*Dirasat***,** Administrative Sciences, Volume **34**, No. **1**, 2007

Modeling the Import and Export System of the United States: Using the Error Correction Model Representation

Mahmoud N. Mourad *

ABSTRACT

This paper deals with the analysis of integration and cointegration of all seasonal frequencies for the export and import system of the United States in aggregated quarterly data that cover the period 1980-2003 (96 quarters). The used procedures are HEGY for the integration and EGHL for the cointegration. The two time series are integrated at order 1 for all frequencies: $0, \frac{1}{2}, \frac{1}{4}$ and $\frac{3}{4}$. The commercial balance series is integrated at order 1 of the frequencies 0 and $\frac{1}{4}$ and consequentely it becomes stationary while filtering it by $(1-B)\times(1+B^2)$. The cointegration analysis shows that these two time series are not cointegrated of the frequencies 0 and $\frac{1}{2}$ whereas they are cointegrated of the frequency $\frac{1}{4}$ (and ¾). Two cointegrating relations have been considered. The first relation (titled $CR_{1,t}$) has a constant deterministic part. The second relation (titled $CR_{3,t}$) has a deterministic part constituted of constant and three seasonal indicatory variables. For each of these two relations, we estimated the Error Correction Model (ECM) representation and we did some forecastings for the period 2002-2003 (8 quarters). The quality of the forecastings has been measured using the MAPE (Mean Absolute Percentage Error) criterion. The Chow test reveals a little structural change (at level 5 %) in the value of the parameters of the ECM representation using the cointegration relation $CR_{3,t}$. But if we choose a level of 1% then we accept the null hypothesis that shows a non- structural change in the model.

Keywords: Export and import, United States, Cointegration, Error correction model, Structural change, Forecast.

1. INTRODUCTION

The occupation of the American United States by its foreign trade began seriously since the beginning of the 19th century. Arrangements have been made for the preparation of statistical accounts of trades of the United States with foreign countries to show the kinds, quantities and value of all exported and imported articles from each foreign country. After World War II, the United States took politics that encouraged its outside engagement. Indeed, this war has succeeded to a disorganization of the international economy, it ruined and ravaged a good part of Europe and Asia. The power of the United States became caricatural: half of the world industrial production and half of the international exchanges assured by only one country (See Le Diascorn and Blondel, 1995). This exceptional situation of the United States allowed the world to leave finally from the rut. This new reorganization of the "economy-world" imposed by the United States, was in conformity with the time to its interests to short and long-term and to the interests of the countries that adopt themselves the market economy. The monetary stability and the liberation of the exchanges of goods and funds were its liberal philosophy and free-trader. The efficiency of the American economy appeared then by a growth rates of GDP (the annual average) around 4% in 1960 accompagnied by a receding more and more important until the time it reached the 0.9% in 1990, passed to (-0.5%) in 1991 (See Paul Kennedy, 1993: 366, 372). The industry of motor vehicles, consumer electronic products, engines and machinery, textiles, steel industry and computer products, a deterioration from the years 1970 (as exception, the aeronautics and chemical industry testified a remarkable expansion). Emmanuel Todd (2003) uses the deficit in the commercial balance of the United States as one of the indicators that predict the decomposition of the American system: "The

* Faculty of Economic Sciences and Business Administration, Lebanese University, Nabatieh, Lebanon. Received on 7/11/2005 and Accepted for Publication on 3/5/2006.

© 2007 DAR Publishers / University of Jordan. All Rights Reserved.

savings rate of an american household is close to zero and every time that the American economy blooms, the imports increase and the deficit in the commercial balance increases also". That reveals a crisis in the American economy attested by the widening of the ditch between the exports and the imports (evolutive deficit of the commercial balance). Even on stock plan, in their analysis of the Dow Jones evolution since 1920, Frost and Prechter (1985) predict in 1990 the arrival of the so-called the overwhelming wave "C" that reaches its summit at the end of the year 2005 (An enormous fall in the Dow Jones value is expected)! (Using the Elliott Wave Approach) A lot of the publications treated the exports and imports of the United States like a couple in a larger macroeconomic system. For example: Clarida (1994) elaborated a model (in U.S. quarterly data) that reveals a unique cointegration relation between the consumer goods imports, the price of imports and the consumption of domestically produced varieties. Carone (1996) used the cointegration techniques in order to estimate the long-run equilibrium relationship between the aggregate demand for both total and non-oil merchandise imports of the United States. Oskooee and Brooks (1999) used Johansen and Juselius' cointegration procedure to test for the existence of a long-run relationship among the variables of import and export demand as well as estimates of the Marshall-Lerner condition. The import and export demand functions are estimated on a bilateral basis between the United States and each of its big trading partners considering a relation between the U.S. real import from trading a partner, with the U.S. real GDP and the real bilateral exchange rate between U.S. and trading partner. Senhadji and Montenegro (1999) studied the income and price elasticities of the export demand function for a lot of industrial and developing countries (included the United-States).

Our aim in this paper is to study the export and import system of the United States regardless of the other macroeconomic variables. we are going first to test for this system the presence of a common tendency, then to search for the real link between the exports and the imports. Since our data are quarterly, we will wait to find a seasonal integration for all frequencies (0,1/4,1/2 and 3/4). The research of a cointegration relationship for every frequency is to find a target that binds the two variables at long-run. In such a case, the fluctuations of short-term will be directed toward the long-term equilibrium. It is the objective of the Error Correction Model (ECM). In the case where the two variables will be cointegrated for a given frequency, their common evolution of long-term permits to put under control the export and import system of the United States. We signal that if the two variable exports and imports of the United States have a parallel evolution (a cointegration relation exists between them) then the system can reflect a crisis when a big ditch exists between them. But if the system evolves following a long-term target then it allows the authorities concerned to take into account this relation to intervene favorably for the interest of the country.

In economics, a lot of time series are available under aggregated data. The monthly data turn into quarterly or yearly data to have more information concerning the economical conjuncture of a certain country. This conjuncture is an important subject for the politicians. We study these time series in order to investigate their evolution and use the results in future planning. However, a lot of macroeconomic and financial time series are not stationary. The detection of the nature of the non-stationarity (i.e. whether the mean evolves as a polynomial of order 1 in time or the variance depends on the time) is important for all subsequent analysis because it permits us to specify the components of the adequate model and to obtain good forecastings. Thus, the abusive application of the filtering methods to make variables stationary conceals the properties of long-run equilibrium. In practice, most macroeconomic time series are dominated by an important seasonality. The specification of the nature of this seasonality (deterministic or stochastic) became primary in the work of the practicians since a bad identification of the reason of the seasonality leads to a bad identification of the model and consequentely we get unrealistic forecastings. Hylleberg et al. (1990) developed the HEGY procedure to test the seasonal unit roots in the case of the quarterly data. When the time series has a syochastic seasonal factor the ARIMA model is can not applicable. The advantage of the HEGY procedure, compared to that proposed by Dickey, Hasa and Fuller (DHF, 1984), is that it treats the seasonal integration frequency by frequency while the DHF procedure treats the seasonal filter as a whole (it accepts or refuses the seasonal integration of all frequencies). That is, the unit module counts for the DHF procedure and not the unit roots associated to a particular seasonal frequency. A lot of publications have been made using the HEGY procedure, as an example, we mention Osborn (1990, 1993), Lee and Siklos (1991), Edlund and Karlsson (1993, Beaulieus and Mirons (1993) (as an extension of the HEGY method for the monthly data), Franses (1991), Ghysels, Lee and Noh (1994) (as a generalization of the HEGY method to the SARIMA models), Franses and Romijn (1993) (for a procedure of testing for seasonal roots in a periodic autoregressive process PAP model).

The importance of the seasonal integration analysis consists in its use as a preliminary stage towards the cointegration. Engle and Granger (1987) demonstrated that the cointegrated time series can be represented by an ECM representation the textbook by Hamilton (1994) and Enders (2003) are good references on the subject. Of these, Hamilton is the more theoretical and Enders the more applied. The particularity of the ECM representation is to separate the static aspect of the model which is interpreted as a long – run equilibrium (the target), from the dynamic aspect (supposed to take into account different factors. The dynamic aspect is viewd a summary of the adjustments around this equilibrium (Gourieroux and Monfort, 1995, chapter 11). This ECM representation is both a static and dynamic model (For ECM representation, see Arino and Franses, 2000).

A lot of publications treated the mechanism of the cointegration of the frequency 0 that consists of searching a stationary linear combination between the I(1) time series (Johansen 1988; Johansen and Juselius, 1990) Perron (1989, 1997), Perron and Vogeslang (1992), Zivot and Andrew (1992), studied the cointegration of the frequency 0 by introducing an intervention variable that takes into account the change of the structure in a macroeconomic variable in Dickey-Fuller regression. Granger and siklos (1995) studied the effect of the aggregation on the cointegration of the frequency 0. However, it is very important to see if the cointegration can be accepted for all seasonal frequencies. A general procedure of the cointegration and seasonal cointegration has been developed by Lee(1992), and a procedure of two stages proposed by Engle and Granger (1987), Engle and Yoo (1987) for the frequencies 0 and ½. To test if there is a cointegration of the frequencies 0 or $\frac{1}{2}$, it is necessary to test the stationarity of the linear combination between the integrated variables for these frequencies. To test this hypothesis, we achieve a Dickey - Fuller equation (DF) or an Augmented Dickey- Fuller equation (ADF). The ADF procedure tests the null hypothesis of non-stationarity, that is, H_0 (there is a unit root) against the alternative hypothesis H_a (stationarity). The critical values are not the classic DF and ADF values because it is the residuals that are tested (Engle and Yoo, 1987; Mackinnon, 1991). Hylleberg et al (1993) proposed a cointegrating procedure of the frequencies $\frac{1}{4}$ and ¾. This procedure will be applied in our research.

