Variance Premium, Downside Risk, and Expected Stock Returns

Online Appendix

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Abstract

We decompose the total variance into a bad and good component and measure the premiums associated with their fluctuations using stock and corresponding option data from a large cross-section of firms. The total variance risk premium (VRP) represents the premium paid to insure against fluctuations in bad variance (called bad VRP) net of the premium received to compensate for fluctuations in good variance (called good VRP). Bad VRP provides a direct assessment of the degree to which asset downside risk may become extreme, while good VRP proxies for the degree to which asset upside potential may shrink. We find that bad VRP is important economically as in the cross-section, its two standard deviation increase is associated with an up to 25% rise in annualized expected excess returns. Simultaneously going long stocks with high and short stocks with low bad VRP yields an annualized risk-adjusted expected excess return of 18%. This result remains significant in double-sort strategies and cross-sectional regressions controlling for a host of firm characteristics and exposures to regular and downside risk factors.

Keywords: Variance Forecasting, Jump Risk Premium

JEL Classification: G12

References

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Table 1: Univariate Sorts on Firm VRP: log HARRV model

In Panel A, at the end of month t we sort firms into quintiles based on their average bad VRP (VRP^b) during month t, so that Quintile 1 contains the stocks with the lowest VRP^b and Quintile 5 the highest. We then form value-weighted portfolios of these firms, holding the ranking constant for the next month. Subsequently, we compute cumulative returns during month $t+1$ for each quintile portfolio. We report the monthly average cumulative return in percentage of each portfolio. Similarly, in Panel B, C and D, we sort firms into quintiles based on their average good VRP (VRP^g), total VRP (VRP) and jump risk premium (JRP), respectively. We also compute the Jensen alpha of each quintile portfolio with respect to the Fama-French five-factor model (Fama and French 2015) by running a time series regression of the monthly portfolio returns on monthly MKT, SMB, HML, RMW, and CMA. The t-statistics test the null hypothesis that the average monthly cumulative return of each respective portfolio equals zero, and they are computed using Newey and West (1987) standard errors to account for autocorrelation, and are reported in parentheses. Significant t-statistics at the 95% confidence level are boldfaced. VRP and JRP are reported in monthly square percentage units.

Panel A: Firm Bad VRP

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	-113506.57	7.74	22.94	48.46	207.03	
VRP^g	212.82	12.94	10.68	9.49	12.05	
VRP	-330366.61	-4.51	11.28	37.03	173.97	
JRP	-7105.48	21.08	34.90	58.33	245.23	
$\mathbb{E}[r]$	-0.13	0.70	1.14	1.14	1.06	1.20
	(-0.33)	(**2.53**)	(**3.18**)	(**2.46**)	(1.62)	(**2.68**)
alpha	-0.77	-0.11	0.33	0.46	0.59	1.37
	(-**4.35**)	(-1.31)	(**2.97**)	(**2.97**)	(**2.34**)	(**3.81**)

Panel B: Firm Good VRP

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	59.69	30.99	23.92	21.87	-428.62	
VRP^g	-51.99	-3.11	6.69	23.55	724.44	
VRP	98.91	32.61	17.22	2.07	-27545.61	
JRP	18.84	27.22	30.20	46.46	114.81	
$\mathbb{E}[r]$	0.50	0.53	0.88	1.07	0.89	0.39
	(1.37)	(1.91)	(**2.73**)	(**2.31**)	(1.25)	(0.85)
alpha	-0.12	-0.37	0.12	0.41	0.51	0.63
	(-0.69)	(-**3.39**)	(1.39)	(**2.91**)	(**2.20**)	(**1.99**)

Panel C: Firm Total VRP

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	-113460.71	10.77	21.88	44.67	196.59	
VRP^g	690.69	17.30	6.77	1.29	-35.28	
VRP	-1154007.50	-7.95	13.97	45.04	229.84	
JRP	5.17	30.13	27.50	45.00	166.61	
$\mathbb{E}[r]$	0.10	0.63	0.84	0.82	1.01	0.91
	(0.17)	(1.77)	(**2.98**)	(**2.13**)	(1.80)	(**2.79**)
alpha	-0.34	-0.10	-0.01	0.06	0.47	0.81
	(-1.73)	(-0.73)	(-0.08)	(0.38)	(1.94)	(**2.45**)

