Asymmetric Effects of United States Monetary Policy on the Economy of Puerto Rico: 1964 to 1994

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Abstract

This paper explores the asymmetrical effects of U.S. monetary policy on the real growth in Puerto Rico and compare it with that of the United States during the period 1964:1 to 1994:4. It also constructs two indexes to measure asymmetry: the index of asymmetry (IOA), and the index of relative asymmetry (IORA). Morgan (1993), in a recent study found evidence of asymmetrical effects of U.S. monetary policy on the real output growth of United States; that is, a easy monetary policy has a weaker effect over the real output than a tight policy.

The results of this study indicate that Puerto Rico and United States real outputs did depict asymmetry effects to U.S. monetary policy. Using an index of asymmetry (IOA), a lower degree of asymmetry was found in Puerto Rico than in the United States. However, when the response of real output to each stance of U.S. monetary policy was considered separately, the relative asymmetry for Puerto Rico was about 10 percent larger under a tight policy and 141 percent greater under an easy policy than the United States.

Two associated elements seemed to induce this larger relative asymmetric in Puerto Rico: (1) consumers in Puerto Rico are more sensitive to changes in the market interest rates than U.S. counterparts, and, (2) consumer prices in Puerto Rico tend to be more flexible downward and upward to the U.S. monetary policy. This greater price flexibility in Puerto Rico serves as a restraint to increases in real consumption during a tight policy and as a boost during a period of an easy policy.

Introduction

The Great Depression, apart from being a landmark in the economic history of the United States has also served as a benchmark to determine the effectiveness of an easy monetary policy designed to revive the U.S. economy in the 1930's. Up to this time, many economists assumed, at least theoretically, that monetary policy had a symmetric effect on the economy, that is , an easy policy would have the same but opposite effectiveness as a tight policy. However, a recent empirical research has shown that while a tight policy tends to have a more significant impact in restraining the economy, an easy policy is somewhat

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weak, if not powerless in stimulating the economy. For instance, Morgan (1993) found that in the United States, an easy policy has a weaker effect on the real output growth than a tight policy in limiting it.[1] Given this situation, it appears fairly acceptable to state that the effects of U.S. monetary policy are rather asymmetric than symmetric, as some economists have asserted.

While the issue of asymmetry is a controversial and debatable topic, three major reasons have been addressed to affirm of a greater effectiveness of a tight monetary policy. One of these has to do with the changing outlook over the business cycle where both business and consumers tend to be more optimistic in an economic boom than during a period of recession. Another reason relates to the stronger impact of higher interest rates, which tend to effectively limit the demand for credit than lower rates resulting from an easy policy. Finally, a third reason deals with the relative flexibility of prices where the general tendency is to be more flexible upward and more sticky downward , if not inflexible, with an easy monetary policy.

In the case of Puerto Rico, because of its special relationship with the U.S. some additional reasons for possible asymmetrical effects of U.S. monetary policy on the local economy could be attributed to the following factors. First, the money supply in Puerto Rico,

1. Other paper by Ramsey and Rothman (1996) has distinguished between "longitudinal" and "transversal" asymmetry. Longitudinal asymmetry means asymmetrical in the direction of the movement of the business cycles--i.e., steepness. Conversely, transversal asymmetry refers to asymmetrical in the vertical displacement of the series--i.e., deepness and sharpness. According to the authors, a series can be both asymmetric.

although sensitive to short-term capital movements[1], might be segmented from the U.S. monetary market due to the ready availability of the 936 market funds [2]. Second, portfolio decisions of some economic agents and the repatriation-dividend policy of U.S. multinational corporations doing business in Puerto Rico might be sensitive to changes in the U.S. interest rate and monetary policy. Third, banking and industrial concentration in Puerto Rico may tend to induce less downward flexibility in prices [3].

In order to examine and understand the asymmetric effects of this policy in Puerto Rico, this study was conducted using the Vector Autoregression Regression (VAR). This statistical technique allows us to perform this task utilizing two "new" relevant devices: (1) the Impulse Response Function (IRF), and (2) the Forecasted Error Decomposition Variance (FEDV). Findings and interpretations are discussed in section five of this paper while section six provides the conclusions of the study. The other section dealt respectively with the banking structure and the 936 funds market, the channel of transmission of U.S. monetary policy to Puerto Rico, and the details of the model.

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1. Ingram (1962) found that bank reserves in Puerto Rico did not behave as suggested by the classical model because they were highly sensitive to short-term capital movements, which is turn are sensitive to the interest rate differential.

2. Some empirical studies have shown that 936 funds market tend to circumvent the effectiveness of U.S. monetary policy in Puerto Rico [Alameda (1996), Estudios Técnicos (1990)].

3. Fry (1979) stated that above- average interest rate in Puerto Rico, Alaska and Hawaii depends upon banking concentration, among other factors.

The Banking System, Capital Movements and 936 Funds market in Puerto Rico

A. The Structure of Banking System and its Role in Capital Movements

As a regional economy of United States, Puerto Rico not only enjoys a common market with the latter, but is also subjected indirectly to the monetary policy established by the Federal Reserve System. Because of this, it is expected that changes in this policy over time will affect the level of output , employment and monetary flows in the Puerto Rican economy. However, these flows are also contingent upon the local banking and financial structure, particularly with respect to a unique feature in the economy known as 936 funds deposited in financial institutions by subsidiaries of U.S. multinational corporations established in Puerto Rico.

