Internet Appendix to "Information Spillover and Corporate Policies: The Case of Listed Options"

This appendix contains detailed results of our robustness tests. In Table A1, we examine alternative measures of the corporate policies. First, we scale variables of interest by market value rather than book value of assets. Second, we include R&D in our measure of investment. Third, we use alternative patent measures. Similar to the analysis in Tables 3 and 5, we report the RDD and full sample IV regression results in Panels A and B of Table A1. Using market value as the deflator of the dependent variables, Columns 1 through 5 reexamine the effects of options availability on financial policies and cash holding policy. We find that the results are consistent with our main results in Tables 3 and 5: options trading significantly increases both equity and debt issues, heightens the firm's reliance on equity, and increases the firm cash balance. These effects are always significant at the 1% level in both RDD and full sample IV estimations except for dividend payout, and the economic magnitude is comparable to results obtained using book value of assets to scale those corporate variables.

Turning to the asset side, we add R&D expenses to capital expenditures to measure firm investment and replicate the investment analysis in Columns 6 and 7. We find that the results are consistent with those when R&D expenses are not included. In particular, options availability significantly increases both firm investment levels and investment-q sensitivity. Following the literature on corporate innovations such as Hall et al., (2005), we then examine alternative patent measures including *PatDum*, a dummy variable indicating whether the firm has any successful patent application in the year; *GENE*, average patent generality calculated as one minus the Herfindahl Index of the three-digit technology class distribution of all the patents that cite it; *ORIG*, average patent originality calculated as one minus the Herfindahl Index of the three-digit technology class distribution of all the patents it cites; and *ValueKPSS*, the total dollar value of innovation produced by a give firm in each year, defined as equation (8) in Kogan, Papanikolaou, Seru, and Stoffman (2017). Columns 8 through 11 in this table show that options availability positively and significantly affects all three alternative measures of innovation outcome. Overall, how the corporate policies are measured does not affect our results.

The second set of robustness tests employ alternative estimation methods of the option listing effects. Specifically, in Table A2, Panel A reports the firm fixed-effect regression results of corporate policies on the options trading status dummy in the full sample. Panels B and C use alternative bandwidth of 0.5

(narrower than in our main analysis) and 0.7 (wider than in our main analysis) to reproduce the fuzzy RDD results. We find that these results are largely consistent with our main findings.

The third robustness test concerns potential manipulations by managers if they have a particular preference of options trading status on the firms' stocks. The regulatory rules are based on market variables of stock price, trading volume, and public float. Although it is difficult for managers to affect trading volume intentionally, stock price and public float might be less costly to manipulate through stock splits and reverse splits. Such intentional actions can violate the exogeneity assumption of our analysis. For robustness, we exclude 1,630 firm-years with stock splits or reverse splits from the main sample. In addition to the year of those events, we also exclude a year prior and a year after to further mitigate potential impact of those corporate actions although this empirical choice is out of conservatism and does not affect our results. Then we replicate the IV estimations in this restricted sample and report the results in Table A3. We find that excluding stock splits has no impact on our main findings. The estimated effects from options availability on all corporate policies remain significant in both statistical and economic terms.

Our primary identification method in the study relies on an instrumental variable based on regulatory requirements for options listing. As an alternative, we also use propensity score matching to further examine the possibility that our results are driven by omitted variables related to the eligibility standards rather than to options listing. Specifically, using a matched sample, we compare the firm policies before and after the options introduction (first difference) to otherwise similar firms (second difference).

We use a different setting to perform a matched-sample DD estimation. We identify the first year of options trading for all firms in our full panel sample between 1998 and 2017. For the treatment subjects, we require no options trading on the underlying equity in the two years prior to the listing event year and require that the firm has continuous options trading in two years after. For control firms, we require that the firm equity be unconnected to listed options during the corresponding five-year event window while meeting all SEC listing requirements in the event year. We estimate a logistic regression model for the likelihood of options listing based on stock price, volatility, trading volume, 12-month stock return momentum, and industry classification as well as all the firm characteristics in our set of control variables (firm size, asset tangibility, Tobin's q, return on assets, and free cash flows). We then match each treated firm to a control firm in the same Fama and French (1997) industry in the same year with the nearest propensity score. In total, the resulting matched sample comprises 816 unique options listing events . We create a listing indicator (Treat) that equals one for treated firms and zero for control firms,

and an event-time indicator (After) that equals one for event years 0, 1, and 2, and zero otherwise (excluding event year 0 from the analysis does not change our conclusion).

