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ABSTRACT

The importance of seasonality in econometric modeling of economic time series has been downplayed by analysts of business cycles. This paper seeks to determine the validity of the assumption of independence between seasonal and cyclical components for Philippine economic time series.

Some issues relating to seasonal unit roots, changing seasonality, nonlinearity and structural change in Philippine economic time series are addressed. Results from test for seasonal integration and seasonality are mixed. However, graphical measures and prior observations by analysis tend to provide support to the result that most Philippine economic time series do not exhibit stability in their seasonal patterns. Using a modeling framework accounting for both nonlinearity and structural change, it was found that moist economic time series exhibiting linked seasonal and cyclical behavior tend to cater to the domestic market whereas those with independent seasonal and cyclical components may have been insulated by their greater exposure to the global economy.

I. Introduction

It has been common practice for analysts interested in the nature of business cycles and long run growth to regard seasonal fluctuations in data as undesired noise and/or errors in variables, Sims (1974), de Goojier and Franses (1997). Seasonal movements are typically depicted as anticipated and thus, not worthy of further attention and deeper analysis. Also, it is presumed that seasonality, if it exists, accounts for an insignificant proportion of the variance and its ability to explain the behavior of macroeconomic variables can be discounted. Hence, statistical analysis is traditionally done on seasonally adjusted data.

Furthermore, econometric modelers choose to ignore the value of information in seasonal fluctuations. The focus has always been on the long-term trend and medium term cyclical performance of economic variables. This presupposes that seasonality in economic time series is independent of the trend and cyclical fluctuations found in these economic variables.

However, there exist ample econometric evidence to suggest that seasonal and non-seasonal characteristics tend to be linked, Barsky and Miron (1989), Beaulieu and Miron (1990) and Beaulieu, Mckie-Mason and Miron (1992). This implies that the effects of seasonal fluctuations can be transmitted to other components of the time series. Changes in the nature of seasonality can have a lasting and profound impact on trend or cyclical

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behavior of economic variables. In addition to that, it has been shown that in a majority of developed countries, seasonal variation accounts for the bulk of the variance in many quarterly and monthly economic variables, Beaulieu and Miron (1990) and Beaulieu, Mckie-Mason and Miron (1992). As such, a fuller understanding of the behavior of economic variables can only be completely grasped if seasonal features of the data are incorporated into the model.

This serves as the main motivation for the study. Borne out by the researcher's work on the econometric analysis of cyclical data, it is posited that seasonal variation in economic data accounts for a considerably large proportion of variability in economic cycles and can be very useful in explaining its behavior. The study also postulates that the seasonal component and cyclical component of Philippine economic time series are linked.

The next section will show the significance of the study. Section III will present the objectives of the study while Section IV will introduce the literature that serves to provide the genealogy leading to this study. Section V will acquaint the reader with the short conceptual framework for the study. Section VI will discuss the research hypotheses and methodology for the research to be conducted. Section VII discusses recent results while Section VIII concludes.

II. Objectives of the study

The desired outcome of research is to produce results that would be valuable to data providers (i.e., statistical agencies), data analysts and future researchers on the techniques for analyzing seasonal economic time series. The aim, therefore, is to probe the existence of a link between the seasonal behavior of economic time series and their cyclical fluctuations and to find a model that could account for the nonlinearity in cyclical behavior. Given that, the objectives of the study are the follo wing:

1. Describe the seasonal pattern for a given set of economic variables using a structural model;
2. Examine the relationship of the hypothesized seasonal pattern and its cycle using a seasonal smooth transition autoregressive model (SEASTAR); and,
3. Evaluate the performance of the seasonal STAR model versus a time-varying smooth transition autoregressive (TVSTAR) model.

The basis for the primary objective is the perceived regularity in the intra-year fluctuations of many Philippine economic variables. It is also noted that the Philippines is a developing country wherein technology has not developed enough to fully mitigate the effects of weather and other seasonal natural processes on economic growth. Furthermore, Philippine culture and history have ensured the preponderance of holidays. Holidays (e.g., Christmas, Holy Week) serve to impose profound changes on output and demand. In economics, holidays / holiday seasons are depicted as changes in preferences by both consumers and producers. Thus, it is worthwhile to establish and summarize the seasonal patterns of economic variables.

For the purposes of the study, the variables of interest are the following:

1. The National Income Accounts with all components (1981-2003);
2. Consumer Price Index (1968 – 2003); and,
3. Major variables in the monetary survey of the Bangko Sentral ng Pilipinas (1978-2003),
    a. Narrow money (M1),
    b. Broad money (M2),
    c. Domestic liquidity (M3).

The variables were chosen on their perceived ability to show the overall picture in the Philippine economy. The National Income Accounts provide an idea for the real sector of the economy and presents the concept of economic output across various sectors of production and consumption. The CPI is the best indicator of the price level. Lastly, the monetary aggregates best describes the uses of money in the economy. This covers money's use as a medium of exchange, a unit of account, a store of value and as a standard of deferred payments.

The study analyzed the relationship between the seasonal pattern and cyclical behavior of the series. The National Statistical Coordination Board (NSCB) has conducted research on the Philippine business cycle. Following the pattern from this as well as Franses (1998) and Franses, de Bruin and van Dijk (2000), a set of stylized facts for both the business cycle and the seasonal properties of the economic time series will be developed and compared.

