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Government Regulation, Executive Compensation, and Risk-Premium-Related Derivatives Usage: Evidence from China*

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Abstract

This paper examines how executive pay-performance sensitivity (PPS) affects the relationship between derivatives usage and firm risk and whether this effect is conditional on government regulation. Using a sample of Chinese-listed companies over the period 2008 to 2015, we observe that performance-based executive compensation contracts have a U-shaped effect on the relationship between derivatives usage and firm risk. Further analyses show a negative relationship between executive compensation and risk-premium-related derivatives usage when the government heightens its regulations. This suggests government regulation can effectively complement executive compensation contracts to lower firm risk through derivatives usage. The results are robust after we address endogeneity concerns and a battery of sensitivity tests. Our findings not only add to the literature on derivatives usage and corporate governance but also have policymaking implications for other developing countries.

Keywords: Derivatives, Firm Risk, Government Regulation, Executive Compensation, Pay-Performance Sensitivity

JEL Classification: G32, G34, G38

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政府监管、高管薪酬与风险溢价有关的金融衍生品使用：中国的实证

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摘要

采用中国非金融上市公司 2008–2015 年数据，本文考察高管薪酬、金融衍生品使用与企业风险相关性以及政府监管对三者关系的调节作用。主要结论包括：（1）基于业绩的高管薪酬对金融衍生品与企业风险之间相关性存在 U 型的非线性影响；（2）政府监管有助于企业通过金融衍生品降低企业风险，表现为政府监管水平较高企业的高管薪酬与金融衍生品使用的风险溢价呈显著负相关，高管薪酬的 U 型非线性影响存在于政府监管水平较低企业。结论表明政府监管机制能有效完善薪酬激励机制，从而抑制投机套利所带来的企业风险增加。本文拓展金融衍生品与公司治理方面的文献，为理解发展中国家套期保值行为及其经济后果提供新的实证证据。

关键词：金融衍生品、企业风险、政府监管、高管薪酬、薪酬业绩敏感度

I. Introduction

Companies often use financial derivatives to hedge financial risk that may adversely affect revenues, the costs of goods sold, and various expenses. Empirical evidence shows that there is a significant relationship between option-based (e.g. stock options and stock grants) executive compensation contracts and derivatives usage and that corporate governance mechanisms affect managers' use of financial derivatives and economic-outcome-related derivatives usage (Fauver and Naranjo, 2010; Allayannis *et al.*, 2012; Lel, 2012). However, the literature has focused almost entirely on US firms, which generally operate in an environment with strong government regulations and sound legal systems. In contrast, companies in developing countries not only operate in environments with weaker investor protection and legal systems but also often use non-option-based (e.g. salaries and equity shares) executive compensation contracts. In this study, we examine how non-option-based executive compensation contracts affect the relationship between derivatives usage and firm risk and whether this effect is conditional on government regulation in China.

According to risk management theories, companies would benefit from using derivatives for hedging to reduce external financing and other costs resulting from volatility of cash flow (e.g. Froot *et al.*, 1993; Adam and Fernando, 2006; Gilje, 2016). Yet, firms may use derivatives to speculate, which would adversely affect shareholders (Géczy *et al.*, 2007; Allayannis *et al.*, 2012). According to a Chinese government report, by the end of October 2008, 68 Chinese state-owned enterprises (SOEs) were using financial derivatives and these companies had incurred a floating net loss of 11.4 billion RMB (around $1.74 billion) (Li, 2009). To tackle the problems associated with the use of financial derivatives, the State-Owned Assets Supervision and Administration Commission (SASAC)[2] has released several rules since 2009 requiring that SOEs be subject to strict regulations on their use of derivatives. Also, governments have strengthened their supervision of SOEs' financial derivatives usage.

However, others are dubious about the presumed effect of greater government regulation on curbing managers' improper use of financial derivatives. While many attribute the global financial crisis to the overflow of over-the-counter (OTC) derivatives such as OTC credit default swaps (CDS), others argue that the US regulation on OTC derivatives in 2009 also had a negative impact on how companies manage their risk.[3] In a recent study, Shao and Sun (2017) show that in response to greater regulation of derivatives, non-financial Chinese firms with foreign exchange exposure reduce the use of financial

[2] In China, SOEs include central SOEs owned by the central government and local SOEs owned by local governments. The SASAC of the State Council and the local SASACs are, respectively, responsible for the supervision and administration of central and local SOEs.

[3] See "Big Companies Go to Washington to Fight Regulations on Fancy Derivatives" by Kara Scannell, *The Wall Street Journal* (10 July 2009, p. B1).

hedging in their risk management strategies. Therefore, we believe the China setting allows us to gauge the effectiveness of government supervision on curbing the self-interest incentives behind managers' use of derivatives, which subsequently affects firm risk.

Compared with shareholders, managers are more risk averse due to their undiversified wealth position (Guay, 1999a). From the perspective of unaffiliated and diversified shareholders, risk-averse managers generally reduce firm risk more than the desired level (Rajgopal and Shevlin, 2002; Knopf *et al.*, 2002). Also, they tend to hedge the risk exposure of their compensation packages by using derivatives (Carpenter, 2000; Knopf *et al.*, 2002; Coles *et al.*, 2006; Gormley *et al.*, 2013). Because of information-scale economies and transaction-scale economies, the costs of hedging in corporate activities are lower than those in managers' self-hedging (e.g. Stulz, 1984; Booth *et al.*, 1984; Block and Gallagher, 1986).[4] Géczy *et al.* (2007) provide empirical evidence that managers prefer to engage in derivative activities through their company. Prior studies argue that corporate governance can curb managers' improper use of financial derivatives and enhance the value of derivatives usage (e.g. Kleffner *et al.*, 2003; Whidbee and Wohar,1999; Géczy *et al.*, 2007; Brunzell *et al.*, 2011; Allayannis *et al.*, 2012; Lel, 2012). However, empirical evidence also shows a strong causal relation between managerial contracts and firms' riskier policy choices (e.g. Carpenter, 2000; Coles *et al.*, 2006; Low, 2009; Gormley *et al.*, 2013; Dittmann *et al.*, 2017), such as speculation (e.g. Smith and Stulz, 1985; Hagelin *et al.,* 2007).

Using a sample of Chinese-listed companies from 2008 to 2015, we find that pay-performance sensitivity (PPS), a measure of the closeness of interests between managers and stockholders, has a U-shaped effect on risk-premium-related derivatives usage. Specifically, before (after) PPS reaches the inflection point, derivative activities are negatively (positively) associated with firm risk when there is an increase in PPS. Also, we find the effect of executive compensation depends on the strength of government regulation. As government regulation escalates, there is a linear and negative relationship between PPS and risk-premium-related derivatives usage. Also, for firms under weak regulation, there is a U-shaped relationship between PPS and risk-premium-related derivatives usage. That is, performance-based executive compensation helps decrease firm risk through derivatives when firms are under strong regulations but not when they are under weak regulations. This indicates that government regulations can effectively complement executive compensation contracts to lower firm risk by using derivatives. Our results are robust after we address endogeneity concerns and conduct sensitivity tests.

This paper contributes to the existing literature in two important ways. First, this is the first study to examine the impact of executive compensation on the relationship between

[4] While information advantages are derived from government or official sources and experience or skills in trading in financial markets, transaction cost advantages are associated with economies of scale in trading (i.e. execution costs).

derivatives usage and firm risk. Previous studies have found mixed evidence on whether derivatives usage decreases firm risk. We provide additional evidence that the impact of derivatives usage on firm risk depends on the sensitivity of managerial compensation to stock prices. Also, recent studies show a strong relationship between option-based executive compensation and firm hedging (e.g. Smith and Stulz, 1985; Guay, 1999b; Hagelin *et al.,* 2007; Dittmann *et al.*, 2017). However, option-based compensation contracts are not common in companies in developing countries such as China. Our results suggest the non-linear effect of executive compensation is robust for all types of performance-based executive compensation contracts. Second, our results show that external government monitoring can complement an internal governance mechanism to motivate managers to be prudent in hedging and therefore decrease firm risk. This finding suggests that the Chinese government's regulation protects shareholders' interests by curbing the speculation involved in bad hedging strategies. Our findings should have policymaking implications for other developing countries and should illustrate the importance of incorporating the strength of corporate governance into testing hedging theories.