The paper is organized as follows: First, we apply the HEGY procedure to analyze the integration for the seasonal frequencies of the two following aggregated time series in quarterly data: Export and import of the United States that cover the period 1980:1 - 2003:4 (96 quarters). Second, we use the EGHL procedure to study whether there is a cointegration between our two variables associated to the four seasonal frequencies $0, \frac{1}{2}, \frac{1}{4}$ and $\frac{3}{4}$. In the case where we get some cointegrating relations to a given frequency, we are going to estimate the corresponding ECM representation and carry out structural change testing and forecasting.

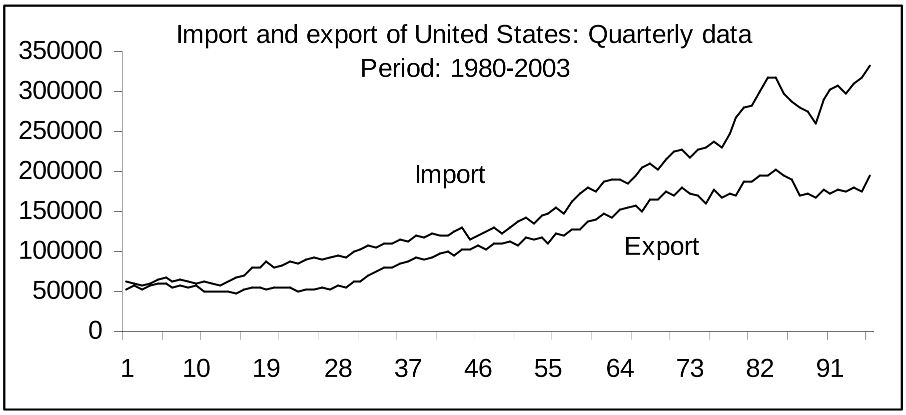
2. DATA

We have two macroeconomic variables (the export and import of the United States). The two time series (in millions of dollars) are aggregated in quarterly data and covering the period 1980-2003 (96 quarters). Each variable contains the following components: foods, feeds beverages, industrial supplies, consumer goods, capital goods, vehicles and other goods. The data are not corrected of the seasonal variations.*

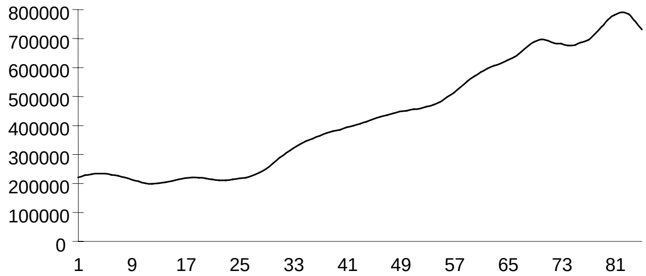
The inspection of the diagram below shows that, in the beginning of the period, the two variables are very close to each other, but during the last three years, an increasing ditch seems to wide them. Except the three first and last three years, the two variables reveal nearly a parallel behavior.

Now let us consider the diagrams of the variables filtered by the filters associated to different frequencies $0, \frac{1}{2}, \frac{1}{4}$ and $\frac{3}{4}$. We will denote the export (respectively the import) at time t by E_t (respectively I_t).

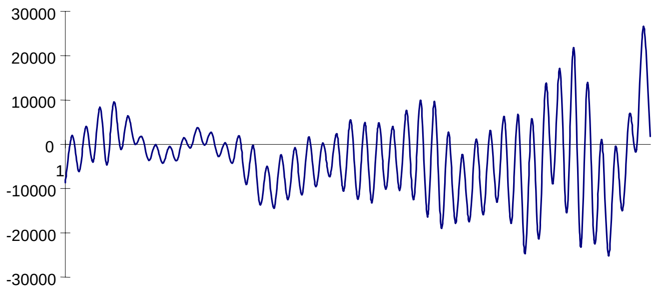
* Data Source: United States Department of Commerce News-Economics and Statistics Administration. U.S. Census Bureau, Bureau of Economic Analysis, 1980Q1-2003Q4.



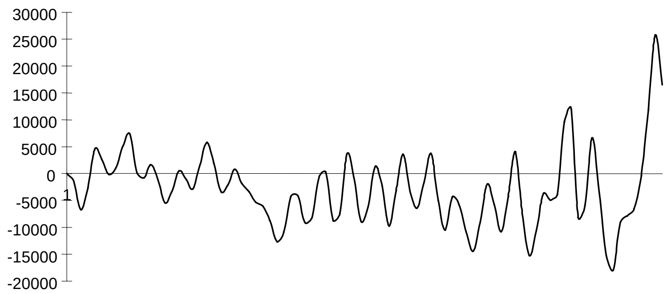
E_t filtered by **(1+B+B²+B³)**: we observe an upward movement over time



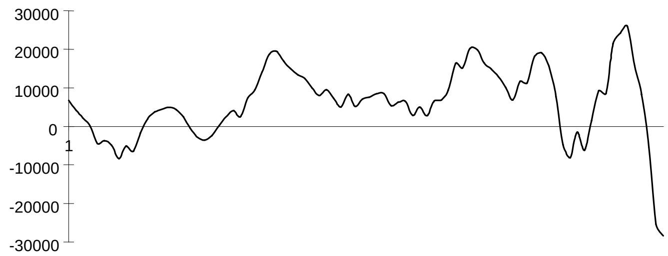
E_t filtered by **-(1-B+B² - B³):** The variability increases over time

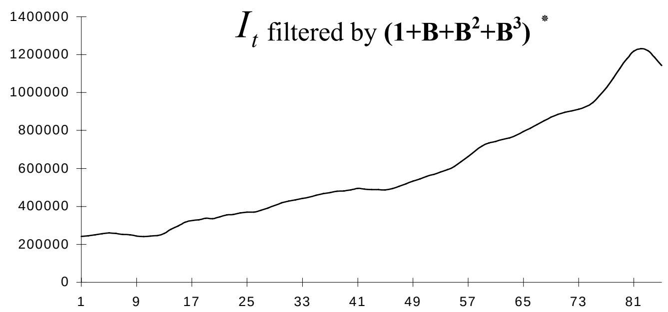


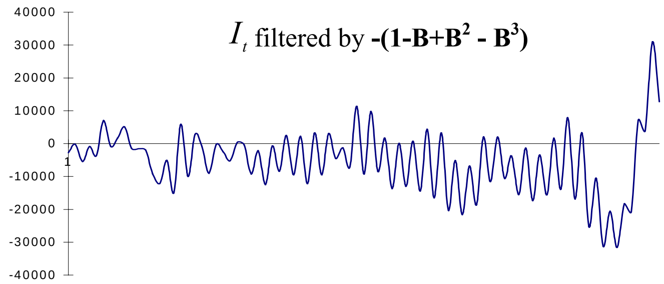
E_t filtered by **- (1 - B²)**: We observe an important variability at the last years

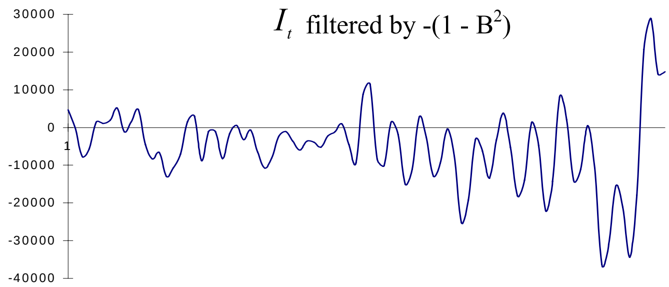


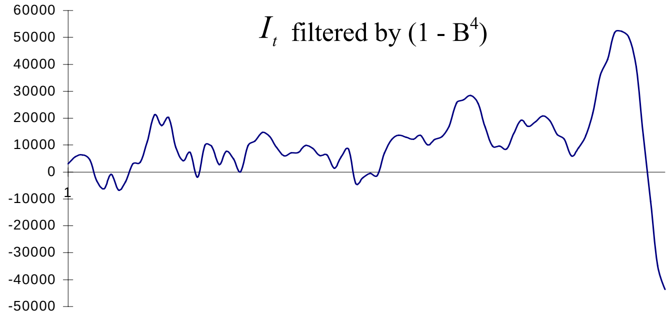
E_t Filtered by **$(1 - B^4)$**: The obtained variable has a weak variability











* The above diagrams have nearly a similar behavior to those associated to the variable of export.