III. Methodology

To analyze the seasonal pattern in Philippine economic time series, a regression model was used to evaluate the seasonal non-stationarity of the series. To bolster this, a separate regression model was estimated to determine the presence of changing seasonality. Formal tests based on these regression models, the HEGY test for seasonal integration and the Canova – Hansen test for changing seasonality, were conducted.

To examine the hypothesized link between the seasonal and cyclical component among Philippine economic time series, the modeling framework of the seasonal smooth transition autoregressive model (SEASTAR) was used. Franses et al (2000) used a similar approach to show the link between seasonality and cyclical behavior of industrial production in 18 countries.

The SEASTAR modeling framework also provides the backdrop for the evaluation of the performance of the seasonal STAR model vis a vis the time – varying STAR model in accounting for the nonlinearity in Philippine economic time series.

Tests for seasonal unit roots for quarterly data are done using the HEGY test developed by Hylleberg, et al (1990). For this, the auxiliary regression

$$\phi^*(B)\, Z_{4t} = \mu_t + \pi_1 Z_{1,t-1} + \pi_2 Z_{2,t-1} + \pi_3 Z_{3,t-2} + \pi_4 Z_{3,t-1} + \varepsilon_t$$

where

$$Z_{4t} = (1-B^4)\, X_t$$
$$Z_{1,t} = (1-B+B^2+B^3)\, X_t$$
$$Z_{2,t} = (1-B)\,(1+B^2)\, X_t \quad \text{and}$$
$$Z_{3,t} = -\,(1-B^2)\, X_t$$

and where $\phi^*(B)$ is an autoregressive polynomial in B and μ_t can include a constant, seasonal dummies and / or a trend to ensure stationarity of residuals. The relevant null hypotheses are:

$H_0^1: \pi_1 = 0$	**versus**	$H_A^1: \pi_1 \neq 0$
$H_0^2: \pi_2 = 0$	**versus**	$H_A^2: \pi_2 \neq 0$
$H_0^3: \pi_3 = \pi_4 = 0$	**versus**	H_A^3: **at least one inequality exists**

The first null hypothesis is that a nonseasonal unit root exists in the series while the second unit root states that a biannual unit root exists. Lastly, the third null hypothesis is that there is an annual unit root in the series. The first two null hypotheses are tested using a one-sided *t*-test (i.e., $\pi_i < 0$) while the third hypothesis utilizes an *F*-test.

However, the HEGY test is reputed to be of low power (Kunst and Reutter, 2002; Rodrigues and Osborn, 1999 and Ashworth and Thomas, 1999). To complement HEGY, the Canova-

Hansen test for changing seasonality, Canova and Hansen (1994) will be implemented. This involves LM tests of the null hypothesis of no unit roots at seasonal frequencies versus the alternative hypothesis of a unit root at either a seasonal frequency or a set of seasonal frequencies.

The Canova Hansen test works on the following seasonal dummy regression model:

$X_t = \Sigma\, a_s D^s_t + U_t$

Where D^s_t is a seasonal dummy for time period s,

a_s is a parameter and

U_t ~(0,? ? ?and uncorrelated with D^s_t

The test assumes that the potential variation in a_s is stochastic of a martingale form given by

A $a_{s,t}$= A $a_{s,t-1}$ + e_t for s = 1,…,4.

where $a_{s,t}$ is the value of the seasonal coefficient at time t and that e_t is a martingale difference sequence with covariance matrix $E(e_t'e_t)$ = ***t*** G. Note that the first value of the sequence $a_{s,t}$, the seasonal coefficient matrix, is fixed. The matrix **A** is an estimation construct used to select which element of the seasonal coefficient matrix a_t is to be allowed to vary under the alternative hypothesis. When the test is for instability in an individual season, **A** takes the form of a unit vector with a 1 in the identified season and zeroes otherwise. On the other hand, when the test is for a joint test of instability among the seasonal intercepts, **A** assumes the form of a 4x1 identity matrix. Note that when ***t*** in the expectation of the stochastic component of the equation is equal to zero, the values of the seasonal coefficients are fixed throughout the sample. Hence, the null hypothesis for the test is H_0: ***t*** = 0. The test statistic evolves to the following equation taken from Canova and Hansen (1995):

$$L = \frac{1}{n^2}\sum_{t=1}^{n}\hat{D}_t^{'}A(A'\hat{\Omega}A)^{-1}A'\hat{D}_t$$

$$= \frac{1}{n^2}tr[(A'\hat{\Omega}A)^{-1}A'\sum_{t=1}^{n}\hat{D}_t\hat{D}_t^{'}A]$$

where $\hat{D}_t$ is the sum of the products of the U_t and the quarterly dummies, **tr** is the trace operator, $(A'\hat{\Omega}A)$ is the re-expression of G as a quadratic form with $\hat{\Omega}$ being defined as a Newey-West estimator of the long-run covariance matrix of D. Hence, $\hat{\Omega}$ is robust to serial correlation and heteroscedasticity. Under the null hypothesis, the test statistic follows a von Mises distribution with the parameter depending on the type of test (e.g., one for testing the instability of a single seasonal coefficient or 4 for a joint test).

