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PPP Theory in a Fixed Exchange Rate System

Miriela G. L. Carolina

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Abstract

In a fixed exchange rate system, the PPP theory implies equality between inflation rates of the anchor country and the fixed exchange rate country. However, inflation rate differentials do exist in a fixed exchange rate system. In this paper, I show that by assuming a linear relationship, there is weak evidence for the PPP to hold and that the inflation rate differentials are consistent with the PPP theory.

JEL Classification: C32, E31, F31.

Keywords: PPP theory, fixed exchange rate system, fixed-to-the dollar exchange rate system.

1 Introduction

This working paper deals with the implications of the validity of the Purchasing Power Parity (PPP) theory in the fixed-to-the dollar environment of the Netherlands Antilles. The focus will be on the bilateral exchange rate relationship between the United States and the Netherlands Antilles'[1] economy. In this paper, I assume the process to be linear and describe it by using an error-correction model. According to the relative PPP theory, exchange rate changes are determined by domestic and foreign inflation. In a fixed exchange rate environment,[2] the PPP theory collapses into an 'inflation rate equality' theory. If

[1] The five Caribbean Islands of the Netherlands Antilles (N.A.), although part of the Dutch Kingdom, have their own currency, which is pegged to the U.S. dollar. The majority of goods is imported, and the main export is services. Imports are mainly from the United States, the Caribbean, and Europe.

[2] Economies with currencies pegged to the U.S. $ are e.g., Aruba, the Bahamas, Barbados, Belize, and the Netherlands Antilles. Seventy countries have exchange rate arrangements with one exchange rate anchor (source: International Financial Statistics, yearbook 2002).

PPP holds in this case, inflation rates between the anchor country and the fixed exchange rate economy are equal. Empirical results show that inflation rate differentials exist in a fixed exchange rate system. Are these differentials the short run deviation from the PPP? The literature provides abundant evidence and plausible answers for the deviation of the PPP theory: tariffs, transportation costs, nontariff barriers, inflation differentials in traded and non traded goods (the Harrod Balassa Samuelson effect) are just a few theories. Developments in cointegration analysis contributed to the revival of interest in the PPP theory in the 1990s. Still, researchers are not unequivocal on the PPP hypothesis. A study by MacDonald (1995) suggested a long run relationship between the exchange rate and prices in the developed countries. More recent studies by Rambarran (1998), and Darius and Williams (2000) showed weak evidence of a long run relationship for some Caribbean countries. In studies of cointegration, the null hypothesis of no cointegration is more often rejected in a fixed exchange rate regime when compared to a floating system. In general, researchers have come to the conclusion that rejection of the PPP theory is due largely to lack of power of the tests (Sarno and Taylor (2002)).

Furthermore, based on recent studies by Sarno (2003), the process of deviations from PPP is believed to be a nonlinear process, rather than the presumed linear approach. The nonlinear approach is beyond the scope of this paper. The paper is divided into the following sections. Section 2 treats the general theory of the PPP and presents a model adapted for a fixed-to-the dollar environment. Section 3 presents the data. The empirical results are presented in section 4, and concluding remarks in section 5.

2 Theory of the PPP and a Linear PPP Model in a Fixed Exchange Rate System

2.1 Theoretical Specification

The theory of the PPP explains the bilateral relationships between countries in the trading of goods. Basically, the PPP theory is founded on three assumptions: (1) the Law of one Price (LOP) (2) related to the first assumption, the arbitrage mechanism, and (3) a constant real exchange. The best-known example applied to the first assumption is the worldwide price comparison of the Big Mac hamburger. Applying the LOP to this case clearly shows that the LOP is invalid, because Big Mac hamburgers are different in each country. The second assumption requires, continuously well informed markets, which is not always the case. The third assumption, a constant real exchange rate, is a fundamental assumption for the PPP to hold.

The absolute PPP theory assumes the LOP. For an identical item in both countries, the following relationship holds:

$$P_t^i = S_t * P_t^{*,i} \quad (1)$$

Where:
P_t^i : The domestic price of good i,
$P_t^{*,i}$: The foreign price of good i, and
S_t : The (nominal) exchange rate of the domestic currency in a unit of foreign currency.

By summing all prices of tradable goods, the absolute PPP equation is obtained:

$$S_t = \frac{P_t}{P^*} \quad (2)$$

Where:
P_t : the weighted average domestic price of all goods,
P^* : the weighted average foreign price of all goods.

