TRANSITORY CONSUMPTION AND MEASUREMENT ERRORS

IN THE PERMANENT INCOME HYPOTHESIS

by

Luigi Ermini

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Abstract

The error term in the equation defining the permanent income hypothesis is sometimes viewed in the literature as transitory consumption (generated by the agent), and is sometimes viewed as measurement error (generated by the observer). In both cases, it is usually assumed to be white noise. Sometimes it is ignored altogether, assumed to be identically zero. Using empirical evidence that combines both monthly and quarterly data, this paper shows that the error term in the permanent income equation cannot be identically zero, and that the presence of both transitory consumption and measurement errors can be consistent with the data. The evidence also confirms that the best model for this term is indeed a white noise process.

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Transitory consumption and measurement errors in the permanent income hypothesis

1. Introduction

The standard version of the permanent income hypothesis states that consumption in every period, $C_t$, is a proportion, not necessarily constant, of permanent income, $P^*_t$. The hypothesis is formally written as

$$C_t = \beta P^*_t + u_t,$$

(1)

where $u_t$ is a suitable "error" term, usually assumed to be a zero-mean white noise process uncorrelated with permanent income. It is fair to say that this assumption about $u_t$ seems to be justified more for its econometric convenience than on theoretical economic grounds. Since the early empirical work on the permanent income hypothesis, in fact, economists have investigated the validity of the hypothesis by treating (1) as a regression equation of consumption against a suitably reconstructed measure of permanent income (for a review, see Deaton and Muellbauer [1980]).

The focus of both theoretical and empirical economists has always been directed exclusively to the interaction between consumption and income, and never to the origin and properties of the error term $u_t$. This lack of focus appears to be so common in the literature that this term receives confusingly different interpretations. Some researchers interpret $u_t$ as transitory consumption, generated in an unspecified fashion by the representative agent (for example, Hayashi [1981], and Wickens and Molnar [1984]). In this case, the related empirical work implicitly assumes the absence of measurement errors. Some others interpret $u_t$ as measurement error, generated by the observer. In this case, the related empirical work assumes the absence of transitory consumption generated by the agent. Finally, some others assume $u_t$ to be identically zero altogether, as the result of aggregating the consumption generated by many individual households at the economy-wide level (for example, Flavin [1981], and Muellbauer [1983]). For recent reviews, see also Deaton [1986], and Campbell and Mankiw [1987].

This lack of focus on the nature of the transitory term in (1) appears even more compelling if one subscribes to the idea that the permanent income hypothesis is in fact an incomplete theory of consumption responses to income changes. For example, it is shown in Ermini [1989a] that the permanent income hypothesis is equivalent to the hypothesis that consumption and disposable income are cointegrated. An interpretation of cointegration is that two cointegrated variables may drift apart in the short-run, but "move together" in the long-run (Granger [1986]). Therefore, the equivalence between cointegration and the permanent income hypothesis means that the latter only establishes a relation between the long-run swings of consumption and income, thus totally neglecting the transitory effects on consumption of the short-run income changes.

So, the permanent income hypothesis offers no model for the transitory component $u_t$ in (1), except for the standard white noise assumption. The purpose of this paper, then, is to establish, through the combined use of both monthly and quarterly consumption data, whether this transitory component is indeed white noise, and whether the available data can simultaneously accommodate the presence of both transitory consumption and measurement error. The investigation is based on the generating mechanism of consumption that Flavin [1981] derives from the permanent income hypothesis. In this sense, the paper can be viewed as an extension of Flavin's model in the direction of inferring a plausible model for $u_t$ different from Flavin's assumption of it being identically zero.

The main results of this exercise are that monthly and quarterly data are consistent, under different ranges of signal-to-noise ratios, with the presence of both transitory consumption and measurement errors, as well as with the presence of only transitory consumption, or of only measurement errors. Moreover, it is found that in all three cases transitory consumption and/or measurement errors can only be white noise processes.

The paper is organized as follows. Section 2 develops the generating mechanism of consumption under the most general case of having both transitory consumption and measurement error, and suggests some testable implications for empirical work. Section 3 relates these implications to the time series properties of monthly and quarterly consumption data reported elsewhere (Ermini [1989b]). Section 4 offers some concluding remarks.
2. The generating mechanisms of consumption

Following Flavin [1981], let permanent income be the annuity \( R \) of human capital \((H_t)\) and non-human capital \((A_t)\), \( Y^K_t = R(A_t\cdot H_t) \), and let human capital be the present value of the expected flow of labor income over the agent's entire life span \( T \), conditional on the information available at time \( t \), \( H_t = \sum_{k=0}^{T} E_t Y_{t+k} R_k \), where \( R_k = \Pi_{j=0}^{T} (1+r_j) \), and \( R = \sum_{j=0}^{T} R_j \). Based on these definitions, Flavin [1981] shows that the permanent income hypothesis (1) implies:

\[
C_t = (1+\beta)C_{t-1} + \beta \phi e_t + u_t - (1+\beta)u_{t-1} \tag{2}
\]

To obtain this generating mechanism of consumption, Flavin assumes an infinite life span \((T = \infty)\), and a constant real interest rate \( r \), so that \( R = \infty \). The term \( \phi e_t \) is related to the unexpected revision, between two consecutive periods, of both human and non-human capital. Thus, by assuming that the unexpected revision of non-human capital is directly linked to the unanticipated revision of property income, \( Y^K_t \), Flavin obtains

\[
\phi e_t = \sum_{k=0}^{T} (E_{t+k} - E_t) \frac{Y^K_{t+k+1} Y^K_{t+2} \cdots Y^K_{t,T}}{R_k} \tag{3}
\]

It follows that consumption innovations are related to the innovations of total income, and not of labor income only. Under the additional assumption of rational expectations, \( e_t \) is a zero-mean white noise process.