Panel D: Firm JRP

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	-103272.74	12.25	25.20	44.76	145.13	
VRP^g	14.61	4.32	8.92	16.39	218.63	
VRP	-103899.45	7.72	16.26	27.73	-70.81	
JRP	-62289.62	15.66	32.39	64.52	454.84	
$\mathbb{E}[r]$	0.07	0.91	1.35	1.34	1.36	1.29
	(0.29)	(**2.91**)	(**3.20**)	(**2.33**)	(1.85)	(**2.12**)
alpha	-0.79	0.07	0.66	0.82	0.95	1.75
	(-**5.78**)	(0.96)	(**4.55**)	(**3.73**)	(**3.70**)	(**5.30**)

Table 2: Conditional Double Sorts on Exposures to Market Risk Neutral Skewness

Stocks are sorted every month in quintiles based on their exposure to market risk neutral skewness in all panels.Then, in Panel A stocks within each quintile of exposure to this factor are further sorted in quintiles based on their bad VRP (VRP^b). Similarly, in Panel B, C and D, stocks within each quintile of exposure to these market risk neutral skewness are further sorted in quintiles based on their good VRP (VRP^g), total VRP (VRP) and jump risk premium (JRP), respectively. Firm exposures to market risk-neutral skewness are estimated following the model of Chang et al. (2013) but in this table we use the level of market risk neutral skewness instead of changes as in the main paper. The table reports average value-weighted excess returns for the bottom quintile (1), the top quintile (5) and for the second (2), third (3) and fourth (4) quintile. We also report the difference in average excess returns between the top and the bottom quintile (5-1). T-statistics are computed using Newey and West (1987) standard errors, and are reported in parentheses. Significant t-statistics at the 95% confidence level are boldfaced. Data are from January 1996 to December 2015.

Panel A: Firm Bad VRP

	Quintiles						
	1	2	3	4	5	5-1	
1	-0.46	0.36	0.23	0.41	-0.13	0.33	(0.82)
2	0.83	0.85	0.66	0.48	0.24	-0.58	(-1.29)
3	1.36	1.39	0.80	0.63	1.23	-0.13	(-0.24)
4	1.01	1.45	1.02	0.90	1.14	0.13	(0.28)
5	1.04	1.76	0.96	1.16	1.05	0.01	(0.02)
5-1	1.49	1.41	0.72	0.74	1.18		
	(**2.56**)	(**2.08**)	(1.79)	(1.77)	(**2.50**)		

Panel B: Firm Good VRP

	Quintiles						
	1	2	3	4	5	5-1	
1	0.29	0.36	0.28	0.06	0.16	-0.13	(-0.26)
2	0.58	0.96	0.46	0.56	0.28	-0.30	(-0.66)
3	1.06	1.42	0.77	1.04	1.28	0.23	(0.44)
4	1.05	1.10	0.80	0.73	1.11	0.06	(0.11)
5	0.40	0.82	0.85	0.86	0.62	0.22	(0.49)
5-1	0.10	0.46	0.57	0.80	0.46		
	(0.21)	(0.91)	(1.50)	(**2.42**)	(0.94)		

Panel C: Firm Total VRP

	Quintiles						
	1	2	3	4	5	5-1	
1	-0.02	0.48	0.36	0.53	-0.38	-0.35	(-0.80)
2	0.83	0.89	0.75	0.47	0.65	-0.18	(-0.31)
3	0.93	1.21	0.54	0.77	0.89	-0.04	(-0.09)
4	0.79	1.16	0.97	1.02	0.73	-0.06	(-0.12)
5	1.06	1.01	0.87	0.62	0.99	-0.07	(-0.12)
5-1	1.08	0.53	0.51	0.09	1.37		
	(**2.21**)	(1.39)	(1.33)	(0.27)	(**2.49**)		