3. HEGY'S Method

The HEGY method is a general procedure for the unit root tests. It has been developed by Hylleberg, Engle, Granger and Yoo (1990). It consists in testing the presence of the module unit roots in the quarterly time series for all seasonal frequencies. The advantage of this method, compared to the other approaches proposed by Dickey-Fuller (1979, 1981), Dickey et al (1984) or Dickey et al (1986), is that it distinguishes between the different seasonal roots. Every root has a different interpretation because it designates a different cycle. It is not the module unit of a complex root that attracts the attention of the analysts of the time series but also the position of this root on the unit circle, that means, its seasonal frequency. In the case of the quarterly data, the seasonal filter $\left(1-B^{4}\right)$ is frequently used to make the series in question stationary. This filter is factorized as following:

$$\left(1-B^{4}\right)=\left(1-B\right)\left(1+B\right)\left(1-iB\right)\left(1+iB\right) \qquad \ldots(1)$$

A process filtered by $\left(1-B^{4}\right)$ reveals a cycle per year of the ¼ frequency, two cycles per year of the ½ frequency, no cycle per year of 0 frequency. The roots **1, -1, i** are respectively related to the frequencies $0, \frac{1}{2}, \frac{1}{4}$. The complex root **(-i)** is interpreted as a conjugated root **i** (a cycle per year). The HEGY procedure permits to write the autoregressive polynomial Φ(B) as:

$$\begin{aligned}\Phi(B) = & -\pi_1 B\left(1+B+B^2+B^3\right)-\pi_2\left(-B\right)\left(1-B+B^2-B^3\right) \\ & -\left(\pi_4+\pi_3 B\right)\left(-B\right)\left(1-B^2\right)+\Phi^*(B)\left(1-B^4\right)\end{aligned} \qquad \ldots(2)$$

$$\begin{aligned}\Phi^*(B)Y_{4t} = & \pi_1 Y_{1,t-1}+\pi_2 Y_{2,t-1}+\pi_3 Y_{3,t-2} \\ & +\pi_4 Y_{3,t-1}+\mu_t+\varepsilon_t\end{aligned} \qquad \ldots(3)$$

where

$$\begin{aligned}Y_{1,t} &= \left(1+B+B^2+B^3\right)X_t = S(B)X_t \\ Y_{2,t} &= -\left(1-B+B^2-B^3\right)X_t \\ Y_{3,t} &= -\left(1-B^2\right)X_t \\ Y_{4,t} &= \left(1-B^4\right)X_t = \Delta_4 X_t = \left(1-B\right)Y_{1,t} \\ &= -\left(1+B\right)Y_{2,t} = -\left(1+B^2\right)Y_{3,t}\end{aligned} \qquad \ldots(4)$$

In the case where we accept the filter $\left(1-B^{4}\right)$ to make stationary X_t^*, the $Y_{k,t}$ k =1,2 et 3, have respectively, the unit roots of the frequencies 0, π and $\pi/2$. For the roots 1, -1 and i, we consider the following null and alternative hypotheses:

$$\begin{aligned}&H_{01}: \Phi(1) = -\pi_1 = 0 \,(\text{root } 1) \\ &H_{a1}: \Phi(1) > 0 \text{ or } \pi_1 < 0\end{aligned} \qquad \ldots(5)$$

$$\begin{aligned}&H_{02}: \Phi(-1) = -\pi_2 = 0 \,(\text{root } -1) \\ &H_{a2}: \Phi(-1) > 0 \text{ or } \pi_2 < 0\end{aligned}$$

$$\begin{aligned}&H_{03}: \left|\Phi(i)\right| = 0 \;\; \pi_3 \cap \pi_4 = 0 \,(\text{roots } \pm i) \\ &H_{a3}:: \left|\Phi(i)\right| > 0 \text{ or } \sqrt{\pi_3^2+\pi_4^2} \neq 0 \Leftrightarrow \pi_3 \neq 0 \text{ or } \pi_4 \neq 0\end{aligned}$$

If $\Phi^*(B)$ =1 then the equation (3) becomes:

$$\begin{aligned}Y_{1,t} &= (1+\pi_1)Y_{1,t-1}+\varepsilon_t \quad \text{if} \quad \pi_2=\pi_3=\pi_4=0 \\ Y_{2,t} &= -(1+\pi_2)Y_{2,t-1}+\varepsilon_t \; \textit{if} \quad \pi_1=\pi_3=\pi_4=0 \\ Y_{3,t} &= -(1+\pi_3)Y_{3,t-2}+\varepsilon_t \; \text{if} \quad \pi_1=\pi_2=\pi_4=0\end{aligned} \qquad \ldots(6)$$

The first and second equations will be treated as in the Dickey-fuller procedure of root unit testing, the third equation permits to test a stochastic seasonality in the case of biannual data. If the statistical results lead to the $\pi_k \neq 0, k=1,2,3,4$ then the X_t process is either stationary or it incorporates a deterministic seasonality and/or linear trend. If $\pi_k \neq 0, k=2,3,4$ and $\pi_1=0$ then the X_t process requires a first difference to become stationary and the regression in (3) is equivalent to the standard test of ADF procedure. In general, if some π_k are zeros then the unit roots exist in the regression. In this situation, the HEGY procedure informs us that the corresponding $Y_{k,t}$ are asymptotically not correlated because the corresponding unit roots have different frequencies. Finally, the HEGY procedure disposes the critical values of test statistics associated to the $\pi_k, k=1,2,3,4$ and $\pi_{34}=\pi_3 \cap \pi_4$. These critical values vary according to the presence of a deterministic part in the regression or not. The optimal degree of the polynomial $\Phi^*(B)$ results from an optimal specification by AIC using the auxiliary regression. The residuals of the corresponding model are accepted as a white noise when

* An innovation ε_t has a permanent effect on the value of X_t, because X_t is the sum of all previous innovations.

the Ljung – Box statistical is favorable. We pay more attention to the testing results when the seasonal indicatory variables are included in the regression. Actually, the inclusion of these variables in the equation, even if it is not necessary, don't provoke a deterioration in the power of the tests, on the other hand, an important bias results from their omission when they are necessary (See EGHL, 1993). The optimal orders of the AR models written under different deterministic parts are given in table (1) for the main and differentiated series. these orders vary between (1) and (5).

In the tables (2 and 3), we presented the statistics of unit roots of all frequencies. The inspection of the two tables shows that the export is integrated at order 1 of the frequencies 0 and $\frac{1}{2}$, therefore, we can accept, the filter $\left(1-B^2\right)$. The ¼ frequency seems masked, but the null hypothesis ($\pi_3 = \pi_4 = 0$) seems accepted to the level 5% (seasonal auxiliary variables are included in the regression). For the Exports variable, we are going to consider the integration of all frequencies, therefore, the filter $\left(1-B^4\right)$ is necessary to make it stationary. With regard to the import variable, the answers of the test statistics seem more lucid: the integration at order 1 is accepted of all frequencies, therefore, the stationarity of this variable is assured by the use of the filter $\left(1-B^4\right)$. For the balance commercial variable (titled IE_t), it is clear that it is integrated of the frequencies 0 and $\frac{1}{2}$ therefore, the filter $\left(1-B\right)\times\left(1+B^2\right)$ is necessary to make it stationary..

Table 1

Variables	**Export**		**Δ(Export)**		**Import**		**Δ(Import)**		**(Import-Export)** IE_t		**Δ(** IE_t **)**	
Deterministic part [a]	p	AIC	p	AIC	p	AIC	p	AIC	p	AIC	p	AIC
--	5	16.71	4	16.70	5	17.17	4	17.28	1	17.13	1	17.13
C	5	16.72	4	16.68	5	17.21	4	17.23	1	17.11	1	17.15
C+SD	2	16.67	1	16.63	5	17.24	4	17.26	1	17.02	1	17.07
C+TR	5	16.67	4	16.72	5	17.24	4	17.20	1	17.09	1	17.20
C+TR+SD	2	16.61	1	16.67	5	17.26	4	17.23	1	17.0	1	17.10

[a] *C= constant, TR = Trend, SD = seasonal indicatory variables: we have defined 3 auxiliary variables as follows:*

$$D_{kt} = \begin{cases} 1 \;\; if \;\; t \;\; corresponds \; to \; the \; quarter \;\; k, k = 1,2,3 \\ 0 \qquad\qquad\qquad\qquad otherwise \end{cases}$$

The quarter 4 has been considered as a basis.

The used general model is:

$$\Phi^*(B)Y_{4t} = a + bt + c_1 D_{1t} + c_2 D_{2t} + c_3 D_{3t} + \pi_1 Y_{1,t-1} + \pi_2 Y_{2,t-1} + \pi_3 Y_{3,t-2} + \pi_4 Y_{3,t-1} + \varepsilon_t$$

The optimal order p of $\Phi^*(B)$ has been identified by the AIC criterion. The period of estimation is 1980-2001.