Given that the changes in seasonality may have occurred at different points in time for the quarters, a smooth transition could best describe this process. This serves as the motivation for the mobilization of the smooth transition autoregressive (STAR) model. Furthermore, the notion that changes in seasonality may have been influenced by changes in cyclical behavior of major economic variables forms the prime motivation for the paper and this can be incorporated into the STAR model using a seasonal STAR model in the form of Franses, de Bruin and van Dijk (2000).

The relationship of the seasonal movement of economic variables and its cycle will be examined using the seasonal smooth transition autoregressive (SEASTAR) model. It is a time series model that allows the analysis of nonlinearity and seasonality simultaneously, Franses, de Bruin and van Dijk (2000). Following Franses (1998) and Franses, de Bruin and van Dijk (2000), the model for a non-trending time series X_t is expressed as

$$\begin{aligned} X_t = {} & FS_t(z_{t-Ds}) (\beta_1^u D_{1,t} + \beta_2^u D_{2,t} + \beta_3^u D_{3,t} + \beta_4^u D_{4,t}) \\ & + (1 - FS_t(z_{t-Ds})) (\beta_1^D D_{1,t} + \beta_2^D D_{2,t} + \beta_3^D D_{3,t} + \beta_4^D D_{4,t}) \\ & + FC_t(z_{t-Dc}) (\phi_1^u X_{t-1} + \phi_2^u X_{t-2} + \dots + \phi_p^u X_{t-p}) \\ & + (1 - FC_t(z_{t-Dc})) (\phi_1^D X_{t-1} + \phi_2^D X_{t-2} + \dots + \phi_P^D X_{t-p}) + \varepsilon_t \end{aligned}$$

where D_i is a seasonal dummy for I= 1, 2, 3, 4

ε_t is a zero mean uncorrelated time series with common variance σ^2

The $FS_t(.)$ for varying deterministic seasonal variation and the $FC_t(.)$ for the nonlinear business cycle are transition functions defined by logistic functions,

$$FS_t(z_{t-Ds}) = \{1 + \exp[-\gamma_s (z_{t-d} - \mu_s)]\}^{-1}, \ \gamma_{s > 0}$$

and

$$FC_t(z_{t-Dc}) = \{1 + \exp[-\gamma_c (z_{t-d} - \mu_c)]\}^{-1}, \ \gamma_{c > 0.}$$

Both transition functions, $FS_t(.)$and $FC_t(.)$, are continuous functions that are bounded between 0 and 1, van Dijk, Terasvirta and Franses (2002). They govern the shift in regime of the process. On the other hand, z_{t-d} represents the transition variable, the variable that describes the jump behavior/shift/transition of the process. The delay parameter d, which is greater than or equal to one, captures the lag in the correlation of the dependent variable to changes in the transition variable. Delay parameters need not be the same for the seasonal and the cyclical part of the model.

The modeling cycle evolves from the databased modeling cycle put forward in Terasvirta (1994). The steps include:

1. Specify a linear AR model of order *p* for the time series under investigation using an appropriate model selection criterion.

2. Select the appropriate transition variable z_{t-d} and the form of the transition function (logistic or exponential). Test the null hypothesis of linearity against the alternative of seasonal STAR nonlinearity.
3. Estimate the parameters in the seasonal STAR model.
4. Evaluate the model using diagnostic tests.
5. Modify the model if necessary.
6. Use the model for descriptive purposes.

The lag order in the specification of the linear AR model will be the one with the lowest AIC and SBC criteria.

To preclude the possibility that a more complicated model (the SEASTAR) might just unnecessarily complicate model – building, a test for linearity is conducted. Using the log first differences of the time series as dependent variable, an auxiliary regression based on a Taylor series approximation of the transition function is performed. To establish the cyclical component, an AR(p) model was estimated to approximate cyclical behavior of the dependent variable. The lag order was determined using AIC.

For the second step, it is recommended that the transition variables be approximately free of seasonality. This is to validate the assumption that there are smooth transitions from one regime to another, Franses, de Bruin and van Dijk (2000). Given this, the natural candidates are the seasonal differences, $\Delta_4 y_{t-Ds}$ for the seasonal part and $\Delta_4 y_{t-Dc}$ for the cyclical part of the model.

Following the suggestion of Franses, de Bruin and van Dijk (2000), two sets of transition variables were used. The first set involves using the same transition variable for both the seasonal and non-seasonal transition function, namely, a lagged form of the dependent variable while the second set uses a time trend for the seasonal transition function and a lagged version of the dependent variable for the non-seasonal transition function. The first set conforms to the functional form of the seasonal STAR model, which shows that the seasonal and cyclical components of the series involved tend to influence each other. This functional form implies that the level of seasonal fluctuations has to do with the level of business activity, thereby adhering to the points raised by Gjermoe (1931) as well as Barsky and Miron (1989). On the other hand, the second set advances the idea that there are other sources of time-variation in seasonal patterns. Technological changes and shifts in institutional / cultural habits and preferences may lead to changes in seasonality as well, van Dijk, Strikholm and Terasvirta (2003). This implies that the time-variation in seasonality leads to a more gradual or smoother transition.

