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*Puerto Rico's Regional Economy and  
the U. S. Business Cycle, 1961-1989*

por

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Arthur J. Mann

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## *Prefacio*

En este trabajo, José I. Alameda y Arthur J. Mann analizan el grado de asociación entre los ciclos económicos en Puerto Rico y en los Estados Unidos. Dado el alto grado de integración que existe entre ambas economías, no es de extrañar que exista asociación entre los ciclos de ambas, máxime cuando los autores reconocen que la economía puertorriqueña es una de tipo regional con relación a la estadounidense. Lo que sí resulta interesante es investigar si la sincronización entre los ciclos de ambas economía ha variado a través del tiempo; donde esto es precisamente lo que hacen.

Con ese propósito utilizan un modelo de rezagos polinomiales distribuidos, en el cual se establece a la ejecutoria de la economía de Puerto Rico (medida a través del Índice de Actividad Económica de la Junta de Planificación de P.R.). Las variables independientes son la ejecutoria de la economía estadounidense (medida a través del Índice de Cuatro Indicadores Coincidentes) y el precio promedio de las importaciones de petróleo de Puerto Rico.

La conclusión del estudio es que ambos ciclos son casi coincidentes, aumentando la sincronización entre ambos a partir de mediados de la década de los años setenta. Para el período de 1961 a 1973, el rezago promedio de la economía de Puerto Rico a fluctuaciones en la economía estadounidense era de cuatro a cinco meses; pero para el período de 1974 a 1989, ese rezago promedio disminuyó a 2.2 meses. Asimismo, los autores concluyen que la ejecutoria de la economía de Puerto Rico es sensitiva a fluctuaciones en los precios del petróleo, registrando un rezago promedio de seis meses.

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**I. Introduction**

The economies of Puerto Rico and the United States are intricately linked in a common trade, financial, and monetary market.<sup>1</sup> Given these ties and the fact that the economy of the latter is approximately 250 times larger than that of the former, it would be expected that the strength of linkage between U.S. economic activity/business cycles and the island's economy would be highly significant. In reality, in many ways the Puerto Rican economy can be taken as simply a small regional economy within a much larger whole. It is the purpose of this paper to examine the degree of association between the business cycles in each economy over the period 1961-1989.

The cyclical transmission mechanisms of trade, capital, labor, and other financial flows between Puerto Rico and the U.S. have been examined in other works on the subject. Baer (1962) was one of the first researchers to study the business cycle link between the two economies. In his seminal analysis he found that the two U.S. recessions of the 1950s (1952-53 and 1957-58) had fairly weak consequences for the Puerto Rican economy. This was due to a strong compensating expansion of factory production in Puerto Rico and the low income elasticity of island exports (agricultural products, light manufacturing). Alameda and Rivera (1976) examined the impact of three U.S. recessions (1960-61, 1969-70, and 1974-75) on Puerto Rico's manufacturing sector, finding that the elasticity between production worker hours in Puerto Rico and U.S. industrial output reflected increasing sensitivity over time. Ayuso (1982), using a vector autoregressive (VAR) model for the period 1952-78, analyzed the innovation shocks of average wages, material prices, and aggregate output in various branches (apparel, textiles, stone, clay and glass) of Puerto Rico's manufacturing sector; he found a strong degree of sensitivity, with the effect being greater in Puerto Rico than in U.S. counterpart groupings. Moreover, the Puerto Rican groupings were significantly more sensitive than the same ones in Canada's economy, which is also open and dependent upon U.S. aggregate economic activity. A final paper by Alameda, Perez, and Rivera (1988), which used simple comparisons of aggregate economic activity, concluded that the island became increasingly sensitive to U.S. recessions over the decades of the 1970s and 1980s.

The second section of this paper offers some aggregate and sectoral evidence regarding the cyclical connection. Section III presents the basic polynomial distributed lag model used in the analysis, while Section IV serves up the statistical results and conclusions.