The remainder of the paper is organised as follows: Section II discusses the institutional background of China's executive compensation contracts and derivative regulations; Section III presents a literature review and the hypothesis development; Section IV discusses the sample and empirical models; Section V presents the empirical results; Section VI discusses the robustness tests; and Section VII presents the conclusions and a summary of the study.

II. Institutional Background

2.1 Executive Compensation Contracts in China

In early 2006, the China Securities Regulatory Commission (CSRC) provided a framework to introduce equity incentives. Under the new rule, publicly traded firms that have completed the non-tradable shares reform can offer stock options or restricted stocks to top management, members of corporate and supervisory boards, and core technology personnel. The CSRC also regulates the disclosure of executive compensation information, requiring publicly traded firms to report the total compensation (i.e. the sum of basic salary, bonuses, fringe benefits, and house allowance) of top management and individual board members after 2006. In the same year, the SASAC of the State Council and the Ministry of Finance jointly issued regulations on equity incentives provided to the top management of SOEs.

Although the CSRC introduced equity incentives, we find that only 195 companies (or 1.02% of the total listed companies) exercised executive stock options during the 2008-2015 period. Instead, stock grants have been widely used as a form of equity compensation.

Furthermore, unlike the high proportion of stock options included in the executive compensation provided by Western companies, for those executives in China who receive stock options, such options make up a very limited proportion of their compensation.[5] When executives hold more equity wealth, they are exposed to greater earnings volatility and therefore have an incentive to undertake derivative trading to lower their personal risk. However, such hedging often increases the firm's risk and hurts firm performance.

2.2 Derivative Regulation in China

China has been the world's factory over the past decades, and Chinese non-financial companies face systematic risk regardless of whether or not they directly engage in international trade. Therefore, companies have increasingly used financial derivatives to manage their risk (e.g. significant exposures to interest rates, exchange rates, or commodity prices) and to place themselves in a proper position in derivatives.

Before 2007, disclosures of financial derivatives were not mandatory and they were included in the off-balance sheet. To improve the quality of the reporting of financial derivatives, the China Accounting Standards for Business Enterprises required that all publicly listed companies record derivatives as either assets or liabilities at fair value and report unrealised gains or losses due to changes at fair value in their income statements covering periods beginning on 1 January 2007. Despite this requirement, there is still a significant gap in the quality and detail of the information disclosed on financial derivatives. A vast majority of Chinese-listed companies report only the aggregate fair value of all the types of risk hedged, not the individual types of risk hedged, which restricts the data available for empirical analysis.

During the 2007-2008 financial crisis, some Chinese central SOEs, including those in the Fortune Global 500 (e.g. China National Aviation Corporation, China COSOC Group, and China Huaneng Group) incurred massive losses caused by using financial derivatives. These losses are attributed not only to managers' incompetence, ignorance, and corruption but also to their failure to comply with financial regulations. Similar observations were made regarding local SOEs and non-SOEs. Therefore, in 2009, the SASAC of the State Council heightened government supervision of the financial derivative transactions of central SOEs. Government regulation of derivatives includes trade registration, trade clearing, exchange trading, and requirements for higher capital and margin. Since 2010, most of the local SASACs have promulgated interim measures for the supervision and administration of local SOEs. These measures require local SOEs to comply with the more stringent vetting and reporting process for financial derivative transactions.

[5] For example, Bird (2018) reports that in Canada, stock options are granted to around 70% of executives, making up around a third of the compensation for those executives in publicly listed companies.

III. Literature Review and Hypothesis Development

3.1 Executive Compensation, Derivatives Usage, and Firm Risk

Prior studies have documented that companies would benefit from hedging by reducing the likelihood of financial distress, allowing them to increase their debt capacity and enjoy the associated tax advantages (Mayers and Smith, 1982; Smith and Stulz, 1985; Leland, 1998). Hedging may also (1) ensure that attractive finance investments are funded internally when external financing becomes costly (Froot *et al.*, 1993; Gilje, 2016) and (2) improve the informativeness of corporate earnings as a signal of management ability (DeMarzo and Duffie, 1989; Breeden and Viswanathan, 2016). As suggested by risk management theories, firms using derivatives for hedging purposes have lower cash flow volatility and less firm risk (e.g. Smith and Stulz, 1985; Bartram *et al.*, 2010; Bartram *et al.*, 2011).

In general, risk-averse managers have the incentive to lower firm risk through hedging because they have relatively undiversified portfolios and their human capital is tied to firm value. However, because of the information asymmetry between managers and shareholders, hedging for managers' self-interest can be used incorrectly or excessively, resulting in undesired outcomes and hurting firm performance (Hagelin *et al.*, 2007). Firms design efficient compensation packages to solve moral hazards and motivate managers. The executive compensation scheme has two significant yet opposing effects on managerial incentives. On the one hand, when compensation is linked to firm performance, it can reduce the cost of monitoring and mitigating agency problems (Holmstrom, 1979; Jensen and Murphy, 1990). When the interests of managers and shareholders align, managers will work harder and use financial derivatives effectively to manage the firm's risk. On the other hand, performance-based executive compensation may induce managers to bear a higher compensation risk caused by earnings volatility and heightened agency conflicts (e.g. Holmstrom, 1979).

As discussed earlier, effective compensation contracts should motivate managers to consider shareholders' interests when they choose corporate risk strategies (Hagelin *et al.*, 2007). Empirical evidence shows a strong causal relation between managerial compensation contracts and a firm's choice of risky policies (e.g. Carpenter, 2000; Coles *et al.*, 2006; Low, 2009; Gormley *et al.*, 2013; Dittmann *et al.*, 2017) such as speculation (e.g. Smith and Stulz, 1985; Hagelin *et al.,* 2007). An increase in equity-based compensation, in the form of stock grants and stock options, would significantly escalate the sensitivity of managerial wealth to stock prices. While a higher sensitivity of managerial wealth to stock prices would motivate managers to work harder or more effectively, it would also expose managers to a higher risk than diversified shareholders, which would prompt risk-averse managers to over-hedge. Furthermore, the increase in equity-based compensation may intensify the sensitivity of managerial wealth to stock volatility, leading to an increase in the value of stock options and provoking risk-averse managers to under-hedge. This argument is also supported by empirical evidence that managers' exposure to stock options leads them to engage in bad hedging, that is, over- or under-hedging (Lambert *et al.*, 1991; Carpenter, 2000; Coles *et al.*, 2006). However, the magnitude of the sensitivity of managerial wealth to stock volatility caused by common stock is much lower than that of stock options (Guay, 1999b). Because stock options account for a very small percentage of total executive compensation in China, our paper focuses on the effect of the sensitivity of managerial wealth to stock prices.

Furthermore, prior studies show a strong relationship between managers' risk exposure from their compensation and derivatives usage when agency conflicts worsen (e.g. Whidbee and Wohar, 1999; Kleffner *et al.*, 2003; Géczy *et al.*, 2007; Brunzell *et al.*, 2011; Lel, 2012). For example, Lel (2012) reports that in a cross-countries setting, companies with weak governance tend to use derivatives more when managers hold relatively undiversified portfolios, even if the degree of currency exposure is lower. Using Chinese data, researchers observe similar results. Cheng (2016), for example, finds that companies with strong governance tend to use financial derivatives for hedging firm-specific risk. In contrast, companies with weak governance tend to use financial derivatives for risk exposure related to executive compensation. Collectively, these findings suggest that agency problems influence the managerial motive behind the use of derivatives, and thus it is important for researchers to include corporate governance when examining the effect of derivatives usage.

