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Currency Area and Non-synchronized Business Cycles between the US and Puerto Rico

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Abstract

Frankel and Rose (1997, 1998) state that greater intensity of trading leads to more highly correlated business cycles across countries. Since 2005 Puerto Rico, which belongs to the US currency area, has suffered from economic stagnation. This raises the issue of whether currency areas lead to synchronized business cycles or not. Following Vahid and Engle (1997), we use a test of codependence to examine the short-run co-movements in outputs and prices between the US and Puerto Rico. The outcomes indicate that both economies share a common non-synchronized business cycle. The response from Puerto Rico to temporary US shocks occurs at a lag of one quarter. In addition, Puerto Rican prices respond to temporary shocks to US prices with a lag of two quarters. Furthermore, the forecast error variance decomposition shows that the Puerto Rican economy is highly dependent on the US economy. All evidence suggests that currency areas do not lead to synchronized business cycles. However, even though Puerto Rico has a non-synchronized common cycle with the US, the results appear to be that the current economic struggle in Puerto Rico is a long-term one, instead of a short-term one.

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1. Introduction

For optimum currency areas, economies should have synchronized common cycles to assure the efficiency of countercyclical policies.¹ According to Frankel and Rose (1997, 1998), trade intensity and synchronicity of business cycles are endogenous. In other words, they take place after the adoption of a currency area. Since 2005, Puerto Rico, which belongs to the US currency area, has suffered from economic stagnation. This raises the following question: Do currency areas lead to synchronized business cycles? For instance, Beine and Hecq (1998) find a synchronized common cycle among Germany, Austria, Belgium, France, and Denmark before the adoption of the euro. In addition, Herrera (2004) finds that since the adoption of NAFTA Mexico and the US have shared a synchronized business cycle.

This paper analyzes the short-term co-movements between the US and Puerto Rico (PR). Previous literature investigated output cross-correlation, both *ex-ante* and *ex-post* the adoption of currency, or free trade, areas. Here, we use a test developed by Tiao and Tsay (1985), but first applied to codependent cycles by Vahid and Engle (1997). This codependent test, hereafter VE, detects whether common synchronized business cycles exist across cointegrated or non-cointegrated series. However, an inconvenience is that PR real GDP is reported annually and with a delay of half a year.² To get around this shortcoming, we use quarterly Coincident Economic Indexes (CEI) and the unemployment rates. Also, we analyzed synchronization in prices. Once a common trend among real GDP, CEI, CPI, and unemployment is found, the outcome indicates that there is a synchronized common cycle in real GDP. However, using CEIs and unemployment rates, the VE test suggests a non-synchronized business cycle after one quarter. Codependent vectors are close to (1, -1) which indicates an appropriate sensitivity of Puerto Rican economy to US temporary shocks, although output is more sensitive than unemployment to US transitory shocks. Using CPIs, the VE test suggests a non-synchronized common cycle. The response in PR prices to US price shocks occurs with a two-quarters lag, which suggests price rigidity in PR. The outcomes show high dependence of the PR economy to the US economy. This is corroborated with the forecast error variance decomposition results. US shocks play a major role in innovations to PR macro variables. The existence of a non-synchronized business cycle suggests that short run rigidities or adjustment costs are present in PR. All evidence suggests that currency areas *per se* do not lead to synchronized business cycles.

However, even though, Puerto Rico has a non-synchronized common cycle with the US, the outcomes suggest that the current economic struggle is a long-term one, rather than a short-term one. Section 2 of this paper briefly summarizes the relevant literature. Section 3 presents the tests and data. Section 4 shows the empirical evidence. Section 5 examines the robustness of the results and section 6 concludes.

2. Relevant Literature

Frankel and Rose (1997, 1998) model the effects of trade intensity on business cycles and find that trade intensity increases the cross correlation of business cycles. Similar works are Wynne and Koo (2000), Calderon, Chong and Stein (2007); Artis, Chouliarakis, Harischandra (2011);

¹ Mundell (1961) and McKinnon (1963)

² 2002 RGDP is obtained from July 2001 to June 2002.