Table 2

Variables	**Deterministic Parts**	$\hat{\pi}_1$	$\hat{\pi}_2$	$\hat{\pi}_3$	$\hat{\pi}_4$	$\hat{\pi}_3 \cap \hat{\pi}_4$	Q_{12}^{a}
Export	-	-1.7	-0.09	-1.07	0.89	0.95	8.67
	C	-2.4	-0.08	-1.11	0.86	0.98	6.66
	C+SD	-4.04[b]	-1.60	-3.71[b]	1.04	7.76[b]	5.08
	C+TR	-2.14	-0.08	-1.12	0.85	0.98	6.48
	C+TR+SD	-4.01[b]	-1.62	-3.68[b]	1.11	7.73[b]	4.6
Import	-	-1.58	-0.4	-0.26	-0.16	0.05	10.4
	C	-3.05[b]	-0.35	-0.33	-0.13	0.07	7.0
	C+SD	-2.93	-1.1	-1.8	-0.05	1.62	6.9
	C+TR	-3.87[b]	-0.33	-0.5	0.07	0.13	5.7
	C+TR+SD	3.79[b]	-1.05	-1.95	0.18	1.92	5.3

Variables	**Deterministic Parts**	$\hat{\pi}_1$	$\hat{\pi}_2$	$\hat{\pi}_3$	$\hat{\pi}_4$	$\hat{\pi}_3 \cap \hat{\pi}_4$	Q_{12}^{a}
IE_t	-	-2.25[b]	-2.37[b]	-1.25	0.52	0.91	14.7
	C	-2.39	-2.33[b]	-1.28	0.57	0.97	14.8
	C+SD	-2.42	-3.41[b]	-3.35	0.73	5.92	9.8
	C+TR	-2.25	-2.30[b]	-1.27	0.57	0.97	15.05
	C+TR+SD	-2.34	-3.37[b]	-3.34	0.75	5.90	10.2

[a] *The statistical* Q_{12} *follows a chi-squared of 12 degrees of freedom (the critical value is 21.03 at the level = 5%). Therefore the residuals associated to every type of deterministic parts are accepted as a white noise.*
[b] *The test is significant at the level = 5% (The critical values are in HEGY 1990).*

Table 3

Variables filtered by (1-B)	**Deterministic parts**	$\hat{\pi}_1$	$\hat{\pi}_2$	$\hat{\pi}_3$	$\hat{\pi}_4$	$\hat{\pi}_3 \cap \hat{\pi}_4$	Q_{12}^{b}
Exports	-	-4.93[a]	-0.12	-0.12	1.33	0.89	9.8
	C	-4.89[a]	-0.12	-0.11	1.32	0.88	9.8
	C+SD	-3.83[a]	-1.43	-2.73	3.03	8.37[a]	13.5
	C+TR	-4.94[a]	-0.10	-0.08	1.30	0.86	10.7
	C+TR+SD	-3.91[a]	-1.41	-2.66	3.02	8.13[a]	14.2
Imports		-4.97[a]	-0.44	-0.26	0.04	0.04	11.7
	C	-4.93a	-0.44	-0.26	0.04	0.04	11.8
	C+SD	-4.85[a]	-1.16	-1.29	1.19	1.57	11.9
	C+TR	-4.92[a]	-0.42	-0.28	0.00	0.04	11.5
	C+TR+SD	-4.84[a]	-1.15	-1.30	1.13	1.51	11.6
IE_t		-5.53[a]	-2.52[a]	-0.45	0.91	0.50	13.3
	C	-5.50[a]	-2.51[a]	-0.45	0.89	0.48	13.3
	C+SD	-5.11[a]	-3.52[a]	-1.60	2.32	3.88	8.06
	C+TR	-5.52[a]	-2.48[a]	-0.46	0.87	0.47	12.9
	C+TR+SD	-5.13[a]	-3.48[a]	-1.61	2.30	3.85	7.7

[a] *The test is significant at the level = 5% (The critical values are in HEGY 1990).*
[b] *the Ljung-Box statistics (the critical value is 21.03 at the level = 5%).*

4. SEASONAL COINTEGRATION

Let's consider a vector X_t of dimension $N \times 1$ whose components have the frequencies 0, ¼, ½, ¾. The Wold representation permits to write $(1-B^4)X_t = C(B)e_t$ where e_t is a white noise vector $IND(0,\Omega)$ and C(B) is a $N \times N$ polynomial matrix in B. If there is a cointegration of the frequency 0 then there exists a $N \times r_1$ matrix A_1 $(N > r_1 \geq 0)$ such that $A'_1\, C(1) = 0$, while a cointegration of the ½ frequency requires the existence of a $N \times r_2$ matrix A_2 $(N > r_2 \geq 0)$ such that $A'_2\, C(1) = 0$. The columns of A_1 and A_2 are called the cointegrating vectors of the frequencies 0 and $1/2$ respectively, while r_1 and r_2 are called the cointegrating ranks. The cointegration of the frequencies $1/4$ and $3/4$ that correspond to the complex roots i and -i, allows an extension of the notion of the cointegrating vector to the cointegrating polynomial $A(B) = A_3 + A_4 B$ such that $A'_k\, C(i) = 0$ (k=3,4) where A_3 and A_4 are $N \times r_3$ matrixes with $(N > r_3 \geq 0)$. In practice, instead of the Wold representation, we consider ECM representation suggested by HEGY (1990):

$$A(B)Y_{4,t} = \gamma_1 A'_1\, Y_{1,t-1} + \gamma_2 A'_2\, Y_{2,t-1} - (\gamma_3 + \gamma_4 B)(A'_3 + A'_4\, B)Y_{3,t-2} + e_t$$

The left member of the equation is a VAR stationary process filtered by $(1-B^4)$. The right member of the equation corresponds to the cointegrating relations of the different frequencies. γ_1, γ_2, γ_3 and γ_4 are matrices of dimensions $N \times r_1$, $N \times r_2$, $N \times r_3$ and $N \times r_4$ respectively. These matrices contain the weights of the cointegrating relations of the different frequencies in the N equations. The polynomial $A(B)$ has all the roots outside of the unit circle and $A(0) = I_N$ (identity matrix). The cointegrating relations of the frequencies 0, ½, ¼ and ¾ are given respectively, by $A'_1 Y_{1,t}$ (one cycle per year i.e. cointegrating relation at long term), $A'_2 Y_{2,t}$ (two cycles per year) and $(A'_3 + A'_4 B)Y_{3,t}$ (four cycles per year). Since our system is constituted of the two variables (import and export), it can exist at most one cointegrating relation of each frequency **θ** (**θ** = 0, ½, ¼ and ¾) provided that each of our variables is $I_\theta(1)$. If for each frequency the cointegrating rank is 1 then the ECM representation has the following form (See Bresson and Pitotte, 1995: 453-459):

$$\begin{pmatrix} A_{11}(B) & A_{12}(B) \\ A_{21}(B) & A_{22}(B) \end{pmatrix}\begin{pmatrix} \Delta_4 X_t^1 \\ \Delta_4 X_t^2 \end{pmatrix} = \begin{pmatrix} g_{11} & -g_{11}a_{12} \\ g_{21} & -g_{21}a_{12} \end{pmatrix}\begin{pmatrix} X_{1,t-1}^1 \\ X_{1,t-1}^2 \end{pmatrix} + \begin{pmatrix} g_{12} & -g_{12}a_{22} \\ g_{22} & -g_{22}a_{22} \end{pmatrix}\begin{pmatrix} X_{2,t-1}^1 \\ X_{2,t-1}^2 \end{pmatrix} - \begin{pmatrix} g_{13} + g_{14}B \\ g_{23} + g_{24}B \end{pmatrix}\left(X_{3,t-2}^1 - A_1 X_{3,t-2}^2 - A_3 X_{3,t-3}^2\right) + \varepsilon_t$$

Where $X_{1,t}^k = \left(1 + B + B^2 + B^3\right)X_t^k$

$$X_{2,t}^k = -\left(1 - B + B^2 - B^3\right)X_t^k$$

$$X_{3,t}^k = -\left(1 - B^2\right)X_t^k$$

k = 1,2 and X_t^1 (resp. X_t^2) represents the export variable (resp. import variable). A cointegration associated to the frequency 0 is interpreted as an indication of a parallel movement at long-run between the non stationary time series. A cointegration of the other frequencies is also interpreted as a parallel movement in the corresponding seasonal. The $X_{k,t}^1$ and $X_{k,t}^2$ (k=1,2,3) have asymptotically an infinite variance (i.e. non stationary variable for a particular seasonal frequency) and all linear combinations will have an infinite variance except the linear combination $I_\theta(0)$ for all value of **θ**:

$$Z_{1t} = X_{1,t}^1 - a_{12}X_{1,t}^2$$

$$Z_{2t} = X_{2,t}^1 - a_{22}X_{2,t}^2$$

$$Z_{3t} = X_{3,t}^1 - A_1 X_{3,t}^2 - A_3 X_{3,t-1}^2$$

The last linear combination is a dynamic relation.

4.1 Cointegrating test of the frequency 0:

W consider the two following regressions:

$$X_{1,t}^1 = \Phi X_{1,t}^2 + u_t$$

$$\Delta u_t = \pi_1 u_{t-1} + \sum_{j=1}^{p} b_j \Delta u_{t-j} + e_t$$

In the first equation, we can introduce a deterministic part constituted of only one constant or a constant and a linear trend. We can also consider the variable $X_{1,t}^1 - X_{1,t}^2$ and then apply the usual Dickey-Fuller test. The cointegrating strategy of the frequency 0 has been elaborated by Engle and Granger (1987), Engle and Yoo (1987). It is a procedure of two stages: the first stage leads to make a regression of $X_{1,t}^1$ on $X_{1,t}^2$ (it is the cointegrating regression). The resulting residuals are interpreted as the cointegrating linear relation. To this stage, the Durbin - Watson statistic DW is used to test the stationarity of the residuals. If the behavior of u_t reveals a unit root, then the DW will be close to 0 and consequently we cannot accept the hypothesis of the cointegrating relation. On the contrary, if the DW is significantly larger than 0, we accept the cointegrating relation of the frequency 0. The second stage consists in making an auxiliary regression that considers the second equation above to calculate the ADF statistic.

