Appendix

Table A1: Descriptive statistics of log prices

	Observations	**Mean**	**SD**	**Min**	**Max**
Crude oil	212,142	4.176848	0.4350601	2.912351	4.99084
Corn	164,466	5.938246	0.4010664	5.250964	6.733104
Cotton	157,106	4.194839	0.2817642	3.493473	5.261549
Gold	213,013	6.700628	0.5548974	5.625461	7.553968
S&P 500	273,8	7.171371	0.2478539	6.50285	7.665941

Source: Author based on data from Tick Data, Inc.

Table A2: Descriptive statistics of 5-minute returns

Variable	**Mean**	**Min**	**Max**	**SD**	**Skewness**	**Kurtosis**	**Observations**
Crude oil (CL)	0.0000089	-0.0341775	0.0384028	0.0022465	-0.1286002	11.5111832	208 705
Corn (CN)	0.0000016	-0.0609825	0.0439631	0.0019734	-0.1057595	24.3690218	161 029
Cotton (CT)	-0.0000091	-0.0338341	0.0523929	0.0020779	0.1040618	20.5265105	153 669
Gold (GC)	0.0000029	-0.0280942	0.0227638	0.0011010	-0.2001009	19.0230779	209 576
S&P 500	-0.00000032	-0.02389203	0.03666528	0.00106975	0.27506588	30.44928775	270 363

Source: Author based on data from Tick Data, Inc.

Table A3: Descriptive statistics of daily realized variances

Variable	**Mean**	**Min**	**Max**	**SD**	**Skewness**	**Kurtosis**	**Observations**
Crude oil (CL)	0.0003065	0.0000093	0.0039532	0.000343	4.0789507	27.2559129	3437
Corn (CN)	0.00018	0.00000	0.00425	0.00020	6.71499	89.18923	3437
Cotton (CT)	0.00019	0.00000	0.00348	0.00022	4.93142	48.00934	3437
Gold (GC)	0.0000739	0.0000039	0.0020434	0.0000931	6.9574072	95.6782445	3437
S&P 500	0.0000900	0.0000025	0.0057833	0.0002180	10.9549756	193.8430740	3437

Source: Author's computations.

Table A4: Descriptive statistics of daily realized positive semivariances

Variable	**Mean**	**Min**	**Max**	**SD**	**Skewness**	**Kurtosis**	**Observations**
Crude oil (CL)	0.0001509	0.0000056	0.0024102	0.0001825	4.8824188	39.6556808	3437
Corn (CN)	0.000091	0.000000	0.002084	0.000113	7.460891	97.780711	3437
Cotton (CT)	0.000096	0.000000	0.002833	0.000133	6.904429	90.979120	3437
Gold (GC)	0.0000362	0.0000014	0.0011482	0.0000485	8.4376699	135.7749452	3437
S&P 500	0.0000453	0.0000014	0.0039692	0.0001240	14.6075444	351.1167638	3437

Source: Author's computations.

Table A5: Descriptive statistics of daily negative realized semivariances

Variable	Mean	Min	Max	SD	Skewness	Kurtosis	Observations
Crude oil (CL)	0.0001556	0.0000036	0.0021295	0.0001877	4.0006299	25.8312976	3437
Corn (CN)	0.000091	0.000000	0.004041	0.000124	13.022621	337.589790	3437
Cotton (CT)	0.000097	0.000000	0.002475	0.000125	5.405588	63.384144	3437
Gold (GC)	0.0000377	0.0000021	0.0016285	0.0000563	9.7747490	209.6757499	3437
S&P 500	0.00004471	0.00000088	0.00181411	0.00010216	8.55460505	104.03274277	3437

Source: Author's computations.

Table A6: Correlation matrix - log prices

	Crude oil	Corn	Cotton	Gold	S&P 500
Crude oil	1.0000				
Corn	0.7105	1.0000			
Cotton	0.6127	0.7277	1.0000		
Gold	0.7369	0.8576	0.7029	1.0000	
S&P 500	0.3512	0.2762	0.2504	0.4436	1.0000

Source: Author based on data from Tick Data, Inc.

Table A7: Volatility spillover table - Sample including commodities only

		From				
		Crude oil	**Corn**	**Cotton**	**Gold**	**Directional from others**
To	**Crude oil**	86.718	2.864	1.738	8.679	13.282
	Corn	3.431	87.729	3.796	5.044	12.271
	Cotton	3.565	4.069	90.242	2.123	9.758
	Gold	10.616	3.471	1.149	84.764	15.236
	Directional to others	17.612	10.405	6.683	15.846	**Total Spillover Index 12.64%**

Source: Author's computations.

