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*José I. Alameda Lozada Ph.D.**

Do Stock Prices Associate with the Real Economy?

Abstract

This paper analyzes the empirical relationship between monthly changes in stock prices and the real fluctuations in the economies of Puerto Rico and United States. Even though Puerto Rico has no stock market, the political and economic relationship between both countries seem to bind both in the singular manner, particularly in the free flows of capital, labor, information and the use of a common currency.

1. Introduction

Conventional wisdom states that stock prices have to reflect the changes in the investors' perception about current and future performances of the business firms. Because of that, stocks prices may change abruptly due to market perceptions of investors and these changes, depending on their magnitude, can affect the behavior of the whole economy. Meanwhile, some economists state that stock prices are leading indicators of the economic swings.

Recently, national stock markets removed many institutional barriers so as to provide for better integration with world markets. Therefore, the effects of changes in one market would be easily spread-out even in the presence of market differences. For instance, one of the main financial analysts of the Inter-American Bank of Development, called the recent Asian stock market crisis in October 1997, as the first shock of stock prices with significant global repercussions, especially in the Latin American stock markets (Lora, 1997).

This paper analyzes the empirical relationship between monthly changes in stock prices and the real fluctuations in the economies of Puerto Rico and United States. Even though Puerto Rico has no stock market, the political and economic relationship between both countries seem to bind both in the singular manner, particularly in the free flows of capital, labor, information and the use of a common currency.

* José I. Alameda Lozada, Ph.D., Associate Professor, Department of Economics, University of Puerto Rico at Mayagüez.

Two stock indexes were considered: the S&P 500 index, and the Puerto Rico Stock Index. In addition two indexes of the real economy were also selected: the Stock and Watson Coincident Composite Index and the Coincident Index from the Planning Board of Puerto Rico. All data relate to the period from December 1979 to February 1998.

This paper will also attempt to address the following questions:

- Do changes in stock prices "cause" changes in the economy or, the other way around, are they caused by changes in the economy ?
- Do changes in the S&P 500 index "cause" changes in Puerto Rico's stock prices index ?
- Do changes in the S&P 500 index "cause" changes in both economies of Puerto Rico and the United States ?
- Does there exist a long-run relationship between stock prices and the economic fluctuations in Puerto Rico and United States?
- Do changes in stock prices promote permanent or transitory changes in the economies of Puerto Rico and United States?

2. The Standard and Poor 500 and the PRSI Indexes

Stock indexes serve to examine the performance of the overall stock market, or any particular subsets of the market. One of the more closely monitored indexes is the Standard and Poor index (S&P 500), which is a value-weighted index of stock prices of 500 larger U.S. corporations. Because this index includes such large companies, many experts believe it a more representative indicator of the U.S. stock market than the Dow-Jones industrial average (Madura, 1998). However, it does not appropriate to focus the behavior of stock prices of small firms?

The Puerto Rico Stock Index (PRSI)—developed by the Government Development Bank and launched in October 1995—is expected to track the behavior or performance of "local" equities and measure the strength and fluctuations of the financial system (Campos-Cruz, 1995). **(See Appendix 1.)**

Table 1 shows the components of the PRSI and its main characteristics. The PRSI value is derived from the values of each stock's performance publicly traded. As shown the Banco Popular's stocks accounted for 54 percent of the weight of the index due to its high capitalization.

Table 1
Components of Puerto Rico Stock Index (PRSI)

Companies	Prices (30-3-98)	Shares Outstanding (000)	As of	Capitalization (000)	Weight
Corecomm Inc	16 7/8	13,074	Sep-97	220,624	3.07
Doral Financial	30 1/2	19,977	Feb-98	609,299	8.84
First Bank	45 15/16	14,958	Dec-97	587,133	9.58
Interstate General	4 1/16	10,257	Sep-97	41,669	0.58
Margo Nursery	2 3/8	1,895	Dec-97	4,501	0.06
Oriental Financial	37 1/14	9,970	Dec-97	371,383	5.17
Pepsi-Cola Bottling	7 5/16	16,500	Feb-98	120,656	1.68
Ponce Bank	25 1/14	6,182	Sep-97	154,992	2.16
Popular Bank	57 5/8	67,718	Feb-98	3,902,250	54.30
Puerto Rican Cement	48 3/4	5,452	Sep-97	265,785	3.70
R&G Financial	34	4,924	Sep-97	167,416	2.33
Western Bank P.R.	15 3/16	42,232	Mar-98	641,399	8.92

Source: Government Development Bank, March, 1998.