There is an optimal hedge ratio.[6] When the sensitivity of executive compensation to stock prices (i.e. PPS) is at a lower level, an increase in PPS alleviates agency conflicts in derivative activities and drives the actual hedge ratio close to the optimal hedge ratio. Therefore, managers tend to use derivatives to reduce the deadweight cost caused by market frictions (e.g. reducing expected taxes or financial distress and mitigating underinvestment), which would lower the firm risk arising from exposure to cash flow volatility. Conversely, when the increase in performance-based compensation and PPS exceeds the optimal point, any further increase in PPS would provoke managers to over-hedge to reduce their compensation risk. Thus, the actual hedge ratio will deviate from the optimal hedge ratio. Prior studies show that risk-averse managers may incur significantly higher costs when they trade in derivative contracts for their own accounts rather than through the company (Stulz, 1984; Booth *et al.*, 1984; Block and Gallagher, 1986; Nance *et al.*, 1993). As such, managers have the incentive to hedge risk exposure related to their compensation contracts to maximise their self-interests (Carpenter, 2000; Bartram *et al.*, 2009) even if the derivative position is beyond the need of enterprise risk management. Such agency conflicts may place the firm in a disadvantaged position and hence increase firm risk. We therefore expect that PPS has a U-shaped effect on the relationship between derivative activities and firm risk. Our hypothesis is stated below:

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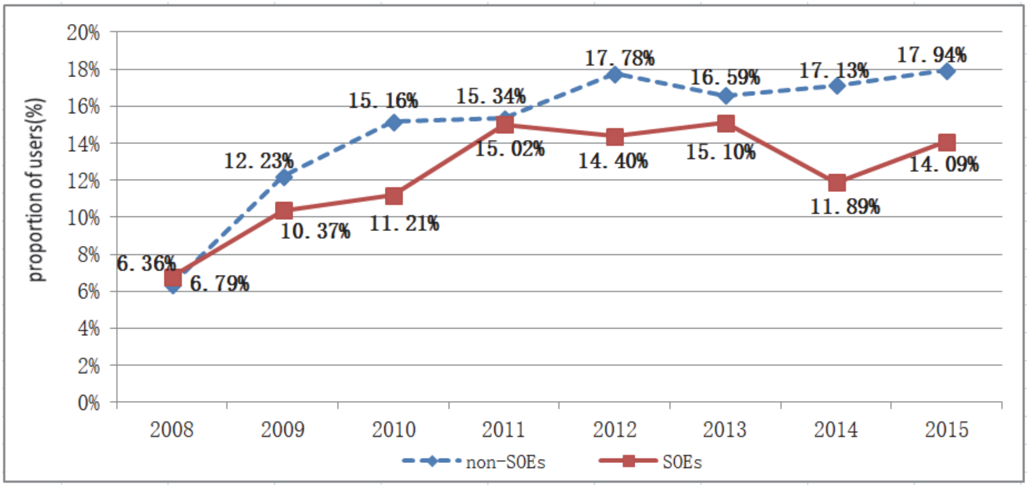
6 Hedging strategies suggest that companies use risk management to pursue their utility maximisation goal. The optimal hedge ratio is based on the maximisation of the expected utility that incorporates both the expected return and risk of the hedged portfolio.

H1: Before (after) the sensitivity of executive compensation to stock prices reaches the inflection point, derivative activities are negatively (positively) associated to firm risk when the pay-performance sensitivity increases.

3.2 The Impact of Government Regulation on Executive Compensation Incentive

Prior studies show that strong corporate governance can constrain managers' self-interest and decrease the bad use of derivatives (e.g. Tufano, 1996; Géczy *et al.*, 2007; Lel, 2012). For firms that have strong internal firm-level or external country-level governance, derivatives usage is associated with a higher value premium (Allayannis *et al.*, 2012). External corporate governance mechanisms received increased attention after the financial crisis (Erkensa *et al.*, 2012). Many countries have regulated the derivatives market to protect the rights and interests of investors: for example, the Dodd-Frank Wall Street Reform and the Consumer Protection Act (in 2010) in the USA; the U.K.'s new approach to financial regulation: judgment, focus, and stability (in 2011); and the European Market Infrastructure Regulation (in 2012). It is expected that heightened regulation should curb speculation and also safeguard the risks of the capital market.

Figure 1 The Proportion of Derivative Users



Note: Figure 1 shows the proportion of derivative users from 2008 through to 2015. We use lagged values (t-1) of derivative activities to measure derivatives usage. For example, we calculate derivatives usage in 2015 using the data of 2014. The dotted line and solid line describe the proportion of derivative users in the sample of non-SOEs and SOEs, respectively. We exclude financial firms from our sample. The source is the annual balance sheets of Chinese listed firms.

SOEs represent public interests in China and attract significant attention in Chinese society when their executives engage in bad hedging. Immediately after massive losses from derivative transactions in several large SOEs made headlines, the Chinese regulatory authorities promulgated rules and guidance to strengthen SOEs' derivative trading, internal control procedures for derivative transactions, and information disclosures. As shown in Figure 1, the proportion of derivative users in SOEs significantly decreased in the post-regulation period (2010-2015).[7] In contrast, the percentage of derivative users in non-SOEs gradually increased throughout the sample period. These findings suggest heightened government supervision motivates the managers of SOEs to be prudent in derivative activities. It is likely that greater government supervision, an external governance force, motivates managers to use derivatives for hedging purposes, which subsequently reduces speculation (i.e. over-hedging) in derivative programmes. We thus expect government regulations to help decrease firm risk through derivatives.

Nevertheless, some argue against the expected effectiveness of government regulation in curbing excessive derivative transactions. Some believe greater oversight would reduce regular hedging activities rather than discourage managers from speculation. This is because heightened government supervision and requirements to disclose information regarding derivatives usage may cause hedgers to forgo risk management policies involving derivatives. For example, many large companies in the United States (including energy producers, airlines, and industrial equipment manufacturers) argue that strict regulation of OTC derivatives in 2009 impaired firms' ability to manage risk by using OTC derivatives. Also, Gwilym and Ebrahim (2013) suggest that the Dodd-Frank Wall Street Reform and the Consumer Protection Act, which impose position limits on commodity futures with the aim of curbing excessive speculation, would reduce the endogenous hedging demand and thus the liquidity of futures contracts.

As discussed above, it is unclear whether government regulation of financial derivatives is effective. If government regulation is effective, it can curb bad hedging (i.e. over-hedging) arising from more risk exposure to managerial compensation by increasing the sensitivity of managerial compensation to stock prices and thus lower firm risk through derivatives. Therefore, we expect a linear and negative relation between the sensitivity of executive compensation to stock prices and risk-premium-related derivatives usage as government regulation escalates. We thus state our hypothesis (in its alternative form) below:

H2: Under the 'effectiveness of regulation' hypothesis, there is a negative relationship between the sensitivity of executive compensation to stock prices and risk-premium-related derivatives usage in firms under strong government regulation.

IV. Data, Variables, and Empirical Specifications

[7] It is noteworthy that we use the lagged value (t-1) of derivative activities to measure derivatives usage in Figure 1.

4.1 Sample Selection

We use data on Chinese-listed firms for the period 2008 to 2015.[8] We choose this period for two reasons. First, we use the lagged values (t-1) of derivative activities to measure derivatives usage. Because Chinese companies were required to disclose their derivatives usage in 2007, the earliest use of derivatives started in 2008. Also, we require three-year-ahead observations to calculate the measures of firm risk. For example, the calculation of firm risk in 2015 requires the 2015, 2016, and 2017 data. Second, during the research period, there is a different level of government regulation on financial derivatives usage pre- and post-regulation, which provides a natural experiment to gauge the effectiveness of government regulation.