Bordo and Hiebling (2011); Artis and Okubo (2011); Inklaar, Jo-A-ping and de Haan (2008); Shin and Wang (2003). Rose (2008) and De Pace (2008) conclude that trade intensity increases the degree of business cycle synchronization through higher correlated business cycles after currency, or free trade, area adoption. However, they do not indicate whether the short-run co-movements occur at the same quarter.

Common features in the literature highlight the short-run co-movements of time series. Not conditional upon cointegration, Engle and Kozicki (1993) introduce the concept of serial correlation common feature (SCCF) to examine the common features among stationary times series; conditional upon cointegration, Vahid and Engle (1993) examine synchronized common cycles; and, Vahid and Engle (1997) extend the latter to examine the presence of synchronized or non-synchronized common features. The use of this in the literature may be found in Engle and Issler (1993), Arnaudo and Jacobo (1997), and Hecq (2002) for some Latin American countries. For African countries, Adom, Sharma, and Morshed (2010) find short-run co-movements. Likewise, for ECCU countries³, Sun and Samuel (2009) find that those countries are very sensitive to US shocks and Canadian shocks.

Specifically for free trade areas, Beine and Hecq (1998) find a synchronized common cycle in output among Germany, Austria, Belgium, France, and Denmark prior to the adoption of the euro.⁴ For all cases, the common feature vector in output is close to (1,-1). In addition, after NAFTA adoption, Herrera (2004) finds that both Mexico and the US share a common trend and a synchronized common cycle. The common feature vector is (1,-0.26) which means that Mexican output responds by 3.78% to a one percent increase in temporary US shocks. Therefore, this implies that the Mexican economy is very responsive to innovations in the US economy

Synchronization should occur in free trade areas and even more so in currency areas. Puerto Rico is a US territory, so free factor mobility, common trade area, common customs union, and a common currency union, as well as a fiscal union, are all present; therefore, the island should share a common synchronized cycle with the US. For more than 50 years, due to tax exemptions, many US firms moved to PR; this increased the importance of the industrial sector in the PR economy. The industrial sector is the most important one in the PR economy; it is even more prominent the tourism sector, which plays a crucial role in the economies of other Caribbean islands. In this process, the industrial sector became highly-dependent on imported intermediate goods. Besides, nearly all final good consumption by Puerto Ricans is done with final goods coming from the US mainland. This makes Puerto Rico an import-dependent economy. The Jones-Shafroth Act of 1917 and the Merchant Marine Act of 1920, which together state that only US-flagged ships can transport final and intermediate goods between the US and PR, exacerbates this dependency. Therefore, a free trade area with high transportation costs and asymmetric trade exist between the US and PR.

3. Tests and Data

³ Antigua and Barbuda, Dominica, Grenada, St. Kitts and Nevis, St Lucia, St. Vincent and the Grenadines belong to the Eastern Caribbean Currency Union and share a common currency, the East Caribbean Dollar, that is pegged to the US dollar.

⁴ Particularly, they use the notation of co-dependence of Gourieroux and Peaucelle (1993).

A reduced VAR(p) with $n=2$ series $I(1)$ is converted into the following VECM:

$$[I + \sum_{i=1}^{p-1} \sum_{j=i+1}^p A_j L^i] \Delta x_t = \tilde{\pi} \Psi + \pi x_{t-1} + \varepsilon_t \quad (1)$$