4.2 Cointegrating test of the frequency ½:

As in the previous case, we consider the two following regressions (See Engle et al., 1993):

$$X_{2,t}^1 = \Phi X_{2,t}^2 + v_t$$

$$\left(v_t + v_{t-1}\right) = \pi_2 (-v_{t-1}) + \sum_{j=1}^{p} b_j \left(v_{t-j} + v_{t-j-1}\right) + e_t$$

The sign (-) is used so that the statistic distribution is the same as Δu_t on u_{t-1}, The cointegrating regression can be realized with or without the deterministic part.

4.3 Cointegrating test of the frequencies ¼ and ¾:

We regress $X^1_{3,t}$ on $X^2_{3,t}$ nd $X^2_{3,t-1}$. Hence we consider

$$X^1_{3,t} = \beta_1 X^2_{3,t} + \beta_2 X^2_{3,t-1} + w_t$$
$$(w_t + w_{t-2}) = \pi_3(-w_{t-2}) + \pi_4(-w_{t-1}) + \sum_{j=1}^{p} b_j (w_{t-j} + w_{t-j-2}) + e_t$$

The null hypothesis of the cointegrating relation of the frequencies ¼ and ¾ implies that $\pi_3 = \pi_4 = 0$ in the auxiliary regression. The critical values of statistics associated to $\pi_3 = 0$, $\pi_4 = 0$ and $\pi_{34} = \pi_3 \cap \pi_4 = 0$ are presented by EGHL (1993). The comparison of the critical values of π_{34} with those that are gotten by HEGY (1990), reveals that working on the estimated residues leads to a distribution that has bigger values. The inclusion of a constant in the cointegrating regression doesn't affect the distributions which are affected only by the inclusion of seasonal variables. In the following, we present the statistics for the different cointegrating tests (tables 4, 5, 6).

Table 4: Cointegrating test of the frequency 0

Cointegrating regression					Auxiliary regression[a]			
Dependent variable	**Independent variable $X^2_{1,t}$**	**Deterministic part**	R^2	**DW**	**Deterministic part**	**P[b]**	Q^c_n	**ADF** $t_{\hat{\pi}_1}$
$X^1_{1,t}$	0.727 (88.8)[d]	-	0.94	0.02	-	1	$Q_{20} = 26$	-2.61
$X^1_{1,t}$	0.667 (38.9)	C	0.95	0.02	-	1	$Q_{20} = 24.9$	-2.36
$X^1_{1,t}$	0.361 (7.14)	C+TR	0.96	0.03	-	1	$Q_{20} = 26$	-2.62
$X^1_{1,t}$	1 fixed	-	-	-	C+TR	5	$Q_{21} = 14.8$	-2.7
$X^1_{1,t}$	1 fixed	-	-	-	C+TR+SD	5	$Q_{21} = 17$	-2.66

[a] The critical values are given by Engle - Yoo (1987) and Dickey - Fuller (1979). F or a sample of 100 observations and at the level of 5%, the critical values are -3.17 and -3.45 respectively. Since $t_{\hat{\pi}_1} \succ t_{tab}$, we accept a unit root in the residues.

[b] The optimal order p in the auxiliary regression is identified by the AIC criterion

[c] Q represents the Ljung – Box statistic. It permits to validate the empiric residues in the auxiliary regression as a white noise

[d] In parentheses, we present the t ratios.

Table 5: Cointegrating test of the frequency ½

Cointegrating regression					Auxiliary regression[a]			
Dependent variable	**Independent variable $X^2_{2,t}$**	**Deterministic part**	R^2	**DW**	**Deterministic part**	**P[b]**	Q^c_n	**ADF** $t_{\hat{\pi}_1}$
$X^1_{2,t}$	0.761 (12.2)	-	0.61	2.56[b]	-	1	$Q_{20} = 20.9$	-1.79[a]
$X^1_{2,t}$	0.81 (11.6)	C	0.61	2.45[b]	-	1	$Q_{20} = 20.6$	-1.97[a]
$X^1_{2,t}$	0.565 (9.85)	C+SD	0.80	2.08[c]	-	1	$Q_{20} = 18.3$	-2.6[a]

[a] Since $t_{\hat{\pi}_1} \succ t_{tab}$, we don't accept the cointegrating relation of the biannual frequency.

[b] The Durbin-Watson statistic leads to accept a correlated residues in the cointegrating regression.

[c] We don't accept the correlation in the residues.

Table 6: Cointegrating test of the frequencies ¼ and ¾

Cointegrating regression					Auxiliary regression[a]				
Dependent variable	Independent variables $X^2_{3,t}$	$X^2_{3,t-1}$	Deterministic part	R^2	p[c]	Q_{20}	$t_{\hat{\pi}_3}$	$t_{\hat{\pi}_4}$ [b]	$t_{\hat{\pi}_3 \cap \hat{\pi}_4}$ [a]
$X^1_{3,t}$	-0.008 (-0.13)	0.475 (7.64)	-	0.44	1	18.6	-0.418 (-4.01)	-0.148 (-1.33)	9.21
$X^1_{3,t}$	-0.017 (-0.26)	0.464 (7.04)	C	0.44	1	18.8	-0.426 (-4.07)	-0.159 (-1.29)	9.42
$X^1_{3,t}$	0.181 (2.83)	0.345 (5.30)	C+SD	0.63	1	11.8	-0.61 (-5.07)	-0.232 (-1.70)	14.61

[a] For a sample size 100, the critical values at the level 5% are respectively 7.10 and 10.12 (cointegrating regression contains a constant C and C + SD) and 7.21 (cointegrating regression without deterministic part). Therefore we accept the cointegrating relation of the frequencies $\frac{1}{4}$ and $\frac{3}{4}$

[b] *we accept* $\pi_4 = 0$ *and we reject* $\pi_3 = 0$

[c] *The corresponding values of AIC are respectively 16.54, 16.14 and 16.55.*

4.4 Cointegrating Relations

The inspection of the results presented in the table (4) shows that the ADF statistics, in all cases, indicate the presence of a unit root and by consequence there isn't a long-term cointegration. We conclude that the filter (1-B) is not adequate. In the same way, the table (5) shows that there is not a cointegration of the biannual frequency. Finally, the results of the tests in the table (6) leads to the acceptance of the hypothesis cointegration of the frequencies $\frac{1}{4}$ and $\frac{3}{4}$. This cointegration reveals a parallel movement between the two non stationary series i.e. it indicates that the yearly seasonal behaviors of the export and the import of the United States are similar.

Since we accepted the cointegration of the frequencies $\frac{1}{4}$ and $\frac{3}{4}$ (table 6), the cointegrating regression (dynamic specification) is considered first without deterministic part, then with deterministic part which contains either only a constant alone, or a constant and the seasonal auxiliary variables(D_{kt} , $k = 1,2,3$). Therefore, we got a cointegrating relation between $X^1_{3,t}$ and $X^2_{3,t}$ under three different shapes:

$$RC_{1,t} = X^1_{3,t} + \underset{(0.13)}{0.008X^2_{3,t}} - \underset{(-7.46)}{0.475X^2_{3,t-1}}$$

$$RC_{2,t} = X^1_{3,t} + \underset{(0.61)}{401.03} + \underset{(0.26)}{0.017X^2_{3,t}} - \underset{(-7.04)}{0.464X^2_{3,t-1}}$$

$$RC_{3,t} = X^1_{3,t} \underset{(-2.0)}{-2055} + \underset{(4.8)}{6597D_{1t}} + \underset{(3.1)}{4343D_{2t}} \underset{(-1.8)}{-2583D_{3t}} \underset{(-2.8)}{-0.181X^2_{3,t}} \underset{(-5.3)}{-0.345X^2_{3,t-1}}$$

By analogy to the ECM representation of the non seasonal case, we consider the ECM version proposed by Osborn (1993), we write:

$$\Delta_4 E_t = \sum_{i=1}^{p} a_i \Delta_4 E_{t-i} + \sum_{j=1}^{q} b_j \Delta_4 I_{t-j} - (b_{11} + b_{12}B) RC_{i,t-2} + \varepsilon_{1t}$$

$$\Delta_4 I_t = \sum_{i=1}^{p} a_i \Delta_4 I_{t-i} + \sum_{j=1}^{q} b_j \Delta_4 E_{t-j} - (b_{21} + b_{22}B) RC_{i,t-2} + \varepsilon_{2t}$$

with E_t and I_t defined as before,

$E_{3,t} = -(1 - B^2)E_t$ and $I_{3,t} = -(1 - B^2)I_t$. The $RC_{i,t-2}$, i =1,2, 3, is one of the above cointegrating relations. The estimation of the ECM representation is the following[*]:

Cointegrating relation without deterministic part:

$$\Delta_4 E_t = 0.877\,\Delta_4 E_{t-1} - 0.485\,\Delta_4 E_{t-4} + 0.382\,\Delta_4 E_{t-5}$$
$$\quad (9.95) \qquad (-3.62) \qquad (3.48)$$

$$+ 0.24\,\Delta_4 I_{t-1} - 0.164\,\Delta_4 I_{t-3} - 0.259\,RC_{1,t-2} + \hat{\varepsilon}_{1t}$$
$$\quad (4.57) \qquad (-3.21) \qquad (-2.64) \qquad (3332)$$

$$\Delta_4 I_t = 1.414\Delta_4 I_{t-1} - 0.256\Delta_4 I_{t-2} - 0.871\Delta_4 I_{t-4}$$
$$\quad (14.46) \qquad (-1.97) \qquad (-6.51)$$

$$+ 0.648\Delta_4 I_{t-5} - (0.276 - 0.266B)RC_{1,t-2} + \hat{\varepsilon}_{2t}$$
$$\quad (5.53) \qquad (2.29)\ (-2.18) \qquad (4854)$$

