BASE CASE MODEL

Table 1: Parameters Used

	VALUE
TRAINING WINDOW	1000
VALIDATION WINDOW	250
TESTING WINDOW	250
LAG (SEQUENCE)	[7,14,21]
NEURONS	[25,50,75,100,250,500]
OPTIMIZER	[ADAM,NADAM,ADAGRAD]
LEARNING RATE	[0.0001,0.01]
# OF HIDDEN LAYERS	[0,1]
DROPOUT	0.075
BATCH SIZE	32
ACTIVATION FUNCTIONS	tanh
LOSS FUNCTION	mean_squared_error
EPOCH	100
PATIENCE	10
COMBINATIONS	216
# OF TRIALS	20
AR DEGREE (p)	0-6
I DEGREE (I)	1
MA DEGREE (q)	0-6

The inputs used are: CLOSING PRICE, VOLUME, REALIZED HISTORICAL VOLATILITY (VIX IN CASE OF S&P 500), RESIDUALS OF ARIMA (IN CASE OF LSTM-ARIMA)

The best model by the following procedure:

1. During Random Search, choose the 5 models with the lowest validation loss.
2. Calculate IR2 for the training data and the validation data and calculate the absolute difference.
3. The *BEST MODEL* was the one with the lowest absolute value and where the IR2 for the Validation data set was *NOT* equal to *ZERO*.

