Diversification analysis of the ALSI using GARCH (come back to this)

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1. Introduction

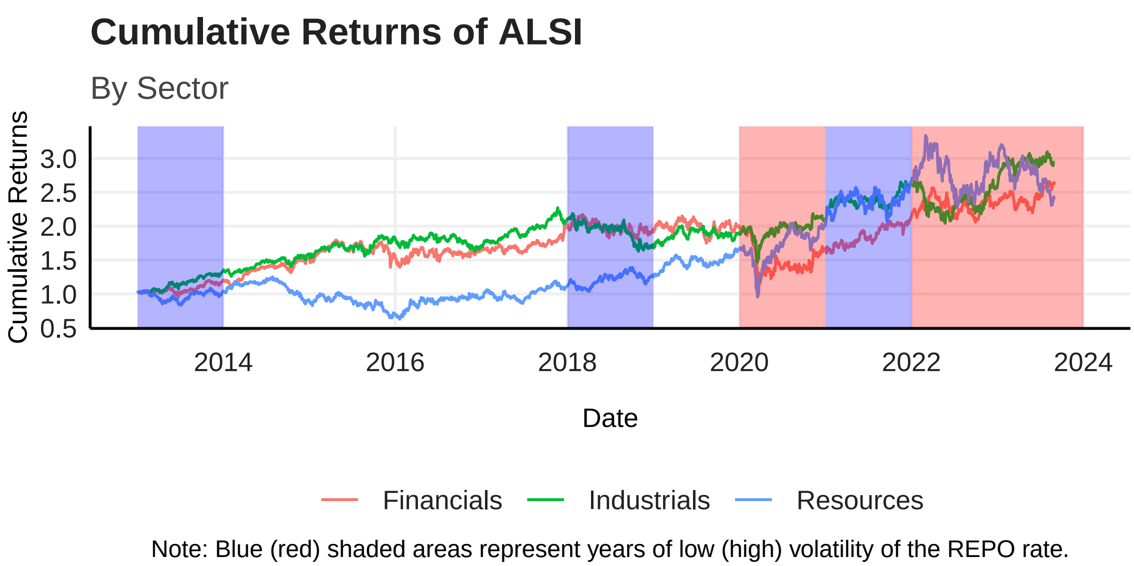

Figure 1.1: Cumulative Returns of ALSI

2. Data

The data used to get the sector returns is the All Share (ALSI) J203 index. This index represents 99% of the full market cap value of all eligible securities listed on the Main Board of the Johannesburg Stock Exchange (JSE) (JSE, 2024). Sector returns are then created for the financial, industrial and resource sectors. All stocks categorised in each of these sectors is reweighted in order to create a index for each sector.

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Other data that was used is the United States Dollar (USD) to South African Rand (ZAR) exchange rate as the depreciation or appreciation of the domestic currency compared to the Dollar is an indicator of changes in the global economy. Lastly the historical repurchase rate (REPO) was obtained from the South African Reserve Bank (SARB).

3. Methodology

I begin by conducting multiple tests for autoregressive conditional heteroskedasticity (ARCH) effects. I do this through graphing the the returns, absolute returns and squared returns which can be found in figures 6.1, 6.2 and 6.3. These figures highlights that the return series of all three sectors show strong first order persistence and potential periods of second order persistence. Lastly, it appears that the series has a long memory in the second order process. To check for this I conduct more formal tests for ARCH effects.

3.1. Tests for Autoregressive Conditional Heteroskedasticity (ARCH) effects.

The first formal test that I conduct is the plotting of the autocorrelation functions of the returns, absolute returns and squared returns for all sectors. Figures 6.4, 6.5 and 6.6 can be found in the appendix. These figures provide more evidence of conditional heteroskedasticity and long memory for all of the sectors. The last test is a formal Box-Ljung test where the null hypothesis is that there are no ARCH effects. Table 3.1 presents the results of the test and it is clear that the null hypothesis of no ARCH effects can be rejected at the 1% confidence level. This means that the condictional heteroskedasticity needs to be controlled for.