As of June 1996, the banking system of Puerto Rico, consisted of twenty-one (21) private commercial banks, and two publicly owned banks—the Economic Development Bank and the Government Development Bank. Among the commercial banks, sixteen (16) are considered domestic banks, two (2) are U.S. national and the rest (3) are regarded as foreign banks. Domestic banks (including trust banks) and the foreign banks are chartered under the local banking Law 55 of 1933, regardless of their capital-ownership structure while the subsidiaries (branches) of U.S. national --the Chase Manhattan Bank and Citibank-- are organized under the laws of the Federal banking system. Conversely, foreign branches belong to the Royal Bank of Canada, the Bank of Nova Scotia and Banco Bilbao Vizcaya but they are chartered under the local banking Law 55 of 1933. Banco Popular de Puerto Rico, the largest banking institution on the Island, although considered a domestic bank, is chartered also under the Federal Reserve System (FRS). As of June 1996, domestic banks

held $26.8 billion in assets or 82.8 percent of total bank assets in Puerto Rico while U.S. national banks accounted for $4.2 billion (13.0 %), and foreign banks for the remaining $1.4 billion (4.2 %).

Under local banking regulations, all domestic and foreign banks are required to hold a minimum legal reserve of 20 percent against certain demand deposits, regardless of the state of the local economy. This reserve requirement is not used as an instrument of monetary policy, but rather as a regulatory and administrative measure designed to achieve specific goals such as the promotion of banking confidence and liquidity. On the other hand, all reserves of banks chartered by the federal banking Laws are directly subjected to the reserve requirements established by the FRS. Since domestic banks are subjected to the control of the FRS, their reserves are not directly influenced by the U.S. monetary policy but rather, indirectly, through changes in the interest rate.

A singular feature of the Puerto Rican banking system is the excess reserves of banks and the manner in which commercial banks can move their excess reserves mainly to U.S. financial market seeking for the most profitable investment opportunity. Ingram (1962) found that changes in local bank reserves depend upon short-term capital movements which are sensitive to differences in the rate of interest. While all banks in Puerto Rico are able to move their excess reserves freely to the U.S. economy, the process by which these funds move, are however somewhat different between banks. All U.S. national banks and some foreign banks having external subsidiaries can move their funds through intra-bank transfers to take advantage of higher interest rates on their mainland branches Domestic banks—especially, those locally owned —are able to do so through their outside branches.

Foreign banks are forced to move their funds using Mainland correspondents. Even though the theory of regional (international) capital movements suggests that these funds will be moving until the interest rate differentials would be largely eliminated, markets are not necessarily under the condition of full-information and capital needs for development are also different between countries. Such conditions preclude for a full adjustment or elimination of the interest rate differentials.

Meanwhile, capital movements will also affect the stock of local money supply by altering the balance sheets of commercial banks, and the regional balance of payments, particularly the short-term capital account. Since banks and economic agents realize about the short-term and long-term interest rate differentials, they will be motivated to capture proceeds from this edge.

B. The 936 funds market

A singular characteristic of this banking structure is the presence of an unique capital market named as "936 funds market". Briefly speaking, the 936 funds market was derived from the Section 936 of the U.S. Internal Revenue Code (1976) which granted U.S. corporate subsidiaries located in Puerto Rico full tax exemption on their profits if these proceeds remain in the Island. By June 1996, this market accounted for about $10.6 billion in deposits in the local banking system, and $2.2 billion were managed by brokers. 936 certificates of deposits (936 CDs) represented about 96. 2 percent of total 936 deposits, and their maturity was biased toward a highly liquid capital market (near 38 per cent of total 936 CDs was less than one month).

In general, the 936 fund market played an important role not only in augmenting total bank resources, but also in allocating such bank resources to enhancing local economy. It also served as an important tool in circumventing U.S. tight policy (Alameda, 1996). Therefore, it obvious that portfolio investment decisions of 936 corporations significantly affected the supply of deposits or the monetary base of the local economy. Corporate decisions, such as repatriating earnings versus depositing them locally, was a function not only of the internal corporate strategy but also of the U.S. Congress legislation toward 936 corporations, and the spread of rates of return between Puerto Rico and the Eurodollar market rates [4].

The Channel of Transmission of U.S. Monetary Policy

The Federal Reserve System (FRS) establishes monetary policy by altering directly the supply of bank reserves and, chance the extension of credit by commercial banks. Through its influence on bank reserves, it can alter the nominal short-term rate of interest, the discount rate and the federal funds rate (FEDR)[5]. For example, when the FED eases monetary policy, it pushes downward these rates, and when it tightens policy, it forces them upward. The changes in the FEDR appear to be a very significant variable with respect to United States monetary policy and the movement of real macroeconomic variables (Bernanke

4. Since the Eurodollar rate was taxable while the 936 CD was not, a comparable return on 936 interest rate on an after tax basis has to be at least 65% of Eurodollar, even after considering the tollgate tax. Thus, the 936 CDs rate was pegged to that of the Eurodollar market rate. Local 936 fund regulations take into account such an equation in order to enhance local real and financial investments from banks and 936 corporations.

5. The FEDR is the rate that banks charge to lend reserves to one another. Although this rate is not directly determined by the FRS, it rather influences by altering the bank reserves.

and Blinder, 1992). For example, Bergante and Blinder found that FEDR is a good indicator of the U.S. monetary policy because it is less contaminated with endogenous responses to contemporaneous economic conditions such as money growth. Therefore, changes or innovations (error disturbances) in the FEDR can be regarded as a good indicator of the stance of U.S. monetary policy--i.e., an increase in the FEDR is associated with a tight policy and a decrease with an easy policy [6].

In the U.S. monetary policy transmission mechanism to Puerto Rico, it is important to evaluate the role of commercial banks. Commercial banks are the main actors in the way in which the U.S. monetary policy shocks are transmitted to Puerto Rico. Short-term capital movements between U.S. money and capital markets and the banking system of Puerto Rico, seem to be highly sensitive to the interest rate differentials. If monetary policy alters banks reserves or changes short-run interest rate, funds in commercial banks will be moved affecting the supply of deposits at the Island.