S&P 500

Figure 1: The Long-Only and Long-Short Strategy on S&P 500

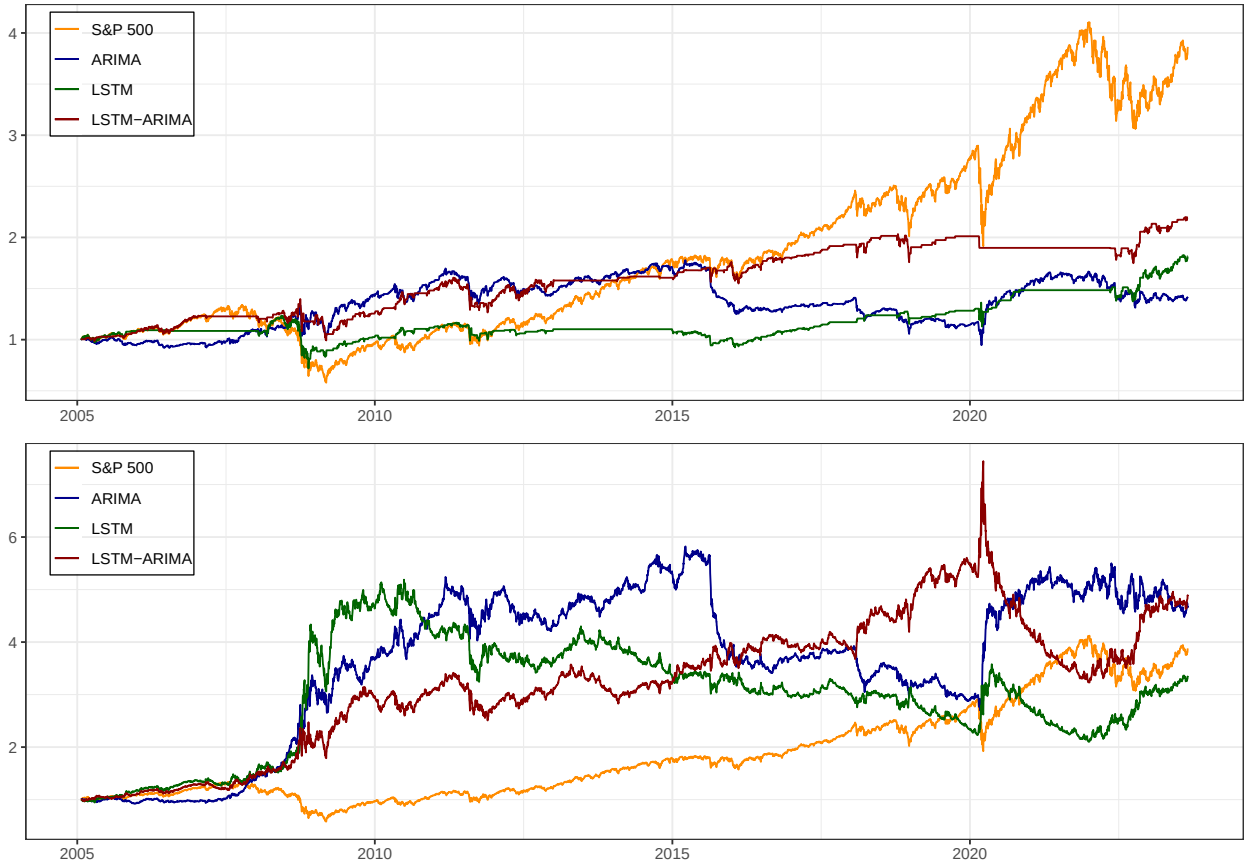


Table 2: Performance metrics for S&P 500

		ARC(%)	ASD(%)	MD(%)	MLD	IR*(%)	IR**(%)
Long Only							
	S&P 500	**7.52**	19.58	56.78	**1.65**	38.43	5.09
	ARIMA	1.89	14.45	46.73	8.45	13.07	0.53
	LSTM	3.26	13.14	41.83	9.8	24.83	1.94
	LSTM-ARIMA	4.32	**11.14**	**28.95**	1.67	**38.79**	**5.79**
Long Short							
	S&P 500	7.52	19.58	56.78	**1.65**	38.43	5.09
	ARIMA	8.66	**19.19**	**54.81**	8.44	45.11	7.13
	LSTM	6.71	19.59	59.44	13.16	34.27	3.87
	LSTM-ARIMA	**8.92**	19.58	56.62	3.44	**45.56**	**7.18**