Cointegrating relation with constant and seasonal indicatory variables[**]

$$\Delta_4 E_t = 0.873\Delta_4 E_{t-1} - 0.477\Delta_4 E_{t-2} + 0.275\Delta_4 I_{t-1}$$
$$\quad (7.9) \qquad (-5.8) \qquad (5.9)$$

$$-0.849RC_{3,t-2} + \hat{\varepsilon}_{1t}$$
$$\quad (-6.6) \qquad (3392)$$

$$\Delta_4 I_t = 1.221\Delta_4 I_{t-1} - 0.951\Delta_4 I_{t-4} + 0.571\Delta_4 I_{t-5}$$
$$\quad (26.03) \qquad (-7.17) \qquad (4.37)$$

$$+ 0.125\Delta_4 I_{t-9} - (0.261 - 0.249B)RC_{3,t-2} + \hat{\varepsilon}_{2t}$$
$$\quad (1.93) \qquad (1.57)\ (-1.45) \qquad (4920)$$

5. Choice of the cointegrating relation

To choose between the two above cointegrating relations, we evaluated the forecastings for the period 1999-2003 (20 quarters) using the corresponding ECM. Indeed, the calculation of the forecastings was always a main object for the economic series. Forecasting and especially forecasting with the minimum error requires the following:

1. Knowing the reason of the non stationarity of the economic time series
2. Detecting the nature of seasonality: deterministic or stochastic
3. Distinguishing between seasonal integration of certain frequency and all seasonal frequencies, etc.

Frances (1991) achieved a comparison of the forecasting performance between the models that incorporate the multiplicative Box-Jenkins filter $(1-B)(1-B^{12})$ and those that require the filter $(1-B)$ accompanied by a constant and 11 seasonal indicatory variables (FDSD model). The result of this comparison revealed that the absence of the seasonal unit roots can have important implications in the forecastings. In the following, we are going to present some briefly convenient techniques that help to evaluate forecastings by the proposed models.

Let's designate by P_t the forecasted value and A_t the real value of a time series. If $P_t = A_t$ then the forecastings are perfectly exact and the linear correlation coefficient between P_t and A_t is equal to 1 (t = 1,2,..., H; H = sample size of forecastings). However, this case is unrealistic because in all modelling, there are errors due to the uncertain factors not explained by the proposed model, and other errors due to a fast decision when the statistical test behaviors are impertinent. To examine the accuracy of the forecastings, we are going to analyze the behavior of the P_t and A_t sequences using the measures most used by the analysts of forecastings. From these measures, we mention:

[*] The order optimal p is identified by the AIC criterion: we first identified p considering the AR(p) model for $\Delta_4 E_t$ in the cointegrating relation.We found AIC(5) = 16.62, then we introduced the variable $\Delta_4 I_t$ and we found AIC(3) = 16.52. Similarly for the variable $\Delta_4 I_t$, we found AIC(5) = 17.16 then AIC(1) = 17.2.

[**] In the cointegrating relation with constant, we note that this constant is not significant, therefore the ECM representation associated is practically the same that has been estimated in the first case (without deterministic part). For the third cointegrating relation, the order optimal p has also been determined by the AIC criterion (AIC(2) = 16.6 then AIC(1) = 16.4 for the first equation of the ECM) and AIC(5)=17.2 then AIC(1) = 17.26 for the second equation.

1- Root Mean Squared Error:

$$RMSE = \sqrt{\frac{1}{H}\sum_{i=1}^{H}(A_i - P_i)^2}$$

From this criterion, we can calculate the different sources of the forecast errors (For application of these techniques, see Joutz – Stekler, 2000). To get the different components of MSE, we follow the next one:

$$MSE = \frac{1}{H}\sum_{i=1}^{H}(A_i - P_i)^2 =$$
$$\frac{1}{H}\sum_{i=1}^{H}\left[\left(A_i - \bar{A}\right) + \left(\bar{A} - \bar{P}\right) - (P_i - \bar{P})\right]^2$$
$$= \frac{1}{H}\sum_{i=1}^{H}\left(A_i - \bar{A}\right)^2 + \frac{1}{H}\sum_{i=1}^{H}\left(P_i - \bar{P}\right)^2$$
$$+ \left(\bar{A} - \bar{P}\right)^2 - \frac{2}{H}\sum_{i=1}^{H}\left(A_i - \bar{A}\right)\left(P_i - \bar{P}\right)$$
$$= \left(\bar{A} - \bar{P}\right)^2 + \left(S_A - rS_p\right)^2 + \left(1 - r^2\right)S_p^2$$

where $\bar{P} = \frac{1}{H}\sum_{i=1}^{H} P_i$, $\bar{A} = \frac{1}{H}\sum_{i=1}^{H} A_i$, S_A and S_P are respectively the standard deviations of the sequences A_t and P_t and r is their linear correlation coefficient. Dividing the two members by MSE, we get

$$1 = U^M + U^R + U^P$$

$U^M = \frac{(\bar{A} - \bar{P})^2}{MSE}$ measures the source of the forecast error resulting from an under - prediction or over - prediction of the average $\bar{P}$

$U^R = \frac{\left(S_A - rS_P\right)^2}{MSE}$ represents the source of the forecast error resulting from an under - prediction or over - prediction of the regression slope of A_t on P_t , t= 1,…,H.

$U^D = \frac{\left(1 - r^2\right) S_P^2}{MSE}$ is the random source of forecasting.

In practice, we wish that U^D is close to 1 and U^M and U^R are near 0. The information about the quality of forecasts obtained by U^M, U^R and U^D, is very important particulary if H is large ($H \geq 30$).

2- Mean Absolute Percentage Error:

$$MAPE = \frac{1}{H}\sum_{i=1}^{H} APE_i \times 100$$

With $APE_i = \frac{|A_i - P_i|}{A_i}$ (Absolute Percentage error).

This criterion is the most advisable to choose among two or several proposed models.

Export variable

Cointegrating relation RC_1			Cointegrating relation RC_3	
Years	2002	2002-2003	2002	2002-2003
MAPE	5.9	4.8	4.9	3.5
$\bar{A}$	173 275	177234	173275	177234
$\bar{P}$	174 785	175086	173418	175390
r	0.48	0.36	0.39	0.54
U^M	0.02	0.05	0.00	0.05
U^R	0.85	0.46	0.84	0.38
U^D	0.13	0.49	0.16	0.57

Import variable

Cointegrating relation RC_1			Cointegrating relation RC_3	
Years	**2002**	**2002-2003**	**2002**	**2002-2003**
MAPE	4.7	5.8	5.7	4.6
$\bar{A}$	290341	302311	290341	302311
$\bar{P}$	277761	285106	295265	301494
r	0.83	0.90	0.89	0.75
U^M	0.59	0.78	0.07	0.00
U^R	0.00	0.01	0.72	0.30
U^D	0.41	0.21	0.21	0.70

The inspection of the one-step ahead forecast errors shows clearly that for the two variable export and import, the relation RC_3 provides the best forecastings. For the horizons 2002-2003 (8 quarters), the statistical MAPE is 3.5% for the export variable and 4.6% for the import one. The real balance passed from (≈ -468) billions[*] dollars in 2002 to (≈ -532) billions of dollars in 2003. On the other hand, the predicted balance deduced from cointegrating relation RC_3 passed from (≈-487) in 2002 to (≈ -522) in 2003. This widened the gap in the commercial balance can be considered as a sign of crisis in the American economy. In the literature of the cointegration, Perron (1989, 1994, 1997), Zivot and Andrews (1992), proposed to introduce in the Dickey-Fuller regression, an intervention variable that takes into account the change of the structure in a macroeconomic time series. Yet, this procedure doesn't take into account the seasonal integrations and its power is limited to test the integration of the frequency zero, in this case, the procedure chooses the ECM representation.