Our study uses two datasets: the China Stock Market and Accounting Research (CSMAR) database and annual financial statements. The CSMAR database provides stock market data and accounting data for all the non-financial companies. We hand-collect the data on firms' use of financial derivatives from their annual balance sheets. The sample excludes financial firms or companies with missing data, resulting in a sample of 9,986 firm-year observations. Among these observations, 1,366 involve engagement in derivative activities. We also winsorise the continuous variables at the top and bottom 1% level to mitigate the effects of outliers.[9]

Table 1 Characteristics of Derivatives Users and Non-Users

Year	(1) Full sample			(2) Sample of SOEs			(3) Sample of non-SOEs			Difference in Means
	Firm	user	user%	Firm	user	user%	Firm	User	user%	
2008	1037	69	6.65	707	48	6.79	330	21	6.36	0.959
2009	1169	129	11.04	752	78	10.37	417	51	12.23	-0.785
2010	1204	153	12.71	749	84	11.21	455	69	15.16	-2.680***
2011	1208	183	15.15	719	108	15.02	489	75	15.34	-1.137
2012	1290	205	15.89	722	104	14.40	568	101	17.78	-3.793***
2013	1368	216	15.79	735	111	15.10	633	105	16.59	-2.144**
2014	1409	203	14.41	732	87	11.86	677	116	17.13	-4.847***
2015	1301	208	15.99	660	93	14.09	641	115	17.94	-3.465***
total	9986	1366	13.68	5776	713	12.34	4210	653	15.51	-6.885***

Note: This table presents the characteristics of derivative users by ownership structure and across the sample period. The derivatives usage data are lagged by one year. The last column shows the t-values of mean tests for SOEs and non-SOEs. ***, **, and * represent significance at the 1%, 5% and 10% levels, respectively.

Table 1 reports the statistics on the number of derivative users by ownership structure across the research period. We observe that an average of 13.68% of the sample firms use

[8] It is noteworthy that the actual starting and ending points of the sample are 2007 and 2017, respectively.
[9] We also run the analysis without winsorising the continuous variables and observe qualitatively similar results.

derivatives, with a significantly higher percentage of derivative users in non-SOEs (15.51%) than in SOEs (12.34%). In particular, we note a different growth trend in the percentage of derivative users between SOEs and non-SOEs since the introduction of the 2009 regulation on SOEs' financial derivative transactions.

4.2 Variables and Models

4.2.1 Measure of firm risk

Following Kothari *et al*. (2002), our first measure is the standard deviation of industry median-adjusted ROA (*Risk_std*), which is computed over three years from t to t+2. Each year, we calculate the difference between a firm's ROA and the average ROA across all firms in the same industry to remove the influence of the industry. Also, we follow Faccio *et al.* (2011) to measure firm risk (*Risk_diff*): the difference between the maximum and minimum adjusted ROA during the period year t to year t+2.

While the standard deviation of stock returns is a commonly used measure for firm risk in the literature (e.g. Bartram *et al.*, 2011), it is unreliable in the China stock market, where stock prices are noisy (Liu *et al.*, 2014) and the markets are highly speculative and stock prices bear little relationship to their fundamental values (Bai *et al.*, 2004; Markoczy *et al.*, 2013). Therefore, we use an accounting-based indicator rather than a market-based indicator as a proxy for firm risk.

4.2.2 Measure of derivatives usage

Following Graham and Rogers (2002), we first identify derivative users by searching public financial statements using keywords such as hedging, derivative, future, forward, option, and swap. After identifying these keywords, we read the adjacent contexts to ensure these keywords involved the use of financial derivatives. We use firms' use of financial derivatives (*Der*) as a measure of derivative activities. A firm is a derivative user (non-user) if it did (did not) report a derivative position. *Der* is a dummy variable which equals 1 for derivative user and 0 otherwise. Further, we use an alternative measure of derivatives usage (*Der%*) in the robustness check. *Der%* is a ratio of the year-end fair value of financial derivatives to the year-end book value of assets.

4.2.3 Measure of pay-performance sensitivity

Following Broussard *et al.* (2004), we use *PPS*, the sum of compensation-performance sensitivity (*Compsensitivity*) and stock-performance sensitivity (*Stocksensitivity*), to measure the closeness of interests between managers and shareholders. Because only a rather small number of our sample firms offer stock-option plans, our calculation of *PPS* includes cash compensation (i.e. the sum of basic salary, bonuses, fringe benefits, and house allowances) and stock grants only. *Compsensitivity* is defined as the change in cash compensation from the prior year divided by the change in the market value of equity from the prior year. The use of cash compensation is consistent with previous research (Firth *et al.*, 2006; Conyon and He, 2011). *Stocksensitivity* is defined as the number of executive shareholdings divided by the number of total shares.

4.2.4 Measure of the implementation of government regulation

As discussed in Section 3.2, there is a significant difference in the strength of government regulation on derivatives usage before and after the implementation of the 2009 regulation. *Reg* is an indicator variable which equals 1 in years when the regulation on derivative activities is implemented (i.e. 2010-2015) and 0 otherwise.

4.2.5 Measure of control variables

We control for a wide array of firm characteristics (including financial characteristics and ownership) that prior literature has shown to be related to firm risk (e.g. Allayannis *et al.*, 2012; Chen and Keefe, 2020). They are defined or calculated as follows: *Size*, calculated by the natural logarithm of total assets; *Lev*, defined as the ratio of total debt to total assets; *Salegrowth*, defined as growth ratio of sales; *Ratio_first*, defined as the percentage of shares held by the largest shareholder in the year t; *Ratio_BH*, defined as the percentage of the sum of B-shares and H-shares issued by a firm in the year t; *Cfo*, defined as the net operating cash flow in the year t scaled by total assets at the beginning of year t; *Age*, calculated by the natural logarithm of the sum of the age of the firm plus one; *Lntobinq,* calculated by natural logarithm of Tobin's Q. Also, we include industry and year dummies in the regression to control for industry (*IND*) and year (*YEAR*) fixed effects.

4.3 Empirical Model

4.3.1 Empirical models for testing H1

There may be endogeneity problems arising from the selection bias of choice in derivative use: that is, whether a firm uses derivatives or not is affected by its characteristics and not randomly assigned. To address this selection bias, we use a propensity-score matched (hereinafter, PSM) pair method and estimate a logistic propensity-score model based on these firm characteristics (e.g. Donohoe, 2015; Chang *et al.*, 2015). Specifically, we identify firm characteristics that are distinct between companies using derivatives and those not using them in the full sample:

$$Der_{i,t} = \alpha_0 + \Sigma\alpha * Incentive_{i,t-1} + \Sigma Industry_{i,t} + \Sigma Year_{i,t} + Error_{i,t}, \quad (1)$$

where *Incentive* is a vector of variables for risk-management incentives that may influence the use of derivatives. Following prior studies (e.g. Hagelin *et al.*, 2007; Allayannis and Weston, 2001; Hanlon and Heitzman, 2010; Bartram *et al.,* 2011), we include the likelihoods of financial distress (*Lev*), investment opportunity (*BM*), tax burden (*ETRs*) and firm size (*Size*). *Lev* is the debt-to-asset ratio. *BM* is the book-to-market ratio. *ETRs* is defined as total income tax expense less deferred taxes divided by pre-tax profit. *Size* is the natural logarithm of total assets. These variables are lagged (t-1) to avoid simultaneity. Industry (*Industry*) and year (*Year*) dummies are included in the regression to control for industry and year fixed effects. The logistic regression results (unreported) show a likelihood ratio of 3543.06 and an LR Chi-square of 851.18, both significant at the 1% level, suggesting that the model is a reasonable fit for the data. Next, we match each derivative user (*Der*=1) to a non-user (*Der*=0) by their nearest propensity score, within common support, without replacement, using a caliper distance of 0.01.

To test H1, we compare the 1,315 derivatives users to the PSM control sample of 1,315 non-users using the following OLS regression:

$$Risk_{i,t} = \beta_0 + \beta_1 Der_{i,t-1} + \beta_2 PPS_{i,t-1} + \beta_3 PPS_{i,t-1} \times Der_{i,t-1} + \beta_4 PPS^2_{i,t-1} + \beta_5 PPS^2_{i,t-1} \times Der_{i,t-1} + \Sigma Control_{i,t-1} + \Sigma Industry_{i,t} + \Sigma Year_{i,t} + Error_{i,t.} \quad (2)$$

Considering there may be a time lag in the implementation of derivative activities and the improvement of economic outcome in the form of decreased firm risk, we use the variable of derivatives usage lagged by one year (t-1). Also, we use lagged (t-1) control variables to avoid simultaneity. Our first hypothesis states there is a U-shaped effect of *PPS* on the correlation between derivative activities and firm risk. The coefficients on $PPS \times Der$ (β_3) and $PPS^2 \times Der$ (β_5) capture the effect of *PPS*. If H1 holds, we expect a positive coefficient on $PPS^2 \times Der$ (β_5).

