# Are Preliminary Data Of Output Growth And Inflation Reliable Predictors?

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**Abstract**

*The hypothesis that the preliminary announcements of output growth and inflation are reliable predictors of the revised data is tested for 1969.1-1991.4 and 1969.1-2000.4. Our test results indicate that these preliminary announcements are unbiased predictors. The output growth revision is orthogonal to the past revisions of both output growth and inflation available at the time of announcement. The inflation revision, however, fails to be orthogonal to such past revisions. While unbiased, the lack of orthogonality of the inflation announcement suggests room for improvement.*

## 1. Introduction

Economic decisions by policy-makers and market participants may often be influenced by preliminary announcements on major economic variables. Policy recommendations and forecasts obtained from econometric models may also be affected by such announcements. The question, then, is whether the preliminary announcements should be relied on as unbiased or, perhaps, rational predictors of the revised data.

More specifically, let $xo_t$, $xp_t$, and $x_t$ be, respectively, a variable's original, preliminary, and revised data. The original data, $xo_t$, is usually a weighted average of the *incomplete* raw data provided to the data collection agency by private sectors. Utilizing the available information at the time, the data collector may make projections about certain components of the variable. Based on these projections, the agency may, then, generate and announce the preliminary data, $xp_t$, which it believes is an "optimal" forecast of the revised data, $x_t$.[1] This raises the question of whether the preliminary announcement is, in fact, an unbiased, or perhaps, rational predictor of the revised data. Unbiasedness implies that the expected value of the preliminary data is equal to the expected value of the revised data; that is, $E(xp_t) = E(x_t)$. In case the preliminary data is an unbiased predictor, one should see if it is rational. Rationality implies that the revision, $x_t - xp_t$, is orthogonal to the relevant information set, $W_t$, available at the time of the announcement; that is, $E(x_t - xp_t \mid W_t) = 0$. See Mankiw, Runkle, and Shapiro (1984).

The purpose of this study is to test the hypotheses of unbiasedness and orthognolity for the preliminary announcements of output growth and inflation. Output growth and inflation are measured, respectively, by the rate of change in real GNP/GDP and the rate of change in the GNP/GDP implicit price deflator. The study by Fixler and Grimm (2002) examines the reliability of GDP and related national income and product accounts (NIPA) estimates based on the mean revision and mean absolute revision. It concludes that such estimates are reliable. Our study differs from Fixler and Grimm (2002) in two respects. First, it concentrates on output growth (by excluding the related NIPA estimates) but includes the examination of the implicit price deflator inflation. Second, our study utilizes more sophisticated statistical techniques to investigate the unbiasedness and predictive information content of the announcements. Our test results indicate that the preliminary announcement of output growth is unbiased and orthogonal to the past known revisions of both output growth and inflation. This suggests that the preliminary announcement of output growth has the potential to be a reliable predictor. The preliminary announcement of inflation is unbiased, but the revision fails to be orthogonal to the past known revisions of inflation and output growth. This suggests that economic agents should constantly evaluate and improve the information content of the preliminary (implicit price deflator) inflation announcement, before using it as the basis for their decisions and recommendations. Swanson and van Dijk (2002) examine, among other variables, the rationality of the preliminary data on the producer price index and reach a similar conclusion.

The format of this paper is as follows: Section 2 discusses the data utilized in this study. Section 3 examines the stochastic behavior of the preliminary and revised series based on the augmented Dickey-Fuller (ADF) test equation for a unit root. Sections 4 and 5 examine the test results of unbiasedness, respectively, for output growth and inflation. Section 6 examines the test results of orthogonality for both output growth and inflation. Section 7 concludes this paper, and Section 8 makes suggestions for future research.

