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ARIMA MODELLING IN SHORT DATA SETS: SOME MONTE CARLO RESULTS*

by

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INTRODUCTION

Accurate forecasts of economic time series in Caribbean economies is a necessary requirement of any Forecasting method since such forecasts, particularly of key economic variables (e.g. GDP, Oil prices, Foreign Exchange Earnings), can often spell the difference between economic growth or retardation. The forecasting methodology based on ARIMA modelling is a powerful tool in the hands of policy makers for generating short term forecasts. This method, for instance, has been employed with some success at the Central Bank of Trinidad and Tobago, in forecasting components (e.g. manufacturing) of the Gross Domestic Product for the Trends, Analysis and Projections (TAP) exercise.

Frequently however, in collecting data for the Modelbuilding exercise quantitative analysts are confronted with a situation in which the number of observations on a time series is often quite small and may

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be insufficient to yield worthwhile information on variables of interest. In the context of Caribbean Annual Macroeconomic data, these time series usually contain no more than thirty observations and often much less. Modelbuilders are generally unaware as to whether or not the series are too short to enable the modelbuilding exercise to be carried out effectively and practitioners often regard with "suspicion" the forecasts and policy decisions which emanate from models using short data sets.

Concern about the length of the time series needed for the construction of good univariate "ARIMA" Models is as well expressed by the "founding fathers" Box and Jenkins (1976, p.18) who write

> " .... If possible at least 50 and preferably 100 observations or more should be used".

Jenkins (1979) reiterates this concern, *arguing that problems occur* because it may not be possible to obtain a satisfactory diagnosis of the structure of the model and accurate estimates of the model parameters, with short data sets.

Contrary to the view of the "founding fathers" Pankratz (1983, pp. 534-549) argues that

> "..... The key is not necessarily the absolute number of observations but rather the amount of 'statistical noise' in the data. If the noise factor (the variance of the random shocks) is small it may be possible to extract enough information from relatively few observations to construct a useful ARIMA model".

In Metropolitan Economies with relatively larger and well-developed databases, the problem of short data sets, though it exists is not as acute a problem as it is in the Caribbean. Short data sets of sizes under 50 observations are the norm in the Caribbean context. Indeed a time series containing 50 observations which may be relatively small to Metropolitan users is often quite large by Caribbean data standards.

Regretably though, whereas this deficiency should be a serious issue in the context of Modelbuilding and forecasting in the Caribbean, it has quite surprisingly received little attention in the Caribbean Economic literature. Where it has received any attention at all, modelbuilders have merely paid 'lip-service' to its existence.[1] By contrast, even within the developed economy context of generally reliable data, this issue of deficiency has received much attention in the literature (see for example Griliches (1985a, 1985b)).

Given the limitation of the sample size available for practical modelbuilding work in the Caribbean the study attempts via Monte Carlo simulation methods to examine the degree of difficulty that observation sets of sizes under the Box Jenkins (B-J) limit of 50 observations impose on the ability to construct good ARMA (p,q) Models.

The paper is divided into four sections. Section 1 discusses the Box-Jenkins Modelbuilding Methodology. Section 2 presents the Experimental Design and Simulation Methodology. Section 3 analyses the results from the Monte Carlo simulations while in Section 4 a summary and conclusion is presented.

1. The Box-Jenkins ModelBuilding Methodology

Box and Jenkins (1976) have proposed a general class of Models called ARIMA (p,d,q) models defined by the following expression

$$\Phi(B)\nabla^d X_t = \theta(B)\varepsilon_t \qquad \varepsilon_t \sim N(0,\sigma_t^2)$$

where

$$\Phi(B) = (1 - \phi_1 B - \phi_2 B^2 - \ldots\ldots\ldots\ldots - \phi_p B^p)$$

$$\theta(B) = (1 - \theta_1 B - \theta_2 B^2 - \ldots\ldots\ldots\ldots - \theta_q B^q)$$

$$\nabla^d = (1 - B)^d$$

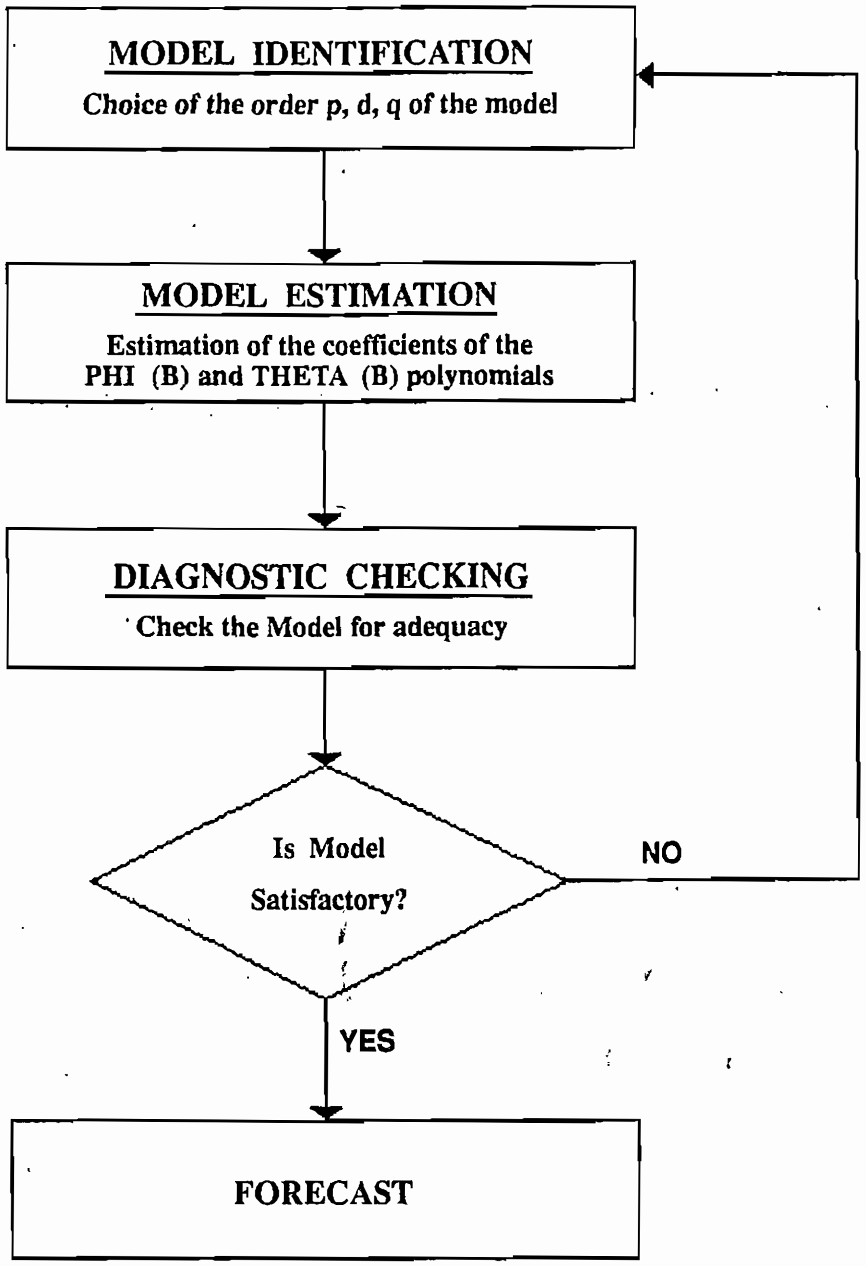
and $B(B^i = X_{t-i})$ is the backward shift operator.

The B-J methodology consists of three iterative stages, namely Model Identification, Model Estimation and Diagnostic Checking.

Model Identification

The main objective of this stage is to find the ARIMA process that is most appropriate for the data. This amounts to finding values of p and q, the order of the AR and MA polynomials. In addition the realizations may have to be differenced d times to transform them to stationary series. Selection of the order p and q of the $\Phi(B)$ and $\theta(B)$ polynomials respectively are based on the behaviour of the Sample Autocorrelation (ACF) and Partial Autocorrelation functions (PACF) which must conform as closely as possible to the behaviour of their established theoretical counterparts. Within recent years several additional methods have been developed to deal with the issue of order determination and

FLOWCHART OF BOX JENKINS-ITERATIVE CYCLE



these are summarized in Gooijer et al. (1985). The more popular among these include the methods of Geweke and Meese (1981), Hannan and Quinn (1979), Hannan (1980), Tsay and Tiao (1984) and Beguin Gourieroux and Monfort (1980).

Model Estimation

The estimation stage is concerned with assigning numerical values to the coefficients of the ϕ (B) and θ (B) polynomials. Numerous estimation techniques have been proposed in the literature to estimate the parameters of ARMA (p,q) models. The preferred technique is largely based on maximizing the likelihood function. The exact form of this likelihood is fairly complicated and expressions of its form are contained in Ali (1977), Newbold (1974), Dent (1977) and Ansley (1979). Whereas Box and Jenkins favour use of the ML criterion in the derivation of estimates of the coefficient values, finding exact ML estimates can be a difficult and cumbersome undertaking. As an alternative they suggest the use of conditional and unconditional maximum likelihood estimates.

Diagnostic checking

Once the model has been identified and the parameters estimated, the diagnostic checking stage attempts to judge whether the model as identified and estimated is accurate. This overall adequacy can be judged by testing the estimated innovations or residuals for "whiteness" or independence. Tests for "whiteness" of the residuals have been developed by Box and Pierce (1979), Ljung and Box (1978) and McLeod and Li (1983).

The Box-Jenkins three part iterative cycle is repeated, if necessary, until a satisfactory Model is obtained. It is then used to forecast values of the time series.

The Box-Jenkins modelbuilding methodology though, is premised largely on the asymptotic properties of the various identification, estimation and diagnostic checking procedures. With the existence generally of small sample sizes in the Caribbean any great reliance on asymptotic assumptions can lead to serious problems of bias and inaccuracy since asymptotic formulae need not necessarily reflect small sample behaviour and can misguide quantitative analysts about the true nature of the process under investigation. There is a small sample literature on the Box-Jenkins methodology but this is limited largely to the Estimation and Diagnostic checking phases of the cycle and concerns itself principally with the relative effectiveness of various Estimation and Diagnostic checking procedures. These include the studies of Ljung (1986), Davidson (1981a, 1981b), Ansley and Newbold (1980), Dent and Min (1978) and Nelson (1974). In this paper we are concerned with all three phases of the Box-Jenkins iterative cycle. Given a short data set, we investigate whether or not the given autocorrelation-partial autocorrelation functions (ACF-PACF) are directly reproducible and, in addition, whether or not the estimation and diagnostic checking procedures are effective in indicating the true underlying ARIMA process from which the data set emanated originally.

2. Experimental Design and Monte Carlo Methodology

The paper employs the Monte Carlo Simulation Methodology. A controlled experiment is designed in which artificial data sets of specific lengths are simulated from selected univariate ARMA (p,q) processes with known, a priori, properties and characteristics. These processes consist of two major types:

(a) Strong Information Processes

These are processes in which the coefficient signal is relatively strong (i.e. the coefficient is large in magnitude within the confines of the stationarity and invertibility restrictions).

(b) Weak Information Processes

These are processes in which the coefficient or information signal tends towards zero so that the process borders on a "no-information" or white-noise process.

i.e. $X_t = \varepsilon_t, \ \varepsilon_t \sim N(0,\sigma_\varepsilon^2)$

The ARIMA processes which are investigated in the paper are as follows:

ARMA (1,0) PROCESS

$$X_t = \phi_1 X_{t-1} + \varepsilon_t, \ \varepsilon_t \sim N(0,\sigma_\varepsilon^2)$$

ARMA (0,1) PROCESS

$$X_t = \varepsilon_t - \theta_1 \varepsilon_{t-1}, \ \varepsilon_t \sim N(0,\sigma_\varepsilon^2)$$

These models are clearly special cases of the more general ARIMA processes. The fact that

i.e. ARIMA (1,0,0): $p = 1$, $d = 0$, $q = 0$

ARIMA (0,0,1): $p = 0$, $d = 0$, $q = 1$

$d = 0$ in all cases (the processes are stationary) does not represent any real constraint. One can always suppose that sufficient differencing has been carried out to attain stationarity. At any rate in most situations of practical importance $d \leqslant 2$.

The pseudo-random numbers $U_i \in (0,1)$ used in simulating the stochastic error terms (ε_t values) were generated on an IBM PC-AT using a standard Multiplicative-Congruential procedure.[2] These ε_t values were converted to normal deviates with mean 0 and standard deviation 1 using an algorithm outlined in Rubinstein (1981) - Procedure N5. Data sets of 150 observations in length were next generated by supplying values for ϕ and θ, appropriate starting values for X_t and the generated values of ε_t. Replication of the experiment (300 in all) was obtained by changing the random seed required to initialize the recursive computations so that different realizations were generated for each of the given processes, X_t. For each generated realization the first and second sample moments[3] were compared with their theoretical counterparts in an attempt to judge how the respective realization sets were mimicking the true statistical properties of the specified ARMA processes.

The first forty (40) observations in the series of 150 observations were omitted in order to eliminate, as far as possible, "initialization" error. Since the objective of our study is to consider the effect of size on the results obtained, a size of 100 observations (large) was used and progressively truncated to a size of 30 (small sample) and then 20 (very small sample) observations. An illustration of the truncating procedures is presented on the following page. All sample sizes were subjected to the Box-Jenkins routine in an effort to quantify the effects (if any) of a loss of sample information. The entire data generation procedures are contained in a BASIC program[4] written specifically to generate the data realizations for each ARMA process.

Table 1 contains a list of the ARMA processes used in the simulation experiment. Some justification of the parameter values assigned will be given in Section 3 where the results are presented.

3. Monte Carlo Simulation Results

3.1 ARMA (1,0) Processes (I, II, III)

The processes chosen can be viewed as lying along a line continuum with the lower and upper extremities representing, respectively, a purely random process ($X_t = \varepsilon_t$) and the non-stationary ARMA (1,0) process ($|\phi| \geq 1$).