where x_t is the vector of time series; Ψ is a vector of deterministic variables; $\tilde{\pi}$ is the matrix of coefficients of Ψ ; $\pi = -(I - \sum_{i=1}^p A_i)$; A_i is the matrix of the VAR coefficients for all I from 1 to p ; L is a lag operator; Δ is the first difference operator; and ε is the matrix of disturbance terms ($\varepsilon \sim N(0, \Omega)$). Ω is the variance-covariance matrix. According to Johansen (1991), if the rank of π is r where $r \in (0, n)$, then r linear combinations of x_t that are $I(0)$ exist. Also, $\pi = \alpha \beta^T$, where α and β are the $(n \times r)$ matrices of adjustment coefficients and cointegrating vectors, respectively. Next, conditional upon cointegration, the VE test is conducted. The test statistic is $c(k, p, s) = -(T - p - 1) \sum_{i=1}^s \ln(1 - (\lambda_i(k)/d_i(k)))$ where T is the number of observations; $\lambda_i(k)$'s, where i goes from 1 to s , are the squared canonical correlations between $\{\Delta x_t\}$ and $W(k, p)$ which is identical to $\{\beta^T x_{t-1}, \Delta x_{t-k-1}, \dots, \Delta x_{t-k-p}\}$; k is the period when the shock occurs (when $k = 0$, synchronized common cycles are indicated and if $k > 0$, non-synchronized common cycles are the implication); $d_i(k = 0) = 1$ and $d_i(k) = 1 + 2 \sum_{v=1}^k \rho_v(\theta^T \Delta x_t) \rho_v(\gamma^T W(k, p))$; at the v -lag, $\rho_v(\alpha^T \Delta x_t)$ and $\rho_v(\gamma^T W(k, p))$ are the sample autocorrelations of $\theta^T \Delta x_t$ and $\gamma^T W(k, p)$, respectively; and, θ and γ are the canonical variates associated with $\lambda_i(k)$. Under the null hypothesis that there are at least s ($< n$) codependent vectors after the k th period, $c(k, p, s)$ has a χ^2 -distribution with $s(np+r) - s(n-s)$ degrees of freedom.

From 1947 to 2009, the Federal Reserve Bank of St. Louis and the PR Planning Board provided US real GDP and PR real GDP, respectively. In addition, from the first quarter of 1970 through the second quarter of 2007, the Conference Board and the PR Planning Board provided US CEI and PR CEI, respectively.⁵ Likewise, we use the unemployment rates from the first quarter of 1976 through the second quarter of 2012, provided by the Bureau of Labor Statistics. Additionally, the Federal Reserve Bank of St. Louis provides the US CPI and the Statistics Agency of PR provides the PR CPIs from the first quarter of 1957 through the fourth quarter of 2010. The data is quarterly and seasonally adjusted. The real GDP, CEI, and CPI series are converted to logs. Figure 1 reports the real GDP, CEI, CPI and unemployment rate series. Finally, Table 1 shows that all of the series are $I(1)$ s.

4. Outcomes

The Johansen test results are reported in Table 2. For all cases, $r \leq 1$ cannot be rejected, while $r = 0$ is rejected. Thus, the real GDP, CEI, CPI and unemployment rates are cointegrated. Furthermore, Table 3 reports results from the VE test. At 5% significance level, $s > 0$ cannot be rejected, and $s > 1$ is rejected. Therefore, the VE test detects a synchronized common cycle. Nevertheless, this result needs further revision because, as was already mentioned above PR real GDP is reported with a delay of six months.

⁵ CEI is recorded monthly on the basis of the construction, manufacturing, and service sectors, as well as job growth and consumer outlays. Primarily, CEI is a measure of business cycles but it is also useful to look at the trend of the economy. For this study, CEIs, CPIs and URs monthly series are used in quarterly series.

Using the CEI series, Table 3 reports that for $k = 0$, $s > 0$ and $s > 1$ are rejected at 5% significance. For $k = 1$, at 5% significance, $s > 0$ cannot be rejected, and $s > 1$ is rejected. So, the US and the PR economies share a non-synchronized common cycle. Using unemployment rates, the same table reports that for $k = 0$, $s > 0$ and $s > 1$ are rejected at the 1% level of significance. For $k = 1$, at 1% significance, $s > 0$ cannot be rejected, and $s > 1$ is rejected. This indicates that the US and the PR economies share a non-synchronized common cycle. Quarterly data indicates that PR responds to temporary US shocks with a one-quarter lag. Using the CPI series, Table 3 reports that for $k = 0$, $s > 0$ and $s > 1$ are rejected at 5% significance. For $k = 1$, at 5% significance, $s > 0$ and $s > 1$ are rejected, and, for $k=2$, at 5% significance, $s > 0$ cannot be rejected, and $s > 1$ is rejected. This indicates that the US and the PR economies share a non-synchronized common cycle in prices.