Table 3.1: Ljung-Box Test Results

	TestStatistic	PValue	Lag
Financials	2667.7971	0	12
Resources	1431.3349	0	12
Industrials	948.8227	0	12

3.2. Univariate Model Selection

A univariate GARCH specification is necassary for the multivariate specification. There are a vast number of extentions to the original GARCH formulation, therefore to obtain the model that best fits the data I employ multiple information criteria to assess the potential model fits in the univariate case. Table 3.2 presents the results of the information criteria and the best model for each sector is different but on average the best fitting model across all sectors is eGARCH so that is the specification that will be used to estimate the dynamic conditional correlations.

Table 3.2: GARCH Model Comparison Results

	Sector	sGARCH	gjrGARCH	eGARCH	apARCH
Akaike	Financials	-5.872282	-5.881912	-5.881702	-5.884481
Bayes	Financials	-5.861235	-5.868656	-5.868446	-5.869016
Shibata	Financials	-5.872289	-5.881922	-5.881712	-5.884495
Hannan-Quinn	Financials	-5.868285	-5.877115	-5.876905	-5.878885
Akaike1	Resources	-5.466560	-5.479735	-5.475142	-5.479025
Bayes1	Resources	-5.455513	-5.466479	-5.461886	-5.463559
Shibata1	Resources	-5.466567	-5.479745	-5.475153	-5.479038
Hannan-Quinn1	Resources	-5.462562	-5.474938	-5.470345	-5.473428
Akaike2	Industrials	-6.246073	-6.267709	-6.270655	-6.261725
Bayes2	Industrials	-6.235026	-6.254453	-6.257399	-6.246260
Shibata2	Industrials	-6.246080	-6.267719	-6.270665	-6.261739
Hannan-Quinn2	Industrials	-6.242075	-6.262912	-6.265858	-6.256129

3.3. Multivariate Models

Now that I have the univariate model specifications I can now fit the multivariate model. I fit three different multivariate GARCH models: DCC, aDCC and GO-GARCH. This follows the literature as the comparison between these two or three models is common Ali, Raza, Vo & Le (2022). After fitting the DCC model I extract the model diagnostics that present multiple Portmanteau and rank based tests that assess whether there is serial correlation. Tsay (2013) provides an in depth discussion about these tests. Th null hypothesis for all the tests are that there is no serial correlation and hence no conditional heteroskedasticity. Tsay (2013: 403) notes that $Q_k(m)$ statistic works well when the distribution of innovations are normal but struggles when fatter tails are present . The robust statistic employs 5% trimming as a means to get a more robust statistic. The results presented in table 3.3 show that for all tests except for the robust version ($Q_r^k(m)$) rejects the null hypothesis of no conditional heteroskedasticity whereas the robust version fails to reject.

Table 3.3: Portmanteau tests

$Q(m)$	$Rank - based\ test$	$Q_k(m)$	$Q_r^k(m)$
51.32 (0.000)	18.63 (0.045)	255.96 (0.000)	173.18 (0.225)
Note: P-values given in brackets.			