Equation 2 can be redefined as follows:

$$S_t * \frac{P_t^*}{P_t} = 1 \quad (3)$$

The left-hand side of equation 3 is the real exchange rate, E. Testing the validity of the PPP theory is the same as testing for the real exchange rate to be equal to one. In other words, one unit of good i in the domestic country is equal to one unit of good i in the foreign country. Since trade barriers, transportation cost, preferences, and other factors will impede equation 2 from holding, it is assumed that these factors can be accumulated in a constant factor Π. In other words, the real exchange rate is constant.

$$S_t * \frac{P_t^*}{P_t} = E = \Pi \quad (4)$$

In logs

$$s_t = \pi + p_t - p_t^* \quad (5)$$

Taking the first differences of equation 5, the relative PPP is obtained:

$$s_t = \Delta p_t - \Delta p_t^* \quad (6)$$

The interpretation of equation 6 is that the change in the exchange rate (depreciation/appreciation) is equal to the difference in the changes in prices in the two countries. For the PPP to hold, $\Delta\pi$ has to be zero. If $\Delta\pi \neq 0$, equation 6 can be considered as the deviation from PPP. Or, if $\Delta\pi$ differs from zero in the short run, the real exchange rate deviates from the PPP theory in the short run. Consequently, an equilibrium error is allowed in the short run when measuring the PPP hypothesis. The PPP theory can be tested in multiple ways. In this paper, I tested the PPP theory using the two most conventional tests. First, I tested whether the real exchange rate/the real effective exchange rate contains a unit root. If it is difficult to reject the unit root behavior of the real exchange rate/the real effective exchange rate, then the real exchange rate/real effective exchange rate follows a random walk and lacks convergence. The second approach is the test for cointegration between the exchange rate and the relative prices. If the variables are cointegrated, the PPP theory holds. As stated in equation 6, short run equilibrium errors are acceptable. However, the equilibrium errors must be stationary for the exchange rate and the relative prices to be cointegrated.

2.2 Empirical Specification of the Vector Error Correction Model

I assumed the process of the relative PPP to be linear and applied a vector error correction model based on the cointegration theory proposed by Engle and Granger (1987), the two step procedure. A general specification of a vector error correction model (VECM) of the $(n\ x\ 1)$ vector y_t is as follows:

$$\Delta y_t = \beta_0 + \beta * y_{t-1} + \beta_1 * \Delta y_{t-1} + \beta_2 * \Delta y_{t-2} + ... + \beta_q * \Delta y_{t-q} + \varepsilon_t \qquad (7)$$

Where:
β_0 : an $(n\ x\ 1)$vector of intercept terms,
β_i : an $(n\ x\ n)$ coefficient matrix for all $i = 1, ..., q$,
β : a matrix with elements, with one or more elements nonzero, and
ε_t : a $(n\ x\ 1)$ vector of white noise disturbances.

To describe the process as equation 7, the data must meet the following criteria: (1) the components of y_t must be of the same order, and (2) the estimated errors of the long run relationship between the components of y_t must be stationary. If these criteria are met, the variables in the relationship are cointegrated. The long run relationship by the components of y_t are estimated using Ordinary Least Squares (OLS). The optimal lag length, q, is derived by χ^2 tests. In an adequate model, the residuals of the equations are white noise.

The specification in the bilateral case of the Netherlands Antilles-United States relationship is as follows:

$$\begin{bmatrix}\Delta p_t \\ \Delta f_t\end{bmatrix} = \begin{bmatrix}\alpha_1 \\ \alpha_2\end{bmatrix} + \begin{bmatrix}\alpha_p \\ \alpha_f\end{bmatrix} * [p_{t-1} - \gamma_0 - \gamma_1 * f_{t-1}] + \begin{bmatrix}\alpha_{1,1} & \alpha_{1,2} \\ \alpha_{2,1} & \alpha_{2,2}\end{bmatrix} \begin{bmatrix}\Delta p_{t-1} \\ \Delta f_{t-1}\end{bmatrix}$$
$$+ ... \begin{bmatrix}\tau_{1,1} & \tau_{1,2} \\ \tau_{2,1} & \tau_{2,2}\end{bmatrix} \begin{bmatrix}\Delta p_{t-q} \\ \Delta f_{t-q}\end{bmatrix} + \begin{bmatrix}\varepsilon_{p,t} \\ \varepsilon_{f,t}\end{bmatrix} \qquad (8)$$

Where:
p_t : the price index of the Netherlands Antilles in logs,
f_t : the foreign price expressed in domestic currency $f_t = s_t + p_t^*$,
s_t : the nominal exchange rate in logs, and
p_t^* : the price index of the U.S. in logs.

The vector y_t defined in equation 7 is represented in equation 8 by $y_t = [p_t,\ f_t]^{'}$. The coefficients α_p and α_f are called the speed of adjustment parameters. It is possible for one of the speed of adjustment parameters to be zero. For example, if f_t is not significantly different from zero, this means that f_t does not respond to the discrepancy in the long run disequilibrium, and p_t does all the adjustment. In this case, f_t is weakly exogenous.

The other components, Δp_{t-q}, and Δf_{t-q} are the short run deviations from the long run equilibrium.