Panel D: Firm JRP

	Quintiles						
	1	2	3	4	5	5-1	
1	-0.48	0.31	0.07	0.28	-0.13	0.35	(0.87)
2	0.34	0.78	0.57	0.80	0.48	0.14	(0.18)
3	1.06	1.43	0.90	0.82	1.20	0.14	(0.30)
4	1.62	1.38	1.14	1.22	1.41	-0.21	(-0.39)
5	1.30	1.53	1.35	1.54	1.50	0.21	(0.38)
5-1	1.77	1.22	1.27	1.26	1.63		
	(**3.03**)	(**2.09**)	(**2.92**)	(**2.84**)	(**3.07**)		

Table 3: Univariate Sorts on Firm Bad VRP Excluding IT- and Financial crises

In Panel A and B, at the end of month t we sort firms into quintiles based on their average bad VRP (VRP^b) during month t, so that Quintile 1 contains the stocks with the lowest VRP^b and Quintile 5 the highest. We then form value-weighted portfolios of these firms, holding the ranking constant for the next month. Subsequently, we compute cumulative returns during month $t+1$ for each quintile portfolio. We report the monthly average cumulative return in percentage of each portfolio. We also compute the Jensen alpha of each quintile portfolio with respect to the Fama-French five-factor model (Fama and French 2015) by running a time series regression of the monthly portfolio returns on monthly MKT, SMB, HML, RMW, and CMA. The t-statistics test the null hypothesis that the average monthly cumulative return of each respective portfolio equals zero, and they are computed using Newey and West (1987) standard errors to account for autocorrelation, and are reported in parentheses. Significant t-statistics at the 95% confidence level are boldfaced. VRP and JRP are reported in monthly square percentage units. The sample period excluding the financial crisis runs from January 1996 until December 2006. The sample period excluding the IT-crisis runs from January 2003 until December 2015.

	Panel A: Excluding Financial Crisis						Panel B: Excluding IT-Crisis					
	Quintiles						Quintiles					
	1	2	3	4	5	5-1	1	2	3	4	5	5-1
VRP^b	-233.46	3.32	31.11	76.08	257.08		-118.51	7.03	24.35	49.48	207.23	
VRP^g	119.54	22.38	13.97	18.51	22.92		66.72	16.40	12.84	9.19	25.88	
VRP	-353.00	-19.05	17.14	57.56	234.16		-185.23	-9.37	11.50	40.29	181.35	
JRP	-113.92	25.70	45.08	94.59	280.01		-51.79	23.43	37.19	58.68	233.11	
$\mathbb{E}[r]$	0.05	0.66	1.25	1.53	1.39	1.33	0.37	0.79	0.89	1.18	1.27	0.90
	(0.10)	(**1.80**)	(**2.79**)	(**2.33**)	(1.56)	(**2.15**)	(0.77)	(**2.58**)	(**2.34**)	(**2.47**)	(**2.01**)	(**2.25**)
alpha	-0.82	-0.30	0.47	1.01	1.14	1.96	-0.54	-0.01	-0.02	0.13	0.23	0.77
	(**-3.31**)	(**-2.40**)	(**2.97**)	(**4.43**)	(**3.07**)	(**3.77**)	(**-2.39**)	(-0.10)	(-0.25)	(0.96)	(1.02)	(**2.00**)

Table 4: Univariate Sorts on Firm Bad VRP: Small, Medium and Large Firms

In Panel A, at the end of month t we sort small firms into quintiles based on their average bad VRP (VRP^b) during month t, so that Quintile 1 contains the stocks with the lowest VRP^b and Quintile 5 the highest. Small firms are in the bottom 30% based on market capitalization. We then form value-weighted portfolios of these firms, holding the ranking constant for the next month. Subsequently, we compute cumulative returns during month $t+1$ for each quintile portfolio. We report the monthly average cumulative return in percentage of each portfolio. Similarly, in Panel B, and C, we sort medium and large firms into quintiles based on their average bad VRP (VRP^g). Medium and large firms are in the middle 40%, and top 30% based on market capitalization. We also compute the Jensen alpha of each quintile portfolio with respect to the Fama-French five-factor model (Fama and French 2015) by running a time series regression of the monthly portfolio returns on monthly MKT, SMB, HML, RMW, and CMA. The t-statistics test the null hypothesis that the average monthly cumulative return of each respective portfolio equals zero, and they are computed using Newey and West (1987) standard errors to account for autocorrelation, and are reported in parentheses. Significant t-statistics at the 95% confidence level are boldfaced. VRP and JRP are reported in monthly square percentage units.