## 2. Data

Utilizing quarterly data, our empirical analysis covers two sample periods of 1969.1-1991.4 and 1969.1-2000.4. For the first sample, output growth and inflation are measured, respectively, by the rate of change in real GNP and the rate of change in the GNP implicit price deflator. By the end of 1991, the emphasis changed from GNP to GDP. Therefore, for the second sample, the GNP definition of output growth and inflation is used for the period up to 1991, and the GDP definition is used from then on.[2]

The preliminary (or advanced) estimates on GDP are released by the Bureau of Economic Analysis (BEA) near the end of April, July, October, and January for, respectively, the first, second, third, and fourth quarters of the year. Due to the lack of complete information at the time, in preparing the preliminary data, the BEA makes projections about certain components of GDP. As more information becomes available, the GDP data are normally revised in the two quarters following the initial release, then each July for three years. Each revision should result in a better measure of the GDP data, since it incorporates more and more information. Other major revisions, called benchmark revisions, happen about every five years. Benchmark revisions, like those in January 1996 and October 1999, usually include methodological and definitional changes that are intended to improve the quality of the data. Changing from a fixed-weight method of calculating real output to a chain-weight method in January 1996 is an example of a methodological change. The change in the treatment of software purchases by businesses and government from an office expense to an investment in October 1999 is an example of a definitional change. See Croushore and Stark (2000).

Given such major revisions, how should we define the revised series? One may suggest utilizing the latest or final series currently available. This, however, creates two problems. The first problem is that it confounds definitional revision of the GDP data with data revisions. For example, final data on GDP growth include the contribution of software, while preliminary data for the most part would not. The second problem is that the GDP data from longer ago have been revised more than the recent data. To overcome these difficulties, we measure the revised series by the data published a year after the initial announcement, making the preliminary announcement a four-quarter-ahead forecast of the revised data. Fixing the horizon helps avoid the latter problem. It also helps avoid definitional revisions to a large extent. The study by Faust, Roger, and Wright (2000) for all G-7 countries does not acknowledge these problems. The revised series is simply measured by the latest or final series. Despite this, their study finds that, for the U.S., the GDP growth revisions are very slightly predictable (p. 17).

Throughout this paper, $YP_t$ and $PP_t$ denote the preliminary series of output growth and inflation, respectively. $Y_t$ and $P_t$, on the other hand, denote, respectively, the revised series of output growth and inflation. The data on these series were obtained from various issues of *Business Conditions Digest* and *Survey of Current Business*.

## 3. Unit root tests

In order to correctly formulate the test equations for unbiasedness and orthogonality, it is important to first investigate the stochastic behavior of the series. For output growth, the following augmented Dickey-Fuller (ADF) equation,

$$\Delta z_t = \delta + \gamma z_{t-1} + \sum_{j=1}^{k} \eta_j \Delta z_{t-j} + v_t \quad (1)$$

is formulated to test the null hypothesis of a unit root for both the preliminary series ($z_t = YP_t$) and the revised series ($z_t = Y_t$.) This test equation does not include a time term due to the absence of a trend in the output growth series (not shown here.).[3] $k$ is the number of augmented terms included to ensure the absence of autocorrelation in $v_t$. Our analysis, however, indicates that $v_t$ is heteroscedastic. Following Hamori and Tokihisa (1997), the White (1980) procedure is utilized to correct the standard errors of the coefficient estimates in (1). Accordingly, the ADF test statistics, reported in the first two columns of Table 1, are calculated using the corrected standard errors. As seen, these ADF test statistics are all significant, indicating that the null hypothesis of a unit root ($\gamma = 0$) is rejected for both series for 1969.1-1991.4 and 1969.1-2000.4. That is, the preliminary and revised series of output growth, $YP_t$ and $Y_t$, are both stationary.