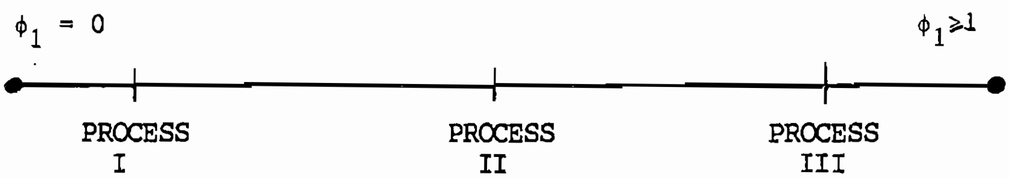


ILLUSTRATION OF TRUNCATION PROCEDURES

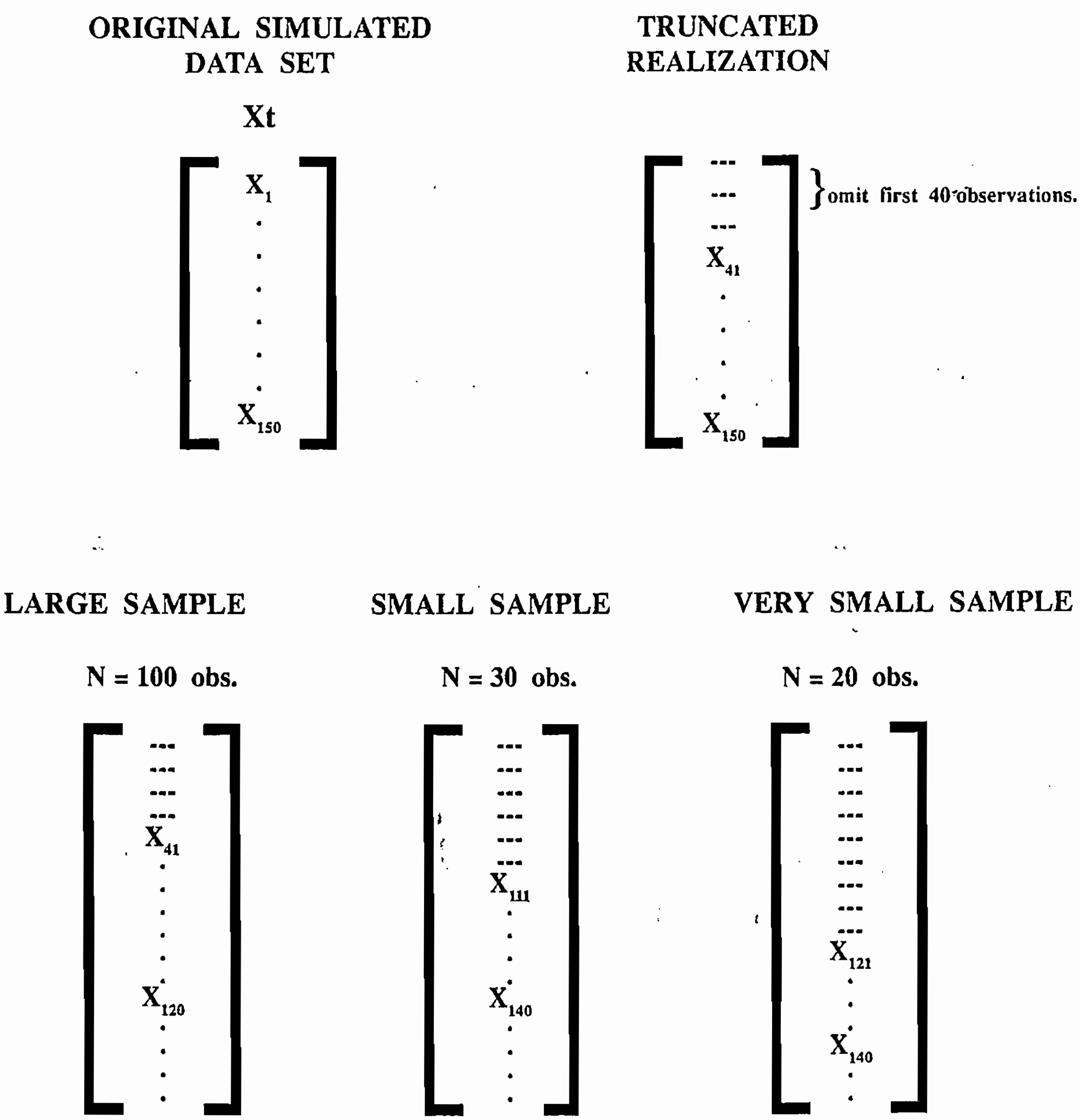


TABLE 1

TABULAR PRESENTATION OF ARMA(1,0) and ARMA(0,1) PROCESSES

Process Name	AR-Parameter	MA-Parameter	Process Description
Process I	0.30	-	Weak Information Signal
Process II	0.50	-	Relatively Strong Information Signal
Process III	0.90	-	Very Strong Information Signal
Process IV	-	0.35	Weak Information Signal
Process V	-	0.60	Relatively Strong Information Signal
Process VI	-	0.80	Very Strong Information Signal

3.1.1 Identification

For the respective sample sizes (N = 20, 30 and 100) each set of observations from Processes I, II and III was subjected to the Box-Jenkins Identification procedure with the objective of finding out how often the identification procedure selected an ARMA (1,0) model when the data were in fact generated by ARMA (1,0) processes.

The results based on 300 replications of each experiment are summarized in Table 2. Two factors seem to influence the results. These are the size of the sample and the strength of the signal (as measured by ϕ). For a very strong signal (ϕ_1 = 0.90), the size of the sample appears to have no influence whatsoever on our ability to identify the

TABLE 2

IDENTIFICATION OF ARMA(1,0) MODELS BASED ON 300 REPLICATIONS OF PROCESS I, II AND III

Process	Sample Size	Number Identified As ARMA (1,0)	% of Total
I (ϕ_1 = 0.30)	N = 100	84	28
	N = 30	51	17
	N = 20	38	13
II (ϕ_1 = 0.50)	N = 100	219	73
	N = 30	109	36
	N = 20	59	23
III (ϕ_1 = 0.90)	N = 100	300	100
	N = 30	300	100
	N = 20	300	100

process correctly. As the signal weakens, however, the size of the sample becomes more important. When $\phi_1 = 0.50$, 73% of the cases involving large samples were correctly identified, while only 36% and 23% of those with sample sizes of 30 and 20 observations, respectively, were correctly identified. For a fairly weak signal ($\phi_1 = 0.30$), a large sample is clearly not a great boon as only 28% of the cases were properly identified compared to 17% and 13% for the small and very small cases respectively. These results indicate that when the coefficient signal is fairly weak it may be impossible to distinguish between near white-noise processes and white-noise processes even for relatively large sample sizes.

3.1.2 Estimation and Diagnostic Checking Procedures

For the three processes, ϕ_1 was estimated by maximum likelihood for each replications using the different sample sizes. Various summary statistical measures (defined in the appendix) were calculated based on the 300 replications. These are are as follows:

(i) The average of the estimated value of ϕ_1 - (AV)

(ii) The Relative Bias (RB)

(iii) The Coefficient of Variation (CV)

(iv) The Root Mean Square Percentage Error (RMSE%)

The calculated values are shown in Table 3.

TABLE 3

SUMMARY STATISTICAL MEASURES BASED ON ESTIMATES OF PROCESS I, II AND III
(300 Replications)

Process	Statistical Measures	SAMPLE SIZE Large (100)	Small (30)	Very Small (20)
I	$AV(\phi_1)$	0.2931	0.2832	0.2844
($\phi_1 = 0.30$)	RB	2.3%	4.6%	5.2%
	CV	31.0%	57.0%	64.0%
	RMSE%	0.3%	0.5%	0.6%
II	$AV(\phi_1)$	0.4857	0.4654	0.4582
($\phi_1 = 0.50$)	RB	2.8%	6.9%	8.4%
	CV	18.0%	35.0%	40.0%
	RMSE%	0.2%	0.3%	0.4%
III	$AV(\phi_1)$	0.8821	0.8531	0.8280
($\phi_1 = 0.90$)	RB	2.0%	5.1%	8.0%
	CV	6.0%	12.0%	16.0%
	RMSE%	0.06%	0.12%	0.17%

In all cases the bias is quite small but the estimates are clearly more reliable when the sample size increases and/or the signal gets stronger. When $\phi_1 = 0.90$, the coefficient of variation varies from 6% to 16% as the sample grows from large to very small. When $\phi_1 = 0.30$, however, the corresponding variation is from 31% to 69%. These results, however, cannot be said to constitute an outright condemnation against the use of small samples for there is no obvious marked advantage in using 100 sample points as opposed to 20 particularly when the signal is not too weak. The information displayed in Table 4 below confirms these observations. It shows what proportion of estimated coefficients were significant at the 5% level in the range centred on the true parameter value. The strength of the signal plays an important role, as well as the size of the sample and, once again, as the signal gets weaker, it becomes more important to have larger samples.

TABLE 4

PROPORTION OF SIGNIFICANT COEFFICIENTS IN RANGE CENTRED ON TRUE VALUE OF PARAMETER

Sample	Process I (%)	Process II (%)	Process III (%)
Very Small (N = 20)	16	93	100
Small (N = 30)	31	77	100
Large (N = 100)	99	100	100

The estimation exercises on which the above results are based were carried out irrespective of whether the process was identified as ARMA(1,0). It remains to see how closely a properly fitted model is related to a properly identified model. A properly fitted model is one which passes the standard diagnostic checks such as significant tests, white noise residuals (the Box-Pierce Portmanteau and the Ljung-Box tests) and those based on cumulative periodograms (Kolmogorov-Smirnov test). Table 5 below distinguishes between properly fitted models that were correctly identified as ARMA(1,0) models and those which were not.

TABLE 5

COMPARISON OF PROPERLY FITTED MODELS AND THEIR RELATION TO MODELS IDENTIFIED AS ARMA(1,0)
(Processes I, II and III)

	Sample Size	A	B	C	D	E	F
Process I ($\phi_1 = 0.30$)	Very Small	38	28	74%	43	16%	71
	Small	51	38	75%	77	31%	115
	Large	84	78	93%	174	81%	252
Process II ($\phi_1 = 0.50$)	Very Samll	59	56	95%	131	54%	187
	Small	109	105	96%	157	82%	216
	Large	219	219	100%	81	100%	300
Process III ($\phi_1 = 0.90$)	Very Small	300	299	99.7%	0	-	299
	Small	300	299	99.7%	0	-	299
	Large	300	300	100.0%	0	-	300

A = Number of Models Correctly Identified as ARMA(1,0) out of 300

B = Number of A Properly fitted

C = (B/A) x 100

D = Properly fitted models not Identified as ARMA(1,0)

E = (D/(300-A) x 100

F = B + D

The main conclusion seems to be that for estimation purposes sample size matters less if the coefficient signal is strong enough. When ϕ_1 = 0.90, the 299 replications that yielded properly identified ARMA(1,0) models in the small and very small sample cases were also properly fitted.

Another important result is that a substantial amount of models not identified as ARMA(1,0) are successfully estimated as such, and the proportion so fitted increases with the size of the sample as well as with the strength of the signal. When ϕ_1 = 0.50, a total of 187 and 216 of the very small and small sample cases (out of a possible 300) were successfully fitted despite the fact that many of these were not properly identified. However, the proportion of those which were both properly identified and fitted is always higher.

It would appear that it is more at the Identification stage than at the Estimation stage that the smallness of the sample as well as the strength of the coefficient signal seems to have greater influence. It is tempting to consider by-passing the Identification stage and proceeding straight to estimation when we have small samples. This is neither as heretical nor as impractical as it may appear at first blush since, in the first place, for most economic series, $p + q \leq 2$ so that, in practice, we need only fit the ARMA(1,0), ARMA(2,0), ARMA(0,1), ARMA(0,2) and ARMA(1,1) models. In the second place, given the small samples and the existence of relatively cheap computing facilities today, computation will not cost a fortune. In fact, it may prove cheaper and more efficient to approach the problem this way rather than going through the Identification stage.[6]

3.2 ARMA(0,1) Processes (IV, V and VI)

. The processes chosen (see Table 1) can be viewed as lying along a line continuum with the lower and upper extremities representing, respectively, a purely random process ($X_t = \varepsilon_t$) and the non-invertible ARMA(0,1) proces ($|\theta| \geq 1$).

3.2.1 Identification

For the various sample sizes, each set of observations from Processes IV, V and VI was subjected to the Box-Jenkins Identification procedure, and based on the sample ACF's and PACF's, a decision was made as to whether or not an ARMA(0,1) process was, in fact, identified. The results based on 300 replications of each experiment are summarized in Table 6 below:

TABLE 6

IDENTIFICATION OF ARMA(1,0) MODELS BASED ON 300 REPLICATIONS OF PROCESS IV, V AND VI

Process	Sample Size	Number Identified As ARMA (1,0)	% of Total
IV ($\theta_1 = 0.35$)	N = 100	109	36
	N = 30	70	23
	N = 20	49	16
V ($\theta_1 = 0.60$)	N = 100	242	81
	N = 30	122	41
	N = 20	90	30
VI ($\theta_1 = 0.80$)	N = 100	298	99
	N = 30	219	73
	N = 20	123	41

As was the case with the ARMA(1,0) processes, the size of the coefficient as well as the sample size seem to have strong influences. In the ARMA(0,1) case, however, the sample size tends to predominate. For the highest coefficient value ($\theta_1 = 0.80$), only 41% of the very small sample cases were properly identified compared to 99% in the large sample case. In the ARMA(1,0) case, all sample sizes resulted in 100% identification. The ARMA(0,1) results may be a consequence of the "pile up" effect noted by Cryer and Ledolter (1981) at the non-invertibility boundary in small samples which can impair the uniqueness between ARMA(1,0) processes and their requisite ACF-PACF forms and may result in pseudo "ACF-PACF" patterns.

3.2.2 Estimation and Diagnostic Checking

The same procedure was followed as in the case of the ARMA(1,0) processes, and Table 7 summarizes the main results:[7]

TABLE 7

SUMMARY STATISTICAL MEASURES BASED ON ESTIMATES OF PROCESS IV, V AND VI
(300 Replications)

Process	Statistical Measures	SAMPLE SIZE Large (100)	Small (30)	Very Small (20)
I ($\theta_1 = 0.35$)	AV(θ_1)	0.3509	0.3642	0.3746
	RB	0.25%	4.1%	7.0%
	CV	31.0%	57.0%	68.0%
	RMSE%	0.31%	0.60%	0.73%
II ($\theta_1 = 0.60$)	AV(θ_1)	0.5982	0.6140	0.6218
	RB	0.3%	2.3%	8.6%
	CV	20.0%	34.0%	38.0%
	RMSE%	0.2%	0.5%	0.4%
III ($\theta_1 = 0.80$)	AV(θ_1)	0.7876	0.7874	0.7907
	RB	1.5%	1.6%	1.2%
	CV	20.0%	25.0%	28.0%
	RMSE%	0.2%	0.24%	0.27%

Accuracy and reliability tend to increase with increasing sample size as well as with the strength of the coefficient. But even when the larger samples yield better results, there is insufficient evidence to suggest that smaller samples cannot be used with some success. In the case of Process VI, where the coefficient is strongest, sample size appears hardly to be making a difference and, in particular, the relative bias as well as the coefficient of variation are approximately equal irrespective of the size of the sample.

The information displayed in Table 8 (below) tend to strengthen the belief that it is more the weakness of the coefficient value rather than the size of the sample that plays the dominant role. It is obvious, however, that when this value is small, a larger sample is clearly more desirable.

TABLE 8

PROPORTION OF SIGNIFICANT COEFFICIENTS IN RANGE CENTRED ON TRUE VALUE OF PARAMETER

Sample	Process IV (%)	Process V (%)	Process VI (%)
Very Small (N = 20)	0	100	100
Small (N = 30)	11.6	100	100
Large (N = 100)	100	100	100

Once again, the strength of the signal plays, as well as the size of the sample are important factors. As the signal gets weaker, it becomes more important to have larger samples.

TABLE 9

COMPARISON OF PROPERLY FITTED MODELS AND THEIR RELATION TO MODELS IDENTIFIED AS ARMA(0,1)
(Processes IV, V and VI)

	Sample Size	A	B	C	D	E	F
Process I ($\theta_1 = 0.35$)	Very Small	49	49	100%	53	21%	102
	Small	70	70	100%	74	32%	144
	Large	109	109	100%	171	90%	280
Process II ($\theta_1 = 0.60$)	Very Samll	90	90	100%	140	67%	230
	Small	122	120	98%	137	77%	257
	Large	242	238	98%	58	100%	296
Process III ($\theta_1 = 0.80$)	Very Small	123	122	99%	158	89%	280
	Small	219	219	100%	69	85%	288
	Large	298	289	97%	2	100%	291

A = Number of Models Correctly Identified as ARMA(0,1) out of 300
B = Number of A Properly fitted
C = (B/A) x 100
D = Properly fitted models not Identified as ARMA(0,1)
E = (D/(300-A) x 100
F = B + D

There is a stronger link here than in the ARMA(0,1) case between proper identification and proper fit, In almost every case, notwithstanding sample size or strength of signal, almost every realization identified as an ARMA(0,1) resulted in a proper fit. But just as in the ARMA(1,0) case many realizations not properly identified resulted in good fits inspite of the sample size, particularly for stronger coefficient values. This strengthens the observation that, particularly in the case of smaller samples, the identification stage is clearly more problematic than the estimation stage and the recommendation about by-passing the identification stage made above gains even more validity.