4. Results

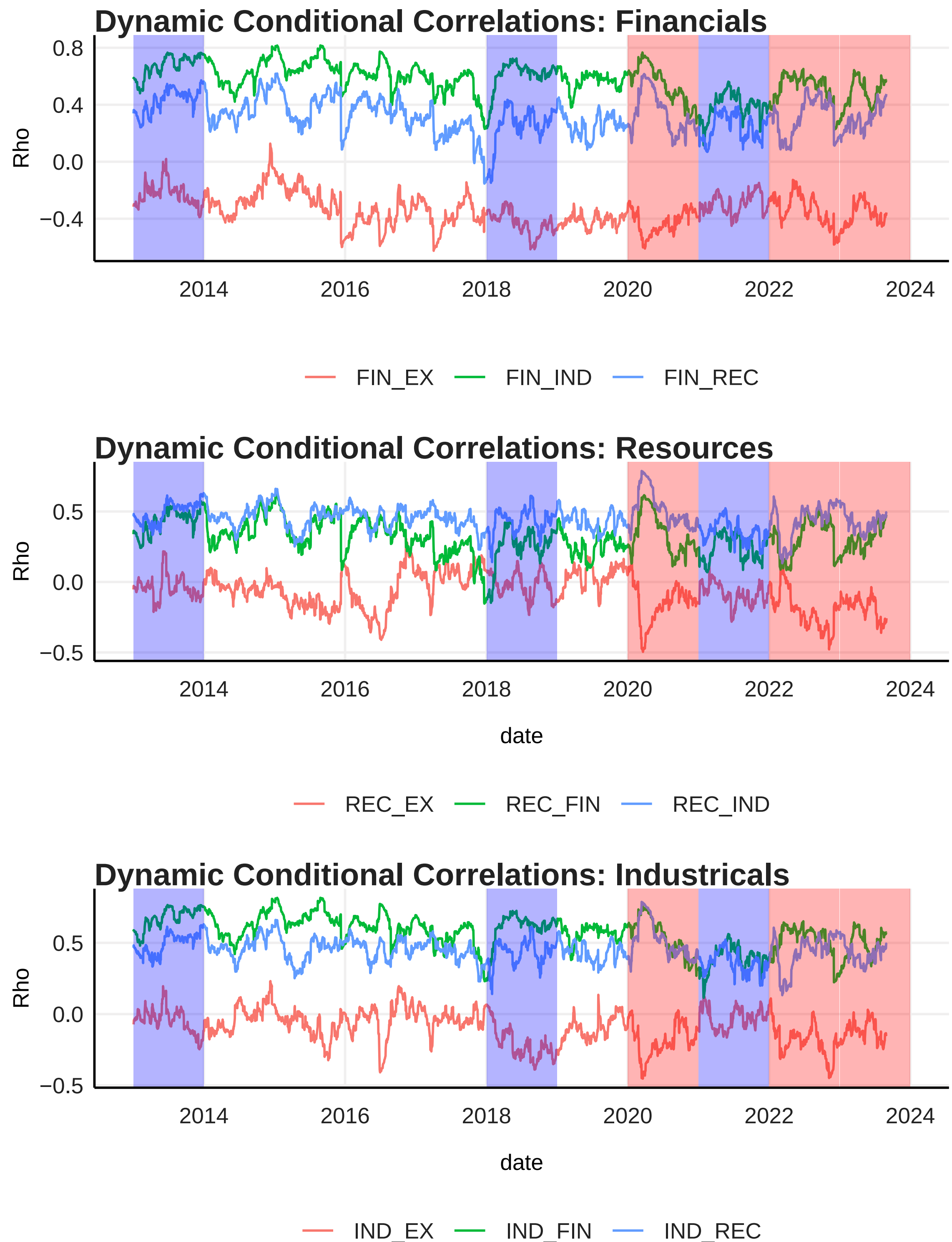

Figure 4.1: DCC

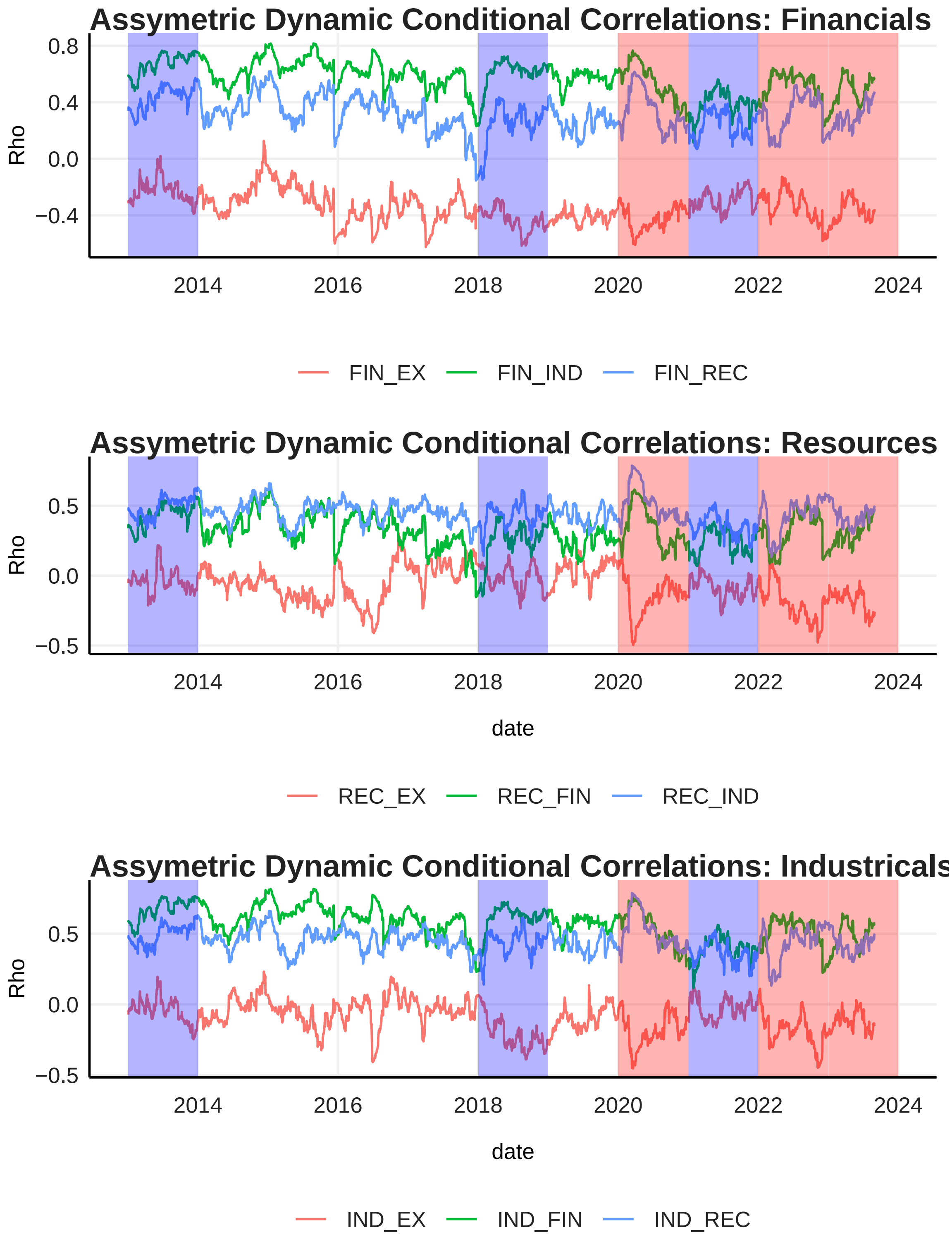

Figure 4.2: aDCC