4.3.2 Empirical model for testing H2

Our approach to test H2 is to use a difference-in-differences (DID) model to exploit the variation in the strength of government regulation over time, examine data before and after the implementation of the regulation to identify its effect, and test the spatial variation created by the regulated firms (SOEs) and unregulated firms (non-SOEs). There are two advantages of a DID design. First, it accounts for variation in an outcome that is not the result of treatment exposure by comparing the treatment group to an untreated control group. Second, it mitigates concerns that market forces or other unobserved factors drive the relation between executive compensation, derivatives usage, and firm risk. We restrict the sample to those firms with derivatives usage (*Der*=1) and construct the following DID model:

$$Risk_{i,t} = \varphi_0 + \varphi_1 PPS_{i,t-1} + \varphi_2 PPS^2_{i,t-1} + \varphi_3 Reg_{i,t} + \varphi_4 Soe_{i,t} + \varphi_5 PPS_{i,t-1} \times Soe_{i,t} \times Reg_{i,t} + \varphi_6 PPS^2_{i,t-1} \times Soe_{i,t} \times Reg_{i,t} + \varphi_7 Soe_{i,t} \times Reg_{i,t} + \varphi_8 PPS^2_{i,t-1} \times Soe_{i,t} + \varphi_9 PPS_{i,t-1} \times Soe_{i,t} + \Sigma Control_{i,t-1} + \Sigma Industry_{i,t} + \Sigma Year_{i,t} + Error_{i,t} \quad (3)$$

Reg is an indicator for identifying whether the regulation is implemented or not. *Soe* is an indicator variable set to equal to 1 for SOEs as the treatment group and 0 for non-SOEs as the controls. If H2 holds, we expect a negative coefficient for *PPS*×*Soe*×*Reg* (φ_5). All variables are defined in Appendix A.

V. Empirical Results

5.1 Descriptive Statistics

In Table 2, we report the descriptive statistics for the key variables. Panel A summarises the descriptive statistics of the PSM sample, and Panel B reports the summary statistics of the subgroups of derivative users and non-users. In Panel A, the means (medians) of *Risk_std* and *Risk_diff* are 0.025 (0.014) and 0.046 (0.026), respectively. The mean (median) of *PPS* is 0.026 (0). The results of our mean tests show that compared to non-users, derivative users have a lower risk and higher PPS.

Table 2 Descriptive Statistics for Key Variables

Panel A Descriptive Statistics of the PSM Sample

Variable	N	Mean	Median	Max	Min	Std.dev
Risk_std	2630	0.025	0.014	0.181	0.001	0.031
Risk_diff	2630	0.046	0.026	0.332	0.001	0.058
Der	2630	0.500	0.500	1	0	0.500
PPS	2630	0.026	0	0.553	-0.005	0.091
Size	2630	22.623	22.411	26.511	20.217	1.374
Lev	2630	0.532	0.547	0.892	0.099	0.183
Salegrowth	2630	0.163	0.116	1.560	-0.372	0.303
Ratio_first	2630	0.380	0.371	0.789	0.091	0.156
Ratio_BH	2630	0.035	0	0.459	0	0.098
Age	2630	2.297	2.445	3.092	0.761	0.574
Lntobinq	2630	0.067	0.117	1.835	-1.802	0.786
Cfo	2630	0.055	0.054	0.339	-0.246	0.092

Panel B Descriptive Statistics of the Subgroups of Derivative Users and Non-users

Variable	Users, N=1,315		Non-users, N=1,315		Difference in Means
	Mean	Median	Mean	Median	
Risk_std	0.023	0.014	0.027	0.014	-3.139***
Risk_diff	0.043	0.026	0.050	0.027	-3.111***
PPS	0.030	0	0.021	0	2.474*
Size	22.643	22.377	22.603	22.425	0.756
Lev	0.533	0.550	0.531	0.546	0.300
Salegrowth	0.177	0.118	0.148	0.116	2.446*
Ratio_first	0.377	0.370	0.384	0.375	-1.131
Ratio_BH	0.042	0	0.027	0	3.916***
Age	2.222	2.358	2.373	2.520	-6.821***
Lntobinq	0.050	0.109	0.083	0.130	-1.085
Cfo	0.054	0.058	0.055	0.050	-0.327

Note: This table presents the descriptive statistics for the sample used in the main tests. Panel A displays the number of observations, the mean, median, minimum and maximum values, and the standard deviation values for the main variables. Panel B reports the number of observations, the means, the medians, and the differences in means between the sample of derivative users and the sample of non-users. See Appendix A for definitions of the variables. All continuous variables are winsorised at the top and bottom 1% levels. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Table 3 Correlation Matrix

Variables	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13
V1: *Risk_std*		**0.999**	-0.019	-0.007	**-0.054**	**-0.126**	**-0.038**	**-0.085**	0.012	**-0.039**	-0.019	**0.135**	**0.051**
V2:*Risk_diff*	**0.998**		-0.019	-0.004	**-0.055**	**-0.127**	**-0.042**	**-0.083**	0.012	-0.038	-0.020	**0.139**	**0.053**
V3: *Der*	**-0.061**	**-0.061**		**0.084**	0.002	0.001	0.008	0.026	-0.015	**0.062**	**-0.135**	-0.020	0.017
V4: *PPS*	0.003	0.005	**0.048**		**0.052**	**-0.155**	**-0.164**	0.013	**-0.150**	**-0.079**	**-0.239**	**0.177**	0.033
V5: *Reg*	**-0.043**	**-0.045**	0.002	**0.074**		**0.081**	**-0.062**	**-0.076**	0.016	**-0.056**	**0.128**	-0.014	**0.068**
V6: *Size*	-0.136	**-0.137**	0.015	**-0.208**	**0.083**		**0.431**	**0.072**	**0.250**	**0.344**	**0.238**	**-0.544**	**0.072**
V7: *Lev*	0.034	0.032	0.006	**-0.233**	**-0.055**	**0.415**		0.024	**0.054**	**0.078**	**0.217**	**-0.594**	**-0.188**
V8: *Salegrowth*	**-0.107**	**-0.105**	**0.048**	0.026	**-0.081**	**0.056**	**0.042**		0.017	0.007	**-0.096**	**0.139**	**0.084**
V9: *Ratio_first*	-0.016	-0.018	-0.022	-0.032	-0.018	**0.282**	**0.052**	0.031		-0.005	**-0.148**	**-0.075**	**0.048**
V10: *Ratio_BH*	**-0.04**	**-0.040**	**0.076**	**-0.086**	**-0.049**	**0.347**	**0.068**	-0.023	-0.025		**0.114**	**-0.149**	**0.077**
V11: *Age*	0.021	0.019	**-0.132**	**-0.351**	**0.151**	**0.18**	**0.247**	**-0.074**	**-0.157**	**0.088**		**-0.216**	**-0.061**
V12: *Lntobinq*	**0.078**	**0.083**	-0.021	**0.175**	-0.005	**-0.551**	**-0.592**	**0.129**	**-0.087**	**-0.123**	**-0.212**		**0.162**
V13: *Cfo*	-0.032	-0.029	-0.006	-0.018	-0.074	**0.076**	**-0.194**	**0.082**	**0.064**	**0.070**	-0.027	**0.172**	

Note: This table presents the correlation matrix for firm risk (*Risk_std, Risk_diff*), pay-performance sensitivity (*PPS*), the use of derivatives (*Der*), and the control variables used in the model. The Pearson correlation coefficients are presented in the lower diagonal, while the Spearman correlation coefficients are presented in the upper diagonal. The correlation coefficients in bold refer to those with a p-value of less than 0.05. See Appendix A for definitions of the variables.

