Economic Uncertainty and Derivatives Usage by Japanese firms

Juxin Yan
Kokushikan University

Yukihiro Yasuda
Hitotsubashi University

1. Introduction

This paper aims to empirically investigate the effects of economic uncertainty on firms' demand for derivatives for hedging purposes focusing on Japanese listed companies. More concretely, we use the VIX (Volatility Index of Japan), which is constructed based on the implied volatility of option prices for a proxy of stock market uncertainty, and the EPU (Economic Policy Uncertainty) index created by Arbatli et al. (2022). Following the study of Baker et al. (2016), they used Japanese newspapers and constructed an index of Japanese EPU based on text mining.

Figure 1. VIX and EPU indexes in Japan since 2013

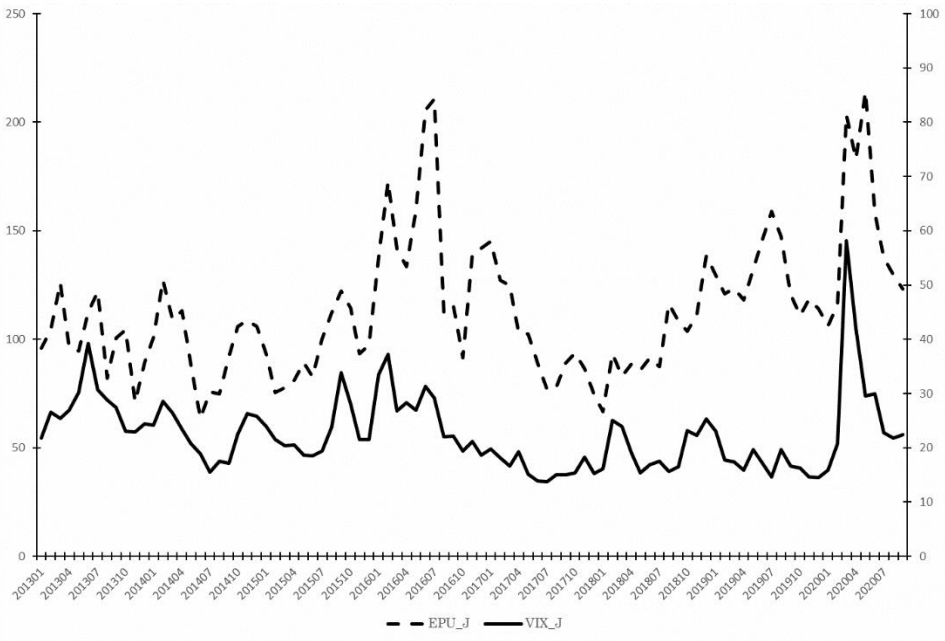

Figure 1 represents both VIX and EPU indexes in Japan since 2013. Both indexes show that they are getting higher when uncertainty is high. We note that EPU_J is much more volatile than VIX_J. As Kumamoto (2019, 2021) discusses, VIX reflects the uncertainty on short-term factors such as investor sentiment or risk tolerance, while EPU reflects the long-term policy uncertainty affecting economic fundamentals. This study focuses on these two uncertainties and their relationship with derivatives usage of individual firm.

２．Related Literature

This paper is closely related to previous research that has examined derivative uses from a risk management perspective. As discussed by Modigliani and Miller (1958), theoretically risk hedging, like financing instruments, does not affect firm value in an efficient market. In other words, market imperfections contribute to the demand for hedging. Therefore, previous studies such as Yanase (2011) have examined the relationship between financially distressed costs, taxes, agency costs, and derivatives usage. Although this paper also investigates the determinants of derivatives usage from a risk management perspective, it differs from previous studies in considering how economic uncertainties such as VIX and EPU affect corporate hedging.