Table A8: Volatility spillover table - Negative realized semivariances

		From					
		Crude oil	**Corn**	**Cotton**	**Gold**	**S&P 500**	**Directional from others**
To	**Crude oil**	77.698	1.147	0.938	3.863	16.354	22.302
	Corn	1.476	93.034	0.917	1.515	3.059	6.966
	Cotton	2.162	0.859	92.175	1.464	3.339	7.825
	Gold	5.872	1.263	0.407	70.643	21.815	29.357
	S&P 500	7.425	0.803	0.734	6.908	84.130	15.869
	Directional to others	16.935	4.072	2.996	13.750	44.568	**Total Spillover Index 16.46%**

Source: Author's computations.

Table A9: Volatility spillover table - Positive realized semivariances

		From					
		Crude oil	**Corn**	**Cotton**	**Gold**	**S&P 500**	**Directional from others**
To	**Crude oil**	77.249	2.486	1.527	5.068	13.670	22.750
	Corn	2.951	89.585	1.308	3.308	2.847	10.415
	Cotton	2.272	1.502	93.262	0.545	2.418	6.738
	Gold	4.539	2.554	0.608	73.260	19.038	26.739
	S&P 500	7.605	1.582	1.499	11.291	78.023	21.977
	Directional to others	17.368	8.125	4.942	20.212	37.973	**Total Spillover Index 17.72%**

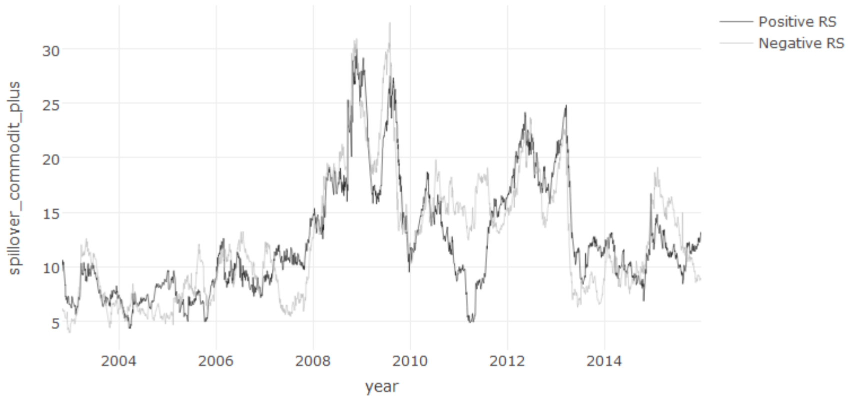
Source: Author's computations.

Table A10: Net volatility spillovers - Negative and positive realized semivariances

	Crude oil	**Corn**	**Cotton**	**Gold**	**S&P 500**
Negative net spillovers	-5.367	-2.894	-4.829	-15.607	28.699
Positive net spillovers	-5.382	-2.29	-1.796	-6.527	15.996

Source: Author's computations.

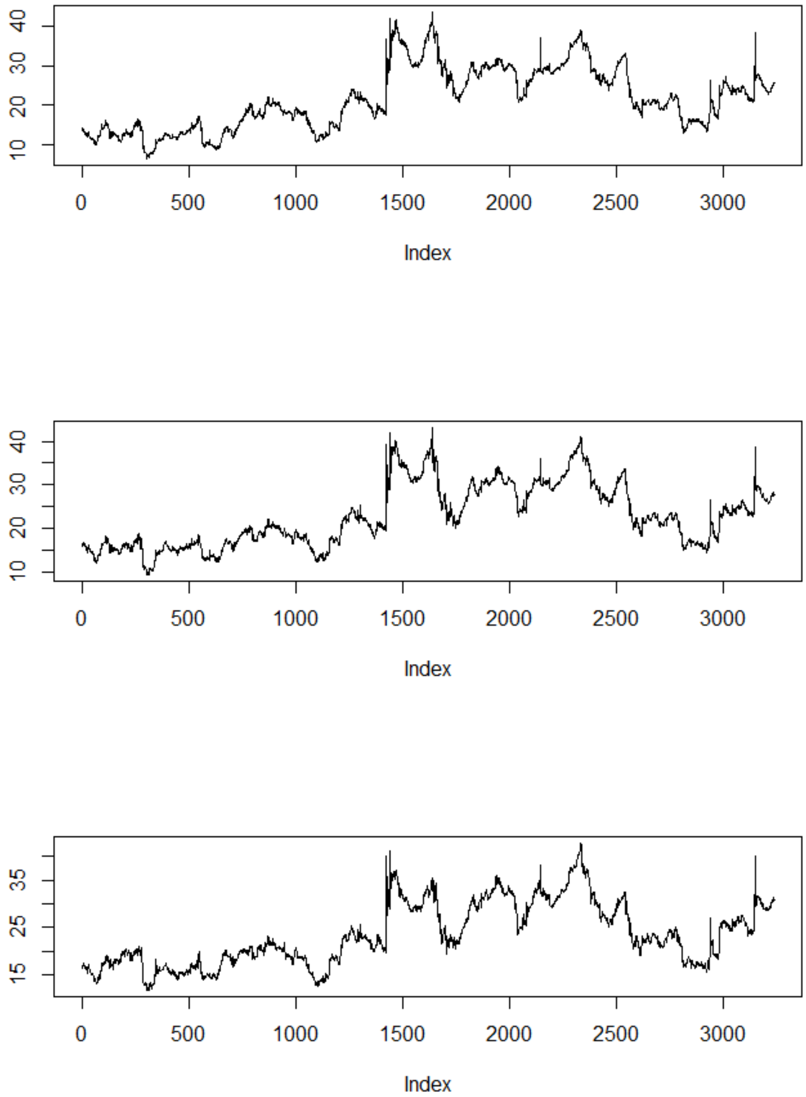
Figure A1: Asymmetric volatility spillovers - sample excluding the S&P 500 Index