4. Summary and Conclusion

Box and Jenkins (1976) suggest that it may be inadvisable to construct ARIMA models with realization sets of under 50 observations. If the B-J restrictions is accepted then modelbuilding using ARIMA(p,q) processes, in the Caribbean, may be a futile undertaking since the number of observations adequate for modelbuilding purposes in the Caribbean, often falls well short of this prescribed lower limit.

The paper clearly contends that there is insufficient evidence to suggest that the size of the sample is of such pre-eminence as to preclude the use of ARIMA type models by those who possess only relatively small samples. There is obviously though, some greater advantage in having larger rather than smaller samples.

Furthermore the length of the data set need not adversely affect the modelbuilding exercise. Evidence from the simulations indicate that if the information content of the data realization is relatively strong then it may still be possible to build good ARIMA models even when faced with short samples of sizes under the B-J limit. The Identification stage of the iterative exercise, however, may prove to be more problematic than the Estimation and Diagnostic Checking Stages.

All in all, the paper suggests that if modelbuilding is to prove to be of any use in Caribbean economic analysis then modelbuilders in our region need to pay much more attention to <u>data deficiency issues</u> and their likely effects on modelbuilding, both in the Econometric and Time Series spheres.

ENDNOTES

1. Previous attempts made to discuss the general problem of data deficiency include Bourne (1984), Farrell (1987) and Watson (1984, 1987).

2. The random numbers were tested to establish the satisfactory "randomness" of the generator. See Ripley (1983) for further details on random number generation.

3. The processes are Gaussian in nature. They can therefore be fully described by their first and second sample moments.

4. A copy of this program is available upon request from the author.

5. Each replication was estimated by maximum likelihood irrespective of whether the process was identified as ARMA(1,0).

6. This issue is a highly debatable one in light of new developments in the Model Identification Literature. The subjective approach of the ACT-PACF is definitely more problematic. One needs however, to firstly compare various identification methods (both subjective and objective) before this suggestion can gain any validity.

7. Detailed results of ARMA(0,1) and ARMA(1,0) processes can be found in Nicholls (1988).

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APPENDIX

The statistics used in Tables 3 and 7 were calculated as follows (where a stands for either ϕ or θ).

1. <u>Average value of the estimated value **AV(a)**</u>

   $AV(a) = m^{-1} \sum_{i=1}^{m} \hat{a}_i$, $m = 300$

2. <u>Relative Bias **(RB)**</u>

   $RB = (\hat{a} - a)/(a)$

3. <u>Coefficient of Variation **(CV)**</u>

   $CV = SE(\hat{a})/AV$

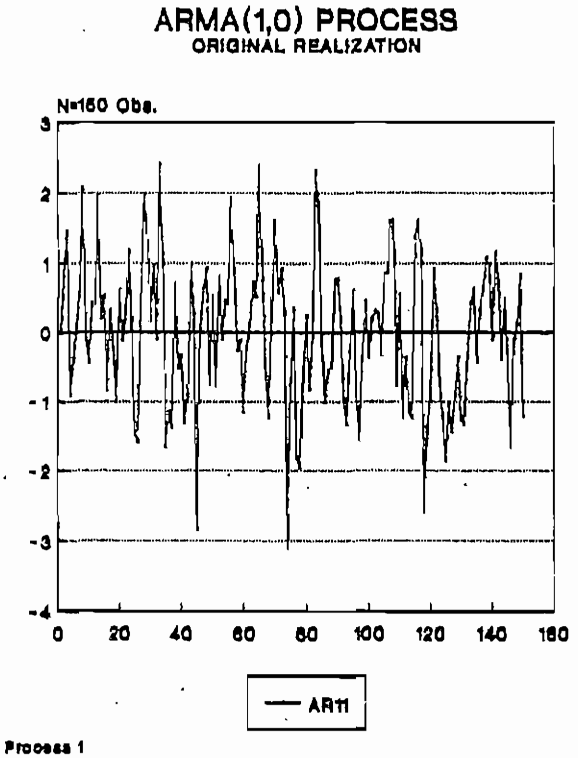
   where $SE(\hat{a}) = \sqrt{m^{-1} \sum_{i=1}^{m} (\hat{a}_i - a)^2}$

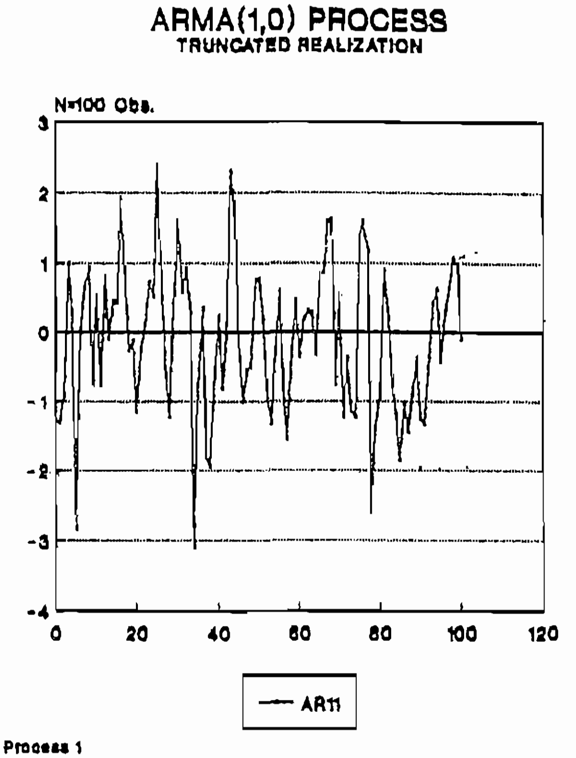
4. <u>Root Mean Square Percentage Error **(RMSE%)**</u>

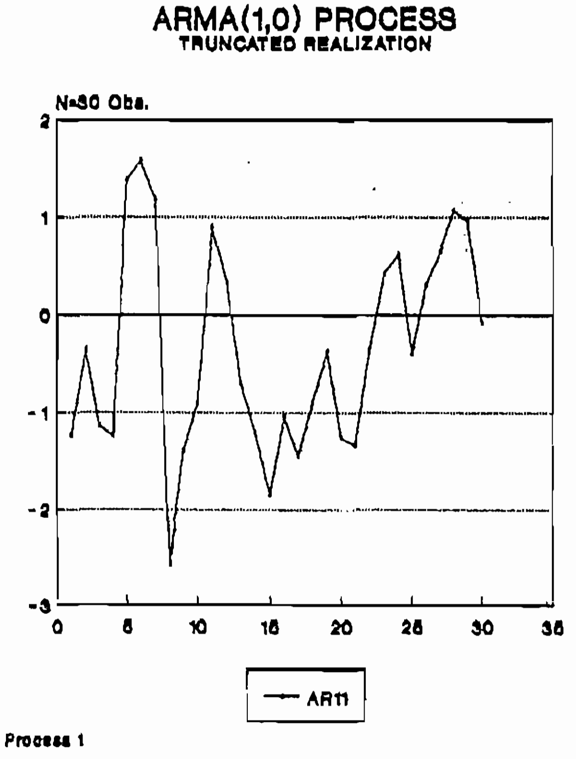
   $RMSE\% = \sqrt{m^{-1} \sum_{i=1}^{m} [(\hat{a}_i - a)/((a)]^2}$

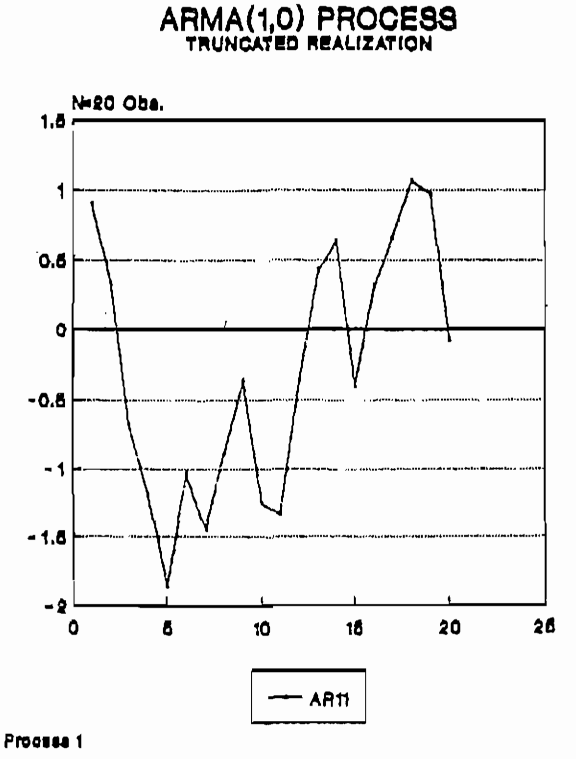
PLOTS OF SIMULATED SERIES FOR AN ARMA(1,0) PROCESS

PROCESS 1









SAMPLE ACF AND PACF FOR SIMULATED ARMA(1,0) PROCESSES

```
SMPL     111   -   140
30 Observations
IDENT AR1290
===========================================================================
     Autocorrelations   Partial Autocorrelations          ac        pac
===========================================================================
|            |*******  |           |*******  |  1   0.6843    0.6843
|            |*****    |           |*        |  2   0.5297    0.1155
|            |***      |          *|         |  3   0.3351   -0.1230
|            |***      |           |**       |  4   0.3330    0.2108
|            |***      |           |         |  5   0.2845    0.0190
|            |**       |         **|         |  6   0.1679   -0.1992
|            |*        |           |*        |  7   0.1071    0.0582
|            |         |          *|         |  8  -0.0041   -0.1198
|           *|         |        ***|         |  9  -0.1452   -0.2962
|          **|         |           |         | 10  -0.2348   -0.0085
|         ***|         |          *|         | 11  -0.3182   -0.1113
|          **|         |           |*        | 12  -0.2391    0.0956
|          **|         |           |*        | 13  -0.2246    0.0654
|           *|         |           |*        | 14  -0.1342    0.1260
|          **|         |          *|         | 15  -0.1886   -0.1187
===========================================================================
 S.E. of Correlations  .1825742          Q-Stat. (15 lags)  42.93956
===========================================================================
```

```
SMPL     111   -   140
30 Observations
IDENT AR1246
===========================================================================
     Autocorrelations   Partial Autocorrelations          ac        pac
===========================================================================
|            |******   |           |******   |  1   0.5725    0.5725
|            |***      |          *|         |  2   0.2676   -0.0895
|            |***      |           |***      |  3   0.3454    0.3446
|            |***      |          *|         |  4   0.2931   -0.0831
|            |**       |           |         |  5   0.1641    0.0319
|            |*        |          *|         |  6   0.1118   -0.0550
|            |         |         **|         |  7  -0.0270   -0.2026
|         ***|         |        ***|         |  8  -0.2811   -0.3371
|        ****|         |         **|         |  9  -0.3732   -0.1863
|         ***|         |           |         | 10  -0.2963   -0.0446
|         ***|         |          *|         | 11  -0.3360   -0.1025
|         ***|         |           |*        | 12  -0.3430    0.1121
|         ***|         |           |         | 13  -0.2830    0.0402
|         ***|         |           |         | 14  -0.2855    0.0383
|        ****|         |         **|         | 15  -0.3716   -0.2316
===========================================================================
 S.E. of Correlations  .1825742          Q-Stat. (15 lags)  44.43395
===========================================================================
```

SAMPLE ACF AND PACF FOR

NON-RECOGNIZABLE ARMA(1,0) PROCESSES

```
SMPL     111  -   140
30 Observations
IDENT AR161
==========================================================================
     Autocorrelations  Partial Autocorrelations           ac        pac
==========================================================================
|           |*          |           |*          |  1   0.0702    0.0702
|           |*          |           |*          |  2   0.1232    0.1188
|           |*          |           |           |  3   0.0514    0.0361
|          *|           |          *|           |  4  -0.0549   -0.0763
|           |           |           |           |  5   0.0107   -0.0081
|         **|           |         **|           |  6  -0.1662   -0.1572
|           |*          |           |*          |  7   0.0653    0.0934
|          *|           |           |           |  8  -0.0564   -0.0357
|           |           |           |           |  9  -0.0381   -0.0339
|          *|           |          *|           | 10  -0.1068   -0.1262
|           |*          |           |*          | 11   0.0539    0.1041
|          *|           |          *|           | 12  -0.0647   -0.0894
|          *|           |           |           | 13  -0.0620   -0.0305
|           |**         |           |**         | 14   0.2163    0.2145
|           |           |           |           | 15  -0.0021   -0.0135
==========================================================================
 S.E. of Correlations  .1825742        Q-Stat. (15 lags)  3.944895
==========================================================================
```

```
SMPL     111  -   140
30 Observations
IDENT AR12
==========================================================================
     Autocorrelations  Partial Autocorrelations           ac        pac
==========================================================================
|           |           |           |           |  1  -0.0087   -0.0087
|           |           |           |           |  2  -0.0094   -0.0095
|           |           |           |           |  3  -0.0008   -0.0009
|       ****|           |       ****|           |  4  -0.3661   -0.3662
|       ****|           |       ****|           |  5  -0.3536   -0.4161
|           |**         |           |**         |  6   0.2050    0.1891
|           |           |           |           |  7  -0.0303    0.0016
|           |**         |           |*          |  8   0.2042    0.0793
|           |***        |           |           |  9   0.2590    0.0188
|           |           |           |           | 10  -0.0006    0.0233
|          *|           |           |           | 11  -0.1264   -0.0057
|          *|           |          *|           | 12  -0.0710   -0.0545
|          *|           |           |*          | 13  -0.1057    0.1357
|          *|           |           |           | 14  -0.0798   -0.0274
|           |           |          *|           | 15  -0.0041   -0.1482
==========================================================================
 S.E. of Correlations  .1825742        Q-Stat. (15 lags)  13.48482
==========================================================================
```