The first step is to test whether the components of the vector $y_t = [p_t,\ f_t]^{'}$ are integrated of the same order. The augmented Dickey-Fuller test is applied to test the order of integration. If both variables of y_t are of the same order, then the long run equilibrium relationship is estimated using OLS. This estimated relationship, $p_t = \gamma_0 + \gamma_1 * f_t$, does not imply the variables of y_t to be cointegrated. If the estimated errors of the long run relationship are stationary, the variables are cointegrated.

3 Data

As mentioned, two approaches were used to test the PPP theory. The first approach tested the unit root of the real effective exchange rate (REER) and the real exchange rate, (RER), which is defined by equation 4. The second approach used the VECM described in the previous section. The data used in the VECM are the consumer price indexes of the United States and the Netherlands Antilles and the nominal exchange rate of the Netherlands Antilles.

The data used in both approaches are monthly indices. The consumer price index (CPI) of Curacao served as a proxy for the CPI of the Netherlands Antilles. The source was the Central Bureau of Statistics. The sample period was January 1987 to December 2004. The CPI of the United States and the REER of the Netherlands Antilles were both obtained from the International Financial Statistics. The data of the REER were unavailable after July 1999. The nominal exchange rate of the Netherlands Antilles has been pegged to the U.S. \$. since 1971, at *fl* 1.79 per 1 U.S. \$.

3.1 Inflation Rates

The first graph (Figure 1, appendix) represents the month-to-month percentage change in the CPI of the Netherlands Antilles and of the United States. The graph clearly shows that the inflation rates in the two countries differed (difference in monthly inflation rates on the right-hand axis). Moreover, the inflation rate of the Netherlands Antilles showed high volatility in October 1990 and in October 1999. The 1990's hike, was due to the increasing oil prices resulting from the Gulf war. The spike in October 1999 was attributed mainly to the rise in the turnover tax from 2% to 5%. The one-year inflation rates (Figure 2) show that although they differed (difference in the annual inflation rate on the right-hand axis), they appear to have a comovement.

3.2 Real Exchange Rates

The REER is a stationary process as the KPSS[3] test was not able to reject stationarity, and the ADF[4] test rejected the unit root hypotheses at conventional levels (Table 1). Data for the REER is presented in Figure 4. Graph 3 is the representation of the RER as presented by equation 4. The RER shows a tendency to increase. However, the theory of the PPP does not allow for a deterministic time trend. In the next section, the tests will show that the hypothesis of a trend in the data is rejected. The KPSS test rejected the hypothesis of stationarity, and the ADF test gave weak evidence of rejecting the unit root hypothesis (Table 1). In the next section, more comprehensive results are presented.

4 Empirical Results

The first method for testing validity of the PPP is a unit root test on the exchange rates, the REER and the RER. The alternative test of the PPP, uses cointegration or the vector error correction described in section 2.2. As already shown, the REER of the Netherlands Antilles (Table 1) is stationary, meaning that the PPP holds. In addition, the RER was tested on stationarity, using the Dickey-Fuller tests (Table 2). To test, the autogenerating process of the RER must be known. In this paper, I focus on three data-generating processes for the RER:

1. In model a, it is assumed that the data-generating (autoregressive) process of the real exchange rate contains a drift term and a trend.
2. In model b, the data-generating process contains a drift.
3. In model c, the data-generating process contains no drift term or a trend.

The model with the lowest AIC and SBC[5] was selected, which was the model with an autoregressive component of the real exchange rate and the constant term, model b. Furthermore, the AC (autocorrelation) and the PAC (partial autocorrelation) indicate the process as AR(1) without a seasonal pattern. Using

[3] Kwiatkowki-Phillips-Schmidt-Shin test on stationarity.
[4] Augmented Dickey-Fuller unit root test.
[5] AIC is the Akaike Information Criterion and SBC is the Schwartz Bayesian Criterion.

the selected model, weak evidence is found of stationarity[6] in the RER, showing some evidence of the validity of the PPP theory. We can conclude that the REER gives evidence for the PPP to hold, and the RER gives weak evidence for the validity of the PPP in the relationship between the Netherlands Antilles and the United States.

Vector error correction offers an alternative for testing PPP, and it gives the following results. Recall the VECM, equation 8, as described in section 2.2.

The variables, consumer prices of the United States, and of the Netherlands Antilles (Table 3) are both I(1). According to the Engle and Granger procedure, we can estimate the long run equilibrium relationships using OLS. To give a better fit, I tried the following:

- The long run equation was estimated by including dummies for October 1990 and 1999. The equation including dummies showed comparable results to the equation without dummies. I excluded the dummies in the equation.
- The long run equation was estimated with and without a constant term. Including the constant is consistent with the relative PPP theory.