## II. *Preliminary Evidence of Cyclical Linkages*

Table 1 displays a comparison between Puerto Rican and U.S. real gross national product (GNP) growth rates between 1955 and 1989. Since the Puerto Rican social accounts are estimated on a fiscal year basis (July 1-June 30), the U.S. accounts were converted into the same annual period by averaging the quarterly data (seasonally adjusted at annual rates) found in the Department of Commerce's Survey of Current Business.

As it is evident from these comparisons, prior to the 1973-74 OPEC-induced oil price crunch Puerto Rican real GNP growth rates easily surpassed (with few exceptions) those of the U.S. economy. The average annual rate of growth in Puerto Rico was 6.1%, while that in the U.S. measured 3.4%. However, after the III/74-II/75 recession, average annual growth rates in both economies became much more similar: 2.6% for Puerto Rico and 3.0% for the U.S.

Another way of examining the business cycle association is via a comparison of composite indexes of economic activity, as is done in Figure 1 covering the period 1961 through 1988. The Puerto Rican aggregate indicator is the Puerto Rico Planning Board's Index of Economic Activity, while the corresponding U.S. series is the Department of Commerce's Index of Four Roughly Coincident Indicators.<sup>2</sup> The high degree of similarity is noteworthy. Moreover, as can be appreciated from the presentation of expansion-recession turning points found in Table 2, there are generally short time gaps (both leads and lags) between peaks and troughs in each economy. Nevertheless, the turning points and the duration and intensity of the cycles do empirically differ. For example, Puerto Rico's longest cyclical downturn in the post-World War II period occurred between November, 1978, and December, 1982, a duration of 49 months and an intensity of 12%. During this same interval the U.S. underwent two cyclical downturns, one of six months duration in 1980 and a second of 16 months between July, 1981 and December, 1982. Despite this lack of precise matching between business cycle turning points, it would not be at all valid to conclude that little association exists between economic cycles in the two economies.

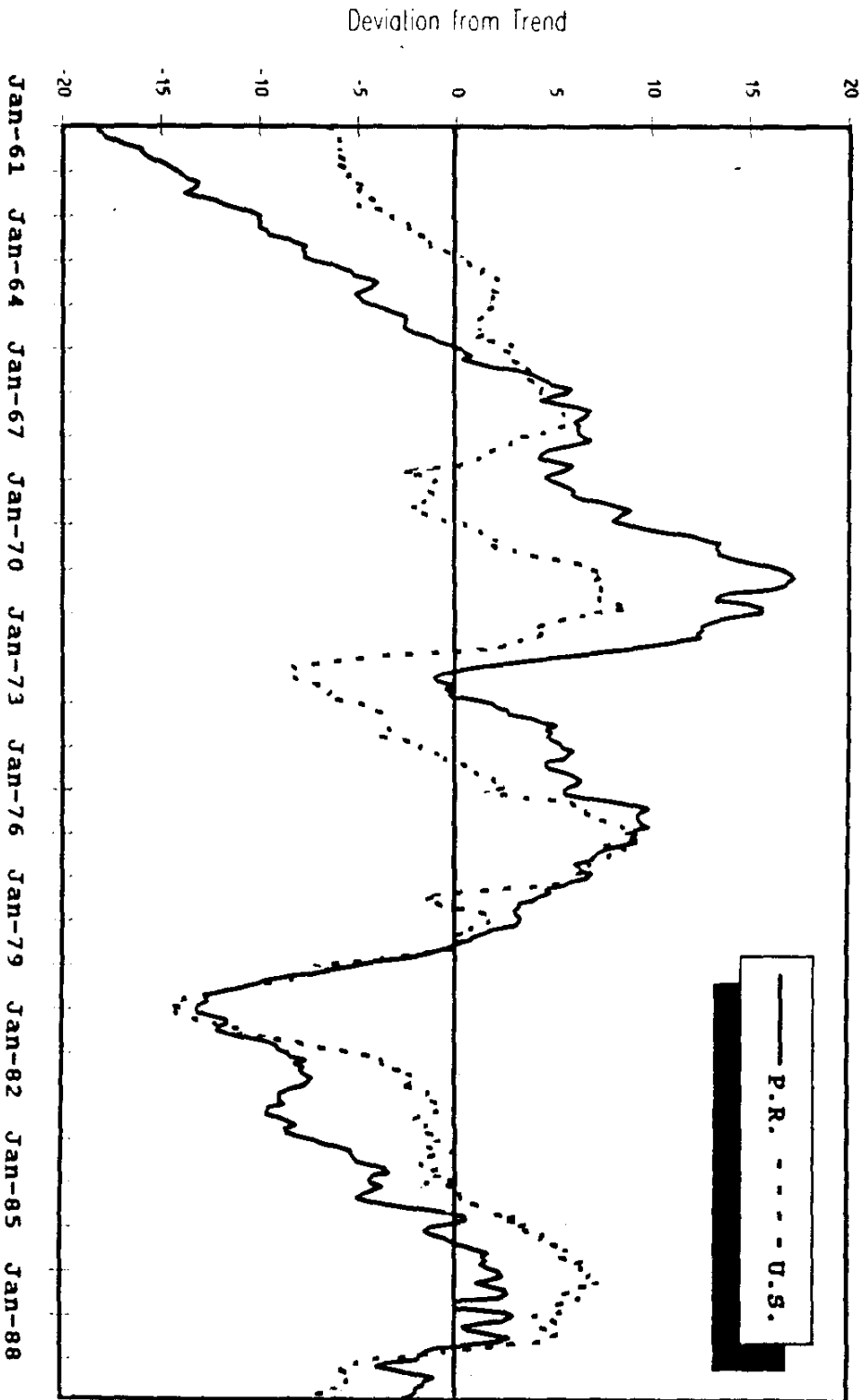
**TABLE I**  
**UNITED STATES AND PUERTO RICO: REAL GROSS**  
**NATIONAL PRODUCT AND REAL GROWTH RATES**  
**1955-1989**