FTSE 100

Figure 2: The Long-Only and Long-Short Strategy on FTSE 100

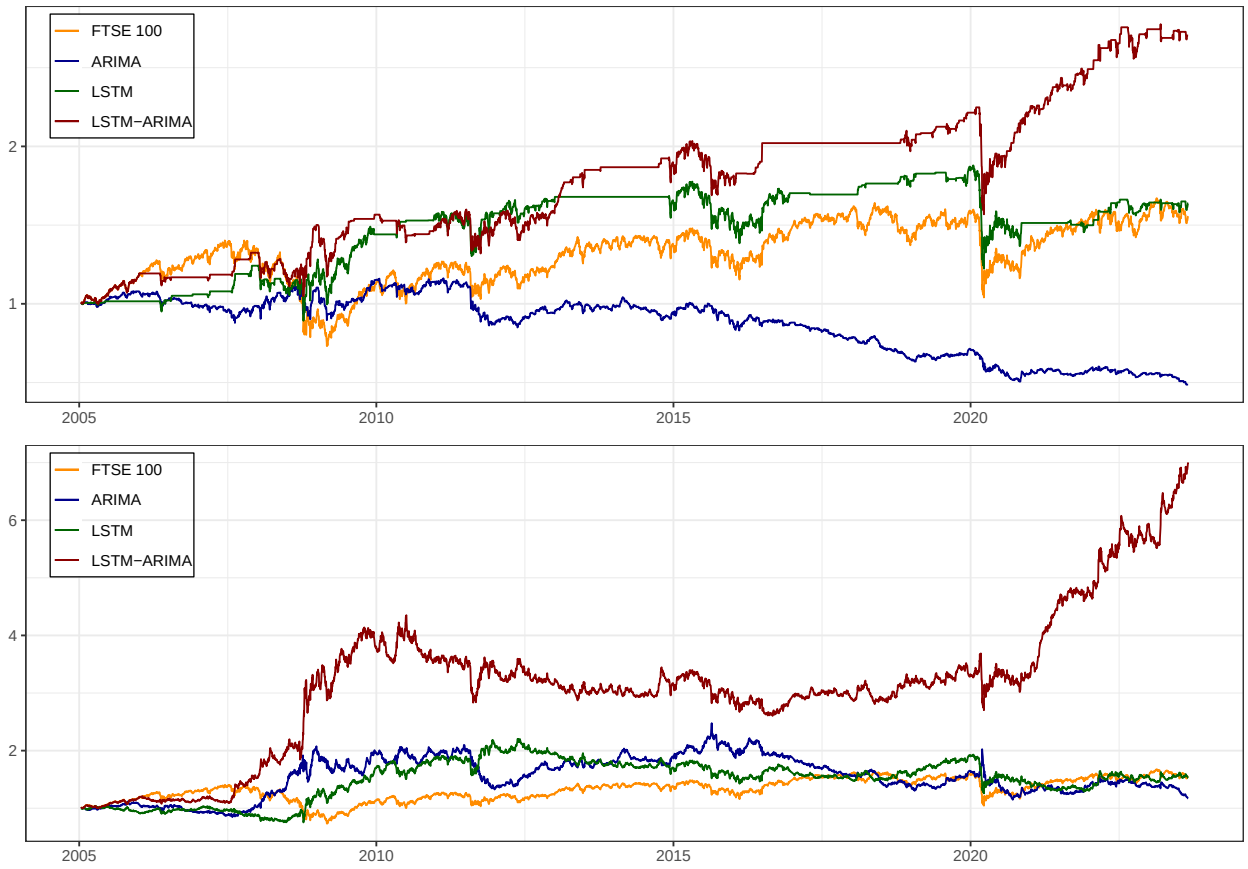


Table 3: Performance metrics for FTSE 100

		ARC(%)	ASD(%)	MD(%)	MLD	IR*(%)	IR**(%)
Long Only							
	FTSE 100	2.39	18.03	47.83	5.94	13.27	0.66
	ARIMA	-3.78	**12.88**	58.12	12.55	0	0
	LSTM	2.68	14.32	34.93	3.61	18.75	1.44
	LSTM-ARIMA	**5.47**	13.79	**30.22**	**0.91**	**39.71**	**7.19**
Long Short							
	FTSE 100	2.39	18.03	47.83	**5.94**	13.27	0.66
	ARIMA	0.84	18.04	53.65	8.03	4.66	0.07
	LSTM	2.28	18.03	42.92	11.3	12.67	0.67
	LSTM-ARIMA	**10.98**	**18.02**	**40.17**	10.89	**60.92**	**16.65**