Two estimated long run equations (one including a constant and one without a constant) are presented (standard errors in parentheses).

$$p_t = \underset{(0.03)}{0.23} + \underset{(0.006)}{0.84} * f_t + e_t \tag{9}$$

$$p_t = \underset{(0.002)}{0.89} * f_t + e_t \tag{10}$$

I proceeded with the long run equation with a constant, consistent with the relative PPP theory. This theory is more plausible, because it takes into account the transportation cost, preferences, and trade barriers. Stock (1987) proved that if the variables are cointegrated, the OLS estimators in the long run, (equation 9), are superconsistent. Next, I tested for the variables p_t, and f_t to be cointegrated. The variables are cointegrated of the order (1,1) if the estimated residuals $\{\hat{e_t}\}$ of equation 9 are stationary. With the Engle-Granger test, the null hypothesis of a unit root is rejected at 10% significance level (Table 4). The variables are cointegrated and can be described by a VECM.

Two definitions of inflation rates were taken into account for modeling the error correction:

1. The month-to-month inflation rate:

$$\Delta p_t = log(cpi\_na)_t - log(cpi\_na)_{t-1} \tag{11}$$

   The same for Δf_t:

[6] The KPSS test rejected stationarity for the real exchange rate. However, the ADF test showed a weak evidence of rejecting the unit root.

$$\Delta f_t = \log(cpi\_usa * s)_t - \log(cpi\_usa * s)_{t-1} \tag{12}$$

2. The annual inflation rate:

$$\Delta p_t = (1 - L_{12})p_t = \Delta_{12} \log(cpi\_na)_t \tag{13}$$

same for Δf_t.
Model (1)
The first model, (1), used the month-to-month inflation rates.

$$\begin{aligned}
\begin{bmatrix} \Delta p_t \\ \Delta f_t \end{bmatrix} = & \begin{bmatrix} \underset{(0.0009)}{-0.0003} \\ \underset{(0.0004)}{0.0007} \end{bmatrix} + \begin{bmatrix} \underset{(0.03)}{-0.06} \\ \underset{(0.01)}{-0.0002} \end{bmatrix} * [p_{t-1} - 0.23 - 0.84 * f_{t-1}] \\
& + \begin{bmatrix} \underset{(0.08)}{-0.03} & \underset{(0.2)}{0.32} \\ \underset{(0.04)}{-0.08} & \underset{(0.07)}{0.4} \end{bmatrix} \begin{bmatrix} \Delta p_{t-1} \\ \Delta f_{t-1} \end{bmatrix} + \begin{bmatrix} \underset{(0.08)}{-0.01} & \underset{(0.2)}{-0.18} \\ \underset{(0.04)}{-0.02} & \underset{(0.08)}{-0.1} \end{bmatrix} \begin{bmatrix} \Delta p_{t-2} \\ \Delta f_{t-2} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.07)}{0.07} & \underset{(0.2)}{0.12} \\ \underset{(0.04)}{0.008} & \underset{(0.08)}{-0.05} \end{bmatrix} \begin{bmatrix} \Delta p_{t-3} \\ \Delta f_{t-3} \end{bmatrix} + \begin{bmatrix} \underset{(0.07)}{0.08} & \underset{(0.2)}{0.03} \\ \underset{(0.04)}{0.008} & \underset{(0.08)}{-0.05} \end{bmatrix} \begin{bmatrix} \Delta p_{t-4} \\ \Delta f_{t-4} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.07)}{-0.09} & \underset{(0.16)}{0.07} \\ \underset{(0.03)}{-0.02} & \underset{(0.08)}{-0.08} \end{bmatrix} \begin{bmatrix} \Delta p_{t-5} \\ \Delta f_{t-5} \end{bmatrix} + \begin{bmatrix} \underset{(0.07)}{-0.2} & \underset{(0.16)}{0.05} \\ \underset{(0.03)}{-0.08} & \underset{(0.08)}{-0.08} \end{bmatrix} \begin{bmatrix} \Delta p_{t-6} \\ \Delta f_{t-6} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.07)}{0.08} & \underset{(0.16)}{0.34} \\ \underset{(0.04)}{0.01} & \underset{(0.08)}{0.01} \end{bmatrix} \begin{bmatrix} \Delta p_{t-7} \\ \Delta f_{t-7} \end{bmatrix} + \begin{bmatrix} \underset{(0.07)}{0.01} & \underset{(0.16)}{-0.25} \\ \underset{(0.03)}{0.04} & \underset{(0.08)}{-0.02} \end{bmatrix} \begin{bmatrix} \Delta p_{t-8} \\ \Delta f_{t-8} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.07)}{-0.06} & \underset{(0.16)}{0.10} \\ \underset{(0.03)}{-0.02} & \underset{(0.08)}{-0.07} \end{bmatrix} \begin{bmatrix} \Delta p_{t-9} \\ \Delta f_{t-9} \end{bmatrix} + \begin{bmatrix} \underset{(0.08)}{-0.05} & \underset{(0.16)}{0.13} \\ \underset{(0.04)}{-0.02} & \underset{(0.08)}{0.1} \end{bmatrix} \begin{bmatrix} \Delta p_{t-10} \\ \Delta f_{t-10} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.07)}{-0.03} & \underset{(0.16)}{-0.05} \\ \underset{(0.03)}{-0.02} & \underset{(0.08)}{0.1} \end{bmatrix} \begin{bmatrix} \Delta p_{t-11} \\ \Delta f_{t-11} \end{bmatrix} + \begin{bmatrix} \underset{(0.07)}{-0.03} & \underset{(0.16)}{-0.04} \\ \underset{(0.03)}{-0.1} & \underset{(0.08)}{0.09} \end{bmatrix} \begin{bmatrix} \Delta p_{t-12} \\ \Delta f_{t-12} \end{bmatrix} \\
& + \begin{bmatrix} \varepsilon_{p,t} \\ \varepsilon_{f,t} \end{bmatrix}
\end{aligned} \tag{14}$$