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
1	0.000000	1.098900	-0.344200	1.145970	1.070500	0.465800	0.163400	2.850673	12.12170
2	0.000000	1.098900	-0.084500	0.714870	0.845500	-0.010300	0.190200	-0.054154	13.62280
3	0.000000	1.098900	-0.017300	0.641761	0.801100	0.386900	0.173700	2.227404	7.660400
4	0.000000	1.098900	0.108100	0.965699	0.982700	-0.025200	0.188300	-0.133829	12.35930
5	0.000000	1.098900	-0.217400	0.762653	0.873300	0.270400	0.177100	1.526821	5.032700
6	0.000000	1.098900	0.356200	1.222573	1.105700	0.473500	0.169100	2.800118	10.90040
7	0.000000	1.098900	-0.308700	0.874225	0.935000	0.328300	0.172200	1.906504	6.676800
8	0.000000	1.098900	0.014600	1.207581	1.098900	0.233900	0.182600	1.280942	9.842600
9	0.000000	1.098900	-0.006600	0.637762	0.798600	0.049300	0.185300	0.266055	10.07970
10	0.000000	1.098900	-0.228600	1.089101	1.043600	0.322800	0.175700	1.837223	3.363400
11	0.000000	1.098900	-0.100800	1.112392	1.054700	0.328100	0.177900	1.844295	8.704700
12	0.000000	1.098900	0.040400	1.099772	1.048700	0.323400	0.176300	1.834373	7.951000
13	0.000000	1.098900	0.343600	1.655854	1.286800	0.268000	0.184700	1.451002	7.585400
14	0.000000	1.098900	0.264500	1.215947	1.102700	0.129000	0.196600	0.656155	8.107600
15	0.000000	1.098900	-0.078400	0.961773	0.980700	0.468700	0.151200	3.099868	19.83810
16	0.000000	1.098900	0.051900	0.919106	0.958700	0.161600	0.181200	0.891832	13.94340
17	0.000000	1.098900	0.043600	1.062342	1.030700	0.133300	0.167400	0.796296	17.62900
18	0.000000	1.098900	-0.031200	1.624860	1.274700	0.333200	0.181200	1.838852	7.648300
19	0.000000	1.098900	0.544500	1.571262	1.253500	0.458300	0.164200	2.791109	10.85050
20	0.000000	1.098900	-0.087900	0.751689	0.867000	0.049500	0.181300	0.273028	11.00610
21	0.000000	1.098900	0.284200	0.792812	0.890400	0.143100	0.183000	0.781967	15.50000
22	0.000000	1.098900	-0.071100	1.438560	1.199400	0.081100	0.205300	0.395032	7.268000
23	0.000000	1.098900	0.164000	1.141906	1.068600	0.098600	0.181400	0.543550	12.05460
24	0.000000	1.098900	-0.143700	0.597529	0.773000	0.104700	0.187200	0.559295	3.637300
25	0.000000	1.098900	-0.201400	0.924290	0.961400	0.225900	0.181000	1.248066	7.600300
26	0.000000	1.098900	-0.060100	1.471854	1.213200	0.422400	0.169500	2.492035	5.960100
27	0.000000	1.098900	0.312500	1.550274	1.245100	0.383700	0.172100	2.229518	5.914700
28	0.000000	1.098900	0.297200	1.016871	1.008400	0.454400	0.165100	2.752271	9.826900
29	0.000000	1.098900	0.198200	0.606529	0.778800	0.178800	0.182400	0.980263	19.19580
30	0.000000	1.098900	-0.501100	1.407782	1.186500	0.052700	0.200100	0.263368	3.862300
31	0.000000	1.098900	-0.645900	0.951990	0.975700	0.462800	0.163800	2.825397	12.99620
32	0.000000	1.098900	-0.578600	1.189627	1.090700	0.516300	0.161000	3.206832	5.596800
33	0.000000	1.098900	-0.285700	1.656112	1.286900	0.103800	0.186500	0.556568	7.181200
34	0.000000	1.098900	0.406000	1.605796	1.267200	0.401400	0.168400	2.383611	8.027000
35	0.000000	1.098900	-0.120600	1.142333	1.068800	0.112700	0.183500	0.614169	10.67790
36	0.000000	1.098900	0.324100	0.719443	0.848200	0.483000	0.155600	3.104113	9.686900
37	0.000000	1.098900	-0.032200	0.717917	0.847300	0.347100	0.171200	2.027453	12.07360
38	0.000000	1.098900	-0.086500	1.190499	1.091100	-0.089500	0.189500	-0.472295	14.71220
39	0.000000	1.098900	-0.212600	0.962753	0.981200	0.385500	0.170900	2.255705	15.73580
40	0.000000	1.098900	0.063900	1.047347	1.023400	-0.202900	0.182000	-1.114835	7.876900
41	0.000000	1.098900	-0.121900	0.769655	0.877300	0.213200	0.181300	1.175951	9.082700
42	0.000000	1.098900	0.155500	1.082224	1.040300	0.365600	0.174400	2.096330	12.22620
43	0.000000	1.098900	0.045700	1.327334	1.152100	0.370800	0.172700	2.147076	9.802100
44	0.000000	1.098900	0.083900	1.274189	1.128800	0.415800	0.167900	2.476474	10.12730
45	0.000000	1.098900	-0.029900	1.025966	1.012900	0.306100	0.176500	1.734278	11.29660
46	0.000000	1.098900	-0.174400	0.727950	0.853200	-0.165100	0.183500	-0.899728	9.503200
47	0.000000	1.098900	0.144500	0.994208	0.997100	0.417600	0.164500	2.538602	5.715800
48	0.000000	1.098900	0.008900	1.210880	1.100400	0.118000	0.184700	0.638874	20.12330

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
49	0.000000	1.098900	0.024900	1.042033	1.020800	0.068200	0.174100	0.391729	13.29180
50	0.000000	1.098900	0.197800	1.099981	1.048800	0.250500	0.178100	1.406513	20.15200
51	0.000000	1.098900	-0.204900	1.665648	1.290600	0.346600	0.173600	1.996544	11.47160
52	0.000000	1.098900	-0.364700	0.712674	0.844200	0.178800	0.180700	0.989485	19.23170
53	0.000000	1.098900	0.107500	0.893214	0.945100	0.267100	0.178900	1.493013	7.340300
54	0.000000	1.098900	-0.066100	1.667198	1.291200	0.462300	0.172300	2.683111	7.293200
55	0.000000	1.098900	0.096900	1.159498	1.076800	0.218100	0.179400	1.215719	6.550600
56	0.000000	1.098900	0.062000	1.023537	1.011700	0.263300	0.185200	1.421706	7.525500
57	0.000000	1.098900	-0.161300	0.884352	0.940400	0.421800	0.168300	2.506239	10.69550
58	0.000000	1.098900	-0.116500	0.922176	0.960300	-0.201500	0.183000	-1.101093	8.028000
59	0.000000	1.098900	-0.494500	0.562650	0.750100	0.266800	0.172600	1.545771	13.31610
60	0.000000	1.098900	0.097000	0.618582	0.786500	0.434500	0.167200	2.598684	10.23630
61	0.000000	1.098900	-0.239900	0.725904	0.852000	0.127300	0.184200	0.691097	4.527700
62	0.000000	1.098900	0.026000	0.864156	0.929600	0.334600	0.177600	1.884009	4.368100
63	0.000000	1.098900	-0.363100	0.594595	0.771100	0.040600	0.201100	0.201890	17.78010
64	0.000000	1.098900	-0.145900	1.349779	1.161800	0.260600	0.181300	1.437397	12.13360
65	0.000000	1.098900	-0.066100	1.162947	1.078400	0.406300	0.178000	2.282584	4.895800
66	0.000000	1.098900	-0.017600	1.220362	1.104700	0.436900	0.170900	2.556466	17.19740
67	0.000000	1.098900	0.126000	1.044280	1.021900	0.213500	0.098700	2.163121	16.79080
68	0.000000	1.098900	-0.435600	1.007213	1.003600	0.122700	0.184300	0.665762	9.443100
69	0.000000	1.098900	-0.367100	0.907256	0.952500	0.186400	0.186900	0.997325	9.540500
70	0.000000	1.098900	-0.300100	0.583085	0.763600	0.150100	0.180100	0.833426	9.776200
71	0.000000	1.098900	0.172000	1.378041	1.173900	0.335600	0.173400	1.935409	8.900900
72	0.000000	1.098900	0.048800	1.353965	1.163600	0.239000	0.180300	1.325568	5.099800
73	0.000000	1.098900	0.037200	0.853591	0.923900	0.114600	0.195900	0.584992	5.750800
74	0.000000	1.098900	0.327700	0.872917	0.934300	0.127500	0.184100	0.692558	5.907800
75	0.000000	1.098900	-0.175200	0.916232	0.957200	0.187000	0.185100	1.010265	14.05100
76	0.000000	1.098900	0.010300	1.073296	1.036000	0.445100	0.161100	2.762880	5.857100
77	0.000000	1.098900	-0.004800	1.262702	1.123700	0.184400	0.191300	0.963931	8.268100
78	0.000000	1.098900	0.288000	0.842908	0.918100	0.181600	0.180800	1.004425	9.816200
79	0.000000	1.098900	0.097000	1.729225	1.315000	0.273200	0.186000	1.468817	11.41180
80	0.000000	1.098900	0.158000	1.204726	1.097600	0.397200	0.174500	2.276218	11.20160
81	0.000000	1.098900	-0.153500	0.904972	0.951300	0.351700	0.173700	2.024755	3.738800
82	0.000000	1.098900	0.042100	1.008016	1.004000	0.419100	0.172600	2.428158	15.96380
83	0.000000	1.098900	0.166500	1.522509	1.233900	0.353600	0.180400	1.960089	6.397700
84	0.000000	1.098900	0.249400	0.842173	0.917700	0.191700	0.182900	1.048114	8.239400
85	0.000000	1.098900	-0.122200	1.037954	1.018800	0.419400	0.166700	2.515897	8.511700
86	0.000000	1.098900	-0.123200	1.025764	1.012800	0.416400	0.160100	2.600874	8.520700
87	0.000000	1.098900	-0.069900	0.791922	0.889900	0.242500	0.177100	1.369283	10.98660
88	0.000000	1.098900	0.168100	1.492307	1.221600	0.367800	0.174400	2.108945	8.374000
89	0.000000	1.098900	-0.031500	1.173756	1.083400	0.131800	0.185800	0.709365	5.247000
90	0.000000	1.098900	-0.156800	0.987837	0.993900	0.368900	0.184200	2.002714	11.72530
91	0.000000	1.098900	0.141400	0.645773	0.803600	0.246100	0.186600	1.318864	10.88110
92	0.000000	1.098900	-0.144900	0.861184	0.928000	-0.260800	0.179600	-1.452116	12.39400
93	0.000000	1.098900	-0.410900	1.188536	1.090200	0.183800	0.178200	1.031425	9.121300
94	0.000000	1.098900	0.155100	1.350941	1.162300	0.363900	0.173100	2.102253	4.868300
95	0.000000	1.098900	-0.095700	0.996004	0.998000	0.363700	0.093900	3.873269	22.76240
96	0.000000	1.098900	0.020100	1.442641	1.201100	0.485700	0.151500	3.205941	8.650100

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
97	0.000000	1.098900	0.659800	1.156055	1.075200	0.407300	0.167000	2.438922	14.36270
98	0.000000	1.098900	0.303400	1.281198	1.131900	0.358500	0.169600	2.113797	10.85750
99	0.000000	1.098900	-0.183900	1.314462	1.146500	0.300400	0.172100	1.745497	7.294000
100	0.000000	1.098900	0.064300	1.054113	1.026700	0.121300	0.191300	0.634083	11.73130
101	0.000000	1.098900	-0.143000	1.257987	1.121600	0.335800	0.171000	1.963743	8.599700
102	0.000000	1.098900	0.530000	1.536856	1.239700	0.581100	0.147500	3.939661	8.534400
103	0.000000	1.098900	-0.044100	0.970422	0.985100	0.140900	0.184600	0.763272	11.98460
104	0.000000	1.098900	0.151700	0.898514	0.947900	0.256300	0.163500	1.567584	6.765200
105	0.000000	1.098900	0.028800	0.996403	0.998200	0.210500	0.172500	1.220290	9.171500
106	0.000000	1.098900	-0.445300	1.140838	1.068100	0.434000	0.167800	2.586412	15.19930
107	0.000000	1.098900	0.430800	1.139983	1.067700	0.154000	0.191600	0.803758	18.10780
108	0.000000	1.098900	0.490300	1.149827	1.072300	0.374300	0.174600	2.143757	6.097000
109	0.000000	1.098900	-0.121300	0.947313	0.973300	0.258400	0.184000	1.404348	15.69950
110	0.000000	1.098900	-0.074400	1.037138	1.018400	0.485100	0.161000	3.013043	19.70020
111	0.000000	1.098900	-0.105300	0.821742	0.906500	0.138800	0.185600	0.747845	17.07730
112	0.000000	1.098900	0.215800	0.847688	0.920700	0.360000	0.186500	1.930295	5.753500
113	0.000000	1.098900	0.018100	1.254176	1.119900	0.008300	0.191700	0.043297	14.26490
114	0.000000	1.098900	-0.126600	1.244563	1.115600	0.446300	0.166500	2.680481	8.552900
115	0.000000	1.098900	0.046400	0.429418	0.655300	-0.070100	0.180200	-0.389012	14.70750
116	0.000000	1.098900	-0.040600	0.609961	0.781000	0.132600	0.183800	0.721436	9.172600
117	0.000000	1.098900	-0.155700	0.733421	0.856400	0.190100	0.174000	1.092529	10.29340
118	0.000000	1.098900	0.052500	0.702579	0.838200	0.401700	0.160400	2.504364	7.212500
119	0.000000	1.098900	0.034000	0.944007	0.971600	0.086400	0.184900	0.467280	11.17500
120	0.000000	1.098900	0.044200	0.716054	0.846200	0.139400	0.182900	0.762165	4.918000
121	0.000000	1.098900	-0.003400	1.059047	1.029100	0.188900	0.184300	1.024959	11.83470
122	0.000000	1.098900	-0.232800	1.159498	1.076800	0.361200	0.172400	2.095128	7.679300
123	0.000000	1.098900	0.118300	0.999800	0.999900	0.405200	0.164800	2.458738	9.646300
124	0.000000	1.098900	-0.349000	0.622994	0.789300	0.008100	0.186100	0.043525	10.58980
125	0.000000	1.098900	-0.351100	1.520782	1.233200	0.309700	0.166300	1.862297	10.70330
126	0.000000	1.098900	0.111900	1.047552	1.023500	0.276500	0.177800	1.555118	10.80690
127	0.000000	1.098900	0.404600	1.306449	1.143000	0.493500	0.166000	2.972892	9.231900
128	0.000000	1.098900	0.027300	0.719443	0.848200	-0.055200	0.190100	-0.290374	8.518200
129	0.000000	1.098900	0.305500	1.367730	1.169500	0.258100	0.178300	1.447560	8.714300
130	0.000000	1.098900	-0.036400	1.455401	1.206400	0.219700	0.182200	1.205818	13.42980
131	0.000000	1.098900	0.116600	1.319282	1.148600	0.449300	0.162500	2.764923	11.58220
132	0.000000	1.098900	0.321500	1.251266	1.118600	0.354400	0.174100	2.035612	5.681700
133	0.000000	1.098900	0.081200	1.011433	1.005700	0.127400	0.183700	0.693522	9.546200
134	0.000000	1.098900	0.167000	1.063786	1.031400	0.443700	0.158500	2.799369	18.92080
135	0.000000	1.098900	-0.450400	1.257762	1.121500	0.583100	0.143600	4.060585	5.655100
136	0.000000	1.098900	0.311600	1.102710	1.050100	0.344700	0.162900	2.116022	8.520900
137	0.000000	1.098900	-0.301000	0.927562	0.963100	0.363500	0.169800	2.140754	6.111100
138	0.000000	1.098900	-0.393800	0.594133	0.770800	0.347900	0.174600	1.992554	8.792100
139	0.000000	1.098900	0.054600	0.738225	0.859200	0.201100	0.182200	1.103732	11.96710
140	0.000000	1.098900	0.317800	1.394997	1.181100	0.469100	0.151200	3.102513	11.60950
141	0.000000	1.098900	0.242500	0.854700	0.924500	0.397400	0.169900	2.339023	9.781500
142	0.000000	1.098900	0.208600	1.024751	1.012300	0.066600	0.184300	0.361367	12.26020
143	0.000000	1.098900	0.199900	0.809820	0.899900	0.058200	0.191200	0.304393	14.15190
144	0.000000	1.098900	-0.165900	0.960988	0.980300	0.441700	0.165900	2.662447	8.250900