CAC 40

Figure 3: The Long-Only and Long-Short Strategy on CAC 40

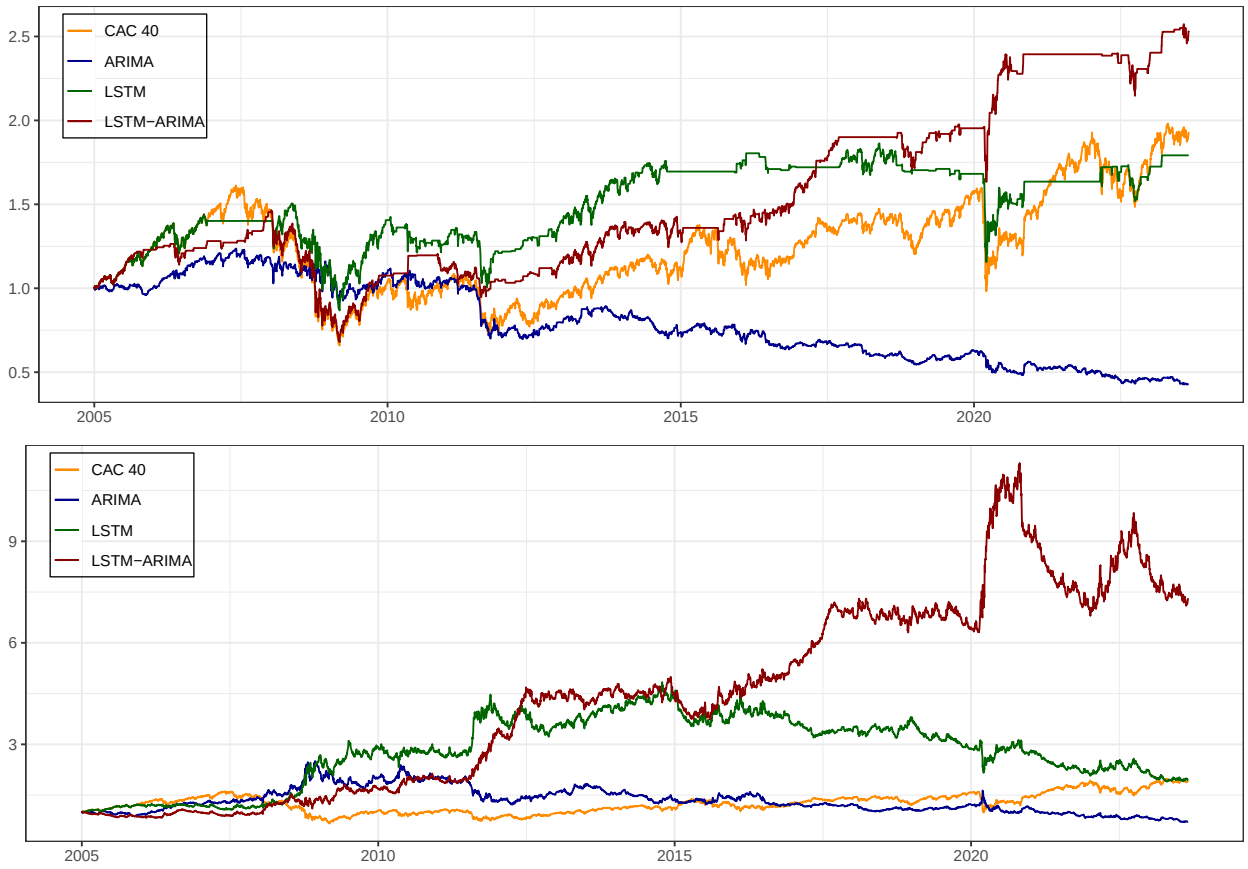


Table 4: Performance statistics for CAC 40

		ARC(%)	ASD(%)	MD(%)	MLD	IR*(%)	IR**(%)
Long Only							
	CAC 40	3.52	21.44	59.16	14.04	16.43	0.98
	ARIMA	-4.38	**15.14**	65.53	16.5	0	0
	LSTM	3.12	16.1	**42.35**	**5.38**	19.4	1.43
	LSTM-ARIMA	**5.02**	15.43	53.65	8.33	**32.52**	**3.04**
Long Short							
	CAC 40	3.52	21.44	59.16	14.04	16.43	0.98
	ARIMA	-1.81	**21.43**	72.02	14.95	0	0
	LSTM	3.56	21.44	60.73	9.01	16.59	0.97
	LSTM-ARIMA	**11.06**	**21.43**	**39.91**	**2.91**	**51.6**	**14.29**