Table 4 shows all normalized vectors. Codependent vectors of the quarterly series are close to (1,-1). PR output positively (negatively) responded by almost 1.28% to a one percent increase (decrease) from a temporary US shock after one quarter. In addition, the PR unemployment rate positively (negatively) responds by 0.81% to a one percent increase (decrease) in the US unemployment rate after one quarter, as well. This outcome means that compared to Mexico, the Puerto Rican economy is not very sensitive to the ups-and-downs of the US economy. Finally, the inflation in PR responds by 0.66% to one percent increase in the US inflation shock. The existence of a non-synchronized business cycle suggests that short run rigidities, or adjustment costs, are present in PR.

5. Robustness

Using the CEI series for Florida (FL) and New York (NY), robustness checks are run to examine whether synchronized business cycles are common across PR and those states. We selected FL because it is the closest state to the island and we selected NY because PR is under the jurisdiction of the Federal Reserve Bank of New York. Table 5 reports that synchronization is not detected at 5% significance. There is a non-synchronized common cycle with FL and NY at two quarters lag.

To examine the short-run relationship between the US and PR beyond the common cycle hypothesis, we run forecast error variance decompositions on CEIs, CPIs and unemployment rates. For this purpose, we use equation (1) without including the error correction term and imposing a short-term restriction, which implies that there are no contemporaneous effects from PR macro variables on the US macro variables. Table 6 shows all outcomes. This result highlights the strong link that the PR economy has with the US economy. Over 10 quarters, US temporary shocks have strong explanatory power for changes in the PR CEI and PR CPI series. Puerto Rican economic performance is tied to US economic performance. For innovations in PR unemployment, US temporary shocks are less important; this means that high unemployment rates in PR have a structural source rather than a cyclical one. The forecast error variance decomposition corroborates the high-dependence in the short run of the PR economy to the US economy. All of our evidence presented here suggests that trade intensity between the two is asymmetric. The US is the most important trading partner for PR, but PR represents a small part of US international trade.

6. Conclusions

This article examines short-run co-movements between Puerto Rico and the US. The results show that the US and the PR economies share a non-synchronized business cycle. In other words, there is a codependent cycle after one quarter. Countercyclical US short-run policies are not efficient on the island. However, even though Puerto Rico has a non-synchronized common cycle with the US, the current economic downturn in PR appears to be more of a long-run issue as opposed to a short-run one. Therefore, Puerto Rican efforts should be focused on long-term economic growth.