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
145	0.000000	1.098900	-0.178400	1.007815	1.003900	0.461500	0.163900	2.815741	8.522100
146	0.000000	1.098900	0.054600	0.766150	0.875300	-0.122200	0.166100	-0.735701	9.168300
147	0.000000	1.098900	-0.536300	1.089936	1.044000	0.476200	0.159200	2.991206	11.96300
148	0.000000	1.098900	-0.173400	1.526460	1.235500	0.343000	0.184300	1.861096	5.281400
149	0.000000	1.098900	-0.034800	1.073296	1.036000	0.609400	0.149300	4.081715	6.521200
150	0.000000	1.098900	-0.220500	1.470156	1.212500	0.327100	0.173700	1.883132	8.174000
151	0.000000	1.098900	-0.150600	1.801770	1.342300	0.021900	0.185100	0.118314	6.567200
152	0.000000	1.098900	-0.345800	1.427308	1.194700	0.461000	0.174400	2.643349	10.63090
153	0.000000	1.098900	-0.171100	1.148541	1.071700	0.132700	0.186900	0.710005	12.68090
154	0.000000	1.098900	-0.092500	0.944978	0.972100	0.047100	0.185400	0.254045	10.96540
155	0.000000	1.098900	0.113900	1.081184	1.039800	0.350100	0.180400	1.940687	8.198600
156	0.000000	1.098900	-0.360400	0.504668	0.710400	0.305600	0.175700	1.739328	8.085800
157	0.000000	1.098900	0.083300	0.783225	0.885000	0.194600	0.182200	1.068057	8.359500
158	0.000000	1.098900	0.124400	0.737366	0.858700	0.195200	0.177300	1.100959	8.437900
159	0.000000	1.098900	-0.466200	1.524978	1.234900	0.589800	0.158400	3.723485	4.556300
160	0.000000	1.098900	-0.221200	0.897377	0.947300	0.298300	0.179300	1.663692	3.841500
161	0.000000	1.098900	-0.228400	0.955702	0.977600	0.370100	0.181300	2.041368	8.596000
162	0.000000	1.098900	-0.006700	1.055962	1.027600	0.358600	0.163200	2.197304	7.611000
163	0.000000	1.098900	0.006500	0.732394	0.855800	0.160500	0.180400	0.889690	7.135500
164	0.000000	1.098900	0.053100	1.411106	1.187900	0.282900	0.173700	1.628670	8.700500
165	0.000000	1.098900	0.500000	1.098514	1.048100	0.627700	0.145200	4.323003	19.03500
166	0.000000	1.098900	-0.192600	1.218816	1.104000	0.161800	0.183500	0.881744	5.671200
167	0.000000	1.098900	-0.197100	1.020302	1.010100	0.174300	0.183000	0.952459	10.67770
168	0.000000	1.098900	-0.316100	0.706776	0.840700	0.336500	0.184900	1.819903	7.738400
169	0.000000	1.098900	0.298600	1.205384	1.097900	0.160100	0.181800	0.880638	6.523600
170	0.000000	1.098900	0.044500	0.827190	0.909500	0.259900	0.175800	1.478385	9.311600
171	0.000000	1.098900	-0.077700	1.150042	1.072400	0.587300	0.150100	3.912725	8.896900
172	0.000000	1.098900	-0.194000	1.024751	1.012300	0.317400	0.189600	1.674051	4.022800
173	0.000000	1.098900	0.364600	1.075369	1.037000	0.142100	0.182000	0.780769	11.74040
174	0.000000	1.098900	-0.136000	1.007414	1.003700	0.179800	0.178800	1.005593	10.42300
175	0.000000	1.098900	-0.128900	1.103970	1.050700	0.363500	0.184900	1.965927	5.399100
176	0.000000	1.098900	0.072000	1.057812	1.028500	0.413300	0.168100	2.458656	10.99180
177	0.000000	1.098900	-0.064900	0.746669	0.864100	0.114000	0.187700	0.607352	5.683300
178	0.000000	1.098900	0.048500	1.235210	1.111400	-0.104400	0.185600	-0.562500	8.720600
179	0.000000	1.098900	0.154300	1.520536	1.233100	0.110800	0.193200	0.573499	23.78000
180	0.000000	1.098900	0.187600	0.753945	0.868300	0.303500	0.175200	1.732306	4.080900
181	0.000000	1.098900	0.409700	0.774576	0.880100	0.471200	0.167000	2.821557	9.541600
182	0.000000	1.098900	0.296500	1.105021	1.051200	0.309600	0.179400	1.725752	10.74510
183	0.000000	1.098900	0.328000	1.058841	1.029000	0.533100	0.139600	3.818768	5.588600
184	0.000000	1.098900	0.369000	1.396415	1.181700	0.475400	0.165000	2.881212	6.269200
185	0.000000	1.098900	0.466300	1.036528	1.018100	0.181500	0.194000	0.935567	8.881700
186	0.000000	1.098900	-0.249500	1.083681	1.041000	0.509600	0.160500	3.175078	14.98760
187	0.000000	1.098900	0.121200	0.920065	0.959200	0.177000	0.178900	0.989380	6.521500
188	0.000000	1.098900	0.042100	1.604276	1.266600	0.480600	0.166800	2.881295	5.685200
189	0.000000	1.098900	-0.170100	1.306678	1.143100	0.207900	0.182000	1.142308	14.96640
190	0.000000	1.098900	0.047300	1.041624	1.020600	0.325400	0.179100	1.816862	11.45460
191	0.000000	1.098900	0.137300	1.302794	1.141400	0.448400	0.167800	2.672229	4.455800
192	0.000000	1.098900	-0.174100	1.321580	1.149600	0.589700	0.161300	3.655921	5.223800

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
193	0.000000	1.098900	0.097600	1.163162	1.078500	0.084800	0.183300	0.462630	20.56040
194	0.000000	1.098900	0.251000	1.100191	1.048900	0.355700	0.166400	2.137620	8.499500
195	0.000000	1.098900	-0.397900	1.013042	1.006500	0.525100	0.160300	3.275733	10.45560
196	0.000000	1.098900	-0.294000	0.982279	0.991100	0.247600	0.185200	1.336933	6.427500
197	0.000000	1.098900	-0.022600	1.400672	1.183500	0.425100	0.166400	2.554688	14.68750
198	0.000000	1.098900	0.015300	0.857291	0.925900	0.167700	0.174000	0.963793	5.964400
199	0.000000	1.098900	0.260600	0.570780	0.755500	0.270600	0.174900	1.547170	6.081900
200	0.000000	1.098900	-0.203200	1.454919	1.206200	0.533000	0.157100	3.392743	8.639900
201	0.000000	1.098900	-0.075200	1.322730	1.150100	0.454300	0.168900	2.689757	9.649100
202	0.000000	1.098900	-0.349300	1.195961	1.093600	0.368500	0.183200	2.011463	10.14580
203	0.000000	1.098900	-0.174300	0.750649	0.866400	0.222900	0.185300	1.202914	15.42000
204	0.000000	1.098900	-0.146900	1.045915	1.022700	0.306100	0.164300	1.863055	10.50880
205	0.000000	1.098900	-0.154700	0.989627	0.994800	0.234900	0.180600	1.300664	7.533300
206	0.000000	1.098900	0.110800	1.089101	1.043600	0.492000	0.171400	2.870479	10.26910
207	0.000000	1.098900	0.318100	0.906114	0.951900	0.110000	0.167100	0.658288	2.842200
208	0.000000	1.098900	0.346200	1.084098	1.041200	0.437700	0.166600	2.627251	6.978500
209	0.000000	1.098900	0.188200	1.418481	1.191000	0.546900	0.156400	3.496803	15.88180
210	0.000000	1.098900	-0.272800	1.298005	1.139300	0.409500	0.156300	2.619962	9.537500
211	0.000000	1.098900	-0.102500	1.403751	1.184800	0.406800	0.167900	2.422871	7.870200
212	0.000000	1.098900	-0.207700	0.752556	0.867500	0.387800	0.172300	2.250726	13.24560
213	0.000000	1.098900	0.081100	1.012438	1.006200	0.236200	0.179700	1.314413	7.213800
214	0.000000	1.098900	0.058200	0.710312	0.842800	0.187200	0.188000	0.995745	7.537900
215	0.000000	1.098900	-0.212800	1.138916	1.067200	-0.089000	0.187000	-0.475936	8.861800
216	0.000000	1.098900	0.215000	0.500132	0.707200	0.203000	0.163000	1.245399	6.065800
217	0.000000	1.098900	0.127500	0.825372	0.908500	0.426100	0.177800	2.396513	5.226800
218	0.000000	1.098900	-0.146500	1.956082	1.398600	0.504300	0.166000	3.037952	9.175500
219	0.000000	1.098900	-0.486200	0.712674	0.844200	0.578400	0.149200	3.876676	5.781900
220	0.000000	1.098900	0.033500	1.550772	1.245300	0.413600	0.170200	2.430082	7.387200
221	0.000000	1.098900	-0.025400	0.656262	0.810100	0.158700	0.185400	0.855987	9.208000
222	0.000000	1.098900	-0.178900	1.452025	1.205000	0.346600	0.170200	2.036428	5.950000
223	0.000000	1.098900	0.263100	0.593516	0.770400	0.045200	0.193200	0.233954	8.909000
224	0.000000	1.098900	0.252400	1.916286	1.384300	0.329100	0.180000	1.828333	8.695800
225	0.000000	1.098900	-0.360200	0.696891	0.834800	0.261900	0.175500	1.492308	9.728600
226	0.000000	1.098900	0.631400	0.714532	0.845300	0.501400	0.167300	2.997011	4.916700
227	0.000000	1.098900	0.177800	1.535369	1.239100	0.359200	0.188700	1.903551	8.850900
228	0.000000	1.098900	0.788200	0.583390	0.763800	0.624300	0.136600	4.570278	5.630400
229	0.000000	1.098900	0.002700	0.606841	0.779000	0.182700	0.182500	1.001096	7.776100
230	0.000000	1.098900	0.167800	0.770182	0.877600	0.129200	0.196500	0.657506	7.275200
231	0.000000	1.098900	0.066100	1.319282	1.148600	0.150700	0.203400	0.740905	6.111600
232	0.000000	1.098900	0.162000	1.410394	1.187600	0.186300	0.191900	0.970818	10.85170
233	0.000000	1.098900	-0.202400	0.772289	0.878800	0.229300	0.185600	1.235453	4.692500
234	0.000000	1.098900	0.417400	1.294589	1.137800	0.440500	0.173400	2.540369	6.913200
235	0.000000	1.098900	-0.013600	0.756726	0.869900	0.339500	0.171100	1.984220	12.60870
236	0.000000	1.098900	-0.043700	1.915733	1.384100	0.375800	0.171800	2.187427	17.96530
237	0.000000	1.098900	0.149500	0.892269	0.944600	0.380700	0.180300	2.111481	4.620700
238	0.000000	1.098900	0.404300	1.062755	1.030900	0.372800	0.173700	2.146229	3.582800
239	0.000000	1.098900	0.005700	0.812702	0.901500	0.385600	0.166600	2.314526	10.71340
240	0.000000	1.098900	-0.040000	0.847873	0.920800	0.101300	0.184400	0.549349	3.139900

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
241	0.000000	1.098900	-0.291400	0.882285	0.939300	0.351200	0.174400	2.013762	9.263400
242	0.000000	1.098900	-0.213300	0.976539	0.988200	0.269400	0.095200	2.829832	9.225600
243	0.000000	1.098900	0.241700	0.958049	0.978800	0.043500	0.185700	0.234249	7.447000
244	0.000000	1.098900	0.045700	0.925059	0.961800	0.352900	0.149100	2.366868	7.678800
245	0.000000	1.098900	-0.044800	1.133160	1.064500	0.237500	0.186000	1.276882	4.835300
246	0.000000	1.098900	0.214000	1.712696	1.308700	0.585100	0.150700	3.882548	11.78330
247	0.000000	1.098900	-0.237000	1.172023	1.082600	0.273900	0.177700	1.541362	8.289200
248	0.000000	1.098900	-0.283200	1.174189	1.083600	0.426800	0.166300	2.566446	9.152400
249	0.000000	1.098900	0.194900	0.734106	0.856800	0.251000	0.176900	1.418881	4.477100
250	0.000000	1.098900	0.475700	1.268101	1.126100	0.352400	0.175000	2.013714	7.436300
251	0.000000	1.098900	0.005400	0.950040	0.974700	0.038300	0.194400	0.197017	7.073300
252	0.000000	1.098900	0.196000	0.801920	0.895500	0.267900	0.175000	1.530857	15.32160
253	0.000000	1.098900	-0.048300	0.725734	0.851900	0.182900	0.183300	0.997818	6.421500
254	0.000000	1.098900	-0.174400	1.044893	1.022200	0.372900	0.173800	2.145570	9.984700
255	0.000000	1.098900	-0.174500	1.172023	1.082600	0.110400	0.194200	0.568486	11.44170
256	0.000000	1.098900	-0.088300	0.950820	0.975100	0.275800	0.169000	1.631953	9.295000
257	0.000000	1.098900	0.119700	0.951015	0.975200	0.222100	0.190500	1.165879	13.24220
258	0.000000	1.098900	0.099300	0.575929	0.758900	0.251400	0.178000	1.412359	4.191900
259	0.000000	1.098900	0.274900	1.670039	1.292300	0.449500	0.161300	2.786733	4.049400
260	0.000000	1.098900	-1902.000	0.710649	0.843000	0.339400	0.175200	1.937215	7.685300
261	0.000000	1.098900	0.006500	1.407071	1.186200	0.329900	0.169700	1.944019	22.45070
262	0.000000	1.098900	-0.358100	1.223015	1.105900	0.388400	0.171300	2.267367	18.28770
263	0.000000	1.098900	0.065500	1.255744	1.120600	0.348700	0.175000	1.992571	9.623800
264	0.000000	1.098900	-0.316000	0.497589	0.705400	0.194500	0.151200	1.286376	7.567000
265	0.000000	1.098900	-0.237700	0.987241	0.993600	0.372700	0.164300	2.268412	7.152300
266	0.000000	1.098900	-0.161400	0.845113	0.919300	0.204000	0.176400	1.156463	7.461900
267	0.000000	1.098900	0.227800	0.925829	0.962200	0.320600	0.176800	1.813348	5.690900
268	0.000000	1.098900	-0.015600	1.178745	1.085700	0.164600	0.182000	0.904396	13.03840
269	0.000000	1.098900	-0.034400	0.906114	0.951900	0.142100	0.185800	0.764801	10.59940
270	0.000000	1.098900	0.174000	0.897946	0.947600	0.362900	0.093600	3.877137	12.12270
271	0.000000	1.098900	0.077300	0.973182	0.986500	0.069600	0.185500	0.375202	4.429300
272	0.000000	1.098900	-0.100700	1.687661	1.299100	0.458300	0.160900	2.848353	3.955600
273	0.000000	1.098900	0.306000	1.301881	1.141000	0.088300	0.187100	0.471940	4.916500
274	0.000000	1.098900	-0.226600	0.823193	0.907300	0.234900	0.182500	1.287123	5.493100
275	0.000000	1.098900	-0.028400	0.958441	0.979000	0.128900	0.180600	0.713732	9.849700
276	0.000000	1.098900	0.179000	0.806763	0.898200	0.202300	0.185900	1.088219	3.016600
277	0.000000	1.098900	-0.127700	0.744942	0.863100	0.342100	0.173900	1.967223	20.15190
278	0.000000	1.098900	-0.308400	0.908209	0.953000	0.200600	0.184000	1.090217	11.80630
279	0.000000	1.098900	-0.212200	0.775809	0.880800	0.205400	0.187400	1.096051	4.800200
280	0.000000	1.098900	-0.114800	1.171590	1.082400	0.235300	0.182100	1.292147	6.218100
281	0.000000	1.098900	0.018900	0.741321	0.861000	0.039600	0.172300	0.229832	9.631800
282	0.000000	1.098900	-0.102500	1.197493	1.094300	0.055700	0.192000	0.290104	7.922700
283	0.000000	1.098900	0.057100	1.279840	1.131300	0.270700	0.186900	1.448368	11.39840
284	0.000000	1.098900	0.454600	0.774576	0.880100	0.289700	0.173000	1.674567	5.860400
285	0.000000	1.098900	0.007800	1.204287	1.097400	0.162900	0.187700	0.867874	4.851400
286	0.000000	1.098900	0.010900	0.628849	0.793000	0.335900	0.178400	1.882848	5.566000
287	0.000000	1.098900	-0.399900	1.006410	1.003200	0.459600	0.165500	2.777039	14.37490
288	0.000000	1.098900	0.390700	1.692081	1.300800	0.491000	0.158800	3.091939	21.34280