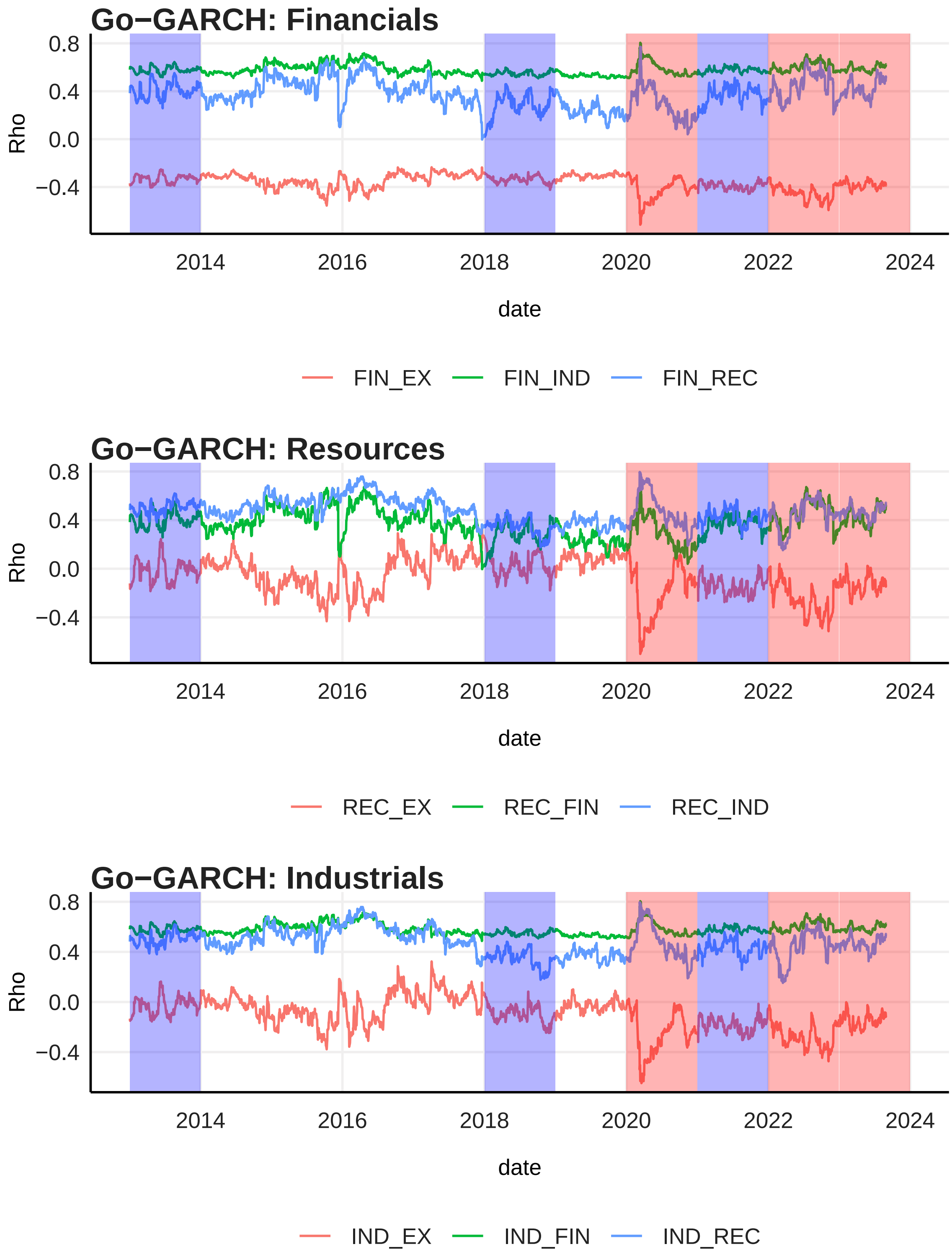

Figure 4.3: GO-GARCH

5. Conclusion

References

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6. Appendix