Figure 4: ARIMA Sensitivity Analysis

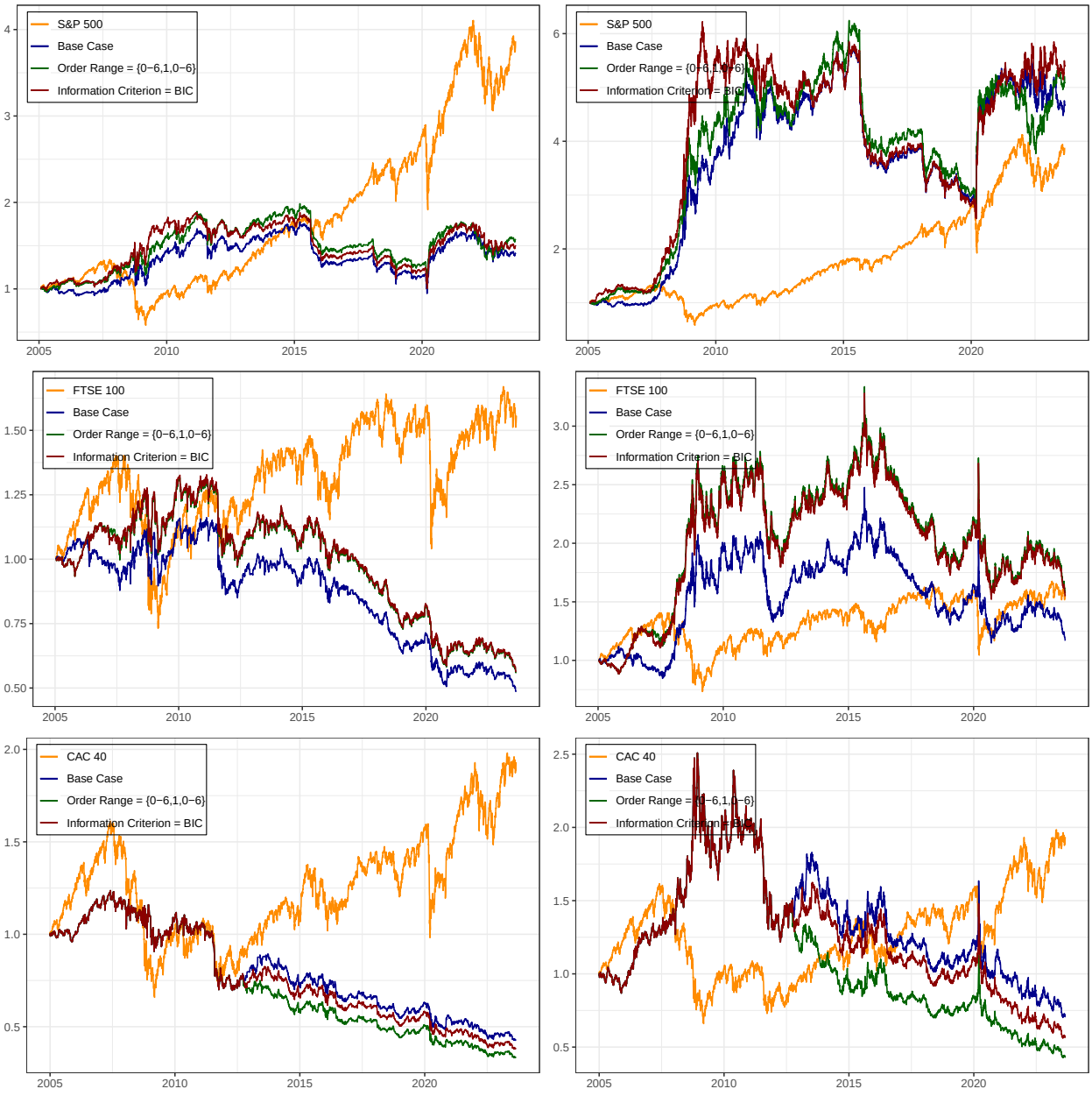
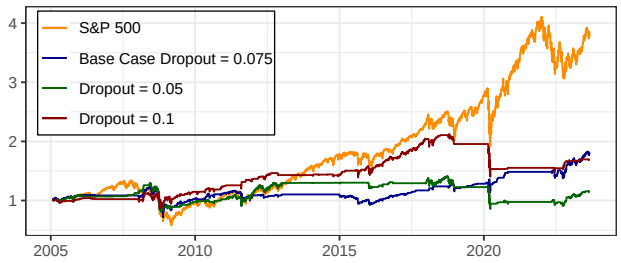
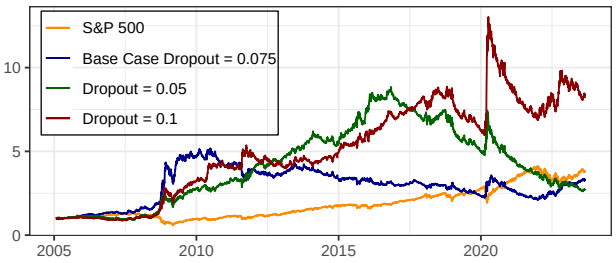