Table 2 compares the performance of PRSI with the S&P 500 index. During the period, the monthly average rate of change (AMRC) of the PRSI was 1.9% with an extremely large standard deviation (1,318). In fact, this standard deviation is also seven times larger than that of S&P 500.

When both series are divided into two selected periods —December, 1979 to February, 1995 and February, 1995 to February 1998— significant differences are found. To begin with, the AMRC for PRSI in the first period was 1.7% while it only 0.83% for S&P500. These values, however, increased to 10.5% and 4.7 % respectively during the second period. The coefficients of variation (standard deviation divided by the average), exhibited larger values in both periods in the PRSI.

The average returns of PRSI were 1.84% in the first period but 3.08 % for the second. Both average returns were higher than that for S&P 500.

Table 2
Performances of PRSI and S & P 500
By selected periods

Periods (monthly)	PRSI	S&P500
1979:12 to 1998:02 (219 months)		
Average value	1,318.00	321.00
Standard Deviation	1,387.00	196.50
Coefficient of Variation (Percent)	105.00	61.00
Average Monthly Rate of Change (Percent)	1.90	1.00
1979:12 to 1995:02 (182 months)		
Average value	807.15	215.50
Standard Deviation	651.10	112.20
Coefficient of Variation (Percent)	80.70	44.60
Average Monthly Rate of Change (Percent)	1.70	0.83
Average return (Percent)	1.84 a/	0.90
1995:02 to 1998:02 (36 months)		
Average value	3,869.50	669.30
Standard Deviation	1,230.30	146.10
Coefficient of Variation (Percent)	31.80	21.80
Average Monthly Rate of Change (Percent)	10.50	4.70
Average return (Percent)	3.08	2.44

a/ from 10/30/1992

3. Do stock prices "cause" real economic fluctuations or the other way around ?

There does exist an extensive discussion about the connection between the stock market and the business cycle of the real economy. In this section we will explore this hypothesis for a system in which both economies and stock prices indexes are taking together. Some of the most relevant questions raised in here are:

- Do changes in stock prices "cause" changes in the economy or are they caused by changes in the economy?

- Do changes in the S&P 500 index "cause" changes in the local (Puerto Rico) stock prices index?
- Do changes in the S&P 500 index "cause" changes in both economies of Puerto Rico and the United States.

Since correlation does not imply causation, the Granger (1969) approach was considered to explain whether "*x* causes *y*" or vice-versa. This statistical approach seeks to determine how much of the current I can be explained by its past values, and then, to verify whether lagged values of *x* can be improved by the statistical explanation. Therefore, *y* is a "Granger-causal" of *x*, if *x* helps in predicting the value of *y*, which means that coefficients of lagged *x*'s are statistically significant. However it is important to understand that the usual scientific sense of causality is not implied by this test. A Granger causality test measures if "*x* precedes *y*" or vice-versa.

The statistical test is a joint hypothesis with F-statistic (Wald statistic) for each equation. The null hypothesis is "*x* does not Granger-cause *y*" in the first regression and, "*y* does not Granger- cause of *x*" in the second regression.

The test results are shown in Table 3, for a length of 12 lag months and considering the first logarithm differences (represented as a "D") of the following variables: PRSI, SP500, US Economy Index from the Stock and Watson coincident (USI) and Index of Puerto Rico's Economic Activity (PRI).

Table 3
Granger Causality Tests
1979:12 to 1997:10

Null Hypothesis: (12 month lags)	F-statistics	P-value
DPRSI does not Granger Cause DSP500	1.38877	0.17486
DSP500 does not Granger Cause DPRSI	1.64732	0.08242
DUSI does not Granger Cause DSP500	0.76983	0.68087
DSP500 does not Granger Cause DUSI	2.03643	0.02357
DPRI does not Granger Cause DSP500	2.21901	0.01265
DSP500 does not Granger Cause DPRI	2.31122	0.00918
DUSI does not Granger Cause DPRSI	0.92634	0.5219
DPRSI does not Granger Cause DUSI	1.58015	0.10094
DPRI does not Granger Cause DPRSI	0.44573	0.94258
DPRSI does not Granger Cause DPRI	1.51853	0.12105

The statistical results are the following:

1. We cannot reject the hypothesis that changes in the PRSI do not "cause" changes in SP500; that is, *DPRSI does not "Granger-cause" of DSP500* (at 10% significance).