A decision was made to set the functional form of the transition function *a priori* The LSTAR specification or logistic form for the transition function was chosen. The advantage of the logistic form is that it allows the depiction of asymmetric changes in the transition variable. For example, when private consumption is modeled, a logistic STAR specification allows for asymmetric behavior of consumption patterns subject to the increases and decrease of the transition variable. This is due to the fact that the logistic is a monotonically increasing function of the transition variable, thereby allowing different dynamics at the extremes of the logistic function (i.e., 0 and 1), Ocal and Osborn (2000). On the other hand, only the distance from the threshold parameter in the exponential specification matters to determine the behavior of the transition function. The only time the exponential specification is similar to the logistic form is when almost all values lie to the right of the location parameter, Terasvirta (1994). This is, of course, a difficult assumption to make.

Relating to the third objective of the paper, which is to test the performance of the seasonal STAR model against the time-varying STAR model. The test for linearity will pit as alternative hypotheses, seasonal STAR-type nonlinearity versus a time-varying STAR-type nonlinear model. The TVSTAR is the model usually used to depict smooth transition (over a time trend variable) and structural change. For the purpose of the study, the only difference of the TVSTAR model with the seasonal STAR model will be the use of a time trend as transition variable in the transition function of the seasonal component.

The null hypothesis of linearity is equivalent to simultaneously testing for the equality of the autoregressive parameters in the cyclical regimes and the equality of the parameters in the seasonal regimes. That is,

$$H_o: \phi_i^u = \phi_i^D,\ i = 1, 2, \ldots, p \quad \text{and} \quad \beta_j^u = \beta_j^D,\ j = 1, 2, 3, 4$$

Versus

$$H_a: \phi_i^u \,?\, \phi_i^D,\ i = 1, 2, \ldots, p \quad \text{and/or} \quad \beta_j^u \,?\, \beta_j^D,\ j = 1, 2, 3, 4,$$

for at least one value of i, j.

Depending on the regressors used in the auxiliary regression, this test challenges the null hypothesis of a linear deterministic seasonal model versus alternative hypotheses indicating seasonal STAR type nonlinearity or time-varying STAR type nonlinearity.

However, note that under the null hypothesis, the model is not identified. Given that they are identified in the alternative hypothesis, this creates the problem of nuisance parameters. Hence, standard likelihood ratio tests, Lagrange Multiplier tests and Wald statistics are not available, Davies (1977, 1987). Lukkonen, Saikkonen and Terasvirta (1988) proposed a solution for STAR models in which the transition function is replaced by a Taylor series approximation. This eliminates the problem and linearity can be tested by a Lagrange Multiplier statistic with a standard asymptotic $?^2$ distribution under the null hypothesis. A variant of this approach using a third-order Taylor series expansion was implemented.

To illustrate the process, the test is basically equivalent to determining whether γ_s and/or γ_c are equal to zero. Under this null hypothesis, the other parameters are not identified; this precludes the usual tests from maximum likelihood theory like the likelihood ratio test and LM test. Luukkonen, Saikkonen and Terasvirta (1988) proposed a Taylor series approximation for the transition function. For simplicity but without loss of generality, the case of a first-order Taylor series approximation of the logistic function will be shown. The derivative of the logistic function for a given variable X

$$F(X) = (1+\exp(X))^{-1}$$

is given by

$$F'(X) = (-1)\ (1+\exp(X))^{-2} \exp(X)\ dX.$$

Evaluated at X=0, this is equal to – 0.25. For the seasonal STAR model, we have

$$Xs = -\gamma_s\ (z_{t-d} - \mu_s) \text{ for } FS_t(z_{t-Ds})$$

and

$$Xc = -\gamma_c\ (z_{t-d} - \mu_c) \text{ for } FC_t(z_{t-Dc})$$

Using the derivative of a logistic function and the values for X, the transition functions can be substituted by $FS_t'(0)Xs$ and $FC_t'(0)Xc$ for the seasonal and cyclical components, respectively.

$$X_t = (0.25\gamma_{s)}\ (z_{t-d} - \mu_s)\ (\beta^u{}_1 D_{1,t} + \beta^u{}_2 D_{2,t} + \beta^u{}_3 D_{3,t} + \beta^u{}_4 D_{4,t})$$
$$+ (1 - (0.25\gamma_{s)}\ (z_{t-d} - \mu_s))\ (\beta^D{}_1 D_{1,t} + \beta^D{}_2 D_{2.t} + \beta^D{}_3 D_{3,t} + \beta^D{}_4 D_{4,t})$$
$$+ (0.25\gamma_{c)}\ (z_{t-d} - \mu_c)\ (\phi^u{}_1 X_{t-1} + \phi^u{}_2 X_{t-2} + \ldots + \phi^u{}_p X_{t-p})$$
$$+ (1 - (0.25\gamma_{c)}\ (z_{t-d} - \mu_c))\ (\phi^D{}_1 X_{t-1} + \phi^D{}_2 X_{t-2} + \ldots + \phi^D{}_P X_{t-p}) + \varepsilon_t$$

However, the threshold parameters, μ_s and $\mu_{c,}$ remain to be unidentified. The seasonal STAR model is then reparameterized to

$$X_t = \sum_{S=1}^{4} (\beta_s D_{s,t} + \beta_{s,1} D_{s.t} z_{t-Ds}) + \sum_{i=1}^{p} (\phi_i X_{t-i} + \phi_{i,1} X_{t-i} z_{t-Dc}) + \mu_t$$

with constant but unknown value of the threshold parameters being subsumed under the other coefficients β_s for the seasonal component and ϕ_i for the cyclical component. Replacing the transition variable for the seasonal component will show the same case for the TV STAR model.