Two main effects are observed in the U.S. monetary transmission to the economy of Puerto Rico: *the bank reserves effect* and *the interest rate effect*. In theory, *the bank reserves effect* is a direct reduction (increase) in the supply of banks' reserves arising from changes

6. For instance, another research study by Bergante and Gertler (1995) employed a vector autoregression (VAR) and used the disturbances to the Fed funds rate equation as shocks to monetary policy. The results from this research are consistent with the conventional analysis of monetary policy transmission in the following four facts (a tightening policy, say): (1) a tightening monetary shocks is followed by a sustained declines in real GDP and the price level; (2) final demand absorbs the initial impact of a monetary tightening but falling relatively quickly after a change in policy. This difference is made by inventory stocks behavior. (3) the earliest and sharpest declines in the final demand occurs in residential investment and secondly in consumer goods; and, (4) fixed investment lagged behind residential investment but it eventually declined. However, some important puzzles were stated by the authors: (1) the magnitude of the policy effects; (2) the timing effect, and (3) the composition of spending effects. According to the authors, these three puzzles are difficult to explain solely in terms of conventional interest rate effects, therefore, they claims to fill this gap using the credit channel theory.

in the U.S. monetary policy. These changes may have greater impact on U.S. national banks than domestic banks on the Island. However, due to the fact that these U.S. national banks maintain low bank reserve balances as a result of the an immediate repatriation of any liquidity surplus to their headquarters, this effect will be minimized. In addition, these banks are capable to quickly offset any reserve decline by transferring funds from other worldwide branches or main office, if local demand for loans is strong enough to obtain a net profit. On the other hand, no changes in reserves of the domestic and foreign banks is expected since these banks are locally chartered and therefore not directly subjected to the policy instruments of the FED.

The interest rate effect is the reaction of commercial banks and their credit creation process when the nominal rate of interest changes as a direct result of the Fed policy. A higher (lower) interest rate makes the free bank reserves more expensive (cheaper). Furthermore, in an open economy these changes in the nominal rate of interest will alter economic agents' decisions regarding to capital inflows (outflows), public and private investment portfolio decisions, and the optimal money balance held by these agents.

The model construction and the selection of the variables

Identifying changes in the stance of the U.S. monetary policy is the central focus in this study. Bergante and Blinder (1992) used the FEDR because it is not only a very informative indicator about the future movements of the real U.S. economy, but also a significant variable to assess the effects of U.S. monetary policy. However, Morgan claimed that this type of approach raises identification problems because not all changes in this Fed

Fund rate reflect changes in the monetary policy. In spite of this controversy, the present study adopted the Bergante and Blinder's approach since a previous study by Ingram (1963), and Horst and Associates (1990), found that short-term and long-term capital movements in Puerto Rico are highly sensitive to changes in the U.S. and world market rate of interest.

The model used to identify changes in the FEDR as an indicator of U.S. monetary policy is a "two-stage regression procedure" similar to Morgan. The first stage regresses the level of the FEDR against its own lagged values, on current and lagged values of U.S. output growth and the inflation rate, including the constant and the trend. In order to capture all possible effects over the time, eight lags in each variable were used (same as Morgan's study). However, the variations in the FEDR as such was not used in identifying the changes in U.S. monetary policy but instead the regression residuals. Positive residuals (observed value greater than predicted value) mean a tight monetary policy while negative residuals (observed value lower than predicted value), indicate an easy monetary policy. Quarterly data used in this first stage extended from 1962:1 to 1994:4. Two regression models were performed, one for Puerto Rico and other to United States.

The second stage regresses Puerto Rico's quarterly output growth (real Gross National Product, at 1954 prices[7]) against its own eight-quarter lagged values and the residuals of the FEDR, including and constant and a trend. The same equation was also used

7. Official figures of quarterly data of real GNP for Puerto Rico do not exist. However, the Office of Analysis and Economic Research of the Government Development Bank of Puerto Rico, using an interpolation method generated figures for the real quarterly GNP. The monthly index of economic activity of the Planning Board of Puerto Rico serves as a benchmark. Quarterly estimates goes from the 1962:1 to 1994:4.

for the real output growth of United States (real Gross Domestic Product, at 1992 prices), in an effort to permit a comparison of the results of both economies. The regression equation is as follows:

(1) $\Delta \log y_t = \alpha + \beta \text{ trend} + \Sigma \delta i \Delta \log y\ t\text{-}i + \Sigma \phi i \text{ FEDR } (+)\ t\text{-}1 + \Sigma \rho i \text{ FEDR } (-)\ t\text{-}1 + \varepsilon i$

when i goes from one to eight quarter lags. D log y t is the real quarterly output growth, FEDR(+) are the positive residuals (tight policy) and, FEDR(-) are the negative residuals (easy policy). Otherwise, the value of zero is considered when the FEDR does not match with either one of the monetary policy regime. Quarterly figures used run from 1964:1 to 1994:4[8]. A Vector Autoregressive Regression (VAR) was performed[9] facilitating a better interpretation of the effect of U.S. monetary in both economies. The VAR results can be easily interpreted by the use of two main statistical devices: the Impulse Response Function IRF) and the Forecast Error Decomposition Variance (FEDV).

In order to measure asymmetry and make a comparison of both economies, two indexes of asymmetry were constructed. The first, called the Index of Asymmetry (IOA), is the absolute value of the difference of two areas (the different between the impulse response of the output growth with a tight policy and an easy policy at an horizon of 10 quarters) divided by the sum of these two areas[10]. Since the value of the area when a tight policy is negative, its absolute value for this area is only considered. The IOA goes from zero to one

8. The difference between time span in the first and the second stage is due to the time lags of eight quarters. Second stages regression lost eight quarters.

9. See appendix for an explanation of the VAR model. In here we assume linearity between the policy and output while Morgan did not.

10. The trapezoidal formula is used to estimate the areas of the integrals--cumulative values of the impulse responses of real output growth.