SUMMARY STATISTICS FOR AN ARMA(1,0) PROCESS

PROCESS I (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	PHI	STDERR	TSTAT	QSTAT
289	0.000000	1.098900	0.437400	1.088266	1.043200	0.439500	0.169100	2.599054	17.45750
290	0.000000	1.098900	-0.429600	0.874225	0.935000	0.743600	0.117700	6.317757	7.950100
291	0.000000	1.098900	-0.188500	1.383211	1.176100	0.399800	0.171200	2.335280	6.093300
292	0.000000	1.098900	-0.249000	0.857661	0.926100	0.164100	0.184700	0.888468	8.027100
293	0.000000	1.098900	0.570100	1.492062	1.221500	0.462800	0.163000	2.839264	6.300200
294	0.000000	1.098900	-0.067100	1.026574	1.013200	0.086200	0.184900	0.466198	9.950600
295	0.000000	1.098900	0.228000	1.492795	1.221800	0.645500	0.162700	3.967425	10.25560
296	0.000000	1.098900	0.035300	1.160575	1.077300	0.298900	0.095700	3.123302	8.778400
297	0.000000	1.098900	-0.251900	0.970422	0.985100	0.108000	0.189600	0.569620	12.66730
298	0.000000	1.098900	-0.218100	0.971802	0.985800	0.157200	0.190800	0.823899	8.016600
299	0.000000	1.098900	-0.700800	1.067709	1.033300	0.525000	0.156600	3.352490	10.80170
300	0.000000	1.098900	0.025500	1.250148	1.118100	0.322500	0.174200	1.851320	10.07470

SAMPLE ACF AND PACF FOR ARMA(0,1) PROCESSES

SMPL 111 - 140
30 Observations
IDENT MA1113

```
==========================================================================
     Autocorrelations  Partial Autocorrelations          ac        pac
==========================================================================
|           *****|      |       *****|         |  1  -0.4503   -0.4503
|               *|      |        ****|         |  2  -0.1163   -0.4002
|                |***   |            |*        |  3   0.2905    0.0552
|               *|      |            |         |  4  -0.1423    0.0252
|                |      |            |         |  5  -0.0296    0.0099
|                |      |           *|         |  6   0.0256   -0.0849
|             ***|      |       *****|         |  7  -0.2935   -0.4838
|                |***   |           *|         |  8   0.3291   -0.0871
|               *|      |            |         |  9  -0.1117   -0.0306
|               *|      |            |*        | 10  -0.1164    0.0575
|                |***   |            |**       | 11   0.2532    0.1630
|               *|      |            |         | 12  -0.0834    0.0401
|                |      |            |         | 13  -0.0160   -0.0102
|                |***   |            |***      | 14   0.2850    0.3166
|             ***|      |            |*        | 15  -0.3489    0.1016
==========================================================================
 S.E. of Correlations  .1825742        Q-Stat. (15 lags)  24.51621
==========================================================================
```

SMPL 111 - 140
30 Observations
IDENT MA192

```
==========================================================================
     Autocorrelations  Partial Autocorrelations          ac        pac
==========================================================================
|           *****|      |       *****|         |  1  -0.5154   -0.5154
|               *|      |      ******|         |  2  -0.1430   -0.5565
|                |***   |          **|         |  3   0.2867   -0.2265
|              **|      |         ***|         |  4  -0.1791   -0.2811
|                |*     |            |         |  5   0.1039   -0.0389
|                |      |            |         |  6  -0.0244   -0.0189
|              **|      |         ***|         |  7  -0.1702   -0.2501
|                |***   |            |         |  8   0.3104    0.0321
|              **|      |           *|         |  9  -0.2113   -0.0746
|               *|      |          **|         | 10  -0.0858   -0.2091
|                |**    |          **|         | 11   0.2179   -0.2035
|                |      |            |*        | 12  -0.0099    0.1004
|              **|      |           *|         | 13  -0.2042   -0.1212
|                |**    |           *|         | 14   0.1597   -0.0695
|                |      |           *|         | 15  -0.0337   -0.0899
==========================================================================
 S.E. of Correlations  .1825742        Q-Stat. (15 lags)  21.14945
==========================================================================
```

SAMPLE ACF AND PACF FOR NON-RECOGNIZABLE ARMA(0,1) PROCESSES

```
SMPL    111  -   140
30 Observations
IDENT MA144
=================================================================
     Autocorrelations  Partial Autocorrelations        ac      pac
=================================================================
|           *|          |           *|          |  1 -0.0662 -0.0662
|          **|          |          **|          |  2 -0.2047 -0.2100
|            |          |           *|          |  3 -0.0466 -0.0808
|            |          |           *|          |  4 -0.0371 -0.0965
|            |          |           *|          |  5 -0.0197 -0.0635
|           *|          |          **|          |  6 -0.1136 -0.1662
|            |****      |            |***       |  7  0.3563  0.3289
|            |**        |            |**        |  8  0.1672  0.1920
|          **|          |           *|          |  9 -0.2191 -0.0688
|            |          |            |          | 10 -0.0450  0.0328
|            |*         |            |**        | 11  0.1447  0.1949
|            |          |            |          | 12 -0.0454 -0.0306
|          **|          |           *|          | 13 -0.1757 -0.1133
|            |*         |            |          | 14  0.0815 -0.0233
|            |          |          **|          | 15  0.0412 -0.1709
=================================================================
 S.E. of Correlations  .1825742       Q-Stat. (15 lags)  9.907863
=================================================================
```

```
SMPL    111  -   140
30 Observations
IDENT MA147
=================================================================
     Autocorrelations  Partial Autocorrelations        ac      pac
=================================================================
|           *|          |           *|          |  1 -0.0788 -0.0788
|            |          |            |          |  2 -0.0021 -0.0084
|           *|          |           *|          |  3 -0.0643 -0.0655
|            |          |            |          |  4 -0.0173 -0.0279
|          **|          |         ***|          |  5 -0.2464 -0.2539
|            |*         |            |*         |  6  0.0971  0.0540
|            |*         |            |*         |  7  0.0979  0.1060
|            |          |            |          |  8 -0.0045 -0.0217
|           *|          |           *|          |  9 -0.0881 -0.1027
|            |*         |            |*         | 10  0.1099  0.0585
|           *|          |           *|          | 11 -0.1127 -0.0614
|           *|          |           *|          | 12 -0.1103 -0.1037
|           *|          |           *|          | 13 -0.0826 -0.1324
|            |          |            |          | 14  0.0379 -0.0371
|            |*         |            |*         | 15  0.0792  0.1304
=================================================================
 S.E. of Correlations  .1825742       Q-Stat. (15 lags)  4.489364
=================================================================
```

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
1	0.000000	1.122500	-0.173800	0.961380	0.980500	-0.063000	0.186700	-0.337440	10.56910	0.020500
2	0.000000	1.122500	-0.027200	1.035510	1.017600	-0.702200	0.189000	-3.715344	10.51590	-0.027700
3	0.000000	1.122500	-0.023900	0.608400	0.780000	-0.332500	0.186600	-1.781886	7.563300	0.002600
4	0.000000	1.122500	0.034200	1.420149	1.191700	-0.723200	0.186700	-3.873594	11.67360	0.128400
5	0.000000	1.122500	-0.067400	0.843642	0.918500	-0.378400	0.186700	-2.026781	5.640800	-0.052100
6	0.000000	1.122500	0.174100	1.094325	1.046100	-0.217400	0.187000	-1.162567	10.91190	-0.095600
7	0.000000	1.122500	-0.135900	0.928140	0.963400	-0.308400	0.186600	-1.652733	6.885600	-0.028900
8	0.000000	1.122500	-0.035900	1.231656	1.109800	-0.218900	0.188100	-1.163743	10.60760	-0.034700
9	0.000000	1.122500	-0.031000	0.855995	0.925200	-0.576500	0.187200	-3.079594	11.12890	-0.144700
10	0.000000	1.122500	-0.112700	1.167696	1.080600	-0.389600	0.185700	-2.098008	3.028100	0.002100
11	0.000000	1.122500	-0.042800	1.101660	1.049600	-0.477300	0.190600	-2.504197	8.221600	0.116400
12	0.000000	1.122500	0.015400	1.077444	1.038000	-0.300500	0.191500	-1.569191	7.589200	0.084500
13	0.000000	1.122500	0.172000	1.798013	1.340900	-0.317000	0.188000	-1.686170	8.305400	0.120500
14	0.000000	1.122500	0.166900	1.568255	1.252300	-0.570300	0.199400	-2.860080	7.966300	0.102000
15	0.000000	1.122500	-0.093100	0.712505	0.844100	0.106400	0.187300	0.568073	20.79680	-0.059500
16	0.000000	1.122500	0.033400	1.212862	1.101300	-0.560500	0.187400	-2.990929	17.01350	0.058900
17	0.000000	1.122500	0.083400	1.402566	1.184300	-0.577400	0.189100	-3.053411	17.67780	0.014000
18	0.000000	1.122500	0.021700	1.494995	1.222700	-0.215800	0.189800	-1.136986	8.420700	0.123300
19	0.000000	1.122500	0.263300	1.426591	1.194400	-0.124400	0.185700	-0.669898	11.01900	0.014700
20	0.000000	1.122500	-0.013400	1.025764	1.012800	-0.635400	0.184600	-3.442037	9.428200	-0.009600
21	0.000000	1.122500	0.153100	1.090771	1.044400	-0.514600	0.188000	-2.737234	15.18680	-0.024190
22	0.000000	1.122500	0.006400	1.765709	1.328800	-0.587800	0.203000	-2.895567	7.906500	0.019000
23	0.000000	1.122500	0.051300	1.538840	1.240500	-0.599300	0.185800	-3.225511	11.75390	-0.013000
24	0.000000	1.122500	-0.073600	0.768778	0.876800	-0.579000	0.190900	-3.033002	3.078900	-0.072400
25	0.000000	1.122500	-0.090400	1.061580	1.030330	-0.416900	0.185900	-2.242604	7.284300	-0.001000
26	0.000000	1.122500	-0.088800	1.210000	1.100000	-0.084000	0.193300	-0.434558	5.211000	0.059000
27	0.000000	1.122500	0.134400	1.416100	1.190000	-0.171200	0.185600	-0.922414	5.566200	0.038200
28	0.000000	1.122500	0.139300	0.918531	0.958400	-0.192600	0.188800	-1.020127	9.892900	0.160600
29	0.000000	1.122500	0.077600	0.783402	0.885100	-0.521500	0.185600	-2.809806	17.96630	-0.014000
30	0.000000	1.122500	-0.265700	2.133937	1.460800	-0.699400	0.197500	-3.541266	4.749100	0.734600
31	0.000000	1.122500	-0.280800	1.072674	1.035700	-0.235500	0.186300	-1.264090	12.36290	-0.146700
32	0.000000	1.122500	-0.277500	1.046324	1.022900	-0.073700	0.190100	-0.387691	5.160300	0.129000
33	0.000000	1.122500	-0.097600	2.211466	1.487100	-0.613900	0.187100	-3.281133	6.904700	0.008600
34	0.000000	1.122500	0.164000	1.579295	1.256700	-0.257000	0.185500	-1.385445	7.893700	0.008900
35	0.000000	1.122500	-0.012700	1.498911	1.224300	-0.534300	0.188900	-2.828481	11.85990	0.021500
36	0.000000	1.122500	0.152200	0.608712	0.780200	-0.141500	0.193600	-0.730888	9.981300	-0.039400
37	0.000000	1.122500	-0.051100	0.721990	0.849700	-0.328500	0.187700	-1.750133	11.60720	-0.079800
38	0.000000	1.122500	-0.067900	1.761725	1.327300	-0.965200	0.186000	-5.189247	9.883500	0.166900
39	0.000000	1.122500	-0.106300	0.973577	0.986700	-0.347100	0.185300	-1.873179	14.08260	0.006400
40	0.000000	1.122500	0.016900	1.738442	1.318500	-0.974900	0.184200	-5.292617	6.622300	0.042900
41	0.000000	1.122500	-0.076400	0.875534	0.935700	-0.420600	0.188100	-2.236045	9.062600	-0.037200
42	0.000000	1.122500	0.058400	1.098514	1.048100	-0.372900	0.186300	-2.001611	11.08710	-0.003700
43	0.000000	1.122500	0.020000	1.209340	1.099700	-0.279900	0.184900	-1.513791	9.580000	-0.011900
44	0.000000	1.122500	0.023300	1.028804	1.014300	-0.086800	0.186200	-0.466166	9.785800	-0.017200
45	0.000000	1.122500	-0.003300	1.095790	1.046800	-0.400700	0.185500	-2.160108	12.39450	0.001500
46	0.000000	1.122500	-0.075100	1.283916	1.133100	-0.757900	0.184700	-4.103411	10.78040	-0.017700
47	0.000000	1.122500	0.069800	0.839422	0.916200	-0.093800	0.193500	-0.484755	4.415200	0.013800
48	0.000000	1.122500	-0.013500	1.418243	1.190900	-0.530800	0.185800	-2.856835	18.83660	0.106800