With the new equation, the new null hypothesis is that the coefficients of the cross-product terms are not significant. This can be tested using ordinary least squares techniques. The steps for evolving the test statistic are:

1.) Regress X_t on the restricted model (i.e., without cross-product terms).
2.) Form the residuals and the residual sum of squares SSE_0.
3.) Regress the residuals on the full model (i.e., with cross-product terms) and obtain the residual sum of squares SSE_1.
4.) Compute the test statistic TS using the formula

$$TS = n\,(SSE_0 - SSE_1) / SSEo$$

where n is the total number of observations.

Luukkonen, Saikkonen and Terasvirta (1988) states that under the null hypothesis, TS is asymptotically distributed as X^2 with p(p+1)/2 degrees of freedom.

A modified approach from Franses, de Bruin and van Dijk (2000) uses the following auxiliary regression from the third -order Taylor series approximation:

$$X_t = \sum_{S=1}^{4} (\beta_s D_{s,t} + \beta_{s,1} D_{s.t} z_{t-Ds} + \beta_{s,2} D_{s,t} z^2_{t-Ds} + \beta_{s,3} D_{4,t} z^3_{t-Ds})$$
$$+ \sum_{i=1}^{p} (\phi_i X_{t-i} + \phi_{i,1} X_{t-2} z_{t-Dc} + \phi_{i,2} X_{t-2} z^2_{t-Dc} + \phi_{i,3} X_{t-2} z^3_{t-Dc}) + \mu_t$$

Joint F-tests for the significance of the cross-product variables are then conducted. If the variables are significant, a SEASTAR model can be applicable. The tests are then run across several values of the delay parameter. The choice of the delay parameter is the taken as the value of d such that the p-value is a minimum. The model can then be estimated by conditional least squares. After which, model evaluation can be done through the analysis of the residuals and residual autocorrelations.

VI. Analysis of Data

<u>Tests for seasonal unit roots</u>

The formal test (HEGY) has been applied to quarterly Philippine macroeconomic time series. Table 1 summarizes the results from the modeling runs. At the 5 percent level of significance, the test statistics associated with the HEGY regressors (t-test for hypotheses 1 & 2 and an F-test for hypothesis 3) show the most of the regressors are not significant. This implies that an overwhelming majority of the variables do not have seasonal unit roots.

Given that these results do not conform to results from the visual inspection of the sample correlogram of Philippine economic time series showing slow decay of the autocorrelation function at seasonal lags and the reputed low power of the HEGY test (Kunst and Reutter, 2002; Rodrigues and Osborn, 1999 and Ashworth and Thomas, 1999), it is suspected that the results need to be further verified. A graphic analysis of the coefficients from the regression of the variables on seasonal dummies using recursive least squares is done for each variable. They show that the coefficients tend to fluctuate unevenly over the estimation period and hint of changing seasonality.

Table 1. Test Statistics for Coefficients of HEGY Equation Regressions

Series	$p_1 = 0$	$p_2 = 0$	$p_3=0$	$p_4=0$	$p_3=p_4=0$
MONETARY					
M1	-0.99	-3.95	-4.73	2.57	18.59
M2	-1.95	-3.46	-4.21	3.73	24.22
M3	-1.94	-3.41	-4.22	3.77	24.72
PRICE					
CPI94	-2.66	-3.89	-1.48	6.88	27.26
REAL					
GNP	-0.27	-3.27	-2.63	3.04	8.12
GDP	-0.41	-2.53	-1.41	3.56	7.38
AGRIFF	-0.22	-2.32	-2.64	2.41	7.21
AGRIFISH	-0.37	-2.33	-2.75	2.07	6.58
FORESTRY	-2.26	-2.38	-1.32	0.61	1.12
INDUSTRY	-0.73	-3.13	-4.09	2.31	12.89
MINING	0.22	-2.74	-4.61	1.64	12.82
MANUFACTURING	-0.94	-2.06	-2.67	1.14	4.20
CONSTRUCTION_IND	1.51	-2.08	-3.01	2.46	8.51
UTILITIES	-0.34	2.84	2.84	5.98	18.58
SERVICES	-0.67	-3.49	-3.10	3.89	13.26
TRANSCOMM	0.86	-0.35	-2.26	1.12	3.13
TRADE_SERV	-0.25	-4.61	-6.32	3.49	32.05
FINANCE	-1.65	-2.26	-1.44	6.99	32.22
ODRE	-1.54	-6.13	-4.59	3.92	10.63
GOV_SERVICES	-1.43	-2.37	-2.32	1.44	3.77
PRIVATE_SERVICES	0.42	-6.77	-10.96	2.02	73.43
PCE	-0.88	-1.74	-5.31	1.00	15.58
GC	-2.05	-2.70	-1.37	3.06	5.70
GDCF	-2.41	-3.29	-4.72	2.95	18.29
GFCF	-1.79	-3.31	-3.96	2.66	13.30
DUREQ	-2.75	-3.62	-3.95	1.98	10.80
BREEDING	1.34	1.10	-3.40	0.57	5.92
CONSTRUCTION_INV	1.82	-2.33	-3.27	2.55	9.87
EXPORTS	-1.83	-3.13	-4.53	3.88	24.61
IMPORTS	-2.90	-3.30	-5.56	4.38	38.93

Canova – Hansen test for changing seasonality

Changing seasonality can be formally tested using the Canova-Hansen test for changing seasonality, Canova and Hansen (1995). Table 2 shows the regression coefficients with their corresponding t-values. On the other hand, Table 3 provides the results from the Canova – Hansen tests on the regression coefficients and they provide strong support to the contention that Philippine economic time series exhibit changing seasonality. Critical values, at the 5 percent level of significance, are 0.470 for the individual tests and 1.240 for the joint tests.