(or one hundred); a value of zero means perfect symmetry, if one hundred, perfect asymmetry. Mathematically expressed IOA is:

IOA = | (Σ IRF to ease policy less | Σ IRF to tight policy |) ÷

(Σ IRF to ease policy plus | Σ IRF to tight policy |) | x 100

where Σ IRF is the impulse response of real output growth for a given economy.

The second measure is the Index of Relative Asymmetry (IORA) which compares the asymmetry of each stance of monetary policy between both economies; for instance, the responses of real P.R. output growth relative to its counterpart of U.S. under a tight or easy policy. The absolute value of the area or integral-- represented by the impulse response of real output growth -- under a given stance of the monetary policy is calculated using the trapezoidal formula. Then,

(3) IORA = [Σ IRFPR to FEDR (n) / Σ IRFUS to FEDR (n)] x 100

where Σ IRFPR is the cumulative area values of the impulse response of real P.R. output growth at 10 quarters and Σ IRFUS is the same but for real U. S. output growth. FEDR (n) is the respective stance of monetary policy (FEDR(+), when is tight policy and FEDR(-), when is easy policy).

Table 1 shows the value of both indexes.

Table 1
Index of Asymmetry (IOA) and Index of Relative Asymmetry (IORA)

Index	Puerto Rico	United States
IOA	21.8	62.4
	Tight Policy	Easy Policy
IORA	110.0	241.0

The empirical evidence of asymmetry effects

The results of the second stage regression using IRF yielded the following conclusions with respect to the effects of U.S. monetary policy on both economies[11]:

1. There is evidence of asymmetry in real GNP growth of Puerto Rico as a result of U.S. monetary policy since the impact of an increase in the FEDR (tight policy) was found to be greater on real output than a decrease in the FEDR(easy policy). Table 2 shows that at an horizon of 10 quarters, the responses of Puerto Rico real output is 17 % larger under a tight policy than under an easy policy (see also Graph 1). However, the IOA for Puerto Rico is relatively low with a value of 21.8.

2. There exists also asymmetric effects on real GDP of United States in response to Federal monetary policy. The impact of a tight policy when compared with as an easy policy at the same horizon (10 quarters) is not only greater but also about three times larger than that of Puerto Rico. The real U.S. output response under a tight policy is 178 % larger than under an easy policy (See Table 3 and Graph 2). This conclusion is consistent with that of Morgan.

Table 2

Impulse Response of Quarterly real GNP growth of Puerto Rico to U.S. Monetary Policy

Horizons (quarters)	Tight monetary policy (FEDR(+))		Easy monetary policy (FEDR (-))	
---	PR GNP	Cumulative	PR GNP	Cumulative
1	-0.00034305	-0.00034305	0.00076085	0.00076085
2	-0.000094	-0.00043702	0.00027894	0.00103979

11. The variable ordering performed in the regression was: FEDR(+), FEDR(-), D yt. The variable ordering FEDR (-) FEDR(+), D y t was also performed but conclusions were similar.

3	-0.00067221	-0.00111407	0.000545	0.00158483
4	-0.00062913	-0.0017432	-0.000091	0.001493848
5	-0.00057774	-0.0023209	0.00063046	0.002124308
6	-0.00082365	-0.0031446	0.00012405	0.002248358
7	-0.00090813	-0.0040527	0.00072632	0.002974678
8	-0.00052834	-0.0045766	0.0010122	0.003986878
9	-0.00062753	-0.0052041	0.0004554	0.004442278
10	-0.000308	-0.0055121	0.0002825	0.004724738

Graph 1
Impulse Response of PR GNP to Cholesky Shocks
of Monetary Policy

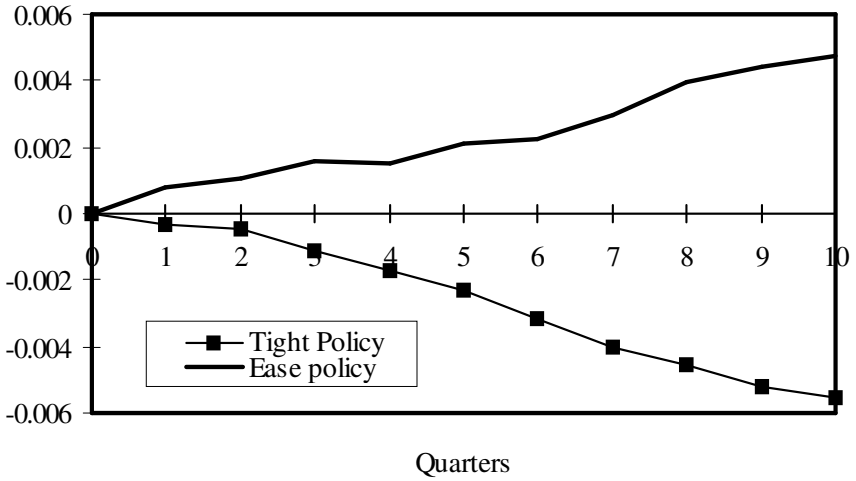
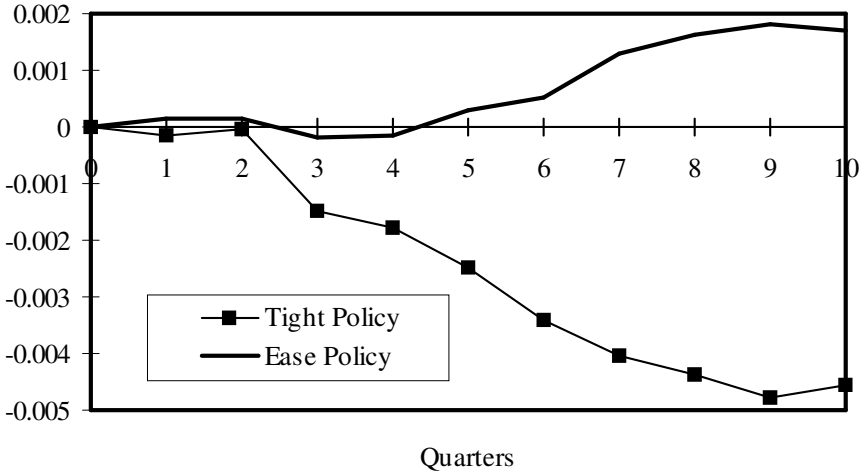