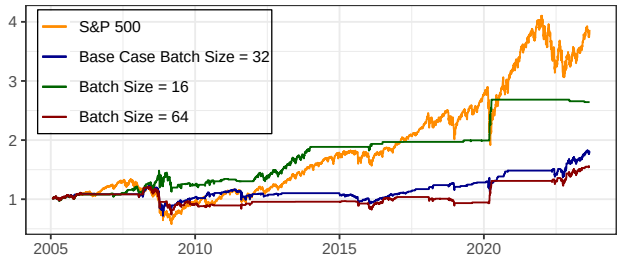
Table 5: ARIMA Sensitivity Analysis performance metrics

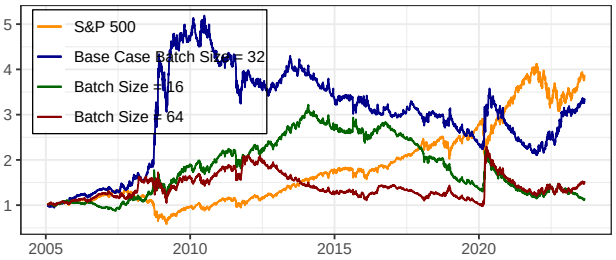
		ARC(%)	ASD(%)	MD(%)	MLD	IR*	IR**
Long Only	**S&P 500**	**7.52**	19.58	56.78	**1.65**	0.3843	0.0509
	Base Case	4.32	**11.14**	**28.95**	1.67	**0.3879**	**0.0579**
	Order Range = {0-3,1,0-3}	2.47	14.45	46.73	8.45	0.1711	0.0091
	Information Criterion = BIC	2.21	14.35	46.73	8.45	0.1541	0.0073
Long Short	Base Case	8.92	19.58	56.62	**3.44**	0.4556	0.0718
	Order Range = {0-3,1,0-3}	9.15	**19.57**	**56.24**	8.44	0.4679	0.0762
	Information Criterion = BIC	**9.52**	**19.57**	58.85	14.18	**0.4862**	**0.0786**
Long Only	**FTSE 100**	**2.39**	18.03	**47.83**	**5.94**	**0.1327**	**0.0066**
	Base Case	-3.78	**12.88**	58.12	12.55	0.0	0.0
	Order Range = {0-3,1,0-3}	-3.06	12.9	57.55	12.55	0.0	0.0
	Information Criterion = BIC	-3.02	12.9	57.55	12.55	0.0	0.0
Long Short	Base Case	0.84	**18.04**	**53.65**	**8.03**	0.0466	0.0007
	Order Range = {0-3,1,0-3}	**2.46**	**18.04**	**53.65**	**8.03**	**0.1366**	**0.0063**
	Information Criterion = BIC	2.37	**18.04**	**53.65**	**8.03**	0.1315	0.0058
Long Only	**CAC 40**	3.52	21.44	59.16	14.04	0.1643	0.0098
	Base Case	**5.02**	15.43	**53.65**	**8.33**	**0.3252**	**0.0304**
	Order Range = {0-3,1,0-3}	-5.62	15.1	73.12	16.5	0.0	0.0
	Information Criterion = BIC	-4.95	**15.07**	69.27	16.5	0.0	0.0
Long Short	**CAC 40**	3.52	21.44	59.16	14.04	0.1643	0.0098
	Base Case	**11.06**	**21.43**	**39.91**	**2.91**	**0.516**	**0.1429**
	Order Range = {0-3,1,0-3}	-4.35	**21.43**	82.97	14.95	0.0	0.0
	Information Criterion = BIC	-2.97	**21.43**	77.67	14.95	0.0	0.0