QUARTER AND YEAR	U.S. GNP (BILLIONS OF 1982 DOLLARS)	REAL GROWTH RATES	PUERTO RICO GNP (MILLIONS OF 1964 DOLLARS)	REAL GROWTH RATES
III/55-II/56	1,516.6	4.4	1,185.7	4.1
III/56-II/57	1,542.5	1.7	1,221.8	3.0
III/57-II/58	1,529.8	-0.8	1,258.4	2.9
III/58-II/59	1,595.0	4.3	1,363.6	8.4
III/59-II/60	1,652.8	3.6	1,473.2	8.0
III/60-II/61	1,671.5	1.1	1,562.8	6.1
III/61-II/62	1,761.4	5.4	1,683.9	7.7
III/62-II/63	1,829.5	3.9	1,820.7	8.1
III/63-II/64	1,928.2	5.4	1,938.9	6.5
III/64-II/65	2,020.6	4.8	2,099.2	8.3
III/65-II/66	2,158.2	6.8	2,240.6	6.7
III/66-II/67	2,236.4	3.6	2,339.4	4.4
III/67-II/68	2,320.6	3.8	2,455.3	5.0
III/68-II/69	2,401.2	3.5	2,684.0	9.3
III/69-II/70	2,418.0	0.7	2,901.4	8.1
III/70-II/71	2,451.7	1.4	3,079.7	6.1
III/71-II/72	2,530.7	3.2	3,236.1	5.1
III/72-II/73	2,692.1	6.4	3,400.3	5.1
III/73-II/74	2,750.9	2.2	3,445.7	1.3
III/74-II/75	2,681.8	-2.5	3,380.0	-1.9
III/75-II/76	2,772.2	3.4	3,454.0	2.2
III/76-II/77	2,881.0	3.9	3,587.8	3.9
III/77-II/78	3,033.1	5.3	3,744.9	4.4
III/78-II/79	3,171.2	4.6	3,947.9	5.4
III/79-II/80	3,199.8	0.9	4,007.1	1.5
III/80-II/81	3,217.4	0.6	4,047.1	1.0
III/81-II/82	3,208.5	-0.3	3,941.8	-2.6
III/82-II/83	3,189.7	-0.6	3,840.1	-2.6
III/83-II/84	3,404.8	6.7	3,986.1	3.8
III/84-II/85	3,558.1	4.5	4,105.8	3.0
III/85-II/86	3,681.0	3.5	4,249.0	3.5
III/86-II/87	3,763.1	2.2	4,428.8	4.2
III/87-II/88	3,948.5	4.9	4,625.6	4.4
III/88-II/89	4,077.5	3.3	4,807.7	4.0

SOURCES: U.S. Dept. of Commerce, Bureau of Economic Analysis, *Survey of Current Business*; Puerto Rico Planning Board, *Income and Product*; various years.