Table 3

Impulse Response of Quarterly real GDP growth of United States to U.S. Monetary Policy

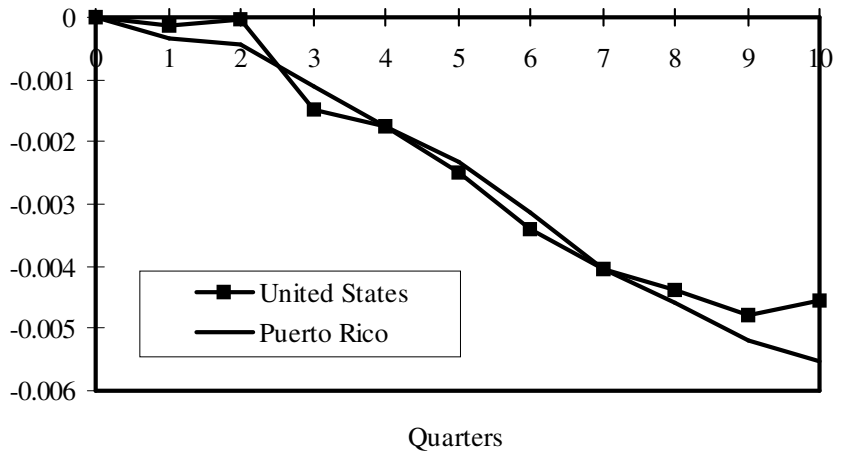
Horizon (quarters)	Tight monetary policy (FEDR(+))		Easy monetary policy (FEDR (-))	
---	US GDP	Cumulative	US GDP	Cumulative
1	-0.00013355	-0.00013355	-0.0001338	0.00013384
2	0.00010888	-0.0000247	0	0.00013377
3	-0.0014582	-0.00148287	0.0003266	-0.0001928
4	-0.00028431	-0.00176718	0.0000538	-0.00013902
5	-0.000716	-0.00248314	0.00042106	0.00028204
6	-0.00091585	-0.0033988	0.000223	0.00050503
7	-0.0006396	-0.00403857	0.00078	0.001284877
8	-0.00034186	-0.00438045	0.0003357	0.001620617
9	-0.0003959	-0.00477635	0.000185	0.001805317
10	0.00021744	-0.00455891	-0.0000973	0.001707998

Graph 2
Impulse Response of US GDP to Cholesky Shocks
of U.S. Monetary Policy

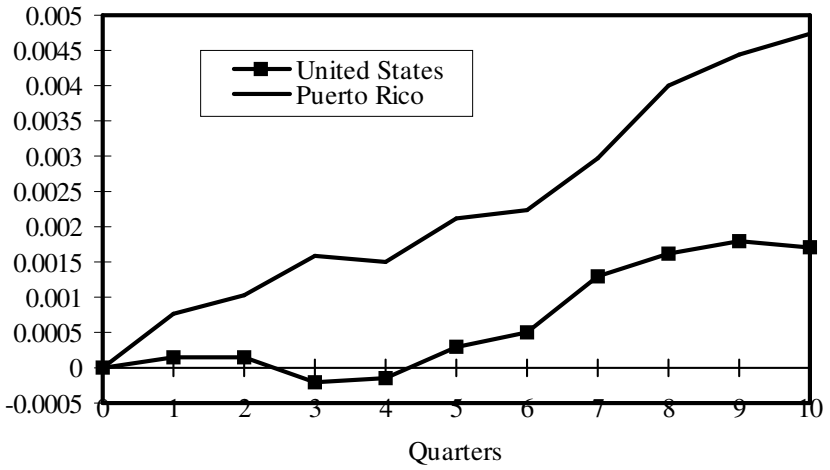


3. Puerto Rico's IORA at an horizon of 10 quarters under a tight policy is 110.4, which indicates that Puerto Rico's output responses are larger than in the U.S. A similar indication was noted under an easy policy with Puerto Rico's IORA reaching 241.2 compared to U.S. counterpart. In view of this, it seems to be clear that under a tight policy or an easy policy, the responses of Puerto Rico's economy are larger than those of United States with the larger relative responses more significant under an easy policy.

Graph 3
Impulse Response of PR GNP and US GDP
to Tight Policy



Graph 4
Impulse Response of PR GNP and US GDP
to Ease Policy



On the basis of the Forecast Error Variance Decomposition, table 4 provides information on the contribution of changes of monetary policy on the real output growth in both economies, the following conclusions can be stated:

Table 4

Contribution of U.S. monetary policy to Real Output Growth--Puerto Rico and United States
Forecast Error Variance Decomposition

Horizons (quarters)	Contribution to real P.R. output growth (percent of total variation)		Contribution to real U.S. output growth (percent of total variation)	
---	Tight	Easy	Tight	Easy
1	0.8	0.88	0.13	0.13
2	0.82	0.24	0.21	0.13
3	3.56	0.8	13.3	0.77
4	5.63	0.52	13.6	0.78
5	7.12	0.44	16.1	0.78
6	10.4	0.15	20	0.94
7	13.6	0.17	20.8	1
8	14	0.26	21	0.58
9	15.4	0.78	21.2	0.51
10	15.6	0.98	21.4	0.5

1. A tight monetary policy at one year horizon, accounted for about 5.6 % growth of output in Puerto Rico and 13.6% in the U.S. growth. However, at a horizon of 10 quarters (two and a half years), a tight policy accounted for 15.6 %, and 21.4 % of real output growth of P.R. and U.S., respectively.