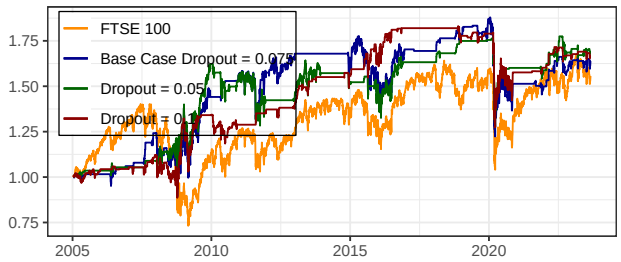
SENSITIVITY ANALYSIS LSTM

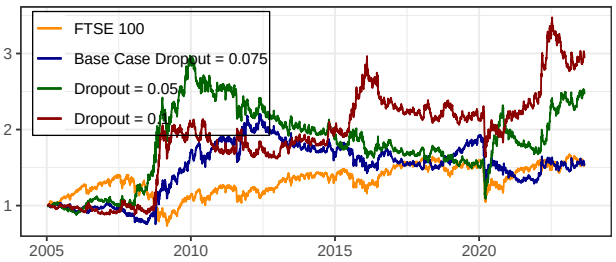


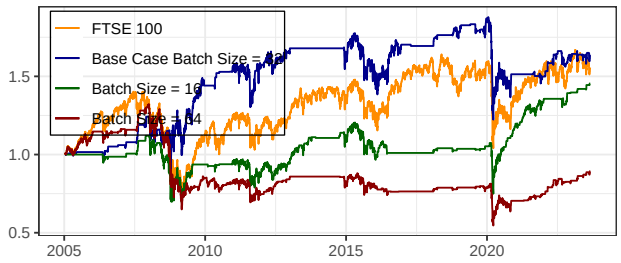


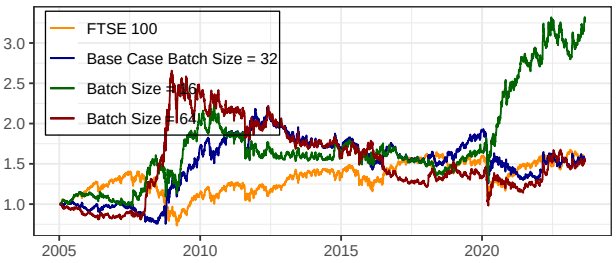


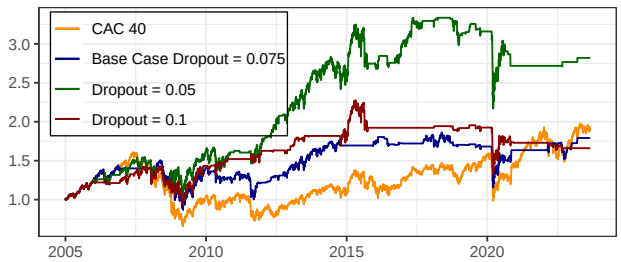


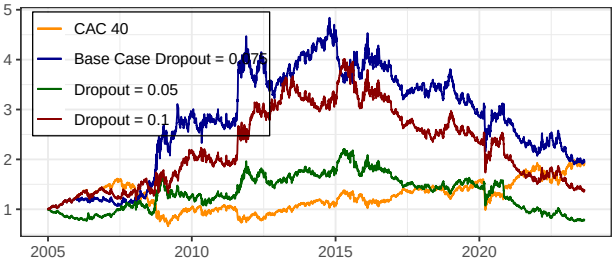












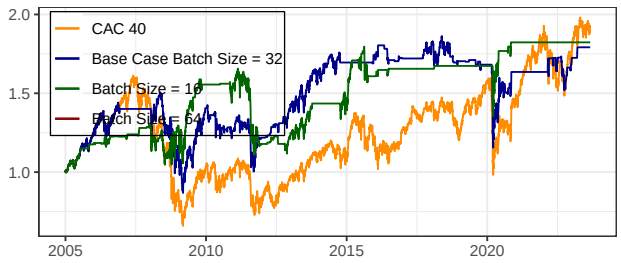


Table 6: LSTM-ARIMA Sensitivity Analysis performance metrics

		ARC(%)	ASD(%)	MD(%)	MLD	IR*	IR**
	S&P 500	7.52	19.58	56.78	1.65	0.3843	0.0509
Long Only	Base Case	3.26	13.14	41.83	9.8	0.2483	0.0194
Panel A: Dropout Rate	Dropout = 0.05	0.79	12.68	39.43	4.94	0.0624	0.0013
	Dropout = 0.1	2.87	11.4	33.93	4.86	0.252	0.0213
Panel B: Batch Size	Batch Size = 16	**5.37**	**10.45**	**24.07**	**3.96**	**0.5137**	**0.1146**
	Batch Size = 64	2.42	10.94	38.72	11.77	0.2214	0.0139
Long Short	Base Case	6.71	19.59	59.44	13.16	0.3427	0.0387
Panel A: Dropout Rate	Dropout = 0.05	5.42	19.59	70.44	6.8	0.2766	0.0213
	Dropout = 0.1	12.0	19.59	47.23	3.4	0.6126	0.1557
Panel B: Batch Size	Batch Size = 16	0.72	19.59	65.51	9.57	0.0367	0.0004
	Batch Size = 64	**2.26**	**19.58**	**53.48**	**8.23**	**0.1155**	**0.0049**
	FTSE 100	2.39	18.03	47.83	5.94	0.1327	0.0066
Long Only	Base Case	2.68	14.32	34.93	3.61	0.1875	0.0144
Panel A: Dropout Rate	Dropout = 0.05	2.85	13.1	27.53	2.45	0.2178	0.0226
	Dropout = 0.1	2.78	11.99	30.44	4.77	0.2317	0.0212
Panel B: Batch Size	Batch Size = 16	**2.03**	**13.84**	**37.95**	**5.86**	**0.1466**	**0.0078**
	Batch Size = 64	-0.59	14.09	58.72	15.68	0.0	0.0
Long Short	Base Case	2.28	18.03	42.92	11.3	0.1267	0.0067
Panel A: Dropout Rate	Dropout = 0.05	4.96	18.03	63.39	13.7	0.2749	0.0215
	Dropout = 0.1	5.96	18.05	44.81	6.09	0.33	0.0439
Panel B: Batch Size	Batch Size = 16	**6.53**	**18.03**	**43.77**	**10.2**	**0.3623**	**0.054**
	Batch Size = 64	2.28	18.04	63.08	14.69	0.1263	0.0046
	CAC 40	3.52	21.44	59.16	14.04	0.1643	0.0098
Long Only	Base Case	3.12	16.1	42.35	5.38	0.194	0.0143
Panel A: Dropout Rate	Dropout = 0.05	5.62	16.79	34.96	5.52	0.3348	0.0538
	Dropout = 0.1	2.71	14.56	42.18	8.49	0.1862	0.012
Panel B: Batch Size	Batch Size = 16	3.22	**13.91**	**33.09**	4.06	**0.2313**	**0.0225**
	Batch Size = 64	**3.69**	16.98	40.42	**3.6**	0.2174	0.0199
Long Short	Base Case	3.56	21.44	60.73	9.01	0.1659	0.0097
Panel A: Dropout Rate	Dropout = 0.05	-1.34	21.43	65.66	8.49	0.0	0.0
	Dropout = 0.1	1.75	21.44	66.37	8.49	0.0816	0.0022
Panel B: Batch Size	Batch Size = 16	-1.5	21.46	55.1	12.72	0.0	0.0
	Batch Size = 64	**3.82**	**21.43**	**47.78**	**3.35**	**0.1785**	**0.0143**