2. We reject the hypothesis that changes in SP500 do not "Granger-cause changes in PRSI; *this means, DSP500 does "Granger-cause" of DPRSI.*

3. We cannot reject the hypothesis that changes in the U.S. economy (DUSI) does not "Granger -cause" of changes in DSP 500; *real U.S. economy does not "Granger-cause" of DSP500.*

4. We reject the hypothesis that changes in S&P 500 do not "Granger-cause" changes in U.S. economy; *that is, DSP 500 does "Granger-cause" DUSI.*

5. We reject the hypothesis that changes in the economy of Puerto Rico do not "Granger-cause" changes in S&P500; *that is, the economy of Puerto Rico causes changes in S&P500.*

6. We reject the hypothesis that changes in S&P500 do not cause changes in the economy of Puerto Rico, *that is, changes in S&P500 do cause changes in the Puerto Rican economy.*

7. We cannot reject the hypothesis that changes in U.S. economy do not cause changes in PRSI; *that is, changes in U.S. economy do not cause changes in PRSI.*

8. We cannot reject the hypothesis that changes in PRSI do not cause changes in U.S. economy; *that means, changes in PRSI do not cause changes in U.S. economy.*

9. We cannot reject the hypothesis that changes in P.R. economy do not cause changes in PRSI; *that means, changes in P.R. economy do not cause changes in PRSI.*

10. We cannot reject the hypothesis that changes in PRSI do not cause changes in P.R. economy; *changes in PRSI do not cause changes in P.R. economy.*

The surprising results are shown in point number five; "Puerto Rican economy causes changes in the S&P 500 index". These results may be explained as follow; the Index of Economic Activity of Puerto Rico is a non-weighted composite indicator of twelve variables in which the manufacturing sector seems to be over-represented. Five out of twelve economic variables are from this sector: employment, merchandise exports, worked hours, payroll, and merchandise imports. Since this sector posits a heavy concentration of the most outstanding U.S. multinationals which are strongly linked to the U.S. capital and stock markets, especially with the S&P index which critically depend upon the performances of worldwide U.S. manufacturers. Therefore, changes in the performance of U.S. subsidiaries located in Puerto Rico may influence the S&P 500 index rather easily.

4. Does there exist a long-run equilibrium relationship between stock prices and both economies?

A recent econometric and analytical tool developed by Engle and Granger (1987), called cointegration provides to test for the evolution of a long-run relationship among several economic variables. Cointegration attempts to assess how a group of variables move together in a common way over time or trend. That is, variables may be influenced by a common random trend, or, this co-movement can be caused by a long-run equilibrium process that tied them together.

In order to test the hypothesis of cointegration, Johansen's cointegration test was considered. This test provides relevant information on whether the variables: PRSI, S&P 500, U.S. Economy (Stock & Watson coincident index), and Puerto Rico Economy (Planning Board economic activity index), are closely tied in a long-run systematic relationship.

Table 4 shows the Johansen test under the assumption of linear deterministic trend in data, and using the variables at their values in logarithm levels with four lags. The maximum eigenvalue likelihood statistic for the null hypothesis is that no cointegration vector exists against the alternative hypothesis that at most one exists, and, so on. Since the maximum likelihood is 34.08, the null hypothesis of no cointegrating vector exists is accepted. The hypothesis that, at most, one cointegrating vector exists has to be rejected at 5% and 1% critical level. This implies that those variables selected in here do not move together in a common way over

time, or have no common trend. This test supports that each variable posits its own dynamic with no systematic long-run equilibrium among of them. It is clear, therefore, that the PRSI and the S&P500 index exhibit it own dynamic although the test does not preclude for some alternative periods of co-movement between them. This feature, however, is beyond this research.

Table 4
Johansen Cointegration Test
Series: LUSI, LSP500, LPRSI, and LPRI
December 1979 to October 1997

Eigenvalue	Likelihood Ratio	5 % Critical Value	1% Critical Value	Hypothesized No. of CE (s)
0.068093	34.0796	47.21	54.46	None
0.054246	19.2699	29.68	35.65	At most 1
0.034629	7.5577	15.41	20.04	At most 2
0.000746	0.1567	3.76	6.65	At most 3

5. Do changes in stock prices promote permanent or transitory changes in the real economy?

Business cycle analysts suggest that many macroeconomic time series can be decomposed into two main components: permanent changes and transitory changes. A permanent change is when a variable departs from its long-run growth trend but does not exhibit a trend to return back to its previous level. Conversely, a transitory change means a temporary deviation from the long-run growth but a return to its previous level.

The Vector Autoregression model (VAR) permits not only assessing the dynamic short-term and long-run relationship among these four variables, but also to evaluate the permanent and transitory changes. Tables 5 and 6, **(See Appendix 2 and 3)** depict the cumulative impulse responses of real and stock prices indexes to innovation shocks in the S&P 500 and the Stock Price Index (PRSI), respectively.