There are some previous studies using the disclosure data from financial reports. In Japan, the quantitative data on derivative transactions based on hedge accounting is available after March 2010. Since then, many analyses use this data, such as Yanase (2011), Yasuda and Yanase (2011), and Limpaphayom et al. (2019). Those studies use the contracted amounts on derivative holdings for which hedge accounting is a proxy for firms' hedging behavior. Yanase (2011) found that the number of firms using interest derivatives is due to the disclosure of hedge accounting. Limpaphayom et al. (2019) found that bank equity ownership positively relates to the corporate usage of derivatives. They also found that derivatives usage is positively associated with firm value. These results are consistent with the view that bank equity ownership increases corporate hedging and results in high firm valuation.

This study is also related to the studies on the relationship with EPU. Nguyen et al. (2018) investigated the link between EPU, firm-level FDI, and firms' hedging behavior. Tran et al. (2021)examined the relationship between the US bank holding companies' hedging in derivatives and EPU. They found that banks use derivatives less when EPU is high. They interpret the result as consistent with the risk allocation hypothesis that they allocate their risk exposure via lending.

３．Empirical Analysis

３.１．Data and Methodology

We gather data on Japanese listed firms in the 1st and 2nd sections, but we exclude all the data on financial or regulated firms. We collect data on derivatives holdings from the NIKKEI value search database. We obtain the financial data and ownership structure from Astra Manager. The Volatility Index Japan (VIX_J) data is obtained from the Center for Mathematical Modeling and Data Science

website, Osaka University. Japan's EPU index is collected from Baker, Bloom, and Davis's (BBD) Economic Policy Uncertainty website.[1]

Based on the panel data set, we estimate the logit model for the demand of derivatives usage and the OLS model for the determinant of derivative amounts as follows:

$$Hedge\_dum_{i,t} = \alpha_1 + \alpha_2 Uncertainty_{i,t-1} + \alpha \cdot X_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

$$Derivative\_at_{i,t} = \beta_1 + \beta_2 Uncertainty_{i,t-1} + \beta \cdot X_{i,t-1} + \varepsilon_{i,t} \quad (2)$$

Regarding the dependent variable of equation (1), we use a dummy variable that takes one if a firm *i* use derivative transactions that apply for hedge accounting and zero otherwise (All_Hedge_dum). More specifically, we use a dummy variable that takes one if interest rate derivatives that apply hedge accounting are used and 0 otherwise (IR_Hedge_dum), and a dummy variable that takes one if currency derivatives that apply hedge accounting are used and zero otherwise (CR_Hedge_dum).

The left-hand side of equation (2) is the ratio of derivative contracts to total assets (Derivataive_at), which measures the extent of derivatives usage with hedge accounting. Many previous studies have used this variable as a proxy for the hedging behavior of firms. All_Derivative_at is the total contract amount of interest rate and currency derivative transactions with hedge accounting, IR_Derivative_at is the contract amount of interest rate derivative transactions with hedge accounting, and CR.Derivative_at represents the contract amount of currency derivatives with hedge accounting. All these variables are scaled by total assets, respectively.

Our primary interest in this paper is the proxies of economic uncertainty. VIX_J is the natural logarithm of the 12-month moving average of the monthly implied volatility of the stock market. EPU_J is the natural logarithm of the 12-month moving average of the monthly EPU index. The starting point is the end of each company's fiscal year, and the retrospective period is one year from that point. The expected sign is positive if a firm is demanding derivatives for hedging purposes.

[1] http://www-mmds.sigmath.es.osaka-u.ac.jp/structure/activity/vxj.php
https://www.policyuncertainty.com/

We include several control variables X. As a proxy for firm size, we use the natural logarithm of total assets (Ln_at). We also have the ratio of debt to total assets (Leverage) as a proxy for leverage and use the ratio of book value to market value (Tobin_Q) as a proxy of Tobin's simple Q, and the growth rate of R&D expenditures (RD_growth). Regarding shareholder ownership, we use the ratio of institutional investors' equity holdings (Inst_own). To estimate of currency derivatives, we add the natural logarithm of foreign sales (Ln_F_Sales) (See Appendix for the definitions and expected signs). We use all explanatory variables at the end of the previous fiscal year. We also include industry dummies (Sector_dum) in each of the specifications.