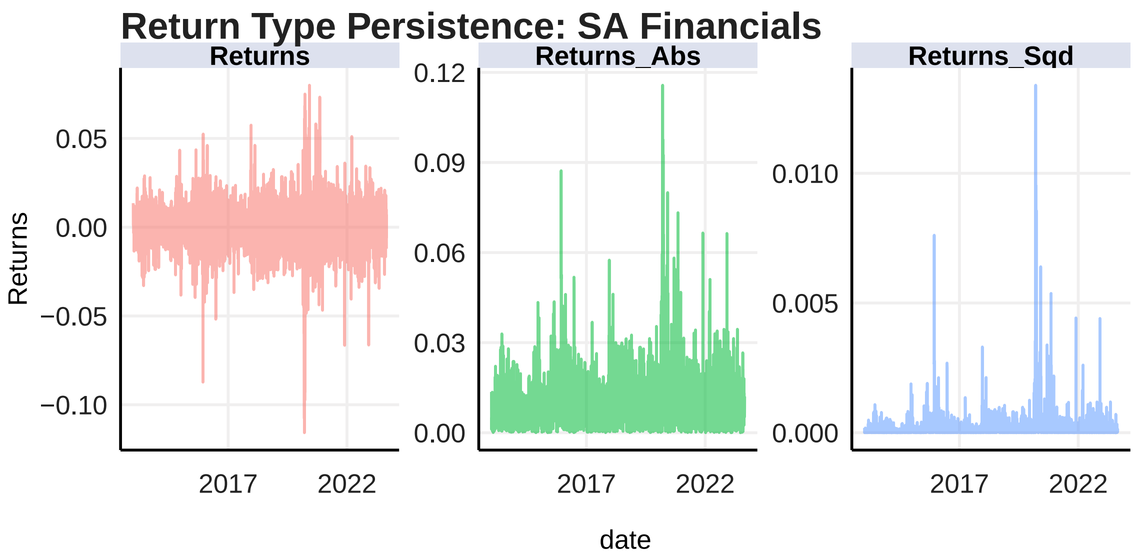

Figure 6.1: Return Persistence: Financials

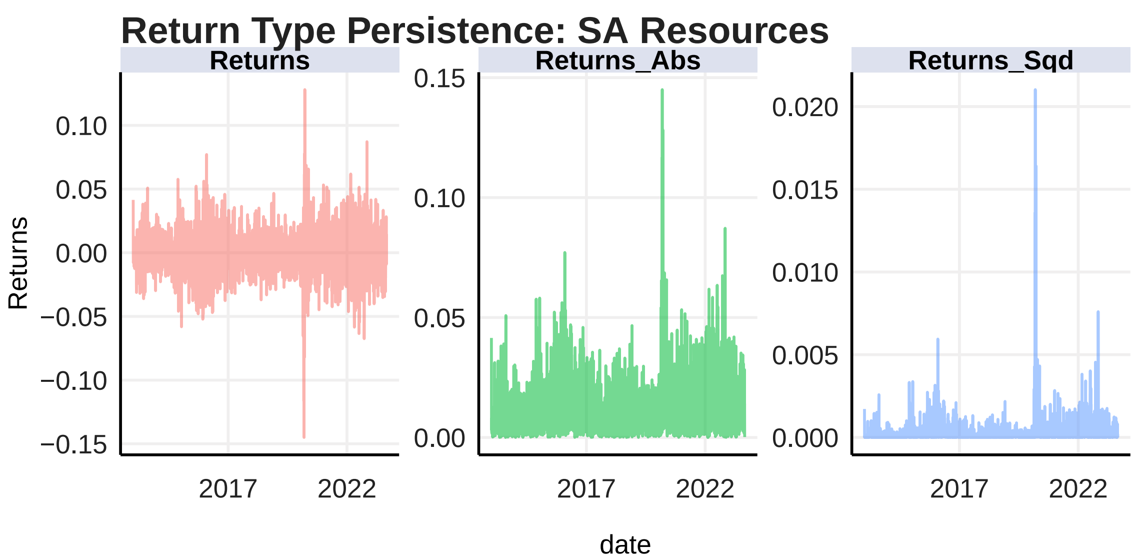