Graphs 2 and 3 **(See Appendix 4)** plot the impulse response values providing a better visual assessment of permanent changes over the time. As can be seen, changes in S&P 500 prices index do have permanent effects over itself but not over the PRSI and the activities of

both economies, over a horizon of twenty months. PRSI tends to be more volatile than both indexes of real economic activity. Meanwhile, the PRI and USI do not exhibit permanent effects from the PRSI. However, S&P 500 exhibited permanent change due to innovation shocks in PR Stock Index.

6. Conclusions

This paper sought to assess the empirical relationship between the stock prices—Index of S&P500 and Puerto Rico Stock Prices Index and both economies. The real economic activity is measured by the Stock and Watson Composite Index of U.S. Economy (DUSI), and the Planning Board Coincident Index (PRI). Using and combining some econometric tools, we concluded the following:

1. Changes in S&P500 index is a "Granger-cause" of changes in Puerto Rico Stock Index and United States economy.
2. The economy of Puerto Rico is a Granger-causal of changes in S&P500 index and not the other way around. This "paradox" could be explained by the strong biased between Puerto Rico's coincident index (PRI) and variable indicators from the manufacturing sector which at the same time, is strongly tied to U.S. multinational corporations.
3. There does not exist a long-run common trend or co-movement over time among the variables of the system.
4. Changes in stock prices do not exhibit permanent effects over the real economic activities of U.S. and Puerto Rico, but not over themselves. That is, changes in stock prices do exhibit permanent effects over stock prices but not over the real economic activity.

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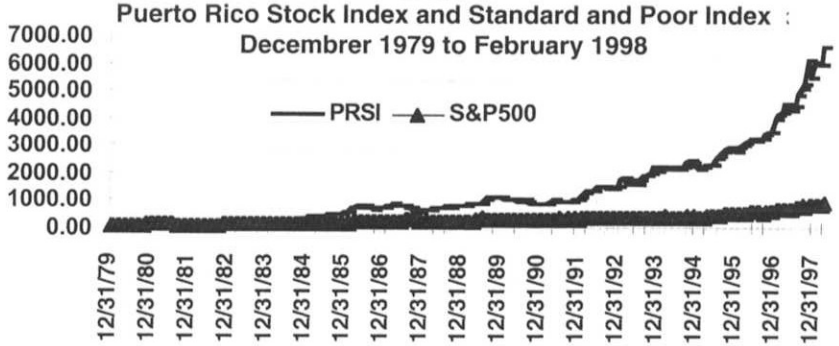
Appendix 1

Graph 1
Puerto Rico Stock Index and Standard and Poor Index : Decembrer 1979 to February 1998



Appendix 2

Table 5
Cumulative Impulse Response of S&P500, USI, PRSI, and PRI to: Innovation Shocks (one-standard deviation) of S&P 500 Index

Horizons	S&P 500	US	PRSI	PRI
0	0	0	0	0
1	0.045904	-0.000382	0.017446	6.61E-05
2	0.039110	-3.29E-04	0.026221	1.23E-03
3	0.038544	1.88E-04	0.034531	1.44E-03
4	0.034104	9.99E-04	0.030262	1.59E-03
5	0.029238	1.55E-03	0.025282	1.46E-03
6	0.031912	1.89E-03	0.024731	1.83E-03
7	0.031896	2.17E-03	0.022926	2.09E-03
8	0.031557	2.22E-03	0.0229071	2.34E-03
9	0.030849	2.30E-03	0.0226701	2.34E-03
10	0.029647	2.35E-03	0.0215391	2.35E-03
11	0.029294	2.40E-03	0.0210841	2.31E-03
12	0.029385	2.43E-03	0.0205791	2.36E-03
13	0.029474	2.44E-03	0.0204551	2.36E-03
14	0.029517	2.43E-03	0.0205105	2.40E-03
15	0.029417	2.43E-03	0.0204926	2.38E-03
16	0.029291	2.42E-03	0.0204194	2.38E-03
17	0.029268	2.43E-03	0.0203826	2.36E-03
18	0.029292	2.43E-03	0.0203289	2.37E-03
19	0.029324	2.43E-03	0.020354	2.37E-03
20	0.029341	2.42E-03	0.0203673	2.37E-03