Table 1 summarizes descriptive statistics for our sample firms. We note that the share of firms using either interest rate derivatives or currency derivatives subject to hedge accounting is 46%, indicating that almost half of the firms use derivative transactions. On the other hand, the ratio of firms that use interest rate derivatives or currency derivatives with hedge accounting is around 34%. As for the ratio of derivative contracts to total assets, interest rate derivatives account for about 4.5%, while currency derivatives account for about 3.6%. These indicate that the number of firms using derivatives and the contract amounts of interest rate derivatives is enormous.

Table 1

. Descriptive Statistics

	N	Mean	Std. dev.	Min	Median	Max
Panel A: Dependent Variables						
Hedge_dum						
All_Hedge_dum	10648	0.460	0.500	0.000	0.000	1.000
IR_Hedge_dum	10648	0.340	0.470	0.000	0.000	1.000
CR_Hedge_dum	6161	0.330	0.470	0.000	0.000	1.000
Derivative_at						
All_Derivative_at(%)	4889	5.630	7.090	0.020	3.170	46.90
IR_Derivative_at (%)	3569	4.490	4.890	0.030	2.800	30.31
CR_Derivative_at (%)	2052	3.600	6.640	0.010	1.220	47.80
Panel B:Independent Variables						
VIX_J	10648	3.070	0.150	2.770	3.050	3.350
EPU_J	10648	4.700	0.170	4.430	4.690	4.990
Ln_at	10648	11.35	1.600	7.690	11.15	15.60
Leverage(%)	10648	17.39	15.09	0.020	13.98	65.40
Tobin_Q	10648	1.170	0.670	0.520	1.010	6.990
RD_growth （%）	10648	1.080	0.390	0.330	1.030	3.670
Inst_own(%)	10648	64.30	17.98	13.07	66.76	94.25
Ln_F_sales	6161	3.500	0.700	0.690	3.630	4.510

3.2. Empirical Results

Table 2 describes the results on the relationship between the derivative usage and the VIX and EPU. Row 1 of Panel A shows that the coefficient of *VIX_J* is positive and statistically significant, indicating that the higher the stock market uncertainty, the higher the risk hedging of using derivatives. In terms of hedging purposes, this implies that firms use derivatives as a risk management tool against the increased risk.

On the other hand, Rows 2 and 3 show that the coefficient of *EPU_J* is negative and statistically significant. The results indicate that firms use derivatives less when EPU is high, which is consistent with the results of Tran et al. (2021). As they focus on banking, we carefully need to investigate non-financial firms. Panel B shows the results with *IR_Hedge_dum* and *CR_Hedge_dum* as explained variables. We note that Panel A reflects the results for interest rate derivatives.

Table 2

Panel A

Dependent Variables	(1) All_Hedge_dum	(2)	(3)	Marginal effect of (3)
VIX_J	0.451		0.529	0.111
	[3.16]***		[3.61]***	
EPU_J		-0.196	-0.304	-0.064
		[-1.55]	[-2.33]**	
Ln_at	0.094	0.096	0.095	0.020
	[4.96]***	[5.03]***	[5.02]***	
Leverage	0.044	0.044	0.044	0.009
	[26.28]***	[26.34]***	[26.25]***	
Tobin_Q	-0.546	-0.562	-0.545	-0.114
	[-10.93]***	[-11.21]***	[-10.89]***	
RD_growth	-0.030	-0.032	-0.030	-0.006
	[-0.52]	[-0.55]	[-0.52]	
Inst_pwm	0.020	0.020	0.020	0.004
	[11.67]***	[11.52]***	[11.65]***	
Constant	-3.802	-1.480	-2.624	
	[-6.18]***	[-2.03]**	[-3.30]***	
Sector_dum	Yes	Yes	Yes	Yes
N	10632	10632	10632	
Pseudo_R2	0.122	0.121	0.122	