(1) Standard errors in parentheses
(2) Q statistic on the errors Q(4)=0.06 (1), Q(8)= 0.25 (1), Q(12) = 0.6 (1).
(3) Q statistics on the squared errors: Q(4)=4.1 (0.4), Q(8)=4.5 (0.8), Q(12)=7.9 (0.7)
(4) Q(n) reports the Ljung-Box statistics for autocorrelation of n residuals

in the estimated model. The p value is in parentheses.

The lag length tests indicated a length of four using χ^2 tests on Δp_t of equation 14. The Ljung-Box Q statistics showed no serial correlation, neither Arch or Garch errors. However, Δf_t of equation 14 with four lags, showed serial correlation. This equation was expanded up to 12 lags. If the lag lengths of equation Δf_t are different from equation Δp_t, the seemingly unrelated regression error-correction model must be applied. I chose similar lag lengths in both equations. The errors of both equations, $\{\hat{e_{p,t}}\}$, $\{\hat{e_{f,t}}\}$, appear to be white noise.

Model (1) is interpreted as follows: With one unit deviation from the long run PPP in period $t-1$, the Netherlands Antillean price index falls by 0.06 units and can lead the Unites States price index to fall by 0.0002 units. The speed of adjustment in absolute terms of the Netherlands Antilles is 25 times larger when compared to the United States, indicating the impact of a large economy like the United States on the adjustment process. The speed of adjustment of the Netherlands Antilles is significant ($t - value = -2.0$), whereas the U.S. speed of adjustment is not significantly different from zero ($t - value = 0.02$), which means that the U.S. prices are weakly exogenous.

Model (2) showed a similar speed of adjustment on the price index of the Netherlands Antilles, but different speed of adjustment of the U.S price index. (However, the speed of adjustment of the U.S. price index is insignificant). I included the term ε_{t-12} due to the seasonality pattern in the data.