FIGURE 1

Business Cycles in  
Puerto Rico and United States  
1961 - 1989



**TABLE 2**  
**UNITED STATES AND PUERTO RICO: RECESSIONS**  
**AND EXPANSIONS, 1961-1989**  
*(month/year)*

<i>Recessions*</i>				<i>Expansions*</i>			
<i>United States</i>		<i>Puerto Rico</i>		<i>United States</i>		<i>Puerto Rico</i>	
<i>Peak</i>	<i>Trough</i>	<i>Peak</i>	<i>Trough</i>	<i>Trough</i>	<i>Peak</i>	<i>Trough</i>	<i>Peak</i>
12\69 <i>(11ms\4.0%)</i>	11\70	-	-	2\61 <i>(106ms\50.6%)</i>	12\69	-	3\73
11\73 <i>(16ms\14.5%)</i>	3\75	3\73 <i>(27ms\11.4%)</i>	6\75	11\70 <i>(36ms\19.4%)</i>	11\73	6\75 <i>(41ms\14.0%)</i>	11\78
1\80 <i>(6ms\5.8%)</i>	7\80	11\78 <i>(49.ms\12.0%)</i>	12\82	3\75 <i>(58ms\28.6%)</i>	1\80	-	-
7\81 <i>(16ms\10.6%)</i>	12\82	-	-	7\80 <i>(12ms\4.7%)</i>	7\81	-	-
				11\82	-	12\82	-

*a/ The numbers in parentheses refer to duration (in months) and intensity, which is defined as  $[(P-T)/(P+T)/2]] * 100$ , where P=peak and T=trough. The U.S. values for P and T correspond to the Index of Four Roughly Coincident Indicators, while those for Puerto Rico represent the Index of Economic Activity.*



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A priori, based on the cyclical transmission mechanisms of trade, investment, and (to a lesser extent) tourism flows, there are very cogent reasons to assume a high degree of association. From a Puerto Rican perspective Table 3 presents statistical time-series evidence on these mechanisms. Certainly the most important mechanism is that of trade flows, and it is readily apparent that Puerto Rico emerges as a classic example of an open economy. In the developmental years of the 1950s and 1960s merchandise exports comprised a little over a third of GNP; in the decade of the 1980s this proportion jumped to two-thirds. Since from 83% to 88% of the total value of exports flows to the U.S., it is evident that the business cycle in the latter may have a large impact on the island's economy.

Thus, from a preliminary glance at export trade flows it could be concluded that Puerto Rico's sensitivity to U.S. economic conditions has increased quite substantially since the early 1970s. This conclusion is empirically supported via the computation of the Spearman rank correlation coefficient<sup>3</sup> for the real GNP growth rates in each economy for two separate periods: 1954 to 1973 and 1974 to 1988. For the first interval the coefficient value is 0.193, indicating a positive relationship. However, a one-tail t-test of this correlation at the 5 percent level reveals no significant statistical relationship (t-value = 0.787). On the other hand, for the 1974-88 interval the coefficient value was computed at 0.814, indicative of a highly positive and statistically significant association between the two gross product growth rates (t-value = 5.06).