For inflation, the following augmented Dickey-Fuller (ADF) equation,

$$\Delta z_t = \delta_0 + \delta_1 t + \gamma z_{t-1} + \sum_{j=1}^{k} \eta_j \Delta z_{t-j} + v_t. \tag{2}$$

is formulated to test the null hypothesis of a unit root for both the preliminary series ($z_t = PP_t$.) and the revised series ($z_t = P_t$.) Due to the existence of a trend in the inflation series (not shown here), the ADF test equation in (2) includes the time term, $t$. Again, our analysis indicates that $v_t$ is heteroscedastic. Accordingly, the standard errors of the coefficient estimates in (2) are corrected using the White (1980) procedure. Utilizing the corrected standard errors, the ADF test statistics are calculated and reported in the last two columns of Table 1. As shown, these ADF test statistics are all insignificant, indicating that the null hypothesis of a unit root ($\gamma = 0$) cannot be rejected for either series for 1969.1-1991.4 and 1969.1-2000.4. That is, the preliminary and revised series of inflation, $PP_t$ and $P_t$, are both integrated. Further examination reveals that these series in the first-difference form are stationary, leading to the conclusion that $PP_t$ and $P_t$ are both I(1).[4]

**4. Test of unbiasedness: output growth**

The unbiasedness of the preliminary data on output growth is examined by estimating

$$Y_t = \alpha + \beta YP_t + \varepsilon_t. \tag{3}$$

This test equation is statistically appropriate, since, as concluded, $Y_t$ and $YP_t$ are both stationary. The pre-liminary series, $YP_t$, is said to be an unbiased predictor of the revised series, $Y_t$, if $\alpha$ and $\beta$ are, respectively, zero and one.

The OLS estimates of (3) for 1969.1-1991.4 and 1969.1-2000.4 are reported, respectively, in rows 1 and 2 of Table 2. Due to the existence of heteroscedasticity, the reported standard errors in parentheses are corrected using the White (1980) procedure. The reported Q-statistics with one, four, and eight degrees of freedom, are all insignificant, indicating the absence of serial correlation in $\varepsilon_t$. As seen, the coefficient estimates of $\alpha$ and $\beta$ in Table 2 are very close to zero and one, respectively. In fact, based on the insignificant $\chi_2^2$-statistics in rows 1 and 2, the joint null hypothesis of unbiasedness cannot be rejected for either sample period. Consistent with these results, the individual null hypotheses $\alpha = 0$ and $\beta = 1$ cannot be rejected either, leading to the conclusion that $YP_t$ is an unbiased predictor of $Y_t$.

**5. Test of unbiasedness: inflation**

Since the preliminary and revised series of inflation are integrated, $PP_t$, is said to be an unbiased predictor of $P_t$, if (i) the two series are cointegrated, and (ii) the intercept and slope parameters in the cointegrating relation are, respectively, zero and one.

The null hypothesis of non-cointegration is tested using the Engle-Granger (1987) test equation,

$$\Delta \hat{u}_t = \gamma \hat{u}_{t-1} + \sum_{j=1}^{k} \eta_j \Delta \hat{u}_{t-j} + v_t \tag{4}$$

where $\hat{u}_t$ is the residual series from the linear OLS estimates of the following relation,

$$P_t = \alpha + \beta PP_t + u_t. \tag{5}$$

Stock (1987) shows that, in case $P_t$ and $PP_t$ are cointegrated, the linear OLS estimates of $\alpha$ and $\beta$ are super-consistent. Nonetheless, these estimates are biased in small samples. In addition, the standard errors of the parameter estimates are incorrect due to the existence of such problems as serial correlation.

To provide reliable estimates of the cointegrating coefficients $\alpha$ and $\beta$ with correct standard errors, Phillips and Loretan (1991) suggest estimating the following nonlinear model for cointegrating series with a unit root,

$$P_t = \alpha + \beta PP_t + \sum_{i=1}^{n} \rho_i (P_{t-i} - \alpha - \beta PP_{t-i}) + \sum_{j=-m}^{m} \varphi_j \Delta PP_{t-j} + \mu_t \qquad (6)$$

where the values of $n$ and $m$ are chosen to ensure the absence of autocorrelation in $\mu_t$. Utilizing the nonlinear OLS estimates from (6), we are, then, able to examine the unbiasedness of $PP_t$ by testing the null hypotheses of $\alpha = 0$ and $\beta = 1$ both individually and jointly.[5]

Table 3 reports the linear OLS estimates of the relation in (5) as well as the calculated ADF test statistics for testing the null hypothesis of non-cointegration from (4). The reported ADF test statistics for both 1969.1-1991.4 and 1969.1-2000.4 are significant, indicating that $P_t$ and $PP_t$ are cointegrated.