$$
\begin{aligned}
\begin{bmatrix} \Delta p_t \\ \Delta f_t \end{bmatrix} &= \begin{bmatrix} \underset{(0.02)}{-0.06} \\ \underset{(0.007)}{0.0005} \end{bmatrix} * [p_{t-1} - 0.23 - 0.84 * f_{t-1}] \\
& \begin{bmatrix} \underset{(0.08)}{0.82} & \underset{(0.19)}{0.56} \\ \underset{(0.03)}{0.02} & \underset{(0.08)}{1.3} \end{bmatrix} \begin{bmatrix} \Delta p_{t-1} \\ \Delta f_{t-1} \end{bmatrix} + \begin{bmatrix} \underset{(0.1)}{0.009} & \underset{(0.31)}{-0.12} \\ \underset{(0.04)}{0.005} & \underset{(0.12)}{-0.5} \end{bmatrix} \begin{bmatrix} \Delta p_{t-2} \\ \Delta f_{t-2} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.1)}{0.09} & \underset{(0.31)}{0.02} \\ \underset{(0.04)}{-0.04} & \underset{(0.13)}{0.16} \end{bmatrix} \begin{bmatrix} \Delta p_{t-3} \\ \Delta f_{t-3} \end{bmatrix} + \begin{bmatrix} \underset{(0.1)}{0.04} & \underset{(0.32)}{-0.4} \\ \underset{(0.04)}{0.06} & \underset{(0.13)}{-0.09} \end{bmatrix} \begin{bmatrix} \Delta p_{t-4} \\ \Delta f_{t-4} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.1)}{-0.16} & \underset{(0.32)}{0.31} \\ \underset{(0.04)}{-0.08} & \underset{(0.13)}{0.12} \end{bmatrix} \begin{bmatrix} \Delta p_{t-5} \\ \Delta f_{t-5} \end{bmatrix} + \begin{bmatrix} \underset{(0.1)}{-0.04} & \underset{(0.31)}{-0.1} \\ \underset{(0.04)}{-0.03} & \underset{(0.13)}{-0.04} \end{bmatrix} \begin{bmatrix} \Delta p_{t-6} \\ \Delta f_{t-6} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.1)}{0.2} & \underset{(0.32)}{0.27} \\ \underset{(0.04)}{0.09} & \underset{(0.13)}{0.05} \end{bmatrix} \begin{bmatrix} \Delta p_{t-7} \\ \Delta f_{t-7} \end{bmatrix} + \begin{bmatrix} \underset{(0.1)}{-0.04} & \underset{(0.31)}{-0.52} \\ \underset{(0.04)}{0.02} & \underset{(0.13)}{-0.06} \end{bmatrix} \begin{bmatrix} \Delta p_{t-8} \\ \Delta f_{t-8} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.1)}{-0.1} & \underset{(0.31)}{0.2} \\ \underset{(0.04)}{-0.04} & \underset{(0.13)}{-0.02} \end{bmatrix} \begin{bmatrix} \Delta p_{t-9} \\ \Delta f_{t-9} \end{bmatrix} + \begin{bmatrix} \underset{(0.1)}{-0.02} & \underset{(0.32)}{0.38} \\ \underset{(0.13)}{-0.007} & \underset{(0.13)}{0.19} \end{bmatrix} \begin{bmatrix} \Delta p_{t-10} \\ \Delta f_{t-10} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.1)}{0.02} & \underset{(0.31)}{-0.27} \\ \underset{(0.03)}{0.05} & \underset{(0.13)}{0.15} \end{bmatrix} \begin{bmatrix} \Delta p_{t-11} \\ \Delta f_{t-11} \end{bmatrix} + \begin{bmatrix} \underset{(0.08)}{0.12} & \underset{(0.2)}{-0.21} \\ \underset{(0.03)}{-0.04} & \underset{(0.08)}{-0.03} \end{bmatrix} \begin{bmatrix} \Delta p_{t-12} \\ \Delta f_{t-12} \end{bmatrix} \\
& + \begin{bmatrix} \underset{(0.02)}{-0.94} & \underset{(0.02)}{-0.91} \end{bmatrix} * \begin{bmatrix} \varepsilon_{p,t-12} \\ \varepsilon_{f,t-12} \end{bmatrix} + \begin{bmatrix} \varepsilon_{p,t} \\ \varepsilon_{f,t} \end{bmatrix} \qquad (15)
\end{aligned}
$$

(1). Standard errors in parentheses

(2). Q statistic on the errors Q(4)=0.27 (0.96), Q(8)= 0.57 (0.99), Q(12) = 4 (0.96)

(3). Q statistics on the squared errors: Q(4)=3.8 (0.27), Q(8)= 4.18 (0.75), Q(12) = 19(0.06).

The second model used the annual inflation rates. This model is interpreted as follows: Again, a one unit deviation from the long run PPP in period $t-1 = t-13$, which would induce the price index of the Netherlands Antilles to fall by 0.06 units. The $t-value$ indicates the speed of adjustment of the United States to be insignificant, which means that the U.S. price index is weakly exogenous.

Both VEC models show that short run deviations on the long run equilibrium does exist and that the U.S. price index is weakly exogenous. Both models estimated the speed of adjustment of the Netherlands Antillean price index as -0.06. As shown in the VECM, the differentials in the prices of the United States and the Netherlands Antilles are consistent with the PPP theory. These differentials, $\alpha_{i,j} * \Delta p_{t-j} - (-\tau_{i,j})\Delta f_{t-j}$, are the short term deviations from the long run path.

5 Concluding Remarks

The main question of this research was centered on the existence of the inflation rate differentials in a fixed exchange system when it is assumed that the PPP theory holds. In this paper, I found evidence of the validity of PPP theory in the case of a fixed exchange rate system of the Netherlands Antilles. Empirical tests, using a linear approach, show a cointegrated relationship between the inflation rates of the anchor country (United States) and an economy with a fixed exchange rate system (Netherlands Antilles). The VECM shows the existence of short run deviations from the long run trend. As shown, the short term deviations in the VECM are inflation rate differentials. This means that inflation rate differentials can exist when assuming the PPP theory and can be interpreted as deviations from the PPP in the short run.

Topics for further research include a nonlinear approach and a panel study of countries that are fixed to the dollar, which will provide a broader database.