Supporting the conclusion of increased sensitivity is the changing composition of Puerto Rico's export mix. Over the decades the relative importance of durables (scientific instruments, computers, electrical and non-electrical machinery, chemical products, drugs, and pharmaceuticals) has increased, while that of non-durables (food, textiles, apparel) has diminished. In fact, by the 1985-87 period durables easily comprised the bulk of exports by value. Given that the income-elasticity of demand for durables is generally greater than that of non-durables, this shifting export mix would increase business cycle convergence. Nevertheless, it is easy to overestimate such possible convergence on the basis of mere export ratio changes. The durables that Puerto Rico has exported in latter decades have a high value-added content which enhances export values but does not necessarily remain in the local economy. Rather, part of the increase in export value and value-added has been increasingly siphoned off in the form of dividend remittances to home companies from their Puerto Rican subsidiaries. For example, factor payments to the rest of the world (mainly U.S.) were generally

TABLE 3  
 PUERTO RICO: INDICATORS OF CYCLICAL TRANSMISSION MECHANISMS, 1950-1987

	External Trade as % of GNP		External Capital Inflows as % of Gross Fixed Domestic Investment	Expenditures by Visitors from U.S. as % of GNP
	Merchandise Exports	Merchandise Imports		

Years\*

1950-52	32.6	48.4	53.6	NA
1955-57	35.4	53.3	43.8	1.8
1960-62	37.6	52.8	72.5	4.7
1965-67	38.7	54.8	71.3	3.9
1970-72	35.5	54.4	74.2	3.6
1975-77	48.8	70.3	110.2	3.7
1980-82	68.1	71.8	110.6	3.9
1985-87	71.0	64.2	NA	3.9

\* Three year averages

NA = not available

Source: Puerto Rico Planning Board, *Income and Product and Balance of Payments*, various years.

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under 10% of GNP in the 1950s and 1960s, but by the 1980s had leaped to around two-fifths of GNP. Such dividend outflows clearly have little cyclical consequence.

Import flows may also have cyclical impact implications. As can be noted from Table 3, Puerto Rican merchandise imports reached a level of approximately half of GNP in the 1950s and 1960s and over two-thirds in more recent years. Although a smaller proportion of imports (relative to exports) enters from the U.S. (around two-thirds), the transmission mechanism works via the prices of inputs; i.e., higher real prices of imported inputs (raw materials and intermediate goods) may have cyclical implications for the island's economy. These impacts were found by Ayuso (1982), and also correspond to a study by Alameda and Mann (1989), which showed significantly increased own-price inelasticities of demand for capital, energy, and labor in post-1973 Puerto Rico.

Another quite potent transmission mechanism is that of capital markets and direct investment. Puerto Rico essentially has no independent capital market nor monetary policy, although the existence of the 936 money market and the island's use and regulation of 936 funds do imply a certain degree of capital market independence. Most of the direct private investment which has flowed into the island over the decades is of U.S. origin. It is probably safe to affirm that these direct investment decisions are based on the state of U.S. and/or world economic conditions, since they are predicated on the subsequent sale of goods in mainland markets. The figures in Table 3 make it evident that Puerto Rico has historically been highly dependent on external capital flows to finance its gross fixed domestic investment, and such dependence has been growing over time.

In closing this section it is noted that the less important transmission mechanism of visitor expenditures also links the two economic cycles. Unlike the two aforementioned mechanisms of trade and investment, the proportional impact of this latter mechanism has not increased across time. Rather, it has remained in the range of 3.6% to 3.9% of Puerto Rico's GNP since the mid-1960s.

### III. *The Polynomial Distributed Lag Model*

To estimate the degree of association over time between the Puerto Rican and United States economies, a polynomial distributed lag model has been adopted.<sup>4</sup> In generalized form it is expressed as:

$$(1) Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \dots + \beta_k X_{t-k} + u$$

The coefficient  $\beta_0$  can be interpreted as the short-run cyclical response of  $Y_t$  with respect to  $X_t$ . The partial sums are labeled cyclical response coefficients (i.e., cyclical elasticities), and represent the mid-term or long-run multiplier. The error term ( $u$ ) is assumed to be normally distributed and independent of  $X_t$ , and corrections are made for serial correlation and heteroscedasticity.

In the bivariate case the standard distributed lag model is expressed as:

$$(2) Y_t = WX_t + U_t$$

where  $Y_t$  = the dependent variable at time  $t$ ,

$X_t$  = a regressor variable expressed as a  $n$ -vector of current and lagged variables,

$W$  = a  $n$ -vector of lag weights,

$U_t$  = a random error term.

