

Discussion - Conclusions (1)

- ✓ Highlight an **external monitoring channel** as a potential **mechanism** through which options **trading volumes** could **associate** with **investment inefficiency**

- ✓ We find that when the **strength** of **external monitoring** and **information-enriching** mechanisms **improve,** proxied by the **size** of **institutional blockholdings** and the **existence** of long-term **S&P debt rating**, the **association** between the **volume** of options trading and **investment efficiency** significantly **weakens:**

- **indicative** of **options trading volumes** and the **strength** of **external monitoring** working as **substitutes** in supporting **more efficient levels** of **investment** through **alleviating information asymmetry** and **moral hazard concerns** stemming from a **poor firm information environment**.

- ✓ Finally, observe that the **negative association** between options **trading activity** and **investment inefficiency** particularly holds for firms with **high unexpected investment** (a signal of **poor performance**) and for firms with **no CDS traded** on their options: the **positive association** of **options trading** volumes with firm **investment efficiency** is **stronger** when firms' **informational efficiency** is **lower.**

- ✓ Findings provide, for the **first** time, evidence on the **size** of **firm-level investment inefficiency** and its relation with **option market trading activity**.

- ✓ Overall, our findings suggest that **managerial skills** and **organizational capabilities** associated with **trading** in **derivatives markets** also **benefit firms' investment activities** through enhancing **optimal resource allocation** and **investment efficiency**.