Equation (2) shows that the generating mechanism of consumption is "driven" by the innovation of total disposable income, and by the transitory component of consumption \( u_t \). Letting \( e_t = r \phi e_t \), for simplicity, and assuming \( \beta = 1 \), we get the model of consumption as generated by the representative agent:

\[
C_t = C_{t-1} + e_t + u_t - (1+\beta)u_{t-1} \tag{4}
\]

Finally, adding the measurement error \( e_t \), we get the model of consumption as observed by the econometrician:

\[
C_t = C_{t-1} + e_t + u_t - (1+\beta)u_{t-1} + e_t - e_t \cdots \tag{5}
\]

The purpose of this paper is to investigate whether the combined use of both monthly and quarterly data can cast some light on the properties of the two different error terms, \( u_t \) and \( e_t \), given that the innovations of total disposable income, \( e_t \), are taken to be a white noise process of variance \( \sigma^2_e \). However, as this paper uses two different series of data (monthly and quarterly), and as in principle consumption can be generated by the agent at intervals shorter than a month (see for example Ermini [1988] for a discussion on the plausibility of this case), we must consider the effect of temporal aggregation (TA) on both models (4) and (5). In fact, we must consider two different effects: (a) the aggregation up to monthly intervals of consumption actually generated by the agent as (4) at shorter intervals; (b) the aggregation of the monthly consumption model to a quarterly interval, in order to check the consistency of the basic model with both sets of data.

Let \( \bar{C} \), be the monthly aggregation of consumption generated by the agent, that is

\[
\bar{C}_t = \sum_{j=0}^{m-1} C_{t+j} \tag{6}
\]

where \( C_{t+j} \) is generated as in (4), and \( m \) is the sampling ratio, that is the ratio between a month and the interval of data generation. Assume that transitory consumption \( u_t \) is not identically zero, and that it follows a zero-mean white noise process of variance \( \sigma^2_u \). Then \( C_t \) in (4) is a first-order integrated first-order moving average process, IMA(1,1), with \( \text{var}(AC) = \sigma^2_e + \sigma^2_u \) and first-order autocorrelation of \( AC \) given by

\[
p(AC) = -\frac{(1+\beta)\sigma^2_u}{\sigma^2_e + \sigma^2_u} = -\frac{1+\beta}{ST^2} \tag{6}
\]

where \( \beta = 1 \), and \( ST^2 = \sigma^2_e \sigma^2_u \). \( ST \) can be interpreted as the the signal-to-noise ratio between permanent and transitory consumption. If transitory consumption in (1) is identically zero \( (\sigma^2_u = 0) \), then consumption is only related to the "permanent" component \( \beta y^K \), and it is generated by a mechanism whose innovation is only the innovation of total disposable income \( e_t \).

It is shown in Ermini [1989b] that under temporal aggregation an IMA(1,1) process remains an IMA(1,1) process for any value of the sampling ratio \( m \), with corresponding variance and first-order autocorrelation depending on the sampling ratio. In our case, and following the derivation in the cited reference, the generating mechanism of monthly aggregated consumption is

\[
\bar{C}_t = \bar{C}_{t+j} + \bar{e}_t + \bar{u}_t \tag{7}
\]

with first-order autocorrelation of \( AC \)

\[
p(AC) = -\frac{h}{1+h^2} = -\frac{(m-1) + 2(m-2) p(AC)}{(2m^2+1) + 8(m-1) p(AC)} \tag{8}
\]

Clearly, for \( m = 1 \) - corresponding to \( C_t \) generated at monthly frequency - \( p_m = p \).
Solving (10) for \( SN \) as a function of \( \rho^{**} \),
\[
SN = \frac{1 + 2\rho^{**}}{h - (1 + h)^2 \rho^{**}},
\]
and substituting in (11),
\[
\rho^{**} = \frac{4 + 11\rho^{**}}{19 + 32\rho^{**}},
\]
we get the apparently striking result that the first-order autocorrelation associated with quarterly data is only function of the first-order autocorrelation associated with monthly data, regardless of the value of the signal-to-noise ratio.

These results can be summarized in the following propositions, which hold under the assumption that the basic generating mechanism of consumption (4) is true:

**PROPOSITION 1:** Under the assumption that both transitory consumption, \( \epsilon \), and measurement error, \( \epsilon \), are white noise, then both monthly and quarterly consumption follow \( \text{IMA}(1,1) \) processes, regardless of whether consumption is generated at monthly intervals or shorter.

**PROPOSITION 2:** If either transitory consumption, \( \epsilon \), or measurement error, \( \epsilon \), or both, are stationary processes, but not white noise, then both monthly and quarterly consumption follow higher order \( \text{ARIMA}(p,q) \) processes.

Finally, recalling Working's (1969) result that a random walk under temporal aggregation becomes an \( \text{IMA}(1,1) \) process for any value of the sampling ratio \( n \), it is easily verified that even if transitory consumption is identically zero, and thus \( \epsilon \) is a random walk, the generating mechanism (7) still holds for monthly consumption, except for \( c = 1 \). So, monthly consumption will appear as \( \text{IMA}(1,1) \) with or without measurement error; consequently, quarterly consumption as well. These results can be summarized in the following:

**PROPOSITION 3:** Both monthly and quarterly consumption follow \( \text{IMA}(1,1) \