The results show that the variables indicate statistically significant seasonal patterns and that, with the exception of imports and M1 (narrow money), the seasonal patterns have changed over the sample. Of all the quarters, it was the first quarter where fewer of the variables showed any change in seasonality. However, the average changes in seasonality are higher in the first and third quarter than in the second and fourth quarters. Furthermore, the results confirm the plots of recursive least squares estimates of the quarterly dummy coefficients where the first quarter dummy coefficient showed the least likelihood to change.

Furthermore, marked changes in seasonal coefficients have been observed based on the results of the Canova – Hansen test and the plots of recursive least squares of the seasonal dummy coefficients.

For monetary aggregates, broad money (M2) has been observed to have significant seasonal mean shifts in the third and fourth quarters. The seasonal mean for the third quarter has risen from previously insignificant levels to become significant by the mid-1990s while the fourth quarter seasonal mean has registered an initial rise during the mid-1990s before receding to previous levels. Similar behavior appears to be observable from domestic liquidity (M3) whereas narrow money (M1) seems to be stable in its seasonal means.

The explanation for this has to do with the various uses of money. Narrow money (M1), consisting of currency in circulation and demand deposits, generally hews to money's definition as a medium of exchange. This suggests that demand for it over the quarters has to do with the level of economic activity (transactions demand for money). That is, cash and checks can be easily transferred among economic agents, making them useful in reducing the resources need to facilitate transactions, Faig (1989). The seasonal rise in the demand for M1 will trigger upticks in the interest rate (its corresponding price). Interest rates may then be unstable such that the added seasonal volatility in interest rates making transactions more difficult to complete. Hence, monetary authorities accommodate the seasonal demand for money. This explains why its seasonality though significant (except in the third quarter) is stable. On the other hand, M2 represents M1 plus savings deposits and augurs more to money's definition as a store of value. Independent of M1, it only increases when gross domestic saving rises. This presumes an increase in income and thence, wealth among economic agents. This explains the change in its seasonal means especially during the mid-1990s when the booming Philippine economy increased the stock of wealth of both households and firms.

For changes in the price level, the plots of the recursive least squares estimates of the seasonal means points to a damping of seasonal dummy coefficients although only the third quarter registers a significant change in the Canova – Hansen test. The results mainly reflect the long-term changes in the structure of the Philippine economy. Increased efficiency from the dismantling of monopolies, privatization of state-owned enterprises, and deregulation of key industries allowed for the price level to settle to a more stable equilibrium. The liberalization in both financial and trade services led to lower costs for both manufacturers and traders. The lesson from the 1995 rice crisis wherein the FVR Administration learned that food prices particularly rice determined the popularity of the sitting president was taken to heart by successive administrations. The National Government has also been ready during the rainy season (third quarter). It readily imports or releases rice and other food products from its stocks to stabilize food prices. Since food accounts for a significant bulk of the weights in the computation of the consumer price index, the stabilization of food prices has led to a significant shift to lower seasonal means during the third quarter. Add to this, the influx of cheap imports provided a ceiling to price rises.

Based on the results of the Canova – Hansen test, we can conclude that the seasonality of many Philippine economic time series is not stable and has gradually changed over time. This bolsters the contention of Hylleberg (1995) that it is best to complement the HEGY test with the Canova – Hansen test in moderate samples to verify results. Furthermore, it provides support to the point raised by Franses (1994) that plots of recursive estimates of coefficients of regressors in seasonal dummy regressions can be used to graphically reveal the structure of seasonal patterns. Lastly, Table 3 bolsters the point of Canova and Hansen that a joint test may be insignificant but an individual test can be