The  $W$  parameter can be expressed as:

$$(3) W = B_t / \Sigma B_t = B_t / B^*$$

in which

$$(4) \Sigma B_t = B_0 + B_1 + B_2 + \dots + B_k = B^*$$

The partial sums of the standardized  $B_i$  yield the proportion of the total impact felt within a given time period.

In order to estimate the  $W$  parameter, the following polynomial is assumed:

$$(5) f(z) = a_0 + a_1z + \dots + a_kz^k$$

where  $k$  expresses the degree of the polynomial. Taking the variable  $z$  as the lag index, it is possible to generate estimates for an arbitrarily chosen finite lag length  $n$ , and a polynomial of degree  $k$ . In practice, it is expected that a fairly low degree polynomial, say two or three, will yield good outcomes.

The lag weights ( $W$ ) and the parameter estimates for the different terms of the polynomial can be obtained directly from the regression run. These basic statistics and estimates may be used to evaluate the degree of the polynomial and to estimate the magnitude of the impact of the U.S. business cycle on the Puerto Rican economy.

The mean lag statistic yields the proportion of the total cyclical impact (long-run) felt by a specific period of time. It is often used to characterize the nature of the lag structure of a distributed lag model. Mathematically, it is defined as the weighted average of all the lags incorporated in the model, with the respective  $B$  coefficients serving as lag weights; it is really a lag-weighted average of time.

$$(6) \text{Mean lag} = \frac{B_k}{\sum B_k} \quad k = 0, 1, 2, \dots$$

$$\text{where } B_k = BW^k$$

For example, a mean lag of 12 months means that fifty percent of the total change in the dependent variable  $Y_t$  is accomplished in 12 months.

**IV. Results and Conclusions**

The equations estimated below take the following form:

$$(7) Y_t = a_0 + W_t X_{t-1} + C_t P_{t-1} + U_t \quad t = 1, 2, \dots, 12.$$

where  $Y_t$  = Index of Economic Activity of the Puerto Rican economy, first differences;

$X_t$  = Index of Four Roughly Coincident Indicators of the U.S. economy, first differences;

$P_t$  = average price of Puerto Rico's crude petroleum imports (dollars per barrel), first differences;

$W_t, C_t$  = lag weight vectors for respective regressor lagged variables  $X_t$  and  $P_t$ ;

$U$  = random error term.

As may be noted, the performance of the Puerto Rican economy is taken as the dependent variable, and that of the U.S. economy as the independent variable. The dependent variable is a monthly index of 12 equally weighted economic time series (1967 = 100). The independent variable is a more well known index calculated monthly by the Bureau of Economic Analysis of the U.S. Department of Commerce. The average price of crude is weighted by quantity values, with data available on a monthly basis from 1971.

To minimize the problems associated with multicollinearity, all variables ( $Y_t, X_t,$  and  $P_t$ ) were converted into first difference values rather than leaving them as absolute magnitudes. A Cochrane-Orcutt procedure was performed within regression runs to deal with autocorrelation difficulties. The data used for estimation purposes run from January, 1961 through June, 1989, although a two period breakdown (January, 1961-March, 1973 and April, 1974-June, 1989) was utilized for reasons subsequently explained.

There exists strong empirical evidence which supports a significant structural break in Puerto Rico's economy during and after the first energy shock of 1973. For example, Alameda and Mann (1989) found that the shock substantially altered relative factor prices and induced structural changes. Despite such evidence a whole period regression was initially run, but which included a time-break dummy variable (zero for pre-1973 and one for post-1973). The estimated t-value for the dummy variable was statistically significant over and above the critical values for polynomial degrees of one, two, and three.<sup>5</sup> Consequently, regressions were carried out for the already mentioned subperiods (January, 1961-March, 1973 and April, 1974-June, 1989). March, 1973 is the official cycle peak preceding Puerto Rico's 1973-75 recession. A 12 month lag dependent variable was incorporated in the estimation procedures.