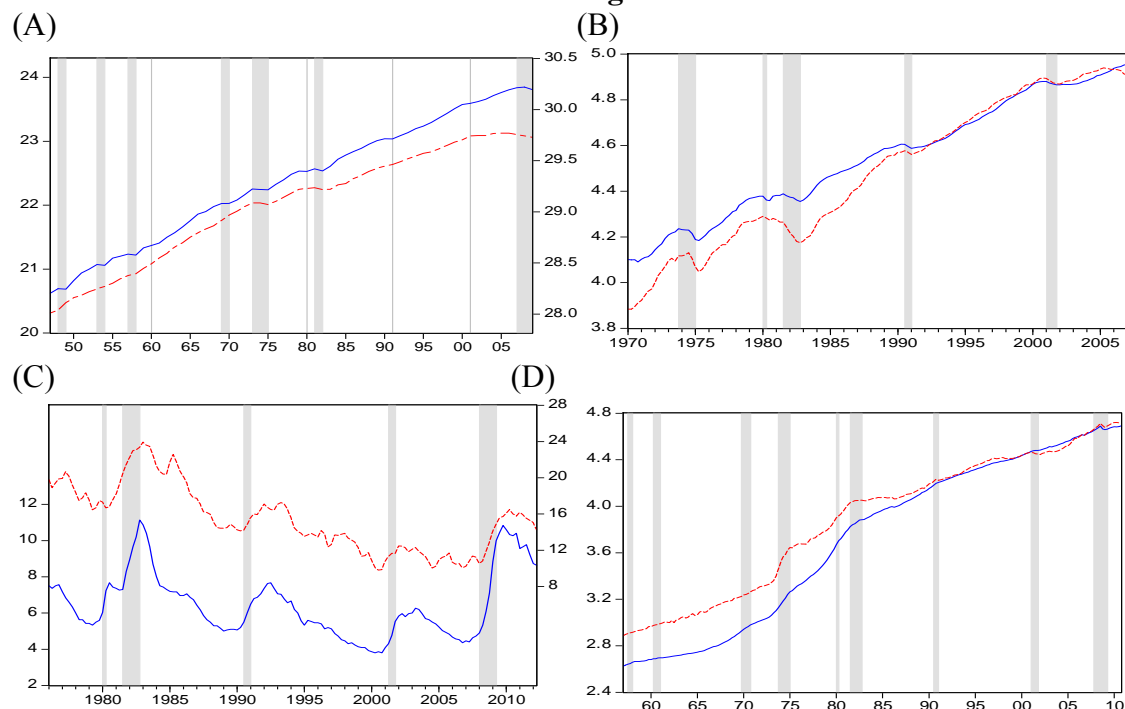
Likewise, having non-synchronized business cycles suggests that there are short-run rigidities, or adjustment costs. One of these might come from the Jones-Shafroth Act of 1917 and the Merchant Marine Act of 1920, which together state that only US-flagged ships can transport final and intermediate goods between the US and PR. So, PR has a free trade area with the US, but with high transportation costs. In addition, the production of some US firms on the island is first sent to their headquarters in the US mainland to be checked before being returned to PR to be sold there. These rigidities should have a strong impact due to the importance of the Puerto Rican industrial sector to their economy. Overall, most of the intermediate goods in PR come from the US mainland. Furthermore, even though tourism plays an important role in other Caribbean islands, this sector, together with remittances from the mainland, plays a minor role in the PR economy. Finally, evidence suggests that there is asymmetry in trade intensity. The US is the most important trading partner for PR, but PR is not an important trading partner for the US. All evidence from this study suggests that currency areas alone do not lead to synchronized business cycles.

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Figure 1



Notes: Panel (A) shows the real GDP series in logs from 1947 to 2009. The vertical axis on the right-hand side of each graph measures the US series and on the left-hand side the PR series (in dotted line); Panel (B) shows the CEI series in logs from 1970Q1 through 2007Q2 (Base year 1996=100); Panel (C) shows the unemployment rates from 1976Q1 through 2012Q2 with the vertical axis on the right-hand side of each graph measuring the PR series (in dotted line) and on the left-hand side the US series; and Panel (D) shows CPIs from 1957Q1 to 2010Q4 (Base year 2006=100). Shadow bars indicate US recessions.

Table I

UNIT ROOT TESTS (P-VALUES)									
		US RGDP	PR RGDP	US CEI	PR CEI	US UR	PR UR	US CPI	PR CPI
Levels	ADF	0.39	0.19	0.82	0.77	0.45	0.31	0.89	0.97
	PP	0.92	0.86	0.93	0.87	0.64	0.56	1.00	0.99
First differences	ADF	0.05	0.03	0.00	0.04	0.00	0.00	0.08	0.00
	PP	0.00	0.07	0.00	0.00	0.00	0.00	0.02	0.00

Notes: The Augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) test results are indicated here. Except for the unemployment rates, the individual series in levels are assumed stationary. The unemployment rate in levels is assumed zero-mean stationary. The first differenced series are assumed zero-mean stationary. For ADF and PP, we used the AIC and HQ to set the optimal lag order.