Table 2. Results from auxiliary regressions for CH test

Variable	Regression Coefficients			
	Seas_1	Seas_2	Seas_3	Seas_4
CPI	0.0242 (7.264)	0.0133 (4.152)	0.0199 (6.183)	0.0158 (4.727)
Narrow Money (M1)	-0.0479 (-4.682)	0.0206 (2.091)	-0.0005 (-0.051)	0.1677 (16.378)
Broad Money (M2)	-0.0067 (-0.735)	0.0280 (3.174)	0.0181 (2.046)	0.1029 (11.219)
Agriculture, Fisheries and Forestry	-0.1452 (-8.896)	-0.0493 (3.105)	-0.1303 (-8.200)	0.3498 (21.431)
Agriculture and Fisheries	-0.1446 (-8.755)	-0.0608 (3.782)	-0.1309 (-8.146)	0.3653 (22.116)
Forestry	-0.3142 (-2.382)	0.3764 (2.932)	0.0038 (0.029)	-0.1594 (-1.209)
Industry	-0.1089 (10.450)	0.0417 (4.108)	0.0418 (4.121)	0.0569 (5.457)
Mining and Quarrying	0.0519 (1.502)	0.0847 (2.518)	-0.0702 (-2.086)	-0.0482 (-1.393)
Manufacturing	-0.1272 (-14.755)	0.0242 (2.885)	0.0594 (7.073)	0.0752 (8.726)
Construction	-0.1017 (-2.001)	0.1047 (2.117)	-0.0045 (-0.090)	0.0287 (0.565)
Electricity, Gas and Water	-0.0276 (-1.580)	0.0579 (3.401)	0.0362 (2.129)	-0.0209 (-1.195)
Services	-0.1213 (-49.981)	0.0677 (28.680)	-0.0146 (-6.177)	0.1107 (45.617)
Transportation, Communications and Storage	-0.0664 (-13.329)	0.0881 (18.163)	-0.0581 (-11.974)	0.0910 (18.256)
Trade Services	-0.2482 (-41.886)	0.1103 (19.131)	0.0000 (-0.017)	0.1797 (30.323)
Financial Services	-0.0324 (-3.619)	0.0508 (-5.823)	-0.0313 (-3.585)	0.0760 (8.842)
Ownership of Dwellings and Real Estate	0.0178 (7.615)	0.0080 (3.516)	-0.0014 (-0.612)	0.0016 (0.697)
Government Services	-0.1122 (-7.307)	0.0265 (1.777)	-0.0261 (-1.749)	0.1507 (9.819)
Private Services	-0.0548 (-7.194)	0.0477 (6.437)	0.0026 (0.350)	0.0416 (5.461)
Private Consumption	-0.1536 (-42.875)	0.0753 (21.589)	-0.019 (-0.543)	0.1178 (32.894)
Government Consumption	-0.0327 (-1.885)	0.0573 (3.394)	-0.0087 (-0.515)	0.0190 (1.094)
Investments	-0.0291 (-0.902)	-0.0384 (-1.222)	-0.0659 (-2.099)	0.2020 (6.259)
Gross Fixed Capital Formation	-0.0225 (-0.908)	-0.0077 (-0.320)	-0.0267 (-1.109)	0.1062 (4.292)
Construction	-0.0915 (-2.092)	0.0858 (2.017)	0.0042 (0.098)	0.0360 (0.824)
Durable Equipment	0.0616 (2.238)	-0.0940 (-3.510)	-0.0153 (-0.572)	0.1180 (4.290)
Breeding Stock and Orchard Development	-0.0602 (-4.185)	-0.0416 (-2.973)	-0.3615 (-25.820)	0.4999 (34.750)
Exports	-0.04326 (-2.199)	0.0320 (1.659)	0.0833 (4.316)	-0.0057 (-0.287)
Imports	-0.0080 (-0.472)	0.1020 (6.184)	0.0229 (1.390)	-0.0340 (-2.003)
Gross Domestic Product	-0.1228 (-19.839)	0.0337 (5.594)	-0.0191 (-3.171)	0.1430 (23.109)
Gross National Product	-0.1165 (-16.459)	0.0335 (4.859)	-0.0161 (-2.334)	0.1408 (19.898)

Table 3. Canova-Hansen test statistics for changing seasonality					
Variable	Instability Tests				
	Joint	Seas_1	Seas_2	Seas_3	Seas_4
CPI	2.5284	0.45	0.53	0.97	0.30
Narrow Money (M1)	0.9803	0.08	0.07	0.07	0.38
Broad Money (M2)	1.4712	0.06	0.62	0.17	0.51
Agriculture, Fisheries and Forestry	2.8900	0.13	1.11	1.18	0.26
Agriculture and Fisheries	2.8902	0.13	0.93	1.12	0.53
Forestry	1.4175	0.28	0.16	0.53	0.11
Industry	2.3822	0.21	0.32	0.52	0.14
Mining and Quarrying	1.3676	0.51	0.25	0.20	0.21
Manufacturing	3.3547	1.24	0.57	0.89	0.59
Construction	1.9307	0.25	0.50	0.10	0.14
Electricity, Gas and Water	2.3408	0.47	0.89	0.30	0.32
Services	2.4379	1.04	0.25	0.13	0.81
Transportation, Communications and Storage	3.0866	1.04	0.29	1.01	0.65
Trade Services	3.1431	0.35	0.83	1.15	0.60
Financial Services	2.3059	0.80	0.17	0.64	0.14
Ownership of Dwellings and Real Estate	1.7841	0.14	0.19	0.60	0.68
Government Services	6.2534	1.45	0.95	1.67	1.51
Private Services	2.8845	0.55	0.70	0.06	0.45
Private Consumption	3.4684	1.29	0.13	0.88	0.76
Government Consumption	5.2019	0.88	1.35	1.18	1.55
Investments	1.8551	0.17	0.54	0.07	0.14
Gross Fixed Capital Formation	2.1838	0.21	0.78	0.16	0.29
Construction	2.0154	0.25	0.64	0.06	0.14
Durable Equipment	2.0272	0.24	0.49	0.49	0.70
Breeding Stock and Orchard Development	4.1114	0.68	1.27	0.71	1.13
Exports	3.0021	0.17	0.31	1.37	0.69
Imports	1.0221	0.12	0.40	0.11	0.23
Gross Domestic Product	2.4177	0.17	0.53	1.08	0.59
Gross National Product	2.1456	0.26	0.52	0.77	0.54

Significant because the joint test allows for some time variation in the seasonal pattern as long as the seasonal intercepts are constrained to sum to the overall mean of the series.