2. An easy monetary policy appears to have very little effect on the real growth of both economies, at a horizon of ten quarters, since it resulted in a 0.98 % in real P.R growth and 0.54% in the United States.

In conclusion, the empirical evidence seems to support that tight monetary policy contributed more to real U.S. output growth than that for Puerto Rico at an horizon of one year or over, although both U.S. monetary policy regimes -- tight policy and easy policy-- contributed little to real output growth-- about 16 % for Puerto Rico and approximately 22% for United States. More than three-fourths of real output growth may be due to changes in fiscal policy and other exogenous or endogenous factors.

Interpretation of results

On the basis of the empirical results, one of the most intriguing questions, apart from others, is why did Puerto Rico's output depicted a higher degree of sensitivity or asymmetry than that of the United States in response to either an easy or tight monetary policy. The answer to this question is complex and hinges on a host of economic and political forces well beyond the scope of this study. Nonetheless the next two hypotheses may shed light with respect to a logical answer.

1. Puerto Rico's businesses and consumers experience a greater degree of responsiveness to changes in market interest rate, and

2. Prices in Puerto Rico are more flexible either upwards or downwards in comparison to the United States.

In order to explore the first hypothesis, the two most significant components of real GDP that are subjected to a significant extent by changes in the market rate of interest: real personal consumption expenditures and gross real fixed investment (excluding changes in business inventories). From 1960 to 1994, real consumption expenditures constituted 83.8% of the real GDP of Puerto Rico while it was 65.9% for the United States. By the same token, real gross fixed investment accounted for 16.1% of Puerto Rico's GDP but 13.3% of U.S. counterpart. Because of this larger proportions in Puerto Rico, significant higher responses of GDP are expected in Puerto Rico than in United States[12]. If businesses and particular, consumers are sensitive to changes in the FEDR, one may expect a higher degree of asymmetry in Puerto Rico than United States.

In order to examine these propositions, two ordinary least squares (OLSQ) regressions were conducted between changes in these each of two component relative to their own lags (two years lagged) and changes in the FEDR.[13] The sum of the regression coefficients of ΔFEDRs indicates the sensitivity of real consumption and investment to the

12. Conventional wisdom posits a larger degree of openness of the Island economy relative to the U.S. However, social accounts data indicate that the ratio of import merchandise to durable and non-durable consumption in 1994 was very similar in both economies: 36 % in Puerto Rico, and 33 % to U.S. The reason why Puerto Rico is believed to be more open than U.S. is because the import of raw materials and intermediate products accounted for a significant proportion (67% in 1994) of total imports.

13. The regression used annual data because quarterly figures for investment and consumption were not available.

ΔFEDRs. Table 5 shows the results from regressed first log changes in the real consumption (Δ C t) to it own two-year lagged real consumption and the first log changes in the FEDR (two-year lagged, also). The t-values for both equations are statistically significant for the ΔFEDR t and ΔFEDR t-1. Residuals are white noise in both equations according to the respective Augmented Dickey-Fuller test. The sum of ΔFEDR coefficients with respect to real consumption in Puerto Rico (-0.138) is practically double to that (-0.0756) of the United States. One possible explanation for this higher sensitivity may relate to the fact that consumers in Puerto Rico tend to finance more their purchases of goods and services using credit than in U.S. consumers. For example, in 1991 the consumer credit outstanding in Puerto Rico was 46.7% of total consumption while in the Unites States it was 6.0%.

Table 5

OLS regression results of changes in real consumption to changes in the fed funds rate Puerto Rico and United States 1960 to 1994

Independent Variables	Puerto Rico's real consumption (regression coefficients and t-values)	United States' real consumption (regression coefficients and t-values)
Constant	.075033 (3.53)**	0.04852 (4.06)**
Trend	-0.00244 (-3.41)**	-0.0013 (-3.82)**
ΔC t-1	0.19096 (0.91)	0.17185 (0.807)
ΔCt-2	0.14502 (0.81)	0.115 (0.6508)
ΔFEDR t	-0.058921 (-2.56)*	-0.03456 (-2.83)**
ΔFEDR t-1	-0.057963 (-2.14)*	-0.003105 (-2.08)*
ΔFEDR t-2	-0.021131 (0.96)	-0.0100 (0.903)
Sum of FEDR coefficients	*-0.138014*	*-0.0756*
	R-square adjusted = 0.56F-statistic (zero slope)= 7.70 **Augmented Dickey-Fuller =-5.33 *	R-square adjusted = 0.547F-statistic (zero slope)= 7.24 **Augmented Dickey-Fuller =-5.70 *

**significant at .01 level *significant at .05 level

With respect to the real gross fixed investment the results are presented in Table 6. While Puerto Rico's equation R-square, t-values and the F-statistic were not found to be

significant, this was not the case for the United States. The sum of ΔFEDRt-i coefficients for Puerto Rico was -0.045 and for United States; -0.2724. Therefore, empirical evidence tends to support a higher degree of sensitiveness of real gross fixed investment in United States than in Puerto Rico. Even more, it seems to be clear that the investment mechanism process in Puerto Rico claims for further research.