Table 4 displays the parameter estimates for the polynomial distributed lag function of degrees one, two, and three, with the results having been disaggregated into the above mentioned subperiods. In Part A appear the parameters for the U.S. index of Four Roughly Coincident Indicators, while in Part B are found those for the average price of Puerto Rico's crude petroleum imports; the t-values, which assess the statistical significance of the coefficients, are shown in parenthesis. From Part A it may be readily noted that the coefficients for the degree of the polynomial of order one prove to be highly statistically significant. For the degree of the polynomial of order two the coefficients begin to lose statistical significance, and the polynomial of order three finds rather weak (or no) significance. Clearly, higher degrees of the polynomial do not generate better statistical fits. From Part B it is evidenced that none of the three degrees of the polynomial even remotely reaches satisfactory levels of statistical significance.

The parameter results for three degrees of the polynomial and by subperiod are found in Table 5. Due to data unavailability the weighted average prices of crude oil imports were omitted for the January, 1961-March, 1973 period; this is probably not at all critical, given that during this period the low and steady prices of crude most likely had little impact on the Puerto Rican economic cycle, and therefore were most likely quite negligible in affecting the high rates of real growth experienced during the 1960s.

**TABLE 4**  
**COEFFICIENT VALUES OF Z FOR THE POLYNOMIAL DISTRIBUTED LAGS WITH COCHRANE-ORCUTT PROCEDURE MODEL**  
*(t-values in parentheses)*

**A. INDEPENDENT VARIABLE: U.S. FOUR ROUGHLY COINCIDENT INDICATORS**

	DEGREE OF POLYNOMIAL					
	ONE		TWO		THREE	
	1961-73	1974-89	1961-73	1974-89	1961-73	1974-89
$a_0$	.1282 (3.74)*	.0844 (4.21)*	.183 (3.8)*	.119 (4.0)*	.1264 (2.32)**	.120 (3.236)*
$a_1$	-.01761 (-3.32)*	-.0087 (-3.00)*	-.0476 (-2.4)**	-.0261 (-2.2)***	.0346 (.812)	-.027 (-.938)
$a_2$	-	-	.00252 (1.59)	.00143 (1.50)	-.0159 (-1.835)	.0017 (.287)
$a_3$	-	-	-	-	.00103 (2.163)***	.00001 (-.418)

**B. INDEPENDENT VARIABLE: AVERAGE PRICE OF CRUDE PETROLEUM IMPORTS**

	DEGREE OF POLYNOMIAL					
	ONE		TWO		THREE	
	1961-73	1974-89	1961-73	1974-89	1961-73	1974-89
$a_0$	-	-.012 (-.720)	-	-.0154 (-.8046)	-	-.01645 (-.80106)
$a_1$	-	-.00011 (-.0469)	-	.00252 (.3085)	-	.00477 (.25478)
$a_2$	-	-	-	-.00020 (-.286)	-	-.00073 (-.17953)
$a_3$	-	-	-	-	-	.00003 (.13159)

\* Significant at a probability value of .005 (critical value 2.576).

\*\* Significant at a probability value of .010 (critical value 2.326).

\*\*\* Significant at a probability value of .025 (critical value 1.960).



TABLE 5  
 THE U.S. - PUERTO RICO CYCLICAL LINK AND THE POLYNOMIAL DISTRIBUTED LAG MODEL  
 (t - values in parentheses)

Polynomial Degree/Period	Constant	R <sup>2</sup>	F-Value	Rho	D-W	ΣW (12 month lags)	Independent Variables		
							ΣG	U.S. Index	Oil Prices
<u>Degree One</u>									
1961-73(n = 147)	.2919 (3.63)*	.26	16.6	.36	1.9	.306 (3.6)*	-	4.5	-
1974-89(n = 183)	-.00781 (-.09971)	.43	27.8	.44	2.0	.417 (8.2)*	-.16 (-3.2)*	2.2	6.1
<u>Degree Two</u>									
1961-73	.29128 (3.624)*	.27	13.2	.36	1.9	.308 (2.8)*	-	4.2	-
1974-89	-.01621 (-.21171)	.43	20.2	.43	2.0	.437 (6.67)*	-.135 (-2.22)*	2.3	5.9
<u>Degree Three</u>									
1961-73	.2897 (3.64)*	.30	11.7	.36	1.9	.295 (2.28)**	-	5.6	-
1974-89	-.0162 (-.21121)	.42	15.6	.42	2.0	.436 (5.4)*	-.134 (-1.86)*	2.2	6.0

\* Significant at a probability value of .005.  
 \*\* Significant at a probability value of .025.

