This thesis studies two topics. The first one investigates the autoregressive and moving average (ARMA) model with time-functional variance (TFV) noises, called the ARMA-TFV model. The consistency and asymptotic normality of its least squares estimator (LSE) are established. Based on the theory, the Wald tests and portmanteau tests are constructed for variable selection and model checking, respectively. It should be mentioned that the process generated from the ARMA-TFV model is not stationary, and the technique in this thesis is nonstandard and may provide insights for future research in this area. The second one studies the quasi-maximum likelihood estimator (QMLE) for the vector ARMA-GARCH (VARMA-GARCH) model. The self-weighted QMLE is showed to be consistent and asymptotically normal under a fractional moment condition. Using the iterative method, the asymptotic normality of local QMLE is also established for the VARMA model with GARCH (finite variance) and IGARCH errors. We construct the Wald tests and portmanteau tests for variable selection and model checking using these two estimators. Simulation results are carried out to access the performance of our methods, and real illustrating examples are given.