Table 6
OLS regression results of changes in real gross fixed investment to changes in the fed funds rate Puerto Rico and United States 1960 to 1994

Independent Variables	Puerto Rico's real fixed investment (regression coefficients and t-values)	United States' real fixed investment (regression coefficients and t-values)
Constant	0.0305 (0.59)	0.11285 (4.19) **
Trend	-0.00064 (-0.26)	-0.0039 (-3.35) **
Δ I t-1	0.434 (2.180) *	-0.927 (0.44)
Δ I t-2	-0.023 (-0.11)	0.0668 (0.382)
ΔFEDR t	0.00758 (-0.77)	-0.01987 (-0.397)
ΔFEDR t-1	-0.01852 (-0.80)	-0.2005 (-3.77) **
ΔFEDR t-2	-0.0346 (-0.366)	-0.05207 (-1.10)
Sum of FEDR coefficients	***-0.045***	*-0.2724*
	R-square adjusted = 0.019F-statistic (zero slope)= 1.10Augmented Dickey-Fuller =-5.32 **	R-square adjusted = 0.49F-statistic (zero slope)= 6.06 **Augmented Dickey-Fuller =-5.80**

**significant at .01 level *significant at .05 level

Therefore, based on previous results, one can states that during a period of tight monetary policy (FEDR increases), Puerto Rican consumers tend to reduce their expenditures in a relatively larger magnitude than U.S. consumers. Conversely, during an easy policy (FEDR decreases), consumers in Puerto Rico boot their consumption expenditures in a larger magnitude than U.S. counterparts. This is why relative asymmetry under any regime of U.S.

monetary policy is found to be larger in Puerto Rico than in United States. Given that real consumption expenditures are relatively larger in Puerto Rico to respect the real output, a larger response is expected in Puerto Rico to U.S. monetary policy.

The second hypothesis assessing the asymmetric effects as a function of prices flexibility. To accomplish this proposition, a VAR model incorporating quarterly data for the indexes of consumer prices was used for both economies[14]. The variable ordering and specification of lags are similar to the second stage regression, but the endogenous variable is now the rate of change in consumer prices[15]. Table 7, Graph 5 and Graph 6, show the cumulative responses of consumer prices in Puerto Rico and United States in response to U.S. monetary policy. The area of impulse responses (absolute value) of consumer prices in Puerto Rico is almost two and an half times the value of the United States. As can be seen, under a U.S. tight policy, consumer prices in both economies tend to increase, however, prices in Puerto Rico tend to indicate a stronger reaction at a horizon of ten quarters, with a response about ten times greater than that of the United States. On the other hand, under an easy policy consumer prices in Puerto Rico tend to decrease, while surprisingly the opposite occurred in the United States. This result led us to the following tentative conclusion: during a tight policy, the relative greater consumer prices increased in Puerto Rico induced to a larger downturn in real consumption expenditures in Puerto Rico, which simultaneously, depressed real output. On the other hand, under an ease policy a decline in consumer prices

14. For United States is the Consumer Price Index for all urban consumers, all items, NSA (1982-84=100) and for Puerto Rico, Consumer Price Index of all families (1967=100).

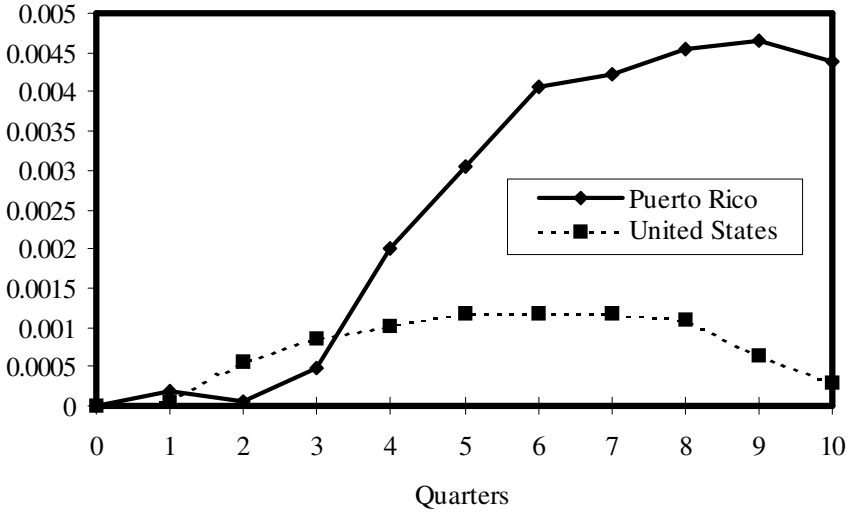
15. The variable ordering is FEDR(+), FEDR(-), and DPRICES, when the latter is the first log differences of consumer prices.

in Puerto Rico and a increase in U.S. prices, led to a larger positive effect over the real consumption in Puerto Rico than in the United States.

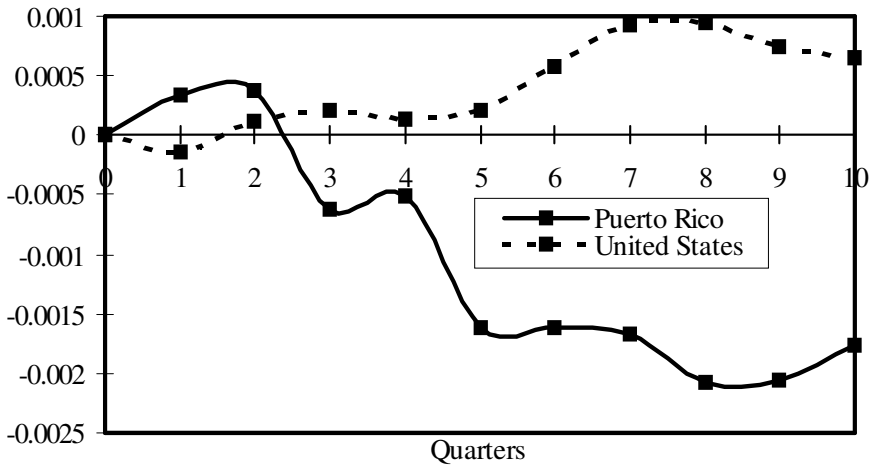
Table 7
Cumulative Impulse Responses of Changes in Quarterly Consumer Prices (CPI)
in Puerto Rico and United States to U.S. Monetary Policy