To be able to test the null hypothesis of unbiasedness, the cointegrating coefficients $\alpha$ and $\beta$ are re-estimated using the Phillips-Loretan model in (6). The nonlinear OLS estimates of the cointegrating coefficients $\alpha$ and $\beta$ along with the Ljung-Box Q-statistics with one, four, and eight degrees of freedom are reported in Table 4. These Q-statistics are all insignificant, indicating the absence of serial correlation in $\mu_t$. As seen, the nonlinear coefficient estimates of $\alpha$ and $\beta$ in Table 4 are very close to zero and one, respectively. In fact, the individual null hypotheses of $\alpha = 0$ and $\beta = 1$ cannot be rejected for either sample period of 1969.1-1991.4 or 1969.1-2000.4. Consistent with these results, the reported $\chi_2^2$-statistics for testing the joint null hypothesis of $\alpha = 0$ and $\beta = 1$ are also insignificant, reinforcing the conclusion that $PP_t$ is an unbiased predictor of $P_t$.

## 6. Tests of orthogonality

The conclusion, so far, is that the preliminary data on output growth and inflation are unbiased predictors. The next question is whether or not the output growth and inflation revisions are orthogonal to the information in the past revisions available at the time of announcement.

The following orthogonality test equation is formulated for output growth,

$$Y_t - YP_t = c_0 + \sum_{j=1}^{2} c_j (Y - YP)_{t-4-j} + \sum_{j=1}^{2} d_j (P - PP)_{t-4-j} + \omega_t \qquad (7)$$

where the second and third term on the right-hand side specify, respectively, the past revisions of output growth and inflation available at the time of announcement. The output growth revision, $Y_t - YP_t$, is said to be orthogonal to the information in such past revisions of output growth, if the null hypotheses of $c_1 = 0$ and $c_2 = 0$ cannot be rejected. Also, the output growth revision, $Y_t - YP_t$, is said to be orthogonal to the information in such past revisions of inflation, if the null hypotheses of $d_1 = 0$ and $d_2 = 0$ cannot be rejected.

The OLS estimates of the test equation in (7) are reported in rows one and two of Table 5, respectively, for 1969.1-1991.4 and 1969.1-2000.4. For these estimates, the calculated values of $R^2$ (= .04 and .02) are not significantly different from zero. Consistent with these results, the individual null hypotheses $c_1 = 0$, $c_2 = 0$, $d_1 = 0$, and $d_2 = 0$ cannot be rejected, indicating that the output growth revision, $Y_t - YP_t$, is orthogonal to the past revisions of output growth and inflation available at the time of announcement. This leads to the conclusion that the preliminary announcement of output growth has the potential to be an optimal estimate or forecast of the revised data.[6]

For inflation, the following orthogonality test equation is formulated,

$$P_t - PP_t = c_0 + \sum_{j=1}^{2} c_j (P - PP)_{t-4-j} + \sum_{j=1}^{2} d_j (Y - YP)_{t-4-j} + \omega_t \qquad (8)$$

where the second and third term on the right-hand side specify, respectively, the past revisions of inflation and output growth available at the time of announcement. The inflation revision, $P_t$ - $PP_t$, is said to be orthogonal to the information in such past revisions of inflation, if the null hypotheses of $c_1 = 0$ and $c_2 = 0$ cannot be rejected. Similarly, the inflation revision, $P_t$ - $PP_t$, is said to be orthogonal to the information in such past revisions of output growth, if the null hypotheses of $d_1 = 0$ and $d_2 = 0$ cannot be rejected.