Source: Author's computations.

Note: The black line represents the spillover index from positive realized semivariances (RS^{+}), the gray line from negative realized semivariances (RS^{-}).

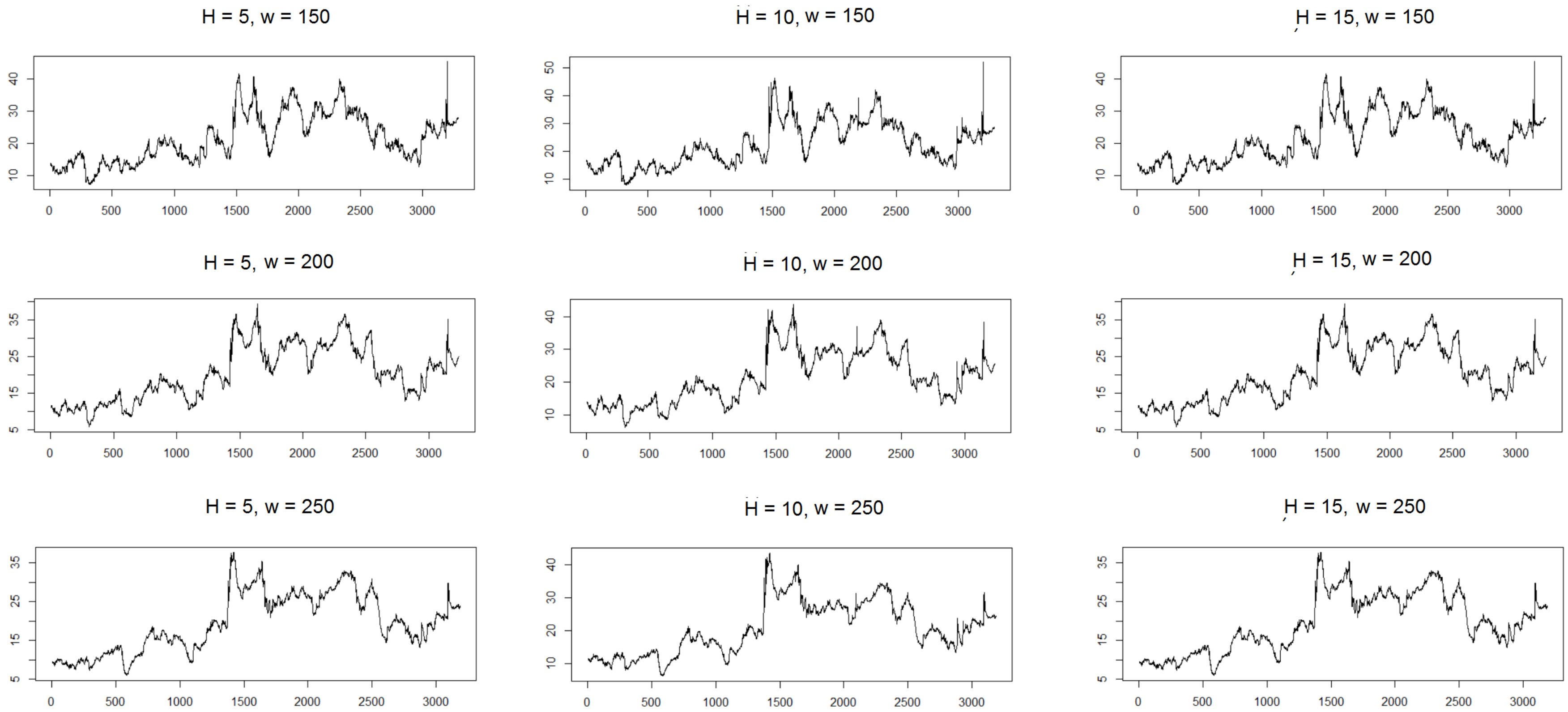
Figure A2: Robustness of volatility spillovers to VAR model specification



Source: Author's computations.

Note: The first plot represents the VAR(2)-based spillover index, second depicts the VAR(5)-based index and the third the VAR(4)-based index.

Figure A3: Robustness check with respect to the window width, w, and forecasting horizon H = 5, H = 10 and H = 15



Source: Author's computations.