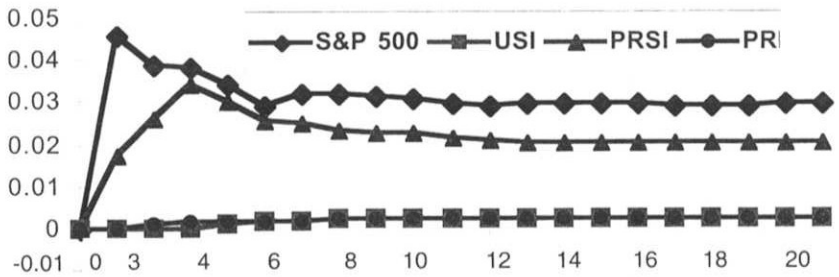
Appendix 3

Table 6
Cumulative Impulse Response of S&P500, USI, PRSI, and PRI to: Innovation Shocks (one-standard deviation) of PR Stock Index

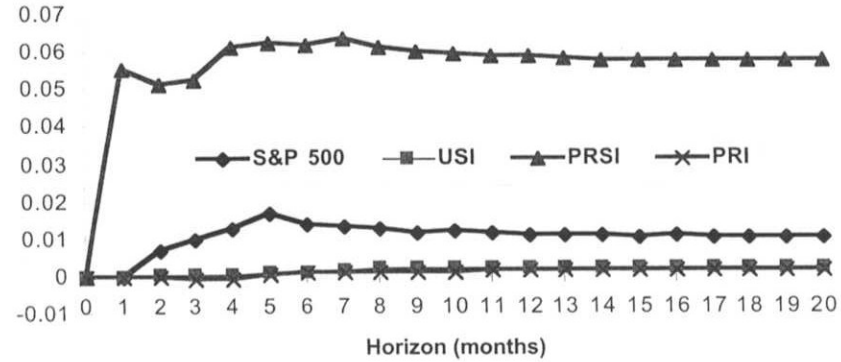
Horizons	S&P 500	USI	PRSI	PRI
0	0	0	0	0
1	0	0	0.055227	-1.75E-04
2	0.006881	3.90E-04	0.051198	-3.32E-04
3	0.009691	5.38E-04	0.052343	-6.57E-04
4	0.012662	4.46E-04	0.061421	-4.67E-04
5	0.016648	1.18E-03	0.062331	3.48E-04
6	0.013762	1.37E-03	0.062044	8.27E-04
7	0.013489	1.64E-03	0.06334	1.10E-03
8	0.012718	1.98E-03	0.061093	1.07E-03
9	0.011689	2.16E-03	0.060197	1.25E-03
10	0.012144	2.29E-03	0.059687	1.35E-03
11	0.011726	2.39E-03	0.058937	1.53E-03
12	0.011280	2.41E-03	0.058766	1.58E-03
13	0.011048	2.46E-03	0.058431	1.64E-03
14	0.010734	2.48E-03	0.057976	1.62E-03
15	0.010718	2.49E-03	0.057876	1.65E-03
16	0.010749	2.50E-03	0.057727	1.64E-03
17	0.010705	2.50E-03	0.0577077	1.67E-03
18	0.010687	2.50E-03	0.0576969	1.66E-03
19	0.010648	2.50E-03	0.0576634	1.67E-03
20	0.010629	2.50E-03	0.0576354	1.66E-03

Appendix 4

Graph 2
Comulative Impulse Responses to Innovation Shocks in the S&P 500 Index



Graph 3
Comulative Impulse Responses to Innovation Shocks in PR Stock Index



Appendix Box

Do stock price indexes follow a random walk?

The random walk hypothesis states that successive changes in stock prices are identically distributed and independent random variables. Given this, past stock price movements cannot be used to forecast future values. The random walk is an example of class of non-stationary processes known as integrated process. If random walk is presented, a non-stationary series is converted to stationary by differenciating it one time. This feature is known as I(1). A white noise process is I(0).

A common measure used to determine the presence of random walk is the unit root test. In this test a particular time series has a unit root (random walk) if the null hypothesis cannot be rejected, and the alternative hypothesis is that this time series follows a trend stationary process. A common statistical test was developed by Dickey and Fuller (1979) and is known as Dickey-Fuller Test of Augmented Dickey-Fuller when lags are considered. Results from this test are shown in Table A. The result confirms that the null hypothesis cannot be reject, so both series exhibited a I (1) process. Therefore, we accept the hypothesis that PRSI and S&P 500 follow a path of random walk.

Table A

Unit Root Test—Dickey-Fuller Test

	PRSI a/	S&P 500 a/
By level		
lags 4	-0.3927	-0.47766
lags 6	-0.3097	-0.46406
First difference		
lags 4	-6.5879 *	-6.2969 *
lags 6	-5.0614 *	-5.3759 *
lags 8	-4.8846 *	-5.3509 *

a/ in natural logarithm* critical values -3.4623 (1%), and -2.8751 (5%)