Table 3 summarises the Pearson (Spearman) correlations for the variables used in the lower (upper) diagonal. The use of derivatives (*Der*) is negatively correlated with firm risk (*Risk_std*; *Risk_diff*). This univariate correlation analysis suggests that derivatives usage is associated with lower firm risk and that firms effectively use derivatives for hedging purposes. None of the correlations between the variables exceeds (the absolute value of) 0.6. Also, we perform diagnostic tests for multicollinearity and find that the variance inflation factor (VIF) scores on all the variables in our models do not exceed 4, well below the standard cut-off of 10.

5.2 Hypothesis Tests

5.2.1 Executive compensation, derivatives usage, and firm risk

Recall that we test whether executive compensation has a non-linear effect on the relationship between derivatives usage and firm risk. Table 4 summarises our regression results. The variable of firm risk is measured by *Risk_std* in columns (1) to (3). First, we exclude the variables of *PPS*, PPS^2, and the interaction terms in column (1). We then add the variables of *PPS* and *PPS*×*Der* in column (2) and continue to include PPS^2 and $PPS^2 \times Der$ in column (3). In all the regressions, we control for the industry and year fixed effects as well as the firm-level clustering effect. The coefficients on *Der* are negative and statistically significant at the 5% level in the columns. These results show that derivatives usage is associated with lower firm risk, suggesting that firms effectively use derivatives for hedging purposes. The negative coefficient on *PPS*×*Der* and the positive coefficient of $PPS^2 \times Der$ are both significant at the 5% level in column (3). These results suggest that *PPS* has a U-shaped effect on the relationship between derivatives usage and firm risk. To see this, we take the first derivative of Equation (2) with respect to *Der* and get the following expression:

$$Risk/Der = \beta_1 + \beta_3 PPS + \beta_5 PPS^2 \quad (4)$$

The above expression clearly shows that the overall impact of derivatives usage on firm risk is not a constant but a non-linear function, depending on β_1, β_3, β_5, the value of *PPS*, and PPS^2. For example, column (3) of Table 4 indicates that β_1, β_3, and β_5 are -0.003, -0.083, and 0.174, respectively, while Table 2 shows that *PPS* lies between -0.005 and 0.553. This suggests that the overall impact of derivatives usage can be positive, zero, or negative, depending on the value of *PPS*. There is an inflection point where the value of *PPS* equals 0.239(=$-\beta_3/2\beta_5$). Before the inflection point, an increase in *PPS* may motivate risk-averse managers to hedge for shareholders' interests, resulting in lower firm risk. However, after the inflection point, an increase in *PPS* provokes risk-averse managers to over-hedge to reduce their compensation risk arising from the high PPS and, therefore, to place the firm in a disadvantaged position, resulting in higher firm risk. Taken together, our results show a

U-shaped effect of *PPS* on the relationship between derivative activities and firm risk. The results for the control variables are generally consistent with the prior literature. In columns (4) to (6), we use an alternative measure of firm risk (*Risk_diff*) and observe qualitatively similar results to those using *Risk_std*. Therefore, H1 is supported.

Table 4 Executive Compensation, Derivatives Usage, and Firm Risk

Variable	*Risk_std*			*Risk_diff*		
	(1)	(2)	(3)	(4)	(5)	(6)
Der	-0.003**	-0.003**	-0.003**	-0.005**	-0.005**	-0.005**
	(-2.46)	(-2.45)	(-2.42)	(-2.43)	(-2.42)	(-2.39)
PPS		0.007	0.071**		0.014	0.136**
		(0.56)	(2.10)		(0.60)	(2.10)
PPS×Der		-0.007	-0.083**		-0.014	-0.158**
		(-0.49)	(-2.09)		(-0.49)	(-2.10)
PPS^2			-0.148**			-0.282**
			(-2.37)			(-2.35)
$PPS^2 \times Der$			0.174**			0.331**
			(2.45)			(2.44)
Size	-0.004***	-0.004***	-0.004***	-0.007***	-0.007***	-0.007***
	(-5.70)	(-5.68)	(-5.80)	(-5.60)	(-5.58)	(-5.69)
Lev	0.032***	0.032***	0.031***	0.059***	0.059***	0.057***
	(5.86)	(5.82)	(5.68)	(5.88)	(5.85)	(5.70)
Salegrowth	-0.011***	-0.011***	-0.011***	-0.020***	-0.020***	-0.020***
	(-4.50)	(-4.49)	(-4.50)	(-4.50)	(-4.50)	(-4.51)
Ratio_first	0.005	0.005	0.006	0.009	0.009	0.011
	(1.22)	(1.26)	(1.47)	(1.10)	(1.14)	(1.35)
Ratio_BH	0.001	0.001	0.001	0.001	0.0004	0.001
	(0.12)	(0.09)	(0.17)	(0.06)	(0.04)	(0.11)
Age	0.001	0.002	0.002	0.002	0.003	0.003
	(1.13)	(1.26)	(1.44)	(1.09)	(1.24)	(1.43)
Lntobinq	0.004***	0.003**	0.003**	0.007***	0.007***	0.007***
	(2.58)	(2.57)	(2.44)	(2.73)	(2.72)	(2.59)
Cfo	-0.004	-0.004	-0.003	-0.006	-0.006	-0.005
	(-0.51)	(-0.49)	(-0.42)	(-0.44)	(-0.42)	(-0.35)
Intercept	0.105***	0.105***	0.106***	0.194***	0.193***	0.195***
	(7.17)	(7.08)	(7.15)	(7.10)	(7.01)	(7.07)
Fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
N	2630	2630	2630	2630	2630	2630
adj. R^2	0.069	0.068	0.070	0.069	0.069	0.070

Notes: This table presents the impact of pay-performance sensitivity on the relationship between derivatives usage and firm risk using an industry-year fixed effect model. *Risk_std* and *Risk_diff* are measures of firm risk. This study further employs a slew of other firm-level control variables that could potentially influence firm risk. *Year* and *industry* dummies are also included to control for year-industry fixed effects. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

Table 5 The Impact of Government Regulation on the Effectiveness of Executive Compensation

Variable	(1) *Risk_std*	(2) *Risk_diff*
PPS	-0.122**	-0.219**
	(-2.33)	(-2.37)
PPS^2	0.326*	0.577*
	(1.76)	(1.73)
Reg	-0.008	-0.015
	(-1.45)	(-1.49)
Soe	-0.159***	-0.279***
	(-6.22)	(-6.43)
PPS×Soe×Reg	-0.439**	-0.687**
	(-2.38)	(-2.31)
$PPS^2 \times Soe \times Reg$	18.655	32.334
	(1.22)	(1.44)
PPS×Soe	0.427	0.668
	(0.37)	(0.30)
$PPS^2 \times Soe$	-18.672	-32.374
	(-0.68)	(0.61)
Reg×Soe	-0.162***	-0.284***
	(-6.07)	(-6.28)
Reg×PPS	0.125	0.225
	(1.44)	(1.34)
$Reg \times PPS^2$	-0.320	-0.564
	(-1.58)	(-1.52)
Size	-0.004***	-0.007***
	(-4.37)	(-4.34)
Lev	0.032***	0.059***
	(4.50)	(4.49)
Salegrowth	-0.009***	-0.016***
	(-3.32)	(-3.22)
Ratio_first	0.013**	0.023**
	(2.12)	(2.07)
Ratio_BH	0.006	0.011
	(0.71)	(0.68)
Age	0.001	0.002
	(0.46)	(0.51)
Lntobinq	0.003**	0.006***
	(1.98)	(2.04)
Cfo	0.005	0.012
	(0.52)	(0.61)
Intercept	0.116***	0.214***
	(5.66)	(5.64)
N	1315	1315
adj. R^2	0.073	0.074

Note: The table reports the impact of government regulation on the relationship between executive compensation, derivatives usage, and firm risk. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

5.2.2 Effect of government regulation on the relationship between executive compensation, derivatives usage, and firm risk

Table 5 summarises the regression results of estimating Equation (3), where the dependent variable is *Risk_std* (*Risk_diff*) in column 1 (column 2). As shown in column (1) of Table 5, the coefficients on $PPS \times Soe$ and $PPS^2 \times Soe$ are insignificant, indicating no significant difference in the relationship between executive compensation and risk-premium-related derivatives usage before the implementation of the 2009 regulation. While the coefficient on $PPS \times Soe \times Reg$ is significant and negative at the 5% level, the coefficient on $PPS^2 \times Soe \times Reg$ is insignificant. The results are consistent with our expectation that when the government heightens its regulation, there is a negative relationship between executive compensation and risk-premium-related derivatives usage. In contrast, the U-shaped effect is more pronounced for firms under weak regulation. We observe similar results for *Risk_diff* in column (2). Consistent with our prediction in H2, our findings indicate that government regulation is effective and can complement executive compensation to decrease firm risk by using derivatives.