Panel B

Dependent Variables	(1) IR_Hedge_dum	(2)	(3)	Marginal effect of (3)
VIX_J	0.948		1.102	0.194
	[6.07]***		[6.92]***	
EPU_J		-0.431	-0.648	-0.114
		[-3.11]***	[-4.54]***	
Constant	-6.082	-1.092	-3.530	
	[-8.99]***	[-1.37]	[-4.03]***	
Control_variables	Yes	Yes	Yes	Yes
Sector_dum	Yes	Yes	Yes	Yes
N	10632	10632	10632	
Pseudo_R2	0.174	0.172	0.176	

Dependent Variables	(1) CR_Hedge_dum	(2)	(3)	Marginal effect of (3)
VIX_J	0.160		0.228	0.044
	[0.81]		[1.13]	
EPU_J		-0.230	-0.275	-0.053
		[-1.32]	[-1.54]	
Constant	-2.811	-1.236	-1.733	
	[-3.36]***	[-1.24]	[-1.59]	
Control_variables	Yes	Yes	Yes	Yes
Sector_dum	Yes	Yes	Yes	Yes
N	6127	6127	6127	
Pseudo_R2	0.107	0.108	0.108	

Table 3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dependent Variable	All_Derivative_at			IR_Derivative_at			CR_Derivative_at		
VIX_J	1.903		2.102	2.248		2.421	-0.827		-0.959
	[2.93]***		[3.16]***	[4.82]***		[4.99]***	[-0.88]		[-1.01]
EPU_J		-0.379	-0.793		-0.251	-0.714		0.316	0.509
		[-0.67]	[-1.37]		[-0.62]	[-1.69]*		[0.39]	[0.62]
Ln_at	0.197	0.204	0.199	0.055	0.061	0.056	-0.483	-0.490	-0.482
	[2.36]**	[2.44]**	[2.38]**	[0.81]	[0.91]	[0.84]	[-3.86]***	[-3.93]***	[-3.85]***
Leverage	0.132	0.133	0.132	0.145	0.146	0.145	0.038	0.038	0.038
	[16.76]***	[16.89]***	[16.71]***	[19.73]***	[19.78]***	[19.70]***	[3.46]***	[3.44]***	[3.48]***
Tobin_Q	0.495	0.423	0.492	-0.415	-0.475	-0.417	-0.034	0.023	-0.021
	[1.25]	[1.07]	[1.24]	[-1.94]*	[-2.22]**	[-1.95]*	[-0.08]	[0.05]	[-0.05]
RD_growth	-0.287	-0.313	-0.292	-0.251	-0.278	-0.258	-0.143	-0.136	-0.142
	[-0.91]	[-1.00]	[-0.93]	[-1.04]	[-1.17]	[-1.07]	[-0.19]	[-0.18]	[-0.19]
Inst_pwm	0.001	0.000	0.001	0.000	-0.002	0.000	0.014	0.015	0.014
	[0.16]	[0.02]	[0.15]	[-0.00]	[-0.24]	[-0.01]	[1.06]	[1.11]	[1.07]
Ln_F_sales							1.616	1.613	1.611
							[4.45]***	[4.44]***	[4.44]***
Constant	-4.146	3.556	-1.018	-7.163	1.016	-4.329	4.980	0.988	2.950
	[-1.63]	[1.16]	[-0.30]	[-4.00]***	[0.47]	[-1.83]*	[1.45]	[0.23]	[0.62]
Sector_dum	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4889	4889	4889	3569	3569	3569	2052	2052	2052
Adj. R-Square	0.144	0.143	0.144	0.285	0.280	0.285	0.180	0.180	0.180

Table 4 summarizes the extent of derivatives usage. In columns 1 and 3, the coefficients on VIX_J are positive and statistically significant, indicating that the use of interest rate derivatives measured by contract value increases when VIX increases. Column 6 shows that the coefficient on *EPU_J* is statistically negative and significant at the 10% level. The result implies that firms reduce the contract amount of interest rate derivatives when EPU increases. However, none of the other columns are statistically significant.