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
49	0.000000	1.122500	-0.020200	1.372178	1.171400	-0.548300	0.183700	-2.984758	10.85450	0.000500
50	0.000000	1.122500	0.127900	1.140410	1.067900	-0.337700	0.190500	-1.772703	20.31860	-0.261600
51	0.000000	1.122500	-0.097000	1.581809	1.257700	-0.228300	0.187500	-1.217600	12.26470	0.082000
52	0.000000	1.122500	-0.157100	0.957071	0.978300	-0.443700	0.188500	-2.353846	18.78850	0.016600
53	0.000000	1.122500	0.052700	0.972590	0.986200	-0.404900	0.186100	-2.175712	7.455100	-0.011100
54	0.000000	1.122500	-0.052200	1.322730	1.150100	-0.094300	0.185700	-0.507808	8.220000	-0.028800
55	0.000000	1.122500	0.039300	1.319282	1.148600	-0.427600	0.185500	-2.305121	6.597400	0.061700
56	0.000000	1.122500	0.055900	1.050215	1.024800	-0.312500	0.188900	-1.654315	7.958900	0.072600
57	0.000000	1.122500	-0.070800	0.720971	0.849100	-0.011100	0.186200	-0.059613	8.274100	-0.050000
58	0.000000	1.122500	-0.067500	1.579798	1.256900	-0.780900	0.185600	-4.207436	7.499000	0.047900
59	0.000000	1.122500	-0.235900	0.855070	0.924700	-0.427300	0.185700	-2.301023	12.25940	-0.065500
60	0.000000	1.122500	0.050600	0.571838	0.756200	-0.322200	0.185700	-1.735057	12.25870	0.019900
61	0.000000	1.122500	-0.107700	0.993012	0.996500	-0.570500	0.182900	-3.119191	5.182400	-0.007900
62	0.000000	1.122500	0.027100	0.870862	0.933200	-0.389200	0.187100	-2.080171	4.977100	0.002900
63	0.000000	1.122500	-0.209500	0.933736	0.966300	-0.582100	0.202200	-2.878833	18.38480	0.609700
64	0.000000	1.122500	-0.096200	1.472340	1.213400	-0.489000	0.187700	-2.605221	10.73550	-0.121200
65	0.000000	1.122500	-0.104600	0.979704	0.989800	-0.123200	0.226200	-0.544651	4.645200	0.200800
66	0.000000	1.122500	-0.033000	0.976935	0.988400	-0.037500	0.193200	-0.194099	15.61920	0.097700
67	0.000000	1.122500	0.048500	1.616204	1.271300	-0.310700	0.187300	-1.658836	10.86220	-0.018000
68	0.000000	1.122500	-0.196500	1.465552	1.210600	-0.601600	0.186700	-3.222282	8.687300	0.307100
69	0.000000	1.122500	-0.193200	1.193775	1.092600	-0.471500	0.189800	-2.484194	9.627600	0.241100
70	0.000000	1.122500	-0.144900	0.830285	0.911200	-0.517800	0.183300	-2.824877	9.552900	-0.098800
71	0.000000	1.122500	0.064900	1.334949	1.155400	-0.265700	0.184800	-1.437771	9.298100	-0.007300
72	0.000000	1.122500	0.038200	1.480115	1.216600	-0.431500	0.183500	-2.351498	5.430100	0.002400
73	0.000000	1.122500	0.031400	1.070811	1.034800	-0.610200	0.194400	-3.138889	6.684300	0.253800
74	0.000000	1.122500	0.143000	1.261803	1.123300	-0.525800	0.186200	-2.823845	6.533200	0.063200
75	0.000000	1.122500	-0.056900	1.083473	1.040900	-0.555700	0.186900	-2.973248	14.81260	-0.025300
76	0.000000	1.122500	-0.033700	0.865644	0.930400	-0.169200	0.188400	-0.898089	5.868600	-0.012800
77	0.000000	1.122500	0.027800	1.444564	1.201900	-0.466200	0.193600	-2.408058	8.241100	0.012900
78	0.000000	1.122500	0.139400	1.099562	1.048600	-0.486700	0.185700	-2.620894	9.556600	-0.004300
79	0.000000	1.122500	0.114400	1.758011	1.325900	-0.283900	0.201300	-1.410333	11.99740	0.117600
80	0.000000	1.122500	0.049300	1.051240	1.025300	-0.150500	0.187100	-0.804383	11.18340	-0.062700
81	0.000000	1.122500	-0.064000	0.873103	0.934400	-0.282200	0.187100	-1.508284	3.684300	-0.044300
82	0.000000	1.122500	0.004200	0.970028	0.984900	-0.374200	0.188600	-1.984093	15.78850	-0.020100
83	0.000000	1.122500	0.130800	1.424204	1.193400	-0.257300	0.189800	-1.355638	6.696600	0.017400
84	0.000000	1.122500	0.122400	1.069776	1.034300	-0.481600	0.188100	-2.560340	7.841900	-0.043800
85	0.000000	1.122500	-0.155900	0.833386	0.912900	-0.474500	0.186800	-2.540150	8.027900	0.088300
86	0.000000	1.122500	-0.076000	0.855995	0.925200	-0.134700	0.185800	-0.724973	9.158300	-0.021400
87	0.000000	1.122500	-0.016000	0.908781	0.953300	-0.597200	0.182500	-3.272329	8.577700	0.030800
88	0.000000	1.122500	0.073800	1.380390	1.174900	-0.261500	0.186600	-1.401393	8.869700	-0.003500
89	0.000000	1.122500	-0.007800	1.442161	1.200900	-0.514900	0.186700	-2.757901	5.340100	0.046900
90	0.000000	1.122500	-0.034600	0.993012	0.996500	-0.348300	0.196900	-1.768918	12.50570	-0.098400
91	0.000000	1.122500	0.076900	0.712167	0.843900	-0.651300	0.186900	-3.484751	11.45040	0.120500
92	0.000000	1.122500	-0.059700	1.449640	1.204010	-0.903900	0.184400	-4.901844	9.517400	0.055500
93	0.000000	1.122500	-0.163100	1.619256	1.272500	-0.608600	0.183400	-3.318430	8.320400	-0.013600
94	0.000000	1.122500	-0.073200	1.280292	1.131500	-0.275600	0.186300	-1.479334	4.999500	-0.002100
95	0.000000	1.122500	0.128400	1.319971	1.148900	-0.568000	0.188100	-3.019671	22.98670	0.106200
96	0.000000	1.122500	-0.044900	1.057031	1.028120	-0.244500	0.185500	-1.318059	8.806500	-0.003800

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
97	0.000000	1.122500	0.319900	1.249700	1.117900	-0.080400	0.185700	-0.432956	14.91900	0.006800
98	0.000000	1.122500	0.173200	1.321580	1.149600	-0.324800	0.185400	-1.751888	9.863100	0.020900
99	0.000000	1.122500	-0.095100	1.368666	1.169900	-0.376900	0.187600	-2.009062	6.978300	-0.049100
100	0.000000	1.122500	0.051400	1.257314	1.121300	-0.510100	0.191800	-2.659541	10.43570	-0.272700
101	0.000000	1.122500	-0.030300	1.252385	1.119100	-0.302400	0.186800	-1.618844	8.829900	-0.056400
102	0.000000	1.122500	0.197900	1.182874	1.087600	-0.101400	0.186500	-0.543700	9.510000	0.070600
103	0.000000	1.122500	-0.012100	1.213963	1.101800	-0.508600	0.186600	-2.725616	12.20590	-0.040100
104	0.000000	1.122500	0.011100	1.007614	1.003800	-0.388100	0.188000	-2.064362	6.609700	0.044000
105	0.000000	1.122500	0.041000	1.111338	1.054200	-0.247600	0.184600	-1.341279	8.819600	-0.018300
106	0.000000	1.122500	-0.182300	1.049600	1.024500	-0.020000	0.194600	-0.102775	14.56860	-0.098300
107	0.000000	1.122500	0.222600	1.546790	1.243700	-0.487300	0.192700	-2.528801	17.48970	-0.222700
108	0.000000	1.122500	0.225800	1.247465	1.116900	-0.272300	0.188000	-1.448404	5.984200	-0.087200
109	0.000000	1.122500	-0.062500	1.069570	1.034200	-0.448800	0.194300	-2.309830	15.18350	-0.006700
110	0.000000	1.122500	-0.047500	0.792634	0.890300	-0.060300	0.185700	-0.324717	22.14820	0.017100
111	0.000000	1.122500	-0.042600	1.035510	1.017600	-0.606400	0.179700	-3.374513	17.42490	-0.027500
112	0.000000	1.122500	0.113900	0.783756	0.885300	-0.008900	0.193300	-0.046042	4.336500	-0.125900
113	0.000000	1.122500	-0.036090	1.729225	1.315000	-0.865900	0.193600	-4.472624	11.59230	-0.037500
114	0.000000	1.122500	-0.039400	1.069776	1.034300	-0.243300	0.188400	-1.291401	8.562500	-0.036600
115	0.000000	1.122500	0.040400	0.657883	0.811100	-0.919700	0.188700	-4.873874	8.871200	-0.065600
116	0.000000	1.122500	-0.021200	0.740977	0.860800	-0.515800	0.192700	-2.676700	7.874800	0.007300
117	0.000000	1.122500	-0.059600	0.913554	0.955800	-0.532900	0.188600	-2.825557	8.993500	-0.112300
118	0.000000	1.122500	0.008500	0.636006	0.797500	-0.295800	0.187700	-1.575919	6.970800	0.057300
119	0.000000	1.122500	0.013500	1.184615	1.088400	-0.602300	0.183400	-3.286805	11.34210	3.00D-05
120	0.000000	1.122500	-0.004800	0.890947	0.943900	-0.505700	0.186900	-2.705725	4.439300	-0.012600
121	0.000000	1.122500	-0.033200	1.295272	1.138100	-0.497900	0.188900	-2.635786	13.43980	0.112300
122	0.000000	1.122500	-0.091600	1.098304	1.048000	-0.239800	0.187300	-1.280299	8.223000	0.049900
123	0.000000	1.122500	0.029900	0.906114	0.951900	-0.335300	0.185400	-1.808522	9.716900	-0.007000
124	0.000000	1.122500	-0.073600	0.768778	0.876800	-0.579000	0.190900	-3.033002	3.078900	-0.072400
125	0.000000	1.122500	-0.090400	1.061518	1.030300	-0.416900	0.185900	-2.242604	7.284300	-0.001000
126	0.000000	1.122500	0.066400	1.178962	1.085800	-0.435300	0.185900	-2.341581	11.44910	-0.013000
127	0.000000	1.122500	0.234600	1.072882	1.035800	-0.109000	0.195900	-0.556406	8.727300	-0.325700
128	0.000000	1.122500	0.041300	1.241442	1.114200	-0.736800	0.101500	-7.259114	10.61440	-0.017500
129	0.000000	1.122500	0.189500	1.563500	1.250400	-0.400000	0.191200	-2.092050	8.655300	-0.189900
130	0.000000	1.122500	-0.037100	1.718459	1.310900	-0.475700	0.187100	-2.542491	13.55270	-0.100300
131	0.000000	1.122500	0.066600	1.004204	1.002100	0.094500	0.187700	0.503463	10.56410	-0.029800
132	0.000000	1.122500	0.134300	1.299600	1.140000	-0.333300	0.188000	-1.772872	5.783700	0.101900
133	0.000000	1.122500	0.019200	1.277804	1.130400	-0.547700	0.185600	-2.950970	9.393200	0.012800
134	0.000000	1.122500	0.055800	0.829375	0.910700	0.019800	0.188200	0.105207	13.57400	-0.085900
135	0.000000	1.122500	-0.232500	0.870302	0.932900	0.090100	0.186000	0.484409	5.348100	0.007300
136	0.000000	1.122500	0.107400	1.163378	1.078600	-0.291300	0.184900	-1.575446	8.553400	0.016400
137	0.000000	1.122500	-0.124300	0.952381	0.975900	-0.250900	0.185700	-1.351104	6.075100	-0.011900
138	0.000000	1.122500	-0.186000	0.719104	0.848000	-0.363900	0.185300	-1.963843	8.234200	0.021500
139	0.000000	1.122500	0.035500	0.854885	0.924600	-0.457400	0.185700	-2.463113	12.22380	0.045100
140	0.000000	1.122500	0.182100	1.174406	1.083700	-0.243000	0.185700	-1.308562	11.50620	0.013300
141	0.000000	1.122500	0.108700	0.789610	0.888600	-0.200200	0.189800	-1.054795	9.172400	0.065300
142	0.000000	1.122500	0.125300	1.406359	1.185900	-0.607500	0.187500	-3.240000	10.77960	-0.088300
143	0.000000	1.122500	0.130300	1.172239	1.082700	-0.630600	0.193400	-3.260600	14.73460	-0.005500
144	0.000000	1.122500	-0.073000	0.780396	0.883400	-0.063200	0.187700	-0.336708	8.544500	-0.013500

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
145	0.000000	1.122500	0.018500	0.954334	0.976900	-0.286300	0.185600	-1.542565	4.680700	0.002600
146	0.000000	1.122500	-0.023200	1.313316	1.146000	-0.993600	0.183000	-5.429508	4.403700	-0.002800
147	0.000000	1.122500	-0.278200	0.998201	0.999100	-0.130400	0.191500	-0.680940	11.19940	0.228500
148	0.000000	1.122500	-0.100000	1.505038	1.226800	-0.296700	0.202000	-1.468812	5.263700	0.043100
149	0.000000	1.122500	-0.030000	0.681450	0.825500	-0.016400	0.187800	-0.087327	6.643600	-0.010500
150	0.000000	1.122500	-0.078400	1.521769	1.233600	-0.341300	0.185600	-1.838901	8.195600	-0.009400
151	0.000000	1.122500	-0.086800	2.561920	1.600600	-0.600500	0.186100	-3.226760	7.269800	0.025300
152	0.000000	1.122500	-0.168600	1.285956	1.134000	-0.216000	0.191200	-1.129707	10.45270	0.127800
153	0.000000	1.122500	-0.088600	1.466763	1.211100	-0.528500	0.189500	-2.788918	12.88410	0.128500
154	0.000000	1.122500	-0.052000	1.239214	1.113200	-0.738700	0.185400	-3.984358	10.70620	0.051700
155	0.000000	1.122500	0.027800	1.019292	1.009600	-0.242900	0.190900	-1.272394	8.105400	0.276200
156	0.000000	1.122500	-0.150500	0.650603	0.806600	-0.400500	0.185900	-2.154384	6.931500	-0.024500
157	0.000000	1.122500	0.026060	0.915849	0.957000	-0.466600	0.185800	-2.511303	8.490300	0.016000
158	0.000000	1.122500	0.041000	0.875909	0.935900	-0.435300	0.185300	-2.349164	7.743100	0.033800
159	0.000000	1.122500	-0.270700	1.106073	1.051700	0.038300	0.215200	0.177974	5.361600	0.002100
160	0.000000	1.122500	-0.112400	0.934702	0.966800	-0.311900	0.189600	-1.645042	4.046700	0.063500
161	0.000000	1.122500	-0.119100	0.906494	0.952100	-0.230100	0.193500	-1.189147	8.409900	0.039600
162	0.000000	1.122500	0.050700	0.998201	0.999100	-0.545200	0.188400	-2.893843	5.106200	0.086500
163	0.000000	1.122500	0.032300	0.911643	0.954800	-0.522400	0.186800	-2.796574	6.836800	-0.005100
164	0.000000	1.122500	0.035600	1.504793	1.226700	-0.392300	0.185600	-2.113685	8.728100	-0.014600
165	0.000000	1.122500	0.212200	0.805865	0.897700	-0.084200	0.188300	-0.447159	17.89460	0.090100
166	0.000000	1.122500	-0.074500	1.525472	1.235100	-0.499900	0.186300	-2.683307	5.757100	-0.039800
167	0.000000	1.122500	-0.081200	1.290950	1.136200	-0.501300	0.185400	-2.703883	10.90510	-0.003000
168	0.000000	1.122500	-0.176300	0.764051	0.874100	-0.328500	0.191800	-1.712722	7.838800	0.082400
169	0.000000	1.122500	0.098600	1.571262	1.253500	-0.552800	0.187400	-2.949840	5.660700	0.008400
170	0.000000	1.122500	-0.004700	0.882285	0.939300	-0.453700	0.185900	-2.440559	8.971100	-0.003200
171	0.000000	1.122500	-0.043100	0.705264	0.839800	0.135700	0.185700	0.730748	7.785100	0.000600
172	0.000000	1.122500	-0.126500	1.034289	1.017000	-0.368200	0.189900	-1.938915	4.274600	-0.225200
173	0.000000	1.122500	0.183300	1.502831	1.225900	-0.503200	0.185300	-2.715596	11.62920	-0.041300
174	0.000000	1.122500	-0.028300	1.219258	1.104200	-0.475200	0.187000	-2.541176	10.52870	0.046700
175	0.000000	1.122500	-0.091700	1.035103	1.017400	-0.246300	0.201800	-1.220515	5.377200	-0.006700
176	0.000000	1.122500	0.033100	0.896430	0.946800	-0.176400	0.195100	-0.904152	11.42520	0.166400
177	0.000000	1.122500	-0.050200	0.912789	0.955400	-0.562300	0.188700	-2.979862	5.507700	0.014200
178	0.000000	1.122500	0.043000	1.948537	1.395900	-0.787900	0.186000	-4.236021	7.782000	-0.016600
179	0.000000	1.122500	0.124600	1.783293	1.335400	-0.463200	0.200100	-2.314843	23.21000	-0.224900
180	0.000000	1.122500	0.082900	0.772289	0.878800	-0.315000	0.192900	-1.632970	4.209400	-0.082800
181	0.000000	1.122500	0.184500	0.751169	0.866700	-0.228900	0.186800	-1.225375	9.195400	-0.094400
182	0.000000	1.122500	0.157700	1.100611	1.049100	-0.163200	0.190100	-0.858495	9.472300	-0.191800
183	0.000000	1.122500	0.116000	0.756552	0.869800	-0.158800	0.186100	-0.853305	5.319200	0.004600
184	0.000000	1.122500	0.199300	1.231656	1.109800	-0.241200	0.188900	-1.276866	6.606200	-0.159000
185	0.000000	1.122500	0.235900	1.477683	1.215600	-0.529400	0.205600	-2.574903	8.641400	-0.397600
186	0.000000	1.122500	-0.107400	0.837042	0.914900	-0.072900	0.186000	-0.391935	14.59320	0.034100
187	0.000000	1.122500	0.070800	1.094116	1.046000	-0.413800	0.183300	-2.257501	6.158400	-0.026300
188	0.000000	1.122500	-0.002500	1.213523	1.101600	-0.004900	0.187300	-0.026161	6.096600	-0.060900
189	0.000000	1.122500	-0.084300	1.485230	1.218700	-0.394800	0.185900	-2.123723	14.40850	-0.050400
190	0.000000	1.122500	0.040600	0.984858	0.992400	-0.228100	0.187800	-1.214590	10.14220	-0.113700
191	0.000000	1.122500	0.065500	1.159929	1.077000	-0.289300	0.185800	-1.557051	5.916400	-0.031900
192	0.000000	1.122500	-0.104500	0.885293	0.940900	0.101600	0.211300	0.480833	4.493200	0.080200