The estimated cyclical response parameters (lag weights) display the expected (correct) signs. All the  $W_i$  values (the sum of the standardized Betas) are positive, indicating that the Puerto Rican and U.S. economies are strongly linked and essentially move in tandem. These lag weight values can be interpreted as the cyclical response of the Puerto Rican economy to the U.S. economy. More specifically, this means that a change of, say, one point in the U.S. coincident index is spread over the Puerto Rican coincident index during a 12 month (or less) period. For example, a value of 0.30 indicates that 30 percent of the total long-run impact on Puerto Rico's economy of a point change in the U.S. index is felt before the end of the first year. In terms of the  $C_i$  values, the fact that all are negative (over the 1974-89 period) suggests that oil price hikes have a definite adverse effect on economic growth. Of course, the inverse is also true in that oil price declines have a positive impact.

That the Puerto Rican economic cycle is strongly influenced by the U.S. cycle is hardly a surprising finding. However, two additional conclusions which flow from Table 5 do shed more light on the magnitude and speed of the impact. First of all, for the 1961-73 period the 12 month lag weight values for each degree of the polynomial are approximately 0.30. By the latter 1974-89 interval these values fall in the 0.42-0.44 range, indicating that the Puerto Rican economy cum business cycle has become increasingly sensitive to the U.S. cycle in the decade of the 1980s; as a corollary, this is also indicative of a greater degree of economic integration.

In the second place, the values attached to the mean lag statistics are very noteworthy. For the 1961-73 period the mean lag for the U.S. index under the three different polynomial degrees ranged from four to five months. However, for the 1974-89 period this lag dropped significantly to 2.2 months. This implies that half of the impact of the U.S. business cycle is felt in Puerto Rico in the subsequent two month period. By the same token, the mean lag associated with the price of crude oil imports was around six months during the 1974-89 interval, meaning that half of the impact on Puerto Rico's economy of oil price variations is felt within an average time lag of six months.

In summation, in recent years the U.S. economic cycle has had an almost instantaneous impact on the Puerto Rican business cycle, whereas oil price changes take a longer (but still short) time to reverberate throughout the island's economy. These results have distinct economic policy implications. Very bluntly, they imply that there is very little that Puerto Rican

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economic policymakers can do to ameliorate the island's business cycle. In the face of a cyclical downturn public (capital) expenditures may be marginally increased, but the use of fiscal policy is severely restricted by the constitutional mandate to balance the central government's budget. Puerto Rico's interest rate structure is certainly influenced by the 936 money market, but 936 interest rates are in turn a function of U.S. and international interest rates.

### NOTES

1. Under the Commonwealth (Freely Associated State) political arrangement with the United States, there are no barriers (other than geographic) to the free flow of labor, capital, entrepreneurial talent, and goods between the island and the continent. The same monetary system exists, and the U.S. tariff structure governs Puerto Rico's non-U.S. trade. As such, Puerto Rico's economy may be viewed as a region of the larger U.S. economy. Since the late 1940s the island's economic development model has been based on tax incentives to draw external capital and technology to this capital- and natural resource-poor region.
2. The Puerto Rico index is taken from the work sheets of the Bureau of Economic Analysis of the Puerto Rico Planning Board; the U.S. index is elaborated by the Bureau of Economic Analysis of the Department of Commerce, and is published in Business Conditions Digest.
3. The coefficient value has a range of 1 to -1. The sign indicates the nature of the relationship (direct or indirect), and the absolute value expresses the magnitude of the association.
4. This model was adopted from Pindyck and Rubinfeld (1981), Chapter 9.
5. The t-values for the dummy were 3.099, 3.170, and -3.127 respectively for the degrees of the polynomial one, two, and three. The critical t-value for a probability of 0.005 is 2.576. The average price of crude petroleum imports was omitted from these particular regressions.

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