４．Final Remarks

We empirically investigated how economic uncertainty affects Japanese firms' demand for derivative transactions for hedging purposes. We found that firms' demand for derivatives usage increases when VIX increases. We also found that the results are mainly for interest rate derivatives. On the other hand, although the results for EPU were not necessarily consistent, we note that demand for derivative usage tends to decrease when EPU increases. This result also is mainly due to interest rate derivatives.

We note that the EPU index in Japan is unique in that it is not limited to the overall index but also discloses EPU indexes for each policy: fiscal, monetary, trade, and exchange rate. The usage of interest rate derivatives might be related to monetary policy uncertainty and currency derivatives to exchange rate policy uncertainty. We will report the results in the next issue and then summarize the characteristics of derivative usage by Japanese firms from the perspective of risk hedging behaviors.

References

Alexandridis, G., Chen, Z., & Zeng, Y. (2021). Financial hedging and corporate investment. Journal of Corporate Finance, 67, 101887.

Arbatli-Saxegaard, E. C., Davis, S. J., Ito, A., & Miake, N. (2022). Policy uncertainty in Japan. Journal of the Japanese and International Economies, 64, 101192.

Baker, S. R., Bloom, N., & Davis, S. J. (2016). Measuring economic policy uncertainty. The quarterly journal of economics, 131(4), 1593-1636.

Fujitani, R., Hattori, M., & Yasuda, Y. (2021). Effects of Economic Policy Uncertainty on Corporate Investment and Strategic Cash Holdings: Evidence from Japan, RIETI Discussion Paper Series, No. 21069.

Gay, G. D., Lin, C. M., & Smith, S. D. (2011). Corporate derivatives use and the cost of equity. Journal of Banking & Finance, 35(6), 1491-1506.

Kuzmina, O., & Kuznetsova, O. (2018). Operational and financial hedging: Evidence from export and import behavior. Journal of Corporate Finance, 48, 109-121.

Limpaphayom, P., Rogers, D. A., & Yanase, N. (2019). Bank equity ownership and corporate hedging: Evidence from Japan. Journal of Corporate Finance, 58, 765-783.

Lin, L. K. K. (2022). An Analysis of Economic Policy Uncertainty and the Target Level of Capital Buffer of Bank. Japan Journal of Finance, JJF-forthcoming2022-001. [Translated from Japanese.]
(Lin, L. K. K. (2022). 「経済政策の不確実性と銀行のターゲット・資本バッファーに関する検証」.『経営財務研究』, JJF-forthcoming2022-001.)

Nguyen, Q., Kim, T., & Papanastassiou, M. (2018). Policy uncertainty, derivatives use, and firm-level FDI. Journal of International Business Studies, 49(1), 96-126.

Tran, D. V., Hassan, M. K., AlTalafha, S. H., & Turunen-Red, A. (2021). Policy uncertainty, the use of derivatives: Evidence from US bank holdingcompanies (BHCs). Research in International Business and Finance, 58, 101447.

Kumamoto, M. (2019). The Impact of Policy Uncertainty on Asset price. Securities Analysts Journal, 57(7), 45-54. [Translated from Japanese.]
(熊本方雄. (2019). 「政策不確実性が資産価格に与える影響」. 『証券アナリストジャーナル』, 57(7), 45-54.)

Kumamoto, M. (2021). The Impact of Global Risk on Stock Market Caused by Economic Policy Uncertainty. In Ogawa, E. (Eds.), Global Risk and the World Economy Crisis Caused by Economic Policy Uncertainty and Risk Management. University of Tokyo Press. [Translated from Japanese.]
(熊本方雄. (2021). 「政策不確実性に起因するグローバル経済リスクが株式市場に与える影響」. 小川英治編『グローバルリスクと世界経済政策不確実性による危機とリスク管理』, 東京大学出版会.)