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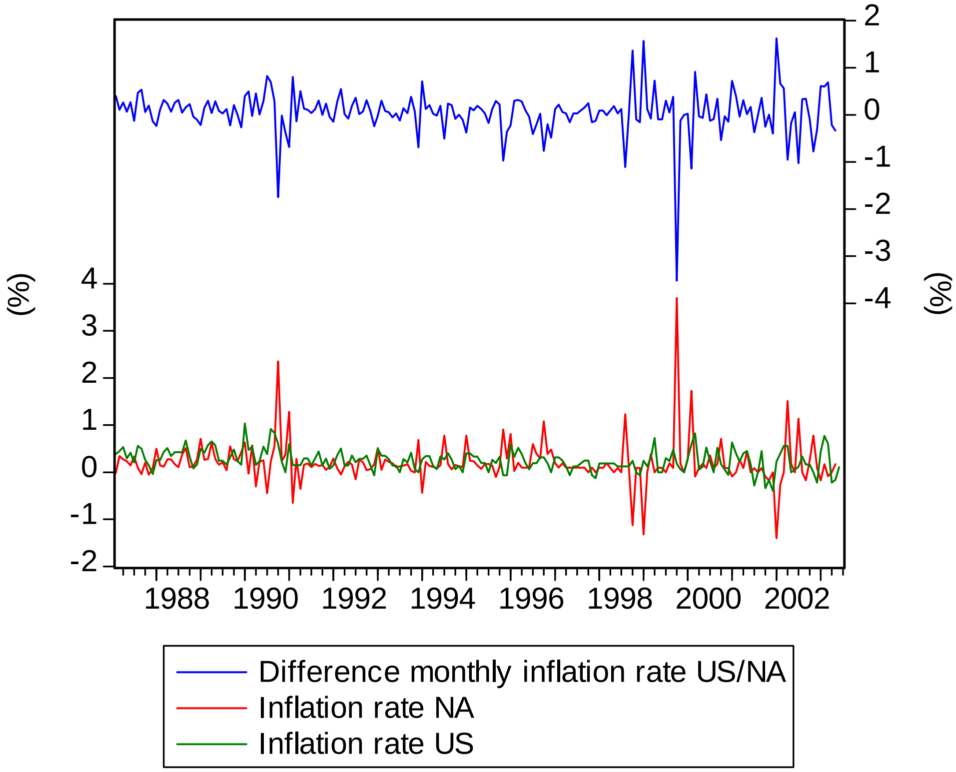