With evidence of changing seasonality, we can now model the transition of the seasonal component under a nonlinear modeling framework. To ensure that a complicated nonlinear model is really needed, tests for linearity were conducted.

The original F-tests were not done because normality of residuals was not a valid assumption for most of the regression runs. Also, persistent residual autocorrelation remained in the equation. As a solution, Wald tests, which are less vulnerable to normality assumptions, were conducted. A hierarchical decision process was followed. First, the p-values were checked. If the p-values are equal, the Wald statistics are examined. Those with the highest Wald statistics determine the delay parameter and outcome of the test of linearity. Therefore, the basis is empirical.

All of the Philippine economic time series under study exhibit significant nonlinearity (Table 5). With this, full STAR modeling can be performed. Most of their components have seasonality that is independent of their cyclical performance. This suggests that several key subsectors are the ones linking the seasonal and cyclical components of the sector to which they belong. For example, construction for which most of the raw materials (labor, cement, gravel and sand, etc) are sourced domestically has its seasonal component influenced by its cyclical performance. The point of having key factors of production as well as sales sourced domestically is very important as it ties them to the domestic economy. Note that a significant bulk of the output of manufacturing and mining is exported. National Income Accounts data from 1992 – 2003 show that manufactured and mineral exports account for an average of 55 percent of all merchandise exports. This helps to insulate them from the domestic cycle, which may suggest that the cyclicality of these subsectors may be a reflection of externally – operating cycles such that it cannot influence the seasonality of output. On the other hand, the utilities subsector derives most of its raw materials (crude oil, natural gas and coal) from abroad.

Again, this implies that the output of the sector is less dependent on the local economic conditions. Furthermore, most power plants especially of independent power producers were built with guaranteed sales contracts. This means that the National Power Corporation regardless of economic conditions bought their output.

For the Services sector, its main driver trade services as well as one of its more dynamic sources of growth, private services help to link its seasonal and cyclical component. These subsectors are more dependent on local conditions than the others. The transportation and communications subsector owes its growth less to seasonal demand than satisfying market needs that were long distorted by regulation while financial services catered to transactions that tend to be fueled by foreign funding (loans, remittances, export receipts, etc). This explains why it was hit hard by the Asian currency crisis. The ownership of dwellings and real estate subsector was run for the most part by a asset bubble rather than seasonal or cyclical demand.

On the demand side, private consumption[2] was fueled by remittance money, which helps to insulate it from seasonal and cyclical economic conditions. The same can be said for government consumption because the government tended to provide services year-round funded by borrowings and less by tax money. The exports sector, of course, was more dependent on external sources of growth than local conditions. M1, which primarily funds consumption, follows the behavior of consumption while M2, which funds investments follows that of domestic capital formation which is a function of seasonal and cyclical factors (confidence, stage in the business cycle, stage of an administration's term, etc). With remittance money and loans powering growth, it is no wonder that GDP and GNP follow the behavior of sectors that prime themselves on these sources of funding. Lastly, the price sector has seen CPI being effectively managed over the years regardless of economic cycles.

Methodologically, the tests for linearity provide key information on the performance of the seasonal STAR model in handling structural change versus the time-varying STAR model, the actual model traditionally used to evaluate simultaneous nonlinearity and structural change. Based on this, we can say that for most Philippine economic time series, the time-varying STAR model is less robust to change vis-à-vis the seasonal STAR model.

[2] Yang (2005)

Table 5. Distribution of Economic Series by Type of Nonlinearity	
SEASTAR	**TV STAR**
Industry	Agriculture, Fishery and Forestry
Construction	Agriculture and Fishery
Services	Mining and Quarrying
Trade Services	Manufacturing
Private Services	Electricity, Gas and Water
Gross Investments	Transportation and Communication
Imports of Goods and Services	Ownership of Dwellings and Real Estate
M2	Financial Services
	Private Consumption Expenditures
	Government Consumption
	Exports of Goods and Services
	GDP
	GNP
	M1
	M3
	CPI

VIII. Summary, Conclusions and Recommendations

Although the HEGY test yielded insignificant results, the Canova – Hansen test showed that there exists widespread changing seasonality among Philippine economic time series. Tests of linearity showed that most of the series exhibited independent seasonal and cyclical components. Preliminary modeling runs used the seasonal smooth transition autoregression (SEASTAR) model to detect breakpoints and provide a richer source of information for explaining the results. However, modeling output has been poor and alternative strategies to describe the link between seasonal and cyclical behavior may have to be used. The preliminary runs indicate a high value for the smoothness parameter suggesting the use of a nonlinear model accounting for faster transition like a threshold autoregressive model. More data points are also needed for STAR modeling runs to be fully viable.

Based on the results, there exists a need to account for changing seasonality especially in seasonal adjustment, identify potential sources of regime switching and detect breakpoints for use in modeling. Further research could cover areas of threshold regression modeling and a parallel study of the SEASTAR model using higher frequency data (e.g. monthly data). Given more data, it may be very meaningful to model the Philippine economic time series using a full-fledged time-varying STAR model or a multiple regime STAR model.

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