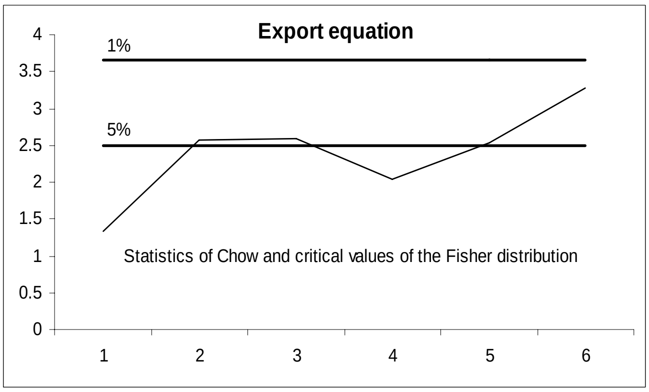
6. STRUCTURAL CHANGE TESTING

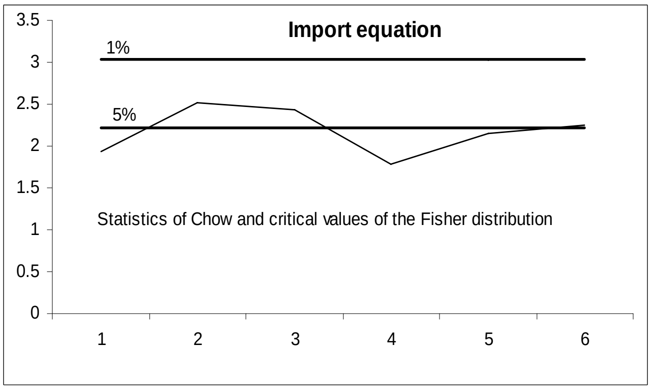
The stability of the parameters of a model plays an important role when we try to understand the economic mechanisms and to achieve some projections. Their stability can reflect some structural or punctual phenomena in the time. In order to study the temporal instability, the econometricians have, since some years, raised one of the fundamental hypotheses: the constancy of the coefficients in the time. The principle is to investigate the variability of the coefficients in the time. A lot of tests of stability of the parameters proposed since the year 1960 like the the likelihood ratio test proposed by Quandt (1960), the Chow test proposed by Chow (1960), the Cumulative Sum of recrursive residuals (Cusum test) and Cumulative Sum of Squares of recursive residuals (Cusum Square test) proposed by Brown, Durbin Evans and (1975, the test of influence of Belsey,Kuh and Welsh (1980). In the following, we limit ourselves to the Chow test for its easiness of setting in practice.

The null hypothesis means the absence of structural change. The evolutive Chow test is based on the following statistic:

$$Chow = \frac{SSR - (SSR_{1h} + SSR_{2h})}{(SSR_{1h} + SSR_{2h})} \times \frac{T - 2K}{K}$$

where SSR is the Residual Sum of Square of the model estimated on the whole T observations of the time series. The result can be regarded as obtained from a pooled sample comprising both the first T_{1h} periods and the last T_{2h} periods. SSR_{1h} (resp. SSR_{2h}) represents Residual Sum of Square of the model estimated on T_{1h} first observations(respectively on the T_{2h} observations) with $T_{1h} = 36+4h$ and $T_{2h}=T-T_{1h}$, $h = 0,1,\ldots,5$. The choice of these two sample sub-periods has been made respecting the requirements of the Central Limit Theorem (sample size > 30). The statistic of Chow follows a Fisher distribution F(K,T-2K). Using the cointegrating relation RC_3 in the ECM representation, we obtain the following plots:





The graphical representation of the statistics of Chow is located below of the statistic of Fisher at 1 % level of significance. It means, for this level, that there is no structural change in the value of the parameters for two equations. The inspection of the graphics at 5 % level shows that the export and import system of the United

[*] 1 billion=10^9

States is provided with a certain little rupture: The biggest is associated to the sub-periods 1980:1-1993:4 and 1994:1-2003:4 for the export variable and to the sub-periods 1980:1-1989:4 and 1990:1-2003:4 for the import variable. The graphic aspect of two time series reveals that a tendency of divergent evolution appeared more and more important between the exports and the imports of the United States and by consequently there would be a possibility to lose the proposed cointegration relationship between them.

7. CONCLUSION:

The first point of our conclusion is that each of the two variables (Export and Import of the United States) is not stationary and each requires a specific treatment to become stationary. Indeed, the two series are integrated of all seasonal frequencies 0, ¼, ½, ¾ which means that they become stationary after the application of the filter $\left(1 - B^4\right)$. The balance commercial variable resulting from the difference between the import and the export is integrated of the frequencies 0, ¼, and ¾. This series becomes stationary after filtering by $\left(1 - B\right)\times\left(1 + B^2\right)$. It encourages the idea that the biannual frequency has been eliminated.

The second point of the conclusion is related to the cointegration of the two series. The whole of our statistical results reinforces the idea of the non cointegration of the frequencies 0 and ½. on the other hand, the cointegration of the yearly frequency seems clear. This implies that outside a stochastic trend, the two series have a similar yearly seasonal behavior and by consequently they are dominated by a certain parallel yearly movement. This result is very close to that found by Engle et al. (1993) in the analysis of the seasonal cointegration concerning the consumption and the income in Japan.

The third point of the conclusion deals with the analysis of the forecasting performance of the ECM representation. Indeed, the stationary linear combination of the two series associated to the ¼ frequency can occur with a deterministic part (constant, or constant and indicatory seasonal variables) or without deterministic part in the cointegrating relation. The cointegrating relation RC_3 (dynamic cointegrating relation) that results from a regression of $X^1_{3,t}$ on $X^2_{3,t}$ and $X^2_{3,t-1}$ seems more adequate with the reality of the export and import system of the United States. The comparison of the quality of the forecastings between $RC_{1,t}$ and $RC_{3,t}$ permits to adopt the RC_3 because it best reflects the reality of the system. The quantity $RC_{3,t}$ is known as a disequilibrium error. It will of course, take a zero value when the export and import system is in equilibrium (long-run equilibrium) i.e:

$$\Delta_2 E_t = DP_t + 0.181\Delta_2 I_t + 0.345\Delta_2 I_{t-1}$$

$$DP_t = -2055 + 6597\,D_{1t} + 4343\,D_{2t} - 2583\,D_{3t}$$

$$\Delta_2 = (1 - B^2)$$

DP_t represents the deterministic part and D_{kt} k=1,2,3, indicates the seasonal indicatory variables (the quarter 4 has been considered as a basis). The survey results of the stability in the time of the parameters show the fragility of this cointegration relation at 5 % level (but the stability of parameters is accepted at 1 % level). If the divergent evolution continues in the future (rise in the imports and decrease in the exports) then it would have an aggravation of the crisis in the American commercial balance. The loss of such a parallel evolution is going to a certain mess in the trade policy of the United States.

Finally, we suggest to apply this econometric models on the economics of the developing countries, and particularly the Arabian ones because this permits to a best planning.

Data Annexe
Quarterly Data, 1980Q_1 to 2003Q_4 (96 observations)
In millions of dollars

Variables	Exports				Imports			
Years	Q_1	Q_2	Q_3	Q_4	Q_1	Q_2	Q_3	Q_4
1980	53017	56592	52989	58108	61984	61001	57308	61073
1981	59738	60763	55154	58085	65017	66695	63632	65639
1982	55313	57028	50241	49694	61694	60498	62819	58941
1983	50076	50505	48380	51578	58053	63504	66379	70113
1984	53789	54902	53276	55923	79346	80731	86461	79189
1985	56146	54322	50345	52333	83502	88010	84596	89167
1986	53654	54466	52829	56356	92872	90798	92292	94000
1987	56145	61692	62216	70352	92970	100562	103737	108632
1988	74860	81174	79080	85272	106148	109701	109745	115689
1989	88192	93452	88891	93233	113369	119579	118586	121863
1990	97597	100626	93903	101466	119755	120936	124329	130291
1991	102760	107641	101468	109863	115498	118824	123803	129002
1992	111229	112985	107628	116322	122403	130883	137430	141947
1993	114027	117915	110297	122854	134620	144544	147454	154042
1994	120826	127227	126573	138001	147831	161598	172991	180835
1995	141009	147070	142967	152819	176246	187080	189660	190445
1996	153831	157052	149771	164418	185854	195717	204016	209704
1997	165021	175097	168755	180022	202744	214423	224814	228743
1998	172703	170341	160624	178470	216714	226660	230785	237739
1999	166448	171792	169846	186924	230293	248575	266586	279577
2000	187806	195977	195675	202460	282120	300735	316507	318659
2001	195262	190279	169954	173604	297044	288533	280837	274585
2002	166456	177950	171800	176895	259999	290955	302178	308233
2003	174295	180715	175920	193840	296487	309895	318260	332479

Note: Data sources: United States Department of Commerce, Economics and Statistics Administration, U.S. Census Bureau, Bureau of Economic Analysis**.**

REFERENCES

Arino, M.A. and Franses, P.H. 2000. Forecasting the Levels of Vector Autoregressive Log-transformed Time Series, *International Journal of Forecasting*, (16): 111-116.

Brown, R.L., Durbin, J. and Evans, J.M. 1975. Techniques for Testing the Constancy of Regression relationship over Time, *Journal of the Royal Statistical Society*, Series B, (37): 149-192.

Belsley, D.A., Kuh, E. and Welsch, R.E. 1980. Regression Diagnostic, John Wiley, New York.

Bresson, G. and Pirotte, A. 1995. Econométrie des Séries Temporelles - Théorie et Applications, Presses Universitaires de France, Paris.

Beaulieu, J.J. and Miron, J.A. 1993. Seasonal Unit Roots in Aggregate U.S. Data, *Journal of Econometrics*, (55): 303-328.

Chow, G. 1960. Tests of Equality between Sets of Coefficients in Two Linear Regressions, *Econometrica*, 28: 591-605.

Clarida, R.H. 1994. Cointegration, Aggregate Consumption, and the Demand for Imports: A Structural Econometric Investigation, *The American Economic Review*, 84 (1): 298-308.

Carone, G. 1996. Modeling The U.S. Demand for Imports Through Cointegration and Error Correction, *Journal of policy Modeling*, 18 (1): 1-48.

Dickey, D.A. and Fuller, W.A. 1979. Distribution of the

Estimators for Autoregressive Time Series With a Unit Root, *Journal of the American Statistical Association*, 74 (366): 427-431.

Dickey, D.A. and Fuller, W.A. 1981 Likelihood Ratio Statistics for Autoregressive Time Series With a Unit Root, *Econometrica*, 49 (4): 1057-1072.