Figure 1: Monthly Inflation Rates

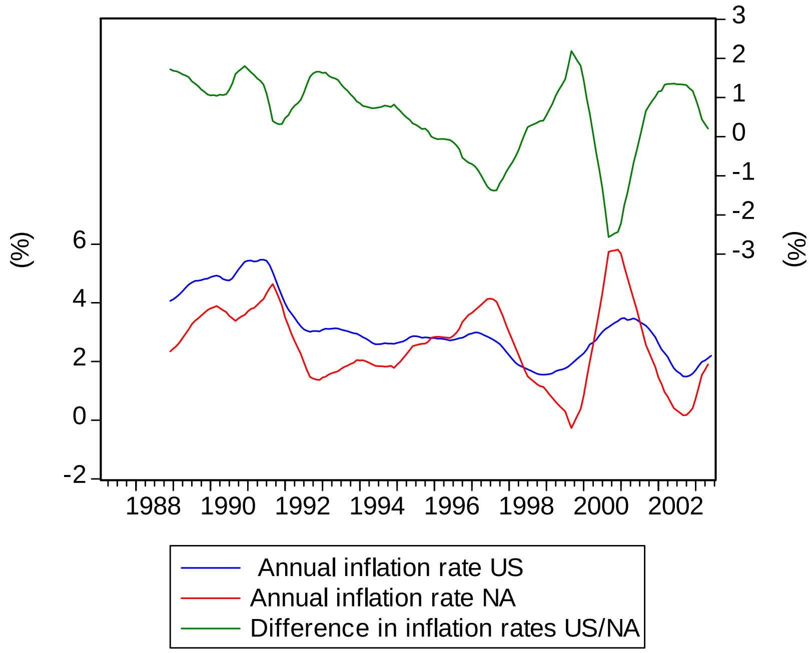

Figure 2: Annual Inflation Rates

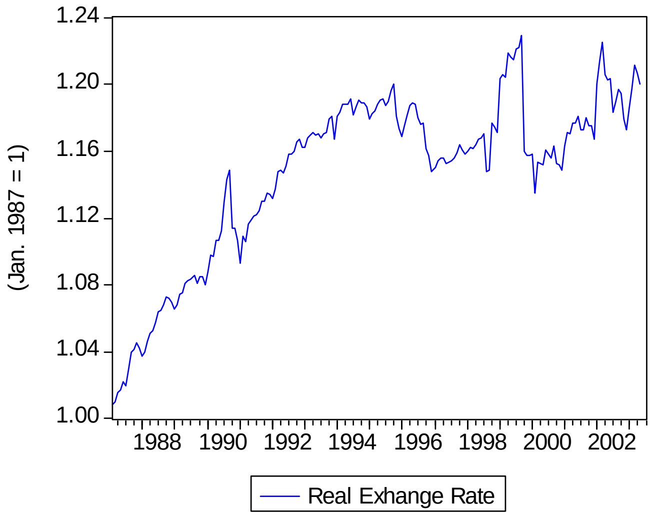

Figure 3: Real Exchange Rate

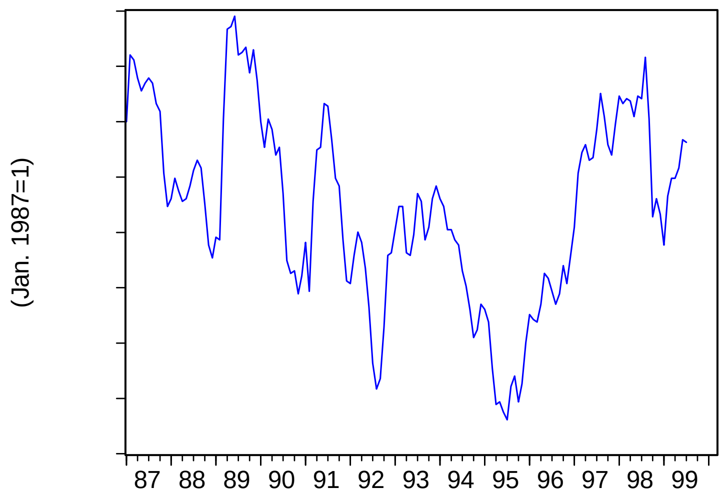

Figure 4: Real Effective Exchange Rates

	ADF test	*KPSS test*
REER	$t = 3.11(1)$	$\eta = 0.35(2)$
RER	$t = 2.57(3)$	$\eta = 1.42(4)$

Table 1: Unit Root Tests

(1) reject the null hypothesis of unit root at 5% and 10%.
(2) Not able to reject the null hypothesis of stationarity
at significance levels 1% and 5%.
(3) Reject the null hypothesis of unit root at 10%.
(4) Reject the null hypothesis of stationarity at 10%, 5%, 1%.

model on RER	hypothesis	test statistic
a. $\Delta\pi_t = \alpha_0 + \gamma * \pi_{t-1} + \alpha_2 * t + \varepsilon_t$	$\gamma = 0$	$t_a = -3.01$
	$\gamma = \alpha_2 = 0$	$F_{a1} = 1.47$
	$\alpha_0 = \gamma = \alpha_2 = 0$	$F_{a2} = 3.58$
b. $\Delta\pi_t = \alpha_0 + \gamma * \pi_{t-1} + \varepsilon_t$	$\gamma = 0$	$t_b = -2.58(*)$
	$\gamma = \alpha_2 = 0$	$F_b = 3.95$
c. $\Delta\pi_t = \gamma * \pi_{t-1} + \varepsilon_t$	$\gamma = 0$	$t_c = 1.49$

Table 2: Unit Root Test on RER

(*) significant at 10% significance level.
The subscript in the test statistics refers to the model a, b, or c.

Model a. The test of a unit root, t_a, cannot be rejected at 10% significance level. The test of joint hypotheses of no trend and a unit root cannot be rejected (F_{a1}). The joint hypotheses of no trend, no drift term, and a unit root cannot be rejected (F_{a2}).

Model b. The test of a unit root, t_b, is rejected at 10% significance level. The joint hypotheses of a unit root and no drift term cannot be rejected.

Model c. The test of a unit root, t_c, cannot be rejected at 10% significance level.

Test on the residuals: In all the models, the autocorrelations were small. The Ljung-Box Q statistics were not significant at conventional levels: Q(5)=2.88, Q(10)=7.5, Q(20)=12.6 (model b). Similarly the Ljung-Box Q statistics of the squared residuals were not significant at conventional levels Q(5)=1.65, Q(10)=6.3, Q(20)=10.9 (model b), which are indications of no ARCH/GARCH effects.

	t-value/one unit root	t-value /two unit roots
f	-2.29	-9.8
p	-2.10	-14.4

Table 3: Test on the order of Integration

Dickey-Fuller critical values for the second column (constant and a trend):
1%: -4.0, 5%: -3.43, 10%: -3.14
Dickey-Fuller critical values for the third column (constant):
1%: -3.46, 5%: -2.87, 10%: -2.17

constant β_0	t-value on $\hat{e_t}$	critical values
$\beta_0 \neq 0$	$-3.08)$	$-3.06(10\%)$
$\beta_0 = 0$	-3.22	$-3.36(5\%)$

Table 4: Engle-Granger Test