Figure 6.2: Return Persistence: Resources

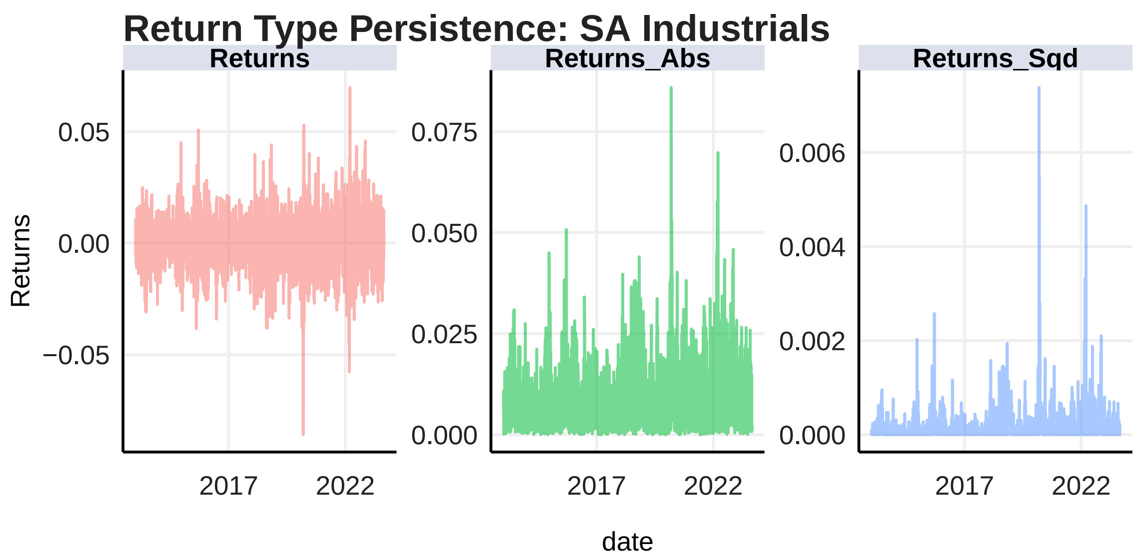

Figure 6.3: Return Persistence: Industrials