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
193	0.000000	1.122500	0.030400	1.452025	1.205000	-0.518800	0.185300	-2.799784	22.14480	-0.001500
194	0.000000	1.122500	0.077000	1.076199	1.037400	-0.197100	0.185500	-1.062534	8.266800	0.000900
195	0.000000	1.122500	-0.131300	0.892080	0.944500	-0.170000	0.189000	-0.899471	10.48930	-0.053500
196	0.000000	1.122500	-0.163100	1.110494	1.053800	-0.368600	0.191600	-1.923800	6.431900	0.078900
197	0.000000	1.122500	-0.028100	1.156485	1.075400	-0.092100	0.185900	-0.495428	16.03810	0.081400
198	0.000000	1.122500	0.043400	1.075576	1.037100	-0.484100	0.185700	-2.606893	6.929800	-0.051700
199	0.000000	1.122500	0.076600	0.658695	0.811600	-0.526200	0.189600	-2.775316	9.210800	0.276500
200	0.000000	1.122500	-0.090000	1.097256	1.047500	-0.184800	0.187000	-0.988235	8.576200	-0.091300
201	0.000000	1.122500	-0.031700	1.067296	1.033100	-0.163300	0.197800	-0.825581	9.594700	0.035900
202	0.000000	1.122500	-0.111800	1.177876	1.085300	-0.203900	0.207300	-0.983599	9.423200	-0.305000
203	0.000000	1.122500	-0.088500	0.891702	0.944300	-0.455600	0.192400	-2.367983	14.37230	-0.121300
204	0.000000	1.122500	-0.118600	1.025561	1.012700	-0.216000	0.186900	-1.155698	10.37350	-0.016000
205	0.000000	1.122500	-0.080300	1.156700	1.075500	-0.463500	0.185700	-2.495961	7.207900	-0.002000
206	0.000000	1.122500	0.066200	0.880594	0.938400	-0.172000	0.189500	-0.907652	10.45610	0.113200
207	0.000000	1.122500	0.191100	1.348386	1.161200	-0.485800	0.181700	-2.673638	2.520500	-0.000800
208	0.000000	1.122500	0.161100	0.970422	0.985100	-0.159700	0.185700	-0.859989	6.720900	-0.013800
209	0.000000	1.122500	0.101000	0.944784	0.972000	0.183200	0.185600	0.987069	10.10610	-0.015000
210	0.000000	1.122500	-0.077300	1.199025	1.095000	-0.305700	0.185700	-1.646204	8.029800	0.001900
211	0.000000	1.122500	-0.054000	1.213302	1.101500	-0.189200	0.193000	-0.980311	7.585700	0.093300
212	0.000000	1.122500	-0.080800	0.714701	0.845400	-0.281000	0.191300	-1.468897	13.76420	-0.231100
213	0.000000	1.122500	0.030700	1.082016	1.040200	-0.326200	0.186300	-1.750939	7.228800	-0.015200
214	0.000000	1.122500	0.035700	0.782340	0.884500	-0.348200	0.189600	-1.836498	7.819700	-0.054100
215	0.000000	1.122500	-0.112600	1.761725	1.327300	-0.763600	0.190500	-4.008399	6.510000	0.251700
216	0.000000	1.122500	0.075500	0.647381	0.804600	-0.469100	0.189200	-2.479387	7.353200	-0.051500
217	0.000000	1.122500	0.070500	0.724541	0.851200	-0.247700	0.192700	-1.285418	4.991600	0.049800
218	0.000000	1.122500	-0.021100	1.485230	1.218700	-0.068000	0.191400	-0.355277	8.862500	0.054000
219	0.000000	1.122500	-0.224500	0.609961	0.781000	-0.142400	0.185800	-0.766415	5.071900	-0.023200
220	0.000000	1.122500	0.007000	1.318363	1.148200	-0.180200	0.185400	-0.971953	7.098900	0.001600
221	0.000000	1.122500	-0.009700	0.790855	0.889300	-0.497500	0.185900	-2.676170	8.307600	0.009300
222	0.000000	1.122500	-0.024780	1.381330	1.175300	-0.260900	0.193500	-1.348320	6.453200	0.026600
223	0.000000	1.122500	0.151800	0.878344	0.937200	-0.611200	0.192700	-3.171769	8.269800	-0.135100
224	0.000000	1.122500	0.156700	2.052916	1.432800	-0.400700	0.188700	-2.123476	9.366600	-0.085100
225	0.000000	1.122500	-0.154900	0.871796	0.933700	-0.394400	0.185200	-2.129590	9.597400	0.001800
226	0.000000	1.122500	0.304900	0.801920	0.895500	-0.220000	0.193600	-1.136364	4.458700	-0.351400
227	0.000000	1.122500	0.001500	1.425397	1.193900	-0.173900	0.213700	-0.813758	8.942400	0.109500
228	0.000000	1.122500	0.333100	0.642082	0.801300	-0.084300	0.186100	-0.452982	4.920600	-0.085400
229	0.000000	1.122500	0.003000	0.684260	0.827200	-0.481000	0.184400	-2.608460	7.957800	0.000700
230	0.000000	1.122500	0.094600	0.964324	0.982000	-0.519400	0.197200	-2.633874	7.113100	-0.179500
231	0.000000	1.122500	-0.000370	1.641730	1.281300	-0.523200	0.203600	-2.569744	6.499000	0.090700
232	0.000000	1.122500	0.024500	1.699894	1.303800	-0.496300	0.195400	-2.539918	10.99190	-0.024100
233	0.000000	1.122500	-0.110400	0.917956	0.958100	-0.457900	0.192200	-2.382414	4.918900	0.059500
234	0.000000	1.122500	0.221100	1.244340	1.115500	-0.249300	0.187500	-1.329600	6.748000	-0.048600
235	0.000000	1.122500	0.019300	0.700904	0.837200	-0.186200	0.188600	-0.987275	13.16410	0.080800
236	0.000000	1.122500	-0.020600	1.601237	1.265400	0.003500	0.185800	0.018837	18.69740	0.016800
237	0.000000	1.122500	0.104200	0.816493	0.903600	-0.247800	0.196000	-1.264286	4.719600	-0.005900
238	0.000000	1.122500	0.194100	1.138062	1.066800	-0.327800	0.188400	-1.739915	3.426200	-0.094300
239	0.000000	1.122500	-0.030800	0.742010	0.861400	-0.261100	0.186300	-1.401503	10.84470	0.001500
240	0.000000	1.122500	-0.014200	1.107756	1.052500	-0.622100	0.183900	-3.382817	3.451100	-0.000200

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
241	0.000000	1.122500	-0.117600	0.902500	0.950000	-0.287200	0.186100	-1.543256	9.662400	-0.021200
242	0.000000	1.122500	0.015500	0.973577	0.986700	-0.262000	0.191900	-1.365294	8.284900	-0.119300
243	0.000000	1.122500	0.095500	1.311025	1.145000	-0.588400	0.186300	-3.158347	6.758700	0.218800
244	0.000000	1.122500	-0.054500	0.832656	0.912500	-0.105300	0.191300	-0.550444	5.784000	-0.090600
245	0.000000	1.122500	-0.002900	1.230325	1.109200	-0.385000	0.190300	-2.023121	4.813400	-0.007400
246	0.000000	1.122500	0.098600	1.091189	1.044600	0.035500	0.185900	0.190963	12.25880	0.041600
247	0.000000	1.122500	-0.091400	1.261129	1.123000	-0.368500	0.185600	-1.985453	8.902000	-0.021000
248	0.000000	1.122500	-0.188100	1.041828	1.020700	-0.161400	0.190000	-0.849474	8.803900	0.081600
249	0.000000	1.122500	0.078400	0.854146	0.924200	-0.557300	0.183000	-3.045355	5.172800	-0.000900
250	0.000000	1.122500	0.201700	1.413959	1.189100	-0.329500	0.186000	-1.771505	7.444700	0.077000
251	0.000000	1.122500	-0.021600	1.244117	1.115400	-0.635300	0.193200	-3.288302	7.209700	-0.146500
252	0.000000	1.122500	0.091600	0.811261	0.900700	-0.216700	0.186900	-1.159444	13.46150	0.050500
253	0.000000	1.122500	-0.011700	0.817397	0.904100	-0.489000	0.184800	-2.646104	7.266800	-0.005100
254	0.000000	1.122500	-0.095100	0.966682	0.983200	-0.227600	0.186600	-1.219721	9.235300	0.072500
255	0.000000	1.122500	-0.101900	1.500135	1.224800	-0.574900	0.194400	-2.957305	10.79220	0.042800
256	0.000000	1.122500	-0.065300	0.937411	0.968200	-0.231300	0.186000	-1.243548	7.172100	-0.043200
257	0.000000	1.122500	0.116200	1.098723	1.048200	-0.463600	0.199000	-2.329648	12.98440	0.097100
258	0.000000	1.122500	0.064500	0.602952	0.776500	-0.421800	0.185800	-2.270183	4.038500	-0.017100
259	0.000000	1.122500	0.087800	1.406359	1.185900	-0.233800	0.185800	-1.258342	3.719800	0.001800
260	0.000000	1.122500	-0.090500	0.682441	0.826100	-0.229200	0.185600	-1.234914	7.532100	-0.005900
261	0.000000	1.122500	-0.010600	1.345368	1.159900	-0.281400	0.186200	-1.511278	21.85390	0.030200
262	0.000000	1.122500	-0.157300	1.160791	1.077400	-0.174900	0.185700	-0.941842	17.40450	0.043500
263	0.000000	1.122500	0.042500	1.183309	1.087800	-0.267100	0.186400	-1.432940	9.968600	-0.018400
264	0.000000	1.122500	-0.194100	0.707617	0.841200	-0.475000	0.184300	-2.577319	6.880600	0.046100
265	0.000000	1.122500	-0.089200	0.943035	0.971100	-0.322000	0.186500	-1.726542	6.684700	0.015500
266	0.000000	1.122500	-0.097600	0.971210	0.985500	-0.564700	0.185300	-3.047491	8.029500	0.069000
267	0.000000	1.122500	0.113900	0.996204	0.998100	-0.383900	0.185700	-2.067313	6.108300	-0.040600
268	0.000000	1.122500	-0.001000	1.451543	1.204800	-0.494700	0.184100	-2.687127	13.51910	0.022300
269	0.000000	1.122500	-0.052800	1.144472	1.069800	-0.584500	0.190800	-3.063417	9.676900	0.050100
270	0.000000	1.122500	0.017100	0.559953	0.748300	-0.357200	0.195800	-1.824310	5.572400	0.096800
271	0.000000	1.122500	0.022000	1.297549	1.139100	-0.593100	0.186300	-3.183575	4.694100	0.043800
272	0.000000	1.122500	-0.026300	1.412532	1.188500	-0.283600	0.185600	-1.528017	4.469700	0.012100
273	0.000000	1.122500	0.173500	1.831692	1.353400	-0.594300	0.188500	-3.152785	6.882500	-0.226500
274	0.000000	1.122500	-0.059800	0.929103	0.963900	-0.325100	0.196200	-1.656983	6.186500	0.011400
275	0.000000	1.122500	-0.059800	1.203409	1.097000	-0.576700	0.189500	-3.043272	9.641600	0.207400
276	0.000000	1.122500	0.065000	0.983667	0.991800	-0.516700	0.190500	-2.712336	3.631500	0.109600
277	0.000000	1.122500	-0.060000	0.689896	0.830600	-0.116200	0.193500	-0.600517	19.95930	0.140400
278	0.000000	1.122500	-0.153400	1.136996	1.066300	-0.493700	0.185300	-2.664328	12.20640	-0.076700
279	0.000000	1.122500	-0.128400	0.906304	0.952000	-0.414700	0.190900	-2.172342	4.830600	0.068700
280	0.000000	1.122500	-0.035100	1.226556	1.107500	-0.389900	0.185100	-2.106429	7.013700	-0.009800
281	0.000000	1.122500	-0.021900	1.056373	1.027800	-0.706600	0.187300	-3.772558	8.360100	-0.026700
282	0.000000	1.122500	-0.071900	1.596432	1.263500	-0.741900	0.190000	-3.904737	7.636300	0.077500
283	0.000000	1.122500	-0.025300	1.249477	1.117800	-0.161500	0.202300	-0.798319	10.22190	0.661000
284	0.000000	1.122500	0.254500	0.960596	0.980100	-0.330100	0.190700	-1.730991	6.042100	-0.174600
285	0.000000	1.122500	0.052800	1.417052	1.190400	-0.488900	0.194600	-2.512333	5.069400	0.010800
286	0.000000	1.122500	-0.010500	0.632661	0.795400	-0.361600	0.189700	-1.906168	5.858200	0.053500
287	0.000000	1.122500	-0.223900	0.894159	0.945600	-0.155300	0.191900	-0.809276	14.27490	0.037100
288	0.000000	1.122500	0.205900	1.335180	1.155500	-0.123800	0.185700	-0.666667	23.95790	0.020300

SUMMARY STATISTICS FOR AN ARMA(0,1) PROCESS
PROCESS IV (N = 30 obs.)

obs	TMEAN	TVAR	MEAN	VAR	STDDEV	THETA	STDERR	TSTAT	QSTAT	MAF
289	0.000000	1.122500	0.209200	1.053497	1.026400	-0.228500	0.186000	-1.228495	17.16240	0.007900
290	0.000000	1.122500	-0.175800	0.468540	0.684500	0.023100	0.186300	0.123994	10.07300	-0.024800
291	0.000000	1.122500	-0.074200	1.316297	1.147300	-0.318100	0.191800	-1.658499	6.296500	0.062500
292	0.000000	1.122500	-0.102600	1.121693	1.059100	-0.520700	0.186900	-2.785982	7.863000	-0.037300
293	0.000000	1.122500	0.247200	1.470641	1.212700	-0.288300	0.185800	-1.551669	5.985900	-0.039900
294	0.000000	1.122500	-0.029400	1.276674	1.129900	-0.537300	0.185700	-2.893376	8.907000	0.015900
295	0.000000	1.122500	0.138800	0.998401	0.999200	-0.022700	0.199900	-0.113557	9.780700	0.348800
296	0.000000	1.122500	0.153700	1.212641	1.101200	-0.315200	0.195300	-1.613927	5.769800	0.001700
297	0.000000	1.122500	-0.091200	1.402566	1.184300	-0.613200	0.186700	-3.284414	15.94570	-0.174900
298	0.000000	1.122500	-0.121300	1.212641	1.101200	-0.493700	0.192400	-2.566008	7.865700	0.050200
299	0.000000	1.122500	-0.344700	1.065850	1.032400	-0.172400	0.186500	-0.924397	9.769100	-0.132200
300	0.000000	1.122500	-0.170800	1.032459	1.016100	-0.351300	0.185600	-1.892780	10.22470	-0.001800

Exchange Rate Management in a Balance of Payments Crisis. The Guyana and Jamaica Experience

By

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Programme of Monetary Studies, Belize City, Belize
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