The OLS estimates of the test equation in (8) are reported in rows three and four of Table 5, respectively, for 1969.1-1991.4 and 1969.1-2000.4. The individual null hypotheses $c_2 = 0$ and $d_2 = 0$ are rejected for 1969.1-1991.4, and the individual null hypotheses $c_1 = 0$, $c_2 = 0$ and $d_2 = 0$ are rejected for 1969.1-2000.4. These results indicate that the inflation revision, $P_t$ - $PP_t$, fails to be orthogonal to the past revisions of inflation and output growth available at the time of announcement. It follows that the preliminary announcement on inflation, while unbiased, needs to be improved in terms of information content, before being utilized as the basis for policy or other economic decisions.

## 7. Conclusions

The hypothesis that the preliminary announcements of output growth and inflation are reliable predictors of the revised data is tested for 1969.1-1991.4 and 1969.1-2000.4. Our test results indicate that the preliminary and revised series of output growth, measured by the rate of change in real GNP/GDP, are both stationary. The preliminary announcement is found to be an unbiased predictor of the revised output growth, and the revision is orthogonal to the past revisions of both output growth and inflation available at the time of announcement. As indicated above, these test results suggest that the preliminary announcement of output growth has the potential for being an optimal estimate or forecast of the revised data.

For inflation, the preliminary and revised series, measured by the rate of change in the GNP/GDP implicit price deflator, each have a unit root, and they are cointegrated. The preliminary announcement is shown to be an unbiased predictor of the revised inflation, but the revision fails to be orthogonal to the past revisions of inflation and output growth available at the time of announcement. While unbiased, the lack of orthogonality suggests room for improvement. In line with Mankiw, Runkle, and Shapiro (1984), this indicates that the preliminary data on (implicit price deflator) inflation should be improved, before being utilized as the basis for policy and other economic decisions.

## 8. Suggestions for future research

Unlike many previous studies in this area, this paper explicitly acknowledges the two problems arising from measuring the revised data by the latest or final series. The first problem is that such a practice confounds definitional revision of the GDP data with data revisions. The second problem is that the GDP data from longer ago have been revised more than the recent data. We believe that valid tests of unbiasedness and orthogonality require fixing the horizon to deal with definitional revisions. Accordingly, we looked at revisions from initial to one-year later. But we recognize that many other revisions exist and could be analyzed. Therefore, one suggestion for future research may be to re-examine the reliability of the preliminary data of output growth and inflation for a shorter or longer horizon than one year. 🕮

## 9. Notes

1. In fact, as also indicated by Faust, Rogers, and Wright (2000), some national statistical offices explicitly discuss the optimal use of all available information in constructing the preliminary data. See the editors' note in Mankiw and Shapiro (1986).
2. The sample period is cut at the end of 1991to reflect the change in emphasis from GNP to GDP. In doing so, we are not claiming that revisions to GNP are different from revisions to GDP.
3. It is important to note that the test results for output growth in Table 1 are robust to the inclusion of a time trend in the ADF test equation in (1).
4. The calculated ADF test statistics for $\Delta PP_t$ is -3.12 (with Q[8] =3.67) for 1969.1-1991.4 and –3.44 (with Q[8] = 4.00) for 1969.1-2000.4. The calculated ADF test statistics for $\Delta P_t$ is –3.37 (with Q[8] = 6.93) for 1969.1-1991.4 and –3.59 (with Q[8] = 7.92) for 1969.1-2000.4. Compared with MacKinnon's (1991) unit root critical values, these test statistics are all significant, indicating that $PP_t$ and $P_t$ are both I(1). Note that the ADF equations for testing the series in the first-difference form include six augmented terms. These test equations, however, exclude the time trend.
5. Applying the Phillips-Loretan nonlinear model to testing market efficiency in energy futures markets, Peroni and McNown (1998) maintain that this model provides more accurate estimates of the cointegrating relation than the simple linear model in (5).
6. Failure to reject the null hypotheses of $d_1 = 0$ and $d_2 = 0$, however, does not necessarily imply that $YP_t$ is rational. This is because the revision, $Y_t - YP_t$, may fail to be orthogonal to other relevant information available at the time of announcement.