Yasuda, Y., & Yanase, N. (2011). An Analysis of the Relationship between Corporate Hedging and Capital Structure. The Journal of Tokyo Keizai University: Economics, 271, 191-204.
(安田行宏, & 柳瀬典由. (2011). 「ヘッジ目的のデリバティブ利用と資本構成の関係について

の分析」.『東京経大学会誌』. 経済学, (271), 191-204.)

Yanase, N. (2011). Japanese Firms' Derivatives Usage and Hedging Behavior. Securities Analysts Journal, 49(2), 66-75. [Translated from Japanese.]
(柳瀬典由. (2011). 「わが国企業のデリバティブ利用とヘッジ行動」. 『証券アナリストジャーナル』, 49(2), 66-75.)

Appendix. Description of variables

Panel A: Dependent Variables	
Variables	**Description**
Hedge_dum	
All_Hedge_dum	Dummy variable equal to one if a firm uses either interest rate derivatives or currency derivatives for hedging purposes and zero otherwise
IR_Hedge_dum	Dummy variable equal to one if a firm uses interest rate derivatives for hedge purposes and zero otherwise
CR_Hedge_dum	Dummy variable equal to one if a firm uses currency derivatives for hedge purposes and zero otherwise
Derivative_at	
All_Derivative_at(%)	The ratio of the sum of notional amounts of interest rate and currency derivatives to total assets at the end of a fiscal year
IR_Derivative_at (%)	The ratio of the notional amount of interest rate derivatives to total assets at the end of a fiscal year
CR_Derivative_at (%)	The ratio of the notional amount of currency derivatives to total assets at the end of a fiscal year

Panel B:Independent Variables	
Variables	**Description**
VIX_J	The natural logarithm of the 12-month moving average of the monthly implied volatility of the stock market. The starting point is the end of each company's fiscal year, and the retrospective period is one year from that point
EPU_J	The natural logarithm of the 12-month moving average of the monthly EPU index. The starting point is the end of each company's fiscal year, and the retrospective period is one year from that point
Ln_at	The natural logarithm of book value of total assets at the end of a fiscal year
Leverage(%)	Interest-bearing debt over total assets of the firm at the end of a fiscal year
Tobin_Q	Market value of equity plus book value of debt over book value of equity plus book value of debt at the end of a fiscal year
RD_growth（%）	The growth rate of R&D expenditures at the end of a fiscal year
Inst_own(%)	The sum of financial institutions' equity ownership, financial securities firms' equity ownership, other corporations' equity ownership, Foreign corporations' equity ownership at the end of a fiscal year
Ln_F_sales	The natural logarithm of foreign sales over operating income times 100 at the end of a fiscal year

Panel C:The expected signs of Independent Variables and the reasons		
Variables	**Expected Sign**	**Reason**
VIX_J	+	If a firm is demanding derivatives for hedging purposes, then we would expect to see a positive relationship between economic uncertainty and derivatives usage.
EPU_J	+	
Ln_at	+	Firm size is positively related to a scale economies effect of using derivatives
Leverage(%)	+	Higher probablity of encountering financial constraints is positively related to derivatives usage
Tobin_Q	-/+	If speculation is a primary reason for derivatives usage, then we would expect to see a negative relationship between firm value and derivatives usage. In the other hand, if hedging is a primary reason for derivatives usage, then we would expect to see a positive relationship between firm value and derivatives usage.
RD_growth（%）	+	If hedging is used as a way to protect investment from the effects of bad incomes on manageable risk exposures, then we would expct R&D growth is positively related to derivatives usage
Inst_own(%)	+	Institutional equity ownership suggusts a strong monitoring relationship of it holding, Firms with bigger institutional equity ownership are expect to use more derivatives to hedge
Ln_F_sales	+	Firms highly dependent on external factors tend to use more currency derivatives for hedge purposes