We perform the DD estimation using the five-year window centered on each listing event year. Specifically, we estimate the following generalized DD model, including firm and calendar year fixed effects, (similar to Bertrand et al., 2004):

$$Y_{it} = \alpha_{1t} + \alpha_{2i} + \beta * Treat_{it} * After_{it} + \Omega * X_{it-1} + \epsilon_{it} \,. \qquad (3)$$

Table A4 Panel A reports our DD estimation results. The estimated treatment effect from options listing is significantly negative for financial leverage, repurchases, and significantly positive for equity issues, debt issues, level of investment, cash holdings, investment-q sensitivity, and number of patents. Therefore, across the 10 different corporate variables we examine, the results are all consistent with our main findings using the IV tests, except that we do not observe significant treatment effects on dividend payout and patent citations in the matched sample. In Table A4 Panel B, we verify parallel trends in the corporate policies between the treated and control firms approaching the year of treatment (Roberts and Whited, 2013). We create a dummy (Trend) that equals one for event year t − 1, and zero for event year t − 2. Then using those two event years, we replace the post-event dummy (After) with the trend dummy in Equation 3. If the treatment and control firms have diverging trends in corporate policies before the actual treatment, the coefficient β will differ significantly from zero in this test. We find no such evidence for any corporate variable of interest in Table A4 Panel B.

Table A1: Alternative Corporate Policy Measures

This table examines the impact of options availability on alternative measures of corporate financial and investment policies. We only report the results for variables of interest while the regressions always control for the same variables as in Tables 3 and 5 as well as firm and time fixed effects. *EQ_MKT*, sale of stocks minus equity repurchased divided by market value of assets at the beginning of the year; *DT_ MKT*, long-term debt issued minus long-term debt reduction divided by market value of assets at the beginning of the year; *LEV_ MKT* , market leverage calculated as debt divided by market value of assets at the beginning of the year; *DIV_MKT*, the dividend ratio calculated as dividends divided by market value of assets at the beginning of the year; *CAPXRD is* capital expenditures plus R&D expenses divided by market value of assets at the beginning of the year. *CASH_MKT*, cash and cash equivalent divided by market assets at the beginning of the year; *Pat_Dum* is a patent dummy equal one if the firm has at least one successful patent application in a year, and zero otherwise. *ValueKPSS* is the total dollar value of innovation produced by a give firm in each year, defined as equation (8) in Kogan, Papanikolaou, Seru, and Stoffman (2017). The standard errors are clustered by firm because option listing occurred at firm level. Corresponding *t*-statistics are reported in parentheses. +, *, and ** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Panel A RDD sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	EQ_MKT	*DT_MKT*	*LEV_MKT*	*DIV_MKT*	*CASH_MKT*	*CAPXRD*	*CAPXRD*	*Pat_Dum*	*GENE*	*ORIG*	*ValueKPSS*
OP_{it}	0.021**	0.011**	-0.042**	-0.001	0.015**	0.003**	0.001**	0.032*	0.006	0.007	0.105**
	(5.82)	(2.90)	(-6.47)	(-0.59)	(2.49)	(2.58)	(3.18)	(2.19)	(0.41)	(0.27)	(2.89)
OP_{it}* MB_{it-1}							0.002+				
							(1.69)				
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	15,028	15,028	15,028	15,028	15,028	15,028	15,028	15,028	7,403	7,403	15,028

Panel B Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	EQ_MKT	*DT_MKT*	*LEV_MKT*	*DIV_MKT*	*CASH_MKT*	*CAPXRD*	*CAPXRD*	*Pat_Dum*	*GENE*	*ORIG*	*ValueKPSS*
OP_{it}	0.017**	0.011**	-0.042**	-0.001	0.016**	0.005**	0.003**	0.018*	0.029**	0.032*	0.035
	(8.51)	(4.98)	(-9.45)	(-0.79)	(4.46)	(2.81)	(3.25)	(2.10)	(3.25)	(2.31)	(0.77)
OP_{it}* MB_{it-1}							0.002+				
							(1.63)				
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	37,994	37,994	37,994	37,994	37,994	37,994	37,994	37,994	22,897	22,897	37,994

Table A2: Alternative estimations

This table reports the results using alternative estimation methods. Panel A reports the fixed effects regressions in the full sample of our IV estimation analysis. Panels B and C uses alternative bandwidths of 0.5 and 0.7 to replicate our main fuzzy RDD analysis, respectively. The standard errors are clustered by firm because option listing occurred at firm level. Corresponding t-statistics are reported in parentheses. +, *, and ** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A Fixed effects regressions in full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
OP_{it}	0.020**	0.014**	-0.015**	-0.000	-0.001	0.005*	0.031**	0.002	0.047**	0.060**
	(4.05)	(4.45)	(-2.68)	(-0.33)	(-1.41)	(2.39)	(5.26)	(0.90)	(4.15)	(2.74)
OP_{it}* MB_{it-1}								0.001		
								(1.17)		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	37,994	37,994	37,994	37,994	37,994	37,994	37,994	37,994	37,994	37,994

Panel B RDD results with bandwidth=0.5

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
OP_{it}	0.042**	0.008	-0.033**	-0.001	-0.002	0.008**	0.033**	-0.007*	0.021	0.092**
	(4.29)	(1.42)	(-4.25)	(-1.00)	(-0.66)	(2.71)	(3.30)	(-2.29)	(1.13)	(3.00)
OP_{it}* MB_{it-1}								0.004*		
								(2.56)		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	11,825	11,825	11,825	11,825	11,825	11,825	11,825	11,825	11,825	11,825