Horizons (quarters)	Tight monetary policy (FEDR(+))		Easy monetary policy (FEDR (-))	
---	PR PRICES	US PRICES	PR PRICES	US PRICES
1	0.00018211	0.0000474	0.00034328	-0.000139
2	0.0000569	0.0005674	0.00037469	0.000121
3	0.00047957	0.0008434	-0.00063	0.000202
4	0.00199417	0.0010269	-0.00050146	0.000132
5	0.00305517	0.0011817	-0.00160876	0.000203
6	0.00407227	0.00117719	-0.001608	0.000578
7	0.00421507	0.0011854	-0.001676	0.000918
8	0.00453537	0.001101165	-0.00206718	0.000944
9	0.00465815	0.00063267	-0.00205381	0.0000749
10	0.00439115	0.00030316	-0.00175819	0.0000655

Graph 5
Impulse Response of Consumer Prices to U.S. Tight Policy
1964:1 to 1994:2



Graph 6
Impulse Response of Consumer Prices to U.S. Ease Policy
1964:1 to 1994:2



Therefore, consumer prices might help to generate stronger asymmetric effects in Puerto Rico than United States. Under a tight policy, increases in consumer prices had a stronger impact in reducing consumption while decline in price in an easy policy boosted to a greater extent in Puerto Rico than the United States.

Conclusions

This paper was devoted to examine the asymmetrical effects of U.S. monetary policy on the real output growth in Puerto Rico and compare it with that of the United States. Morgan, in a recent study found evidence of asymmetrical effects of U.S. monetary policy on the real output growth of United States; that is, a easy monetary policy has a weaker effect over the real output than a tight policy.

The results of this study indicate that Puerto Rico and United States real outputs did depict asymmetry effects to U.S. monetary policy during the period 1964:1 to 1994:4. Using an index of asymmetry (IOA), a lower degree of asymmetry was found in Puerto Rico than in the United States. However, when the response of real output to each stance of U.S. monetary policy was considered separately, the relative asymmetry for Puerto Rico was about 10 percent larger under a tight policy and 141 percent greater under an easy policy than the United States.

Two associated elements seemed to induce this larger relative asymmetric in Puerto Rico: (1) consumers in Puerto Rico are more sensitive to changes in the market interest rate than U.S. counterpart, and, (2) consumer prices in Puerto Rico tend to be more flexible downward and upward to the U.S. monetary policy. This greater price flexibility in Puerto Rico serves as a restraint to increases in real consumption during a tight policy and as a boost during a period of an easy policy.

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Appendix: The Var Model

The VAR model is an unconstrained reduced form of a dynamic simultaneous equations model expressing a vector of endogenous variables as linear functions of their own and other lagged values[16]. VAR is a useful estimation technique which purports not to impose any structural priori restrictions on causality among the variables as do traditional large models. In VAR, each member of a group of random variables is a linear function of past values of itself, past values of the other members of the group, but including perhaps, a constant and/or a time trend variable. VAR provides estimates for dynamic response patterns that are of interest to many analysts of business cycles and its dynamics.

The results of the VAR model are more easily interpreted by the use of two devices: the Impulse Response Function (IRF) and the Forecast Error Decomposition Variance (FEDV). The former constitutes an important device because it depicts the response of one endogenous variable over time to a single surprise or sudden jump (shock) in any other endogenous variable(s), including itself. It enables one to examine whether a given endogenous variable follows a permanent or transitory path from shocks in any other real or monetary variable.

The FEVD measures the contribution of each innovation in the VAR to the k-step ahead forecast error variance of the dependent variables. The Orthogonalization of

16. VAR were originally introduced by C. Sims (1980) as a reaction to the prevailing "large" structural macroeconomic models developed by the Cowles Commission. He strongly argued that such type of "large" models imposed too many unrealistic a priori assumptions about the exogeneity of some variables. See the path-breaking study done by C. Sims, "Macroeconomics and Reality". 1980. **Econometrica**,(48) pp.1-48.

innovations (residuals) by Choleski decomposition converts moving average representation (impulse response) in a unique, uncorrelated innovations.

A general description of a VAR model can be expressed as:

(A.1) $y_t = \mathbf{A(L)}\, y_{t-i} + e_t$

where y is an n-vector of endogenous variables, A(L) is a n times n invertible matrix of polynomial in L, the backward-shift operator, and the n- vector e_t satisfies;

(A.2) $E(e_t) = 0$

$E(e_t, e'_t) = \Sigma$, t=s

$E(e_t, e'_t) = 0$, t=/=s.

The moving average representation of is:

(A.3) $y_t = (I-A(L))^{-1}\mathbf{e}_t = \mathbf{B(L)}\mathbf{e}_t$

where $\mathbf{B_o}$ is the identity matrix, given the normalization of **B(L)**. **B(L)** is a n times n matrix of polynomials in the lag operator L ($B(L) = B_0 + B_1 L + B_2 L^2 + ...$). It is often more useful to look at the moving average representation with orthogonalized innovations. These orthogonalized innovations possess the convenient property that they are uncorrelated both across time and across equations. The orthogonal innovations have two main advantages over the non-orthogonal innovations. First, since they are uncorrelated, it is very simple to compute the variance of linear combinations. Secondly, it is rather misleading to talk about any shock in isolation. Since many macroeconomic variables move in tandem, the orthogonalization takes these comovements into account but uncorrelating contemporaneous innovations.

The usual procedure to orthogonalized innovations is done by the factorization of the variance-covariance matrix using Choleski decomposition. It is usually explored mostly by an ordering a set of variables; to the top of the ordering sequence those variables understood as to influences all innovations contemporaneously without being influenced by any of the other variables. At the end, setting the variable in which its innovation influences only itself contemporaneously, but not any other innovations in the system. This procedure suggests an order from the more exogenous variables to the more endogenous variables. Ordering the variables is crucial in interpreting the results of the FEDV.