VI. Robustness Tests

6.1 Alternative Proxy for Derivatives Usage

Following Guay and Kothari (2003) and Lel (2012), we use the derivatives ratio, that is, the ratio of year-end fair value[10] of financial derivatives to book value of year-end assets, as an alternative measure for the use of derivatives. We repeat our analyses with this new measure and present our results for *Risk_std* (*Risk_diff*) in columns (1) and (3) (columns (2) and (4)) of Table 6. As shown in column (1), the negative coefficient on $PPS \times Der\%$ and the positive coefficient on $PPS^2 \times Der\%$ are significant at the 5% level. In column (3), the coefficient on $PPS \times Soe \times Reg$ is negative and significant at the 5% level while the coefficient on $PPS^2 \times Soe \times Reg$ is insignificant. We find qualitatively similar results in columns (2) and (4). These results confirm what we observe in our main analyses.

6.2 Alternative Model Specification—Subsample Analysis

As discussed earlier, the government regulation on derivative activities may have a different impact on SOEs and non-SOEs after its implementation in 2009. Therefore, we examine the moderating role of government regulation by investigating its impact on SOEs and non-SOEs in the post-regulation period (2010-2015).

[10] The fair value is calculated by the value of the items on the balance sheets, such as current assets/liabilities, other current assets/liabilities, and financial assets/liabilities held for derivatives trading.

Table 6 Alternative Proxy for Derivatives Usage

Variable	The impact of executive compensation		The moderating role of government regulation	
	(1) *Risk_std*	(2) *Risk_diff*	(3) *Risk_std*	(4) *Risk_diff*
Der%	-0.337***	-0.647***		
	(-4.26)	(-4.43)		
PPS	0.017	0.033	-0.022*	-0.042*
	(0.93)	(0.95)	(-1.74)	(-1.76)
PPS×Der%	-11.945**	-22.751**		
	(-2.54)	(-2.55)		
PPS^2	-0.034	-0.063	0.041*	0.077*
	(-1.12)	(-1.12)	(1.88)	(1.78)
PPS^2*×Der%*	22.346**	42.308**		
	(2.16)	(2.18)		
Reg			-0.002	-0.004
			(-0.54)	(-0.53)
PPS×Soe×Reg			-0.048**	-0.088**
			(-2.47)	(-2.46)
PPS^2*×Soe×Reg*			0.048	0.094
			(1.07)	(1.11)
Control	Yes	Yes	Yes	Yes
Intercept	0.101***	0.187***	0.102***	0.187***
	(6.90)	(6.82)	(6.89)	(6.81)
Fixed effect	Yes	Yes	Yes	Yes
N	2630	2630	1315	1315
adj. R^2	0.069	0.069	0.068	0.069

Note: This table presents the impact of executive compensation on the relationship between the use of derivatives and firm risk and the impact of government regulation on executive compensation incentive. *Der%* is the derivatives ratio. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively.

We split the sample companies with respect to their ownership structure into a strong-regulation subgroup (*Soe*=1) and a weak-regulation subgroup (*Soe*=0). Further, we re-estimate Equation (2) using the subsample analysis. As shown in Table 7, for *Risk_std*, we observe significant and negative coefficients on *PPS×Der* (at the 10% level) in both subgroups (columns (1) and (2)). Also, while the coefficient on PPS^2*×Der* is positive and significant (at the 5% level) in the weak-regulation subgroup, it is insignificant in the strong-regulation subgroup. We find qualitatively similar results for *Risk_diff* (columns (3) and (4)). Collectively, our findings show there is a negative relationship between PPS and risk-premium-related derivatives usage in the firms under the strong regulation, compared with the U-shaped relationship in the firms under the weak regulation. These findings are consistent with our results using the DID approach.

Table 7 Subsample Analysis

Variable	*Risk_std*		*Risk_diff*	
	(1) strong-regulation	(2) weak-regulation	(3) strong-regulation	(4) weak-regulation
Der	-0.016*	-0.003*	-0.030*	-0.006*
	(-1.90)	(-1.77)	(-1.91)	(-1.71)
PPS	0.475*	0.103**	0.924*	0.200**
	(1.66)	(2.34)	(1.67)	(2.39)
PPS×Der	-0.482*	-0.103*	-0.934*	-0.200**
	(-1.68)	(-1.93)	(-1.73)	(-1.98)
PPS^2	-0.004	-0.210***	-0.004	-0.408***
	(-0.31)	(-2.72)	(-0.15)	(-2.76)
$PPS^2 \times Der$	-0.015	0.210**	-0.031	0.408**
	(-0.67)	(2.32)	(-0.72)	(2.37)
Control	Yes	Yes	Yes	Yes
Intercept	0.116***	0.140***	0.212***	0.262***
	(5.40)	(5.28)	(5.28)	(5.29)
Fixed effect	Yes	Yes	Yes	Yes
N	1263	971	1263	971
adj. R^2	0.105	0.060	0.105	0.061

Note: This table reports the moderating role of government regulation using the data from 2010 to 2015. The SOEs (non-SOEs) are included in the strong-regulation (weak-regulation) subgroup. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

6.3 Addressing the Endogeneity Problem—Heckman (1979) two-stage procedure

Even when we control for company differences by using the PSM sample, there still may be a selection bias due to unobserved variables that could affect the outcome. This potential endogeneity problem resulting from the selection bias can be reduced by using the two-stage Heckman (1979) model. In the first stage, we estimate Equation (1) using a probit model and then calculate the Inverse Mills Ratio (*IMR*). In the second stage, *IMR* is used as an additional control variable in our models. The first-stage regression results (unreported) show a likelihood ratio of 3534.53 and that most of the four determinants of derivatives usage are significantly associated with *Der.* The coefficients on *IMR* are significant at the 5% level, suggesting that the Heckman model is a reasonable method for dealing with endogeneity concerns. Table 8 reports the results from the second-stage regression. The results for *Risk_std* show after controlling for *IMR*, the positive coefficient on the two-way interactions of $PPS^2 \times Der\%$ is statistically significant at the 5% level in column (1). The negative coefficient on the three-way interactions of *PPS×Soe×Reg* is significant at the 10% level, while the coefficient on $PPS^2 \times Soe \times Reg$ is insignificant in column (3). We observe qualitatively similar results for *Risk_diff* in columns (2) and (4). Collectively, the results in Table 8 provide support that our main findings are robust to the issue of correlated omitted variables or self-selection bias.

Table 8 Regression Results of Heckman Procedure

Variable	The impact of executive compensation		The moderating role of government regulation	
	(1) *Risk_std*	(2) *Risk_diff*	(3) *Risk_std*	(4) *Risk_diff*
Der%	-0.569***	-1.092***		
	(-3.23)	(-3.29)		
PPS	0.015	0.029	-0.110*	-0.198*
	(1.39)	(1.37)	(-1.79)	(-1.77)
PPS×Der%	-10.278*	-19.427*		
	(-1.79)	(-1.78)		
PPS^2	-0.033	-0.061	0.297*	0.525*
	(-1.56)	(-1.51)	(1.78)	(1.73)
PPS^2*×Der%*	20.150**	37.934**		
	(2.06)	(2.16)		
Reg			-0.004	-0.008
			(-1.28)	(-1.24)
PPS×Soe×Reg			-0.332*	-0.460*
			(-1.90)	(-1.85)
PPS^2*×Soe×Reg*			15.681	25.894
			(0.98)	(0.98)
IMR	-0.001**	-0.001**	-0.017**	-0.032**
	(-2.16)	(-2.14)	(-2.17)	(-2.15)
Control	Yes	Yes	Yes	Yes
Intercept	0.113***	0.211***	0.114***	0.213***
	(3.02)	(2.97)	(3.05)	(3.00)
Fixed effect	Yes	Yes	Yes	Yes
N	9827	9827	1361	1361
adj. R^2	0.068	0.068	0.072	0.071

Note: This table reports the results from the second-stage regression using the two-stage Heckman (1979) procedure. The Inverse Mills Ratio (*IMR*) is from the first-stage regression. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively.