SENSITIVITY ANALYSIS ARIMA-LSTM

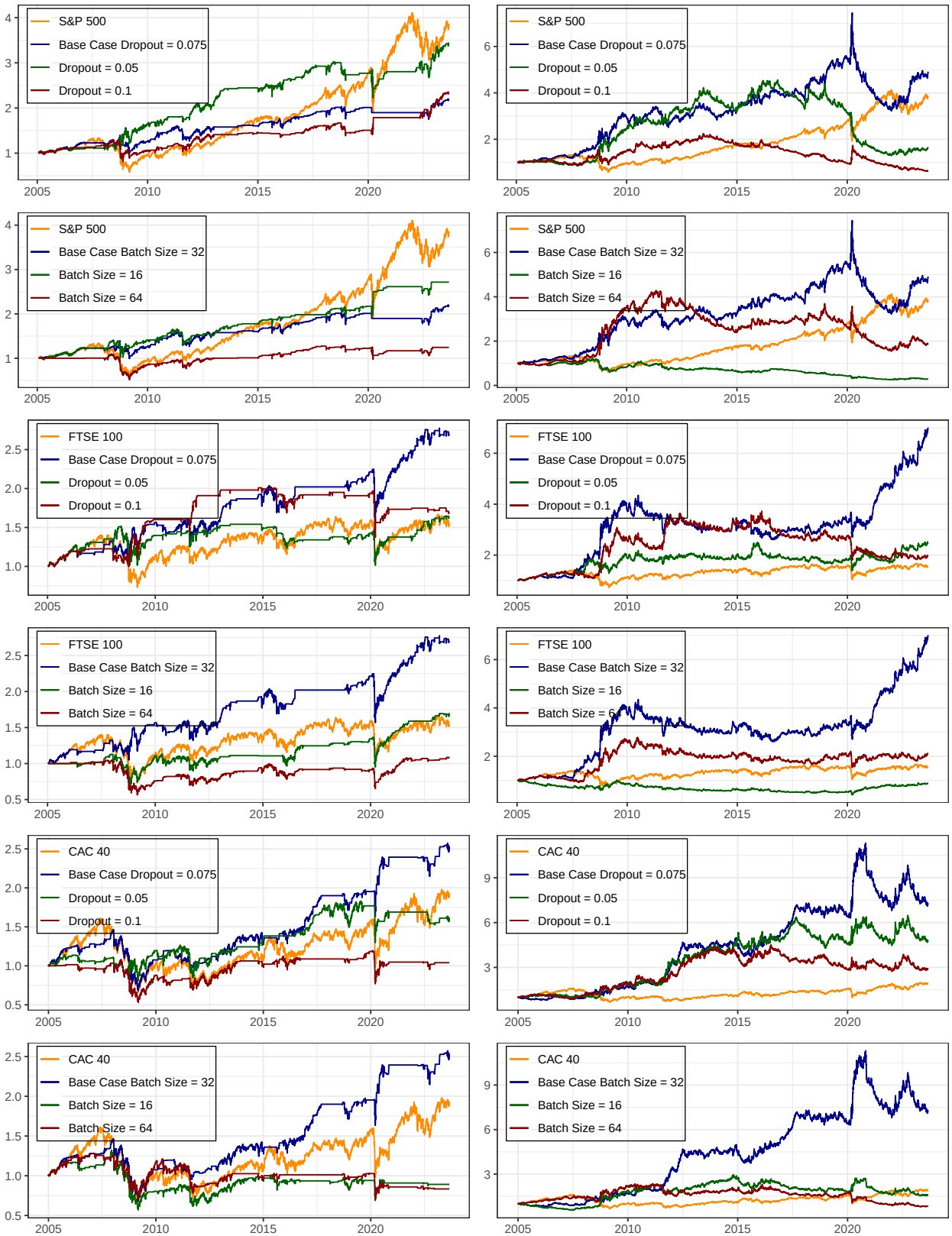


Table 7: LSTM-ARIMA Sensitivity Analysis performance metrics

		ARC(%)	ASD(%)	MD(%)	MLD	IR*	IR**
	S&P 500	7.52	19.58	56.78	1.65	0.3843	0.0509
Long Only	Base Case	4.32	11.14	28.95	1.67	0.3879	0.0579
Panel A: Dropout Rate	Dropout = 0.05	6.88	13.7	26.63	3.92	0.5025	0.1299
	Dropout = 0.1	4.72	13.5	37.99	3.66	0.3499	0.0435
Panel B: Batch Size	Batch Size = 16	**5.53**	**12.03**	**27.83**	**1.54**	**0.4592**	**0.0911**
	Batch Size = 64	1.19	14.44	52.99	7.54	0.0823	0.0018
Long Short	Base Case	8.92	19.58	56.62	3.44	0.4556	0.0718
Panel A: Dropout Rate	Dropout = 0.05	2.63	19.6	71.5	6.8	0.134	0.0049
	Dropout = 0.1	-2.5	19.6	72.1	10.17	0.0	0.0
Panel B: Batch Size	Batch Size = 16	-6.58	**19.58**	79.19	15.19	0.0	0.0
	Batch Size = 64	**3.35**	19.59	**63.83**	**12.32**	**0.1712**	**0.009**
	FTSE 100	2.39	18.03	47.83	5.94	0.1327	0.0066
Long Only	Base Case	5.47	13.79	30.22	0.91	0.3971	0.0719
Panel A: Dropout Rate	Dropout = 0.05	2.66	13.36	34.18	9.02	0.199	0.0155
	Dropout = 0.1	2.85	10.94	31.62	8.88	0.261	0.0235
Panel B: Batch Size	Batch Size = 16	**2.88**	**13.63**	**36.25**	**0.73**	**0.2115**	**0.0168**
	Batch Size = 64	0.44	14.25	46.13	13.54	0.0307	0.0003
Long Short	Base Case	10.98	18.02	40.17	10.89	0.6092	0.1665
Panel A: Dropout Rate	Dropout = 0.05	4.91	18.02	44.39	7.59	0.2724	0.0301
	Dropout = 0.1	3.61	18.03	51.81	7.56	0.2003	0.014
Panel B: Batch Size	Batch Size = 16	-0.63	**18.03**	60.17	14.14	0.0	0.0
	Batch Size = 64	**3.98**	18.04	**44.77**	**13.2**	**0.2208**	**0.0196**
	CAC 40	3.52	21.44	59.16	14.04	0.1643	0.0098
Long Only	Base Case	5.02	15.43	53.65	8.33	0.3252	0.0304
Panel A: Dropout Rate	Dropout = 0.05	2.55	15.34	33.09	4.24	0.1661	0.0128
	Dropout = 0.1	0.21	16.86	51.01	7.47	0.0123	0.0001
Panel B: Batch Size	Batch Size = 16	**-0.61**	17.15	56.9	**15.95**	**0.0**	**0.0**
	Batch Size = 64	-0.95	**15.78**	**45.06**	16.98	**0.0**	**0.0**
Long Short	Base Case	11.06	21.43	39.91	2.91	0.516	0.1429
Panel A: Dropout Rate	Dropout = 0.05	8.64	21.44	32.86	3.09	0.4031	0.106
	Dropout = 0.1	5.7	21.44	39.43	7.27	0.2657	0.0384
Panel B: Batch Size	Batch Size = 16	**2.4**	21.46	**48.23**	**9.01**	**0.1119**	**0.0056**
	Batch Size = 64	-0.89	**21.44**	65.76	12.72	0.0	0.0