Dickey, D.A., Hasza, D.P. and Fuller, W.A. 1984. Testing for Unit Root in Seasonal Time Series, *Journal of the American Statistical Association*, 79 (386): 355-367.

Dickey, D.A., Bell, R.B. and Fuller, W.A. 1986. Unit Roots in Time Series Models: Tests and Implications, *The American Statistician*, 40 (1): 12-26.

Enders, W. 2003. Applied Econometric Time Series, 2nd edition, John Wiley and Sons.

Engle, R.F. and Yoo, B.S. 1987. Forecasting and Testing in Co-integrated Systems, *Journal of Econometrics*, (35): 143-159.

Engle, R.F., Granger, C.W.J., Hylleberg, S. and Lee, H.L. 1993. Seasonal Cointegration: the Japanese Consumption Function, *Journal of Econometrics*, 55: 275- 298.

Engle, R.F. and Granger, C.W.J. 1987. Co-integration and Error Correction: Representation, Estimation and Testing, *Econometrica*, 55 (2): 251-276.

Edlund, P.O. and Karlsson, S. 1993. Forecasting the Swedish Unemployment Rate VAR vs. Transfer Function Modelling, *International Journal of Forecasting*, (9): 61-76.

Franses, P.H. 1991. Seasonality, Non-stationarity and Forecasting of Monthly Time Series, *International Journal of Forecasting*, (7): 199-208.

Franses, P.H. and Romijn, G. 1993. Periodic Integration in Quarterly UK Macroeconomic Variables, *International Journal of Forecasting*, (9): 467-476.

Frost, A. and Prechter, R. 1985. Elliott Wave Principle: Key to Stock Market Profits, New Classics Library, Inc., Gainesville, Georgia U.S.A.

Gourieroux, C. and Monfort, A. 1995. Séries Temporelles et Modèles Dynamiques, Economica, Paris.

Ghysels, E., Lee, H.S. and Noh, J. 1994. Testing for Unit Roots in Seasonal Time Series, *Journal of Econometrics*, (62): 415-442.

Granger, C.W.J. and Siklos, P.I. 1995. Systematic Sampling, Temporal Aggregation, Seasonal Adjustment, and Cointegration Theory and Evidence, *Journal of Econometrics*, (66): 357-369.

Hamilton, J. 1994. Time Series Analysis, Princeton: Princeton University Press.

Hasza, D.P. and Fuller, W.A. 1982. Testing for Non-stationarity Parameters Specifications in Seasonal Time Series Models, *The Annals of Statistics*, 10 (4): 1209-1216.

Hylleberg, S., Engle, R.F., Granger, C.W.J. and Yoo, B.S. 1990. Seasonal Integration and Cointegration, *Journal of Econometrics,* (44): 215-238.

Indjehagopian, J.P., Lantz, F. and Simon, V. 2000. Dynamics of Heating Oil Market Prices in Europe, *Energy Economics*, (22): 225-252.

Johansen, S. 1988. Statistical Analysis of Cointegration Vectors, *Journal of Economic Dynamic and Control*, 12 (213): 231-254.

Johansen, S. and Juselius, K. 1990. Maximum Likelihood Estimation and Inference on Cointegration with Applications to the Demand for Money, *Oxford Bulletin of Economics and Statistics*, 52 (2): 169-210.

Joutz, F. and Stekler, H.O. 2000. An Evaluation of the Predictions of the Federal Reserve, *International Journal of Forecasting*, (16): 17-38.

Kennedy, P. 1993. Preparing for the Twenty-First Century, *Arabic Version Traducted by Mohammad Abdil Kader and Ghazi Massoud*, Dar Al Shourouk, Amman-Jordan.

Le Diascorn, Y. and Blondeel, D. 1995. Le Nouveau Désordre Économique Mondial: Le Capitalisme et ses crises, Ellipses, Paris-France.

Lee, H.S. and Siklos, P.I. 1991. Unit Uoots and Seasonal Unit Roots in Macroeconomic Time Series, *Economics Letters*, (35): 273-277.

Lee, H.S. 1992. Maximum Likelihood Inference and Seasonal Cointegration, *Journal of Econometrics*, (54): 1-47.

Mackinnon, J.G. 1991. Critical Value for Co-integration Tests, in Long Run Equilibrium Relationships (Engle and Granger, Oxford University Press.

Osborn, D.R., 1990. A Survey of Seasonality in UK Macroeconomic Variables, *International Journal of Forecasting* (6): 327-336.

Osborn, D.R. 1993. Seasonal Cointgration, *Journal of Econometrics,* (55): 299-303.

Oskooee, M.B. and Brooks, T.J. 1999. Cointegrating Approach Estimating Bilateral Trade Elasticities between U.S. and Her Trading Partners, *International Economic Journal*, 13 (4): 119-128.

Perron, P. 1989. The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis, *Econometrica*, (57): 1361-1401.

Perron, P. 1997. Further Evidence on Breaking Trend Functions in Macroeconomic Variables, *Journal of Econometrics,* (80): 355-385.

Perron, P. and Vogelsang, J. 1992. Testing for Unit Root in a Time Series With a Changing Mean: Correction and Extensions, *Journal of Business and Economic Statistics*, (4): 467-470.

Phillips, P.C.B. 1987. Towards a Unified Asymptotic Theory for Autoregression, *Biometrika*, (74): 535-547.

Pierse, R.G. and Snell, A.J. 1995. Temporal Aggregation and the Power of Tests for a Unit Root, *Journal of Econometrics*, (65): 333-345.

Quandt, R.E. 1960. Tests of the Hypothesis that a Linear Regression System Obeys two Separate regimes, *Journal of the American Statistical Association*, 55: 324-330.

Senhadji, A.S. and Montenegro, C.E. 1999. Time Series Analysis of Export Demand Equations: A Croos-Country Analysis, *IMF Staff Paper*, 46 (3): 259-273.

Todd, E. 2002. Après l'empire: Essai sur la décomposition du système américain, Editions Gallimard, Paris-France. Arabic Version (2003) Traducted by Mohammad Ismail "Dar Al Saki", Beyrut – Lebanon.

Zivot, E. and Andrews, D. 1992. Further Evidence on the Great Crash, the Oil Price Shock and the Unit Root Test Hypothesis, *Journal of Business and Economic Statistics*, (10): 251-270.

تشكيل نظام الاستيرادِ والتصدير في الولايات المتحدة باستعمال "نموذج الأخطاء المصحَّحة"

محمود نجيب مراد *

ملخص

تهدف هذه الدِّراسة إلى تحليل التكامل والتكامل الفصلي المشترك لظاهرتي الاستيراد والتصدير في الولايات المتحدة الأمريكية لكل من التّرددات الموسميّة الأربعة، وذلك عبر دراسة البياناتِ الفصليةِ التي تغطي الفترة الزمنية من 1980 إلى 2003. لذا استخدمنا طريقة HEGY لدراسة التكامل، وطريقة EGHL لدراسة التكامل المشترك. وقد بينت نتائج الدراسة أنَّ كلاً من الواردات والصادرات في أميركا تحتوي على التكامل ذي الدرجة الواحدة ولكل من الترددات: ¾ ,½ ,¼ ,0. أما بالنسبة لظاهرة الميزان التجاري ، فإنَّها متكاملة ذات درجة واحدة مع التردُّدات ¼,0 وبالتالي تصبح ساكنة بعد تصفيتها بواسطة $(1 - B)\times\left(1 + B^2\right)$. وأظهرت النتائج أنَّ الواردات والصادرات تمثلان تكاملاً مشتركاً مع كل من التردُّدات ¼، ¾، ولا تتكاملان مع التردُّدات 0، ½. وبعد ذلك خلصنا إلى بناء علاقتين للتكامل المشترك: الأولى تحتوي على كمية ثابتة في القسم الحتمي، والثانية تحتوي على كمية ثابتة مع ثلاثة متغيرات تأشيرية موسمية. وقد قمنا لكل من هاتين العلاقتين، بحساب التوقعات للعامين الأخيرين 2002−2003 مستخدمين نموذج الأخطاء المصحَّحة، ودرسنا بعد ذلك جودة هذه التوقعات باستعمال معيار MAPE. وعليه لم تتجاوز نسبة الخطأ في التوقعات 3.5 % بالنسبة للصادرات و4.6 % للواردات، وذلك باستخدام علاقة التكامل المشترك الثانية (كمية ثابتة مع ثلاثة متغيرات تأشيرية موسمية في القسم الحتمي). وأخيراً قمنا باختبار التغير الهيكلي لنظام الصادرات والواردات الأمريكية وذلك باستخدام اختبار Chow الذي أظهر استقرارية واضحة بمستوى المعنوية 1 % في نموذج ECM وبوجود علاقة التكامل المشترك $CR_{3,t}$ بينما لحظنا بعض التغير الهيكلي بمستوى المعنوية 5 %.

الكلمات الدالة: الصادرات والواردات، الولايات المتحدة الأمريكية، التكامل المشترك، نموذج الأخطاء المصحَّحة، التغير الهيكلي، التوقعات.

---

* كلية العلوم الاقتصادية وإدارة الأعمال، الجامعة اللبنانية، النبطية، بيروت، لبنان. تاريخ استلام البحث 2005/11/7، وتاريخ قبوله 2006/5/3.