6.4 Political Sensitivity of Executive Compensation and the Effectiveness of Government Regulation

One may argue that the different moderating effects of executive compensation between SOEs and non-SOEs can mainly be attributed to the political sensitivity of executive compensation in SOEs rather than the effectiveness of government regulation itself.

Executive compensation is generally lower in SOEs than in non-SOEs of similar size. In our sample, the mean of *PPS* in the SOE sample (0.002) is much smaller than that in the non-SOE sample (0.058). There are two main reasons for this. First, the executives of SOEs are generally quasi-official officers who are both enterprise managers and administrative officials. In addition to receiving compensation, they can benefit from a promotion to the next level. Therefore, political promotion can be a substitute for executive compensation. Second, SOEs often set a cap on total compensation for their executives to narrow the gap between executive compensation and the average compensation of rank-and-file employees. In our sample period, the Chinese government released regulations to limit the pay levels of SOE executives in 2004, 2009, and 2015, respectively. Prior studies address how these constraints on executive compensation may reduce PPS (e.g. Jensen and Murphy, 1990; Cuñat and Guadalupe, 2009; Hadley, 2016).

Table 9 The Impact of Government Regulation on Effectiveness of Executive Compensation

Variable	*Risk_std*		*Risk_diff*	
	(1) pre-regulation	(2) post-regulation	(3) pre-regulation	(4) post-regulation
Der	-0.002*	-0.002**	-0.003*	-0.005**
	(-1.69)	(-2.37)	(-1.76)	(-2.40)
PPS	-5.269	0.738	-9.922	1.380
	(-1.21)	(1.49)	(-1.18)	(1.49)
PPS×Der	5.135	-0.997*	9.543	-1.896*
	(1.16)	(-1.92)	(1.12)	(-1.96)
PPS^2	18.783**	-0.154	34.961**	0.570
	(2.11)	(-0.03)	(2.04)	(0.05)
$PPS^2 \times Der$	19.315**	2.496	35.633**	4.965
	(2.13)	(0.34)	(2.03)	(0.35)
Control	Yes	Yes	Yes	Yes
Intercept	0.075***	0.115***	0.134***	0.208***
	(3.63)	(5.34)	(3.58)	(5.21)
Fixed effect	Yes	Yes	Yes	Yes
N	252	1263	252	1263
adj. R^2	0.132	0.105	0.129	0.105

Note: This table reports whether or not the political sensitivity of executive compensation impacts the moderating effect of government regulation. We use the sample of SOEs over the period 2008 to 2015 and employ subsample analysis. The 2008-2009 observations are included in the pre-regulation sub-period. Other observations are included in the post-regulation sub-period. The t-statistics in parentheses are computed on the basis of standard errors clustered at the firm level. ***, **, and * represent significance at the 1%, 5%, and 10% levels, respectively. The continuous variables are winsorised at the 1% level.

In this section, we investigate whether the political sensitivity of executive compensation impacts the effectiveness of government regulation. We exclude non-SOEs from the sample and then split the sample of SOEs into a pre-regulation sub-period sample (*Reg*=0) and a post-regulation sub-period sample (*Reg*=1). We further re-estimate Equation (2) using subsample analysis.[11] As discussed earlier, there is a significant difference in the

[11] We do not use the DID approach in the absence of the untreated control group.

strength of government regulation of SOEs' use of derivatives around 2009, allowing us to examine whether or not the political sensitivity of executive compensation has an impact.

Table 9 summarises the regression results. *Risk_std* (*Risk_diff)* is the measure of firm risk in columns (1) and (2) (columns (3) and (4)), respectively. We check for the impact of the political sensitivity of executive compensation using the pre- and post-regulation sub-periods. The results for *Risk_std* show that the coefficient on $PPS^2 \times Der$ is positive and significant at the 5% level in the pre-regulation sub-period but insignificant in the post-regulation sub-period. We observe similar results for *Risk_diff*. The results suggest our findings are robust after controlling for the impact of political sensitivity on executive compensation.

VII. Conclusions

Using a sample of Chinese-listed companies over the period 2008 to 2015, we examine the effect of executive compensation on the relationship between derivatives usage and firm risk as well as the moderating role of government regulation on executive compensation incentive. Our analysis shows that executive compensation has a U-shaped effect on the relationship between derivatives usage and firm risk. Furthermore, the effect of executive compensation depends on the level of government regulation. Specifically, before (after) the PPS of executive compensation reaches the inflection point, derivative activities are negatively (positively) associated with firm risk when there is an increase in PPS. We also find with the increase in the level of government regulation, there is a negative relationship between PPS and risk-premium-related derivatives usage in the firms under strong regulation compared to the U-shaped relationship in the firms under weak regulation. We conduct many additional tests to gauge the robustness of the results. Our collective findings demonstrate the important role of government regulation, suggesting it can complement internal governance to influence managers' risk management and, subsequently, firm risk. Our findings not only add to the literature on derivatives usage and corporate governance but also have policymaking implications for other developing countries.

Although we address endogeneity concerns and conduct a battery of sensitivity tests, our findings may still be affected by unobservable factors. We view our work as an initial attempt to investigate the effect of government regulation on the economic outcomes of using derivatives. Future studies can identify the most effective channels that government regulation can use to ascertain whether companies use hedging properly. Another line of future inquiry is to investigate how environmental factors and managerial characteristics influence the relationship between government regulation, executive compensation, and risk-premium-related derivatives usage.

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Appendix A Variable Definitions

Firm risk variables

Risk_std	The standard deviation of industry-adjusted ROA over three years from t to t+2.
Risk_diff	The difference between the maximum and minimum adjusted ROA during the period year t to year t+2.
Derivatives variables	
Der	A dummy variable that equals 1 if the firm reports a position in derivatives and 0 otherwise. This variable identifies the derivative user (=1) and non-user (=0) samples.
Der%	Derivatives ratio, defined as the ratio of year-end fair value of financial derivatives to the book value of year-end assets.
Pay-performance sensitivity variable	
PPS	The sensitivity of executive compensation to stock prices, defined as the sum of compensation-performance sensitivity (*Compsensitivity*) and stock-performance sensitivity (*Stocksensitivity*). *Compsensitivity* is calculated by the change in cash compensation from the prior year divided by the change in the market value of equity from the prior year. *Stocksensitivity* is calculated by the number of executive shareholdings divided by the number of total shares.
Measure of the implementation of government regulation	
Reg	A dummy variable that equals 1 in the years for which the regulation on derivative activities is required (2010-2015) and 0 otherwise.
Measures of risk management incentives	
Lev	Debt-to-asset ratio, defined as the total liability divided by total asset
BM	Book-to-market ratio, defined as the ratio of book value per share to market price-year end
ETRs	Book effective tax rate, defined as total income tax expense less deferred taxes divided by pre-tax profit
Size	Firm size, defined as natural logarithm of total assets
Other variables	
Salegrowth	Growth ratio of sales
Ratio_first	The percentage of shares held by the largest shareholder
Ratio_BH	The percentage of the sum of B-shares and H-shares issued by a firm
Cfo	The net operating cash flow in the year t scaled by total assets at the beginning of year t
Age	The natural logarithm of the sum of the age of the firm plus one
Lntobinq	Natural logarithm of Tobin's Q
Soe	A dummy variable that equals 1 if the firm is state owned and 0 otherwise. A firm is defined as state owned if its ultimate controlling shareholder is the government or a quasi-state institution (such as another state-owned company).
IMR	Inverse Mills ratio calculated on the basis of the coefficient estimates from Eq. (1)