**10. References**


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**Table 1**

**Augmented Dickey-Fuller tests of unit roots for output growth and inflation**

| | Output growth | | Inflation | |
|---|---|---|---|---|
| | Preliminary ($YP_t$) | Revised ($Y_t$) | Preliminary ($PP_t$) | Revised ($P_t$) |
| Sample: 1969.1-1991.4 | | | | |
| ADF | -4.23[a] | -4.54[a] | -2.47 | -2.24 |
| Q[8] | 1.02 | 1.01 | 3.07 | 1.87 |
| Sample: 1969.1-2000.4 | | | | |
| ADF | -4.59[a] | -4.73[a] | -2.57 | -2.33 |
| Q[8] | 0.97 | 0.89 | 3.17 | 1.94 |

Notes: $YP_t$ and $Y_t$ are, respectively, the preliminary and revised data on real GNP/GDP growth. $PP_t$ and $P_t$ are, respectively, the preliminary and revised data on the GNP/GDP implicit deflator inflation. The calculated ADF statistics, compared with Mackinnon's (1991) unit root critical values, test the null hypothesis of a unit root (i.e., $\gamma = 0$ in equations 1 and 2). The number of augmented lags, *k*, included in ADF test equations (1) and (2) is seven. The adequacy of the lag length is checked with tests for serial correlation using the Ljung-Box Q-statistics at eight degrees of freedom. Significance is indicated by a (1%), b (5%), and c (10%).

**Table 2**
**Test of unbiasedness for output growth**

$$Y_t = \alpha + \beta\, YP_t + \varepsilon_t$$

| Sample | $\alpha$ | $\beta$ | $R^2$ | $\chi_2^2$ | Q[1] | Q[4] | Q[8] |
|---|---|---|---|---|---|---|---|
| 1969.1-1991.4 | 0.168 (0.162) | 1.004[a] (0.031) | 0.90[a] | 1.72 | 0.25 | 0.77 | 4.31 |
| 1969.1-2000.4 | 0.123 (0.141) | 1.001[a] (0.030) | 0.89[a] | 1.37 | 0.36 | 0.92 | 3.58 |

Notes: Numbers in parentheses are the standard errors corrected for heteroscedasticity. Significance is indicated by a (1%), b (5%), and c (10%). The calculated $\chi_2^2$-statistic tests the joint null hypothesis of unbiasedness (i.e., $\alpha = 0$ and $\beta = 1$); the 10% critical value of the $\chi_2^2$-statistic is 4.61. The absence of serial correlation in $\varepsilon_t$ is tested using the Ljung-Box Q-statistics at one, four, and eight degrees of freedom.

**Table 3**
**Engle-Granger tests of non-cointegration for inflation**

$$P_t = \alpha + \beta\, PP_t + u_t$$

| | | | ADF on the residuals ($\hat{u}_t$) | |
|---|---|---|---|---|
| Sample | $\alpha$ | $\beta$ | ADF | Q[8] |
| 1969.1-1991.4 | 0.141 | 0.989 | -4.60[a] | 0.51 |
| 1969.1-2000.4 | 0.092 | 0.995 | -4.92[a] | 0.37 |

Notes: The ADF test statistics, which come from the ADF equation in (4), are calculated using the standard errors corrected for heteroscedasticity. These statistics, compared with MacKinnon's (1991) cointegration critical values, test the null hypothesis of non-cointegration ($\gamma = 0$). The ADF test equations include six augmented lags, where the adequacy of the lag length is checked with tests for serial correlation using the Ljung-Box Q-statistic at eight degrees of freedom, Q[8]. Significance is indicated by a (1%), b (5%), and c (10%).