Panel A: Small Firms

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	-338.99	10.41	61.34	124.55	415.65	
VRP^g	160.24	47.19	26.17	29.87	33.48	
VRP	-499.23	-36.78	35.17	94.68	382.17	
JRP	-178.75	57.60	87.51	154.42	449.13	
$\mathbb{E}[r]$	-1.06	0.77	1.07	1.46	0.97	2.03
	(-1.66)	(1.49)	(**2.27**)	(**2.49**)	(1.42)	(**6.00**)
alpha	-1.91	-0.21	0.14	0.67	0.33	2.24
	(-**7.77**)	(-1.07)	(0.69)	(**3.07**)	(0.98)	(**5.67**)

Panel B: Medium Firms

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	-155.13	7.19	33.44	66.55	189.77	
VRP^g	87.91	23.03	12.49	12.51	22.58	
VRP	-243.04	-15.84	20.95	54.04	167.19	
JRP	-67.22	30.21	45.93	79.05	212.35	
$\mathbb{E}[r]$	-0.31	0.76	0.98	1.31	1.31	1.62
	(-0.57)	(1.94)	(**2.48**)	(**2.97**)	(**2.20**)	(**5.42**)
alpha	-1.01	-0.23	-0.01	0.41	0.79	1.80
	(-**4.52**)	(-1.55)	(-0.08)	(**2.62**)	(**3.23**)	(**5.04**)

Panel C: Large Firms

	Quintiles					
	1	2	3	4	5	5-1
VRP^b	-67.15	5.54	17.67	34.07	100.07	
VRP^g	39.29	10.25	6.69	5.52	11.64	
VRP	-106.44	-4.71	10.98	28.55	88.43	
JRP	-27.86	15.79	24.35	39.59	111.72	
$\mathbb{E}[r]$	0.22	0.73	0.74	1.09	1.12	0.89
	(0.63)	(**2.65**)	(**2.61**)	(**3.00**)	(**2.18**)	(**2.77**)
alpha	-0.48	-0.05	-0.09	0.36	0.57	1.05
	(-**3.27**)	(-0.52)	(-1.01)	(**2.59**)	(**2.45**)	(**3.08**)

Table 5: Independent Double Sorts on Good and Bad Firm VRP

Stocks are sorted every month in quintiles independently based on bad (VRP^b) and good VRP (VRP^g). Then, we form portfolios by taking the intersection of these quintiles. The table reports average value-weighted excess returns for the bottom quintile (1), the top quintile (5) and for the second (2), third (3) and fourth (4) quintile. We also report the difference in average excess returns between the top and the bottom quintile (5-1). T-statistics are computed using Newey and West (1987) standard errors, and are reported in parentheses. Significant t-statistics at the 95% confidence level are boldfaced. Data are from January 1996 to December 2015.

		Firm Good VRP						
		Quintiles						
		1	2	3	4	5	5-1	
Firm Bad VRP	1	-2.04	-0.46	0.41	0.32	-0.34	1.70	(**3.79**)
	2	-0.22	0.20	0.79	1.00	1.21	1.43	(**2.62**)
	3	0.18	0.76	1.25	1.43	1.08	0.90	(1.44)
	4	0.42	1.06	1.48	1.94	1.81	1.38	(**2.76**)
	5	0.84	1.01	1.70	1.54	1.88	1.04	(**2.11**)
	5-1	2.88	1.47	1.29	1.22	2.22		
		(**5.19**)	(**2.85**)	(**2.22**)	(**2.36**)	(**4.78**)		