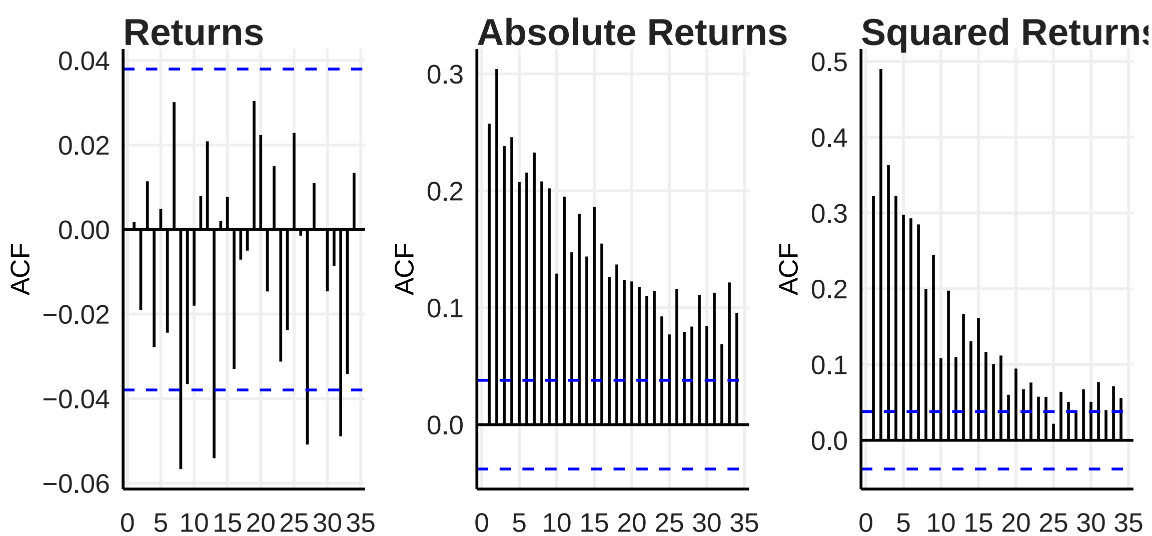

Figure 6.4: Autocorrelation Functions: Financials

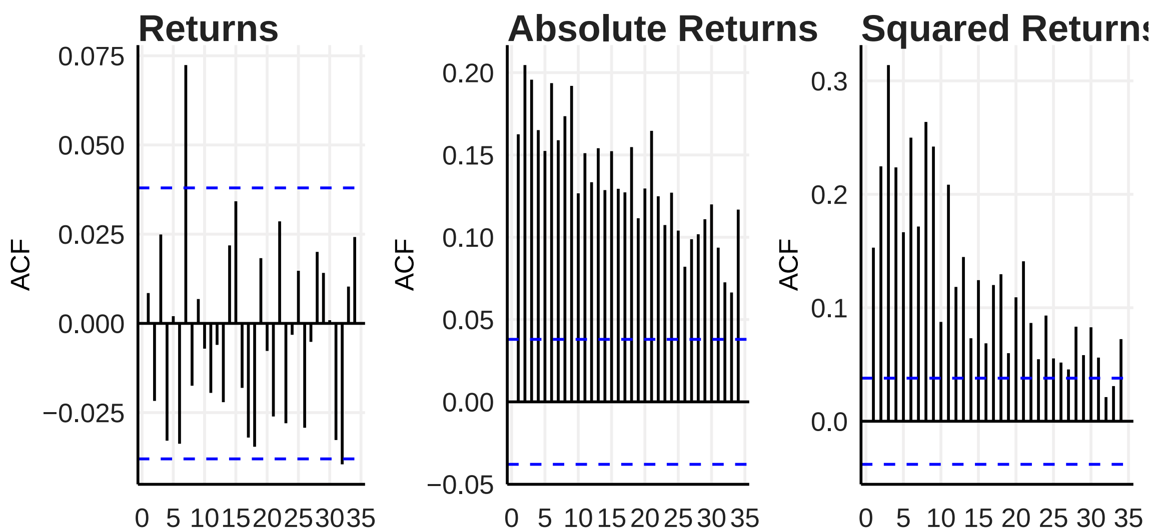