**Table 4**
**Nonlinear OLS estimates of the cointegrating coefficients for inflation: test of unbiasedness**

$$P_t = \alpha + \beta PP_t + \sum_{i=1}^{n} \rho_i (P_{t-i} - \alpha - \beta PP_{t-i}) + \sum_{j=-m}^{m} \varphi_j \Delta PP_{t-j} + \mu_t$$

| Sample | $\alpha$ | $\beta$ | $R^2$ | $\chi_2^2$ | Q[1] | Q[4] | Q[8] |
|---|---|---|---|---|---|---|---|
| 1969.1-1991.4 | -0.075<br>(0.135) | 1.025[a]<br>(0.024) | 0.93[a] | 2.06 | 0.01 | 0.81 | 2.36 |
| 1969.1-2000.4 | -0.002<br>(0.074) | 1.017[a]<br>(0.030) | 0.95[a] | 2.30 | 0.06 | 1.25 | 2.55 |

Notes: In the above model, *n* and *m* are set equal to six and one, respectively. The terms with highly insignificant t-statistics are dropped to increase the efficiency of the estimates. Numbers in parentheses are standard errors corrected for heteroscedasticity. Significance is indicated by a (1%), b (5%), and c (10%). The calculated $\chi_2^2$-statistic tests the joint null hypothesis of unbiasedness (i.e., $\alpha = 0$ and $\beta = 1$); the 10% critical value of the $\chi_2^2$-statistic is 4.61. The absence of serial correlation in $\mu_t$ is tested using the Ljung-Box Q-statistics at one, four, and eight degrees of freedom.

**Table 5**
**Tests of orthogonality**

| Sample | $c_0$ | $c_1$ | $c_2$ | $d_1$ | $d_2$ | $R^2$ | Q[1] | Q[4] | Q[8] |
|---|---|---|---|---|---|---|---|---|---|

$$Y_t - YP_t = c_0 + \sum_{j=1}^{2} c_j (Y - YP)_{t-4-j} + \sum_{j=1}^{2} d_j (P - PP)_{t-4-j} + \omega_t$$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 69.1-1991.4 | 0.210 | -0.103 | -0.037 | 0.064 | 0.277 | 0.04 | 0.78 | 1.54 | 3.76 |
| | (0.148) | (0.094) | (0.125) | (0.223) | (0.265) | | | | |
| 69.1-2000.4 | 0.135 | -0.066 | -0.018 | 0.086 | 0.196 | 0.02 | 0.82 | 1.63 | 3.07 |
| | (0.114) | (0.082) | (0.108) | (0.198) | (0.226) | | | | |

$$P_t - PP_t = c_0 + \sum_{j=1}^{2} c_j (P - PP)_{t-4-j} + \sum_{j=1}^{2} d_j (Y - YP)_{t-4-j} + \omega_t$$

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 69.1-1991.4 | 0.130 | -0.151 | -0.266[b] | -0.056 | -0.105[c] | 0.11[b] | 0.00 | 1.09 | 2.00 |
| | (0.086) | (0.100) | (0.108) | (0.058) | (0.055) | | | | |
| 69.1-2000.4 | 0.100 | -0.185[b] | -0.202[b] | -0.041 | -0.089[b] | 0.10[b] | 0.00 | 0.48 | 1.73 |
| | (0.061) | (0.087) | (0.097) | (0.049) | (0.045) | | | | |

Notes: Numbers in parentheses are standard errors corrected for heteroscedasticity. Significance is indicated by a (1%), b (5%), and c (10%). The absence of serial correlation in $\omega_t$ is tested using the Ljung-Box Q-statistics at one, four, and eight degrees of freedom.

**Notes**