Panel C RDD results with bandwidth=0.7

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
OP_{it}	0.062**	0.012*	-0.053**	-0.002+	-0.005	0.015**	0.058**	-0.012**	0.039*	0.103**
	(6.09)	(2.09)	(-6.06)	(-1.87)	(-1.30)	(4.70)	(5.54)	(-3.68)	(2.16)	(3.41)
$OP_{it} * MB_{it-1}$								0.006**		
								(3.77)		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	18,544	18,544	18,544	18,544	18,544	18,544	18,544	18,544	18,544	18,544

Table A3: Excluding Stock Splits

This table repeats the main analysis in Tables 3 and 5 after excluding three years surrounding 1736 stock splits and reverse splits in our sample. We only report the results for variables of interest while the regressions always control for the same variables as in Tables 3 and 5 as well as firm and time fixed effects. The standard errors are clustered by firm because option listing occurred at firm level. Corresponding *t*-statistics are reported in parentheses. +, *, and ** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Panel A RDD sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
OP_{it}	0.054**	0.013*	-0.047**	-0.001	-0.011	0.013**	0.044**	-0.009**	0.032	0.120**
	(4.76)	(1.97)	(-4.74)	(-1.10)	(-1.02)	(3.84)	(3.90)	(-2.86)	(1.55)	(3.59)
$OP_{it}*MB_{it-1}$								0.004**		
								(2.97)		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	14,578	14,578	14,578	14,578	14,578	14,578	14,578	14,578	14,578	14,578

Panel B Full sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
OP_{it}	0.045**	0.016**	-0.048**	-0.001+	-0.014**	0.017**	0.055**	-0.005**	0.007	0.042*
	(7.65)	(4.68)	(-7.77)	(-1.88)	(-2.43)	(7.61)	(8.16)	(-4.84)	(0.62)	(2.34)
$OP_{it}* MB_{it-1}$								0.003**		
								(5.83)		
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	36,308	36,308	36,308	36,308	36,308	36,308	36,308	36,308	36,308	36,308

Table A4: A Propensity Score Matching Study

This table conducts an event study using option introductions. To be included in the sample, the treatment firm (*Treat* = 1) selected for initial option listing must not have options traded on its stocks in the two years prior to the year of listing and have continuous option trading for at least two years afterward. Each treatment firm is matched to an eligible but not selected firm, the control firm (*Treat* = 0), in the same Fama-French (1997) industry and the same year. The control firm must meet all the SEC's requirements of option listing in the event year t, but have no options traded on its stock any time from year t-2 to t+2. Matching is done based on the estimated propensity of option listing using a logistic model following Mayhew and Mihov (2004). Panel A reports the diff-in-diff estimation results of Equation (3) in the event sample. *After* is a time dummy equal one for event years 0 to 2. We only report the results for variables of interest while the regressions always control for the same variables as in Tables 3 and 5. Panel B reports test results regarding the prelisting trends in the treated and control firms matched based on the propensity of option listing. We use the 2 event years before an option listing event (t - 1 and t - 2) and create a trend dummy (*Trend*) equals one for event year t - 1 and zero for event year t - 2. Reported are the regression results of Equation (3) using this trend dummy instead of the event time dummy. The standard errors are clustered by firm because option listing occurred at firm level. Corresponding t-statistics are reported in parentheses. +, *, and ** indicate statistical significance at the 10%, 5%, and 1% level, respectively

Panel A Difference-in-difference results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
$Treat*After_{it}$	0.058**	0.013**	-0.017**	-0.001	-0.006**	0.008**	0.059**	0.007+	0.042*	0.069
	(5.54)	(2.66)	(-3.14)	(-1.08)	(-2.88)	(2.94)	(6.71)	(1.78)	(2.29)	(1.64)
$Treat*After_{it}*MB_{it-1}$								0.003+		
								(1.84)		
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	7,425	7,425	7,425	7,425	7,425	7,425	7,425	7,425	7,425	7,425

Panel B Pre-listing trends

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	EQISSUE	*DTISSUE*	*LEV*	*DIV*	*REPO*	*CAPX*	*CASH*	*CAPX*	*PAT*	*CITE*
$Treat*Trend_{it}$	0.013	-0.01	-0.007	0.001	0.004	0.003	0.011	-0.005	-0.004	-0.001
	(0.86)	(-1.02)	(-0.73)	(0.73)	(0.80)	(0.99)	(1.02)	(-0.94)	(-0.12)	(-0.01)
$Treat*Trend_{it}*MB_{it-1}$							0.003			
							(1.20)			
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	2,770	2,770	2,770	2,770	2,770	2,770	2,770	2,770	2,770	2,770