Figure 6.5: Autocorrelation Functions: Resources

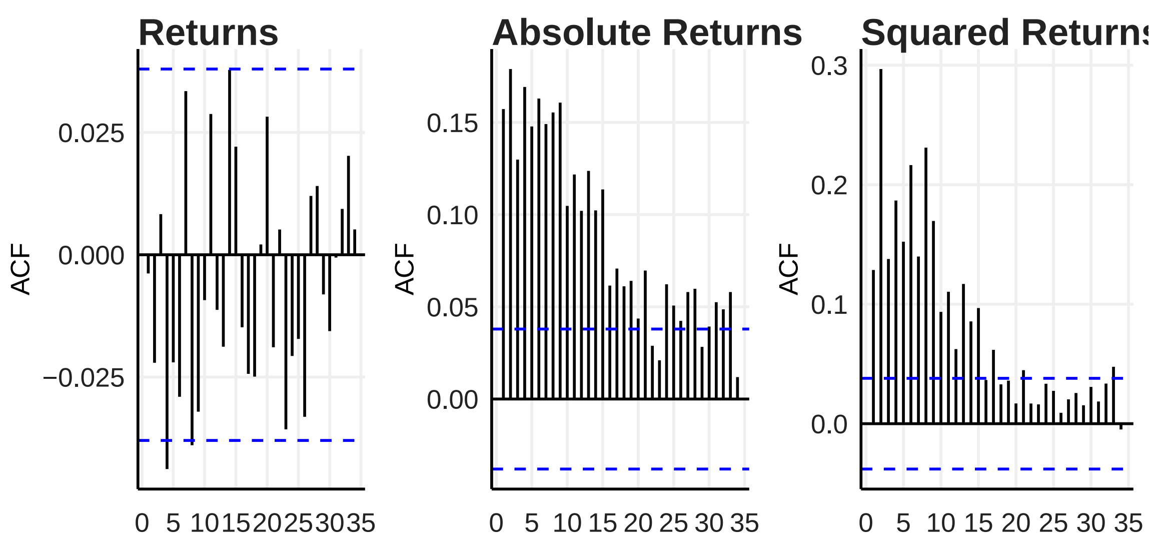

Figure 6.6: Autocorrelation Functions: Industrials