Table II

JOHANSEN'S (1991) TRACE TEST (P-VALUES)				
H_0	RGDPs	CEIs	URs	CPIs
$r=0$	0.03	0.07	0.01	0.09
$r\leq 1$	0.18	0.92	0.15	0.27

Notes: For all tests except CPIs, Eq.(1) has a restricted trend.

Using AIC and HQ, for real GDP, the optimal lag order is 1. For the CEI, the optimal lag order is 3. For the unemployment rates, the optimal lag order is 2. For the CPIs the optimal lag order is 4. The CEI series are also cointegrated at the 5 percent level of significance using the Maximum Eigenvalue test.

Table III

VE OUTCOMES - US VS. PR						
	H_0	$C(k=0,p,s)$	$C(k=1,p,s)$	$C(k=2,p,s)$	DF	CV 5%
RGDPs	$s>1$	17.99	-----	-----	6	12.59
	$s>0$	5.33	-----	-----	2	5.99
CEIs	$s>1$	111.90	25.27	-----	14	23.69
	$s>0$	15.06	5.31	-----	6	12.59
CPIs	$s>1$	390.11	82.36	40.65	18	28.87
	$s>0$	79.65	31.29	6.04	8	15.51
						CV 1%
URs	$s>1$	109.71	27.94	-----	10	23.21
	$s>0$	30.57	12.18	-----	4	13.28

NOTE: Standard errors in parentheses. $k=0$ means "synchronized common business cycles" and $k>0$ means "non-synchronized common business cycles"

Table IV

NORMALIZED LONG AND SHORT-TERM VECTORS				
		US	Puerto Rico	Trend
RGDPs	Cointegrating vector	1	-0.26(0.04)	-0.021 (0.002)
	Codependent vector, $k=0$	1	-0.64 (0.22)	
CEIs	Cointegrating vector	1	-0.033(0.10)	-0.006(0.001)
	Codependent vector, $k=1$	1	-0.78(0.34)	
URs	Cointegrating vector	1	-0.583 (0.064)	-0.034(0.01)
	Codependent vector, $k=1$	1	-1.24 (0.40)	
CPIs	Cointegrating vector	1	-1.22(0.024)	
	Codependent vector, $k=2$	1	-1.503(0.54)	

NOTE: Standard errors in parentheses. $k=0$ means "synchronized common business cycles" and $k>0$ means "non-synchronized common business cycles."

Table V

VE OUTCOMES – PR VS. FL AND NY					
H_0	$C(k=0,p,s)$	$C(k=1,p,s)$	$C(k=2,p,s)$	DF	$CV\ 5\%$
PR CEI and NY CEI					
$s>1$	270.7	47.26	23.84	14	23.69
$s>0$	66.77	15.13	9.69	6	12.59
PR CEI and FL CEI					
$s>1$	258.53	47.96	27.76	10	18.31
$s>0$	58.17	14.23	8.91	4	9.487

Notes: . FL CEI and NY CEI are from 1979Q1 to 2007Q2. Both of them are $I(1)$ s. PR CEI and NY CEI are cointegrated at the 5% level of significance. PR CEI and FL CEI are cointegrated at the 5% significance level. Eq.(1) has a restricted trend. For NY the optimal lag order is 3 and for FL, two was the optimal lag order.

Table VI

FORECAST ERROR VARIANCE DECOMPOSITION FOR QUARTERLY SERIES (%)						
Horizon (quarters)	US shock	PR shock	US shock	PR shock	US shock	PR shock
	<i>CEI of US</i>		<i>Unemployment rate of US</i>		<i>CPI of US</i>	
1	100	0	100	0	100	0
2	100	0	99	0	100	0
3	99	1	93	7	100	0
4	98	2	91	9	100	0
5	97	3	91	9	100	0
10	97	3	90	10	99	1
	<i>CEI of PR</i>		<i>Unemployment rate of PR</i>		<i>CPI of PR</i>	
1	37	63	4	96	32	68
2	53	47	12	88	41	59
3	54	46	19	81	43	57
4	53	47	21	79	46	54
5	53	47	24	76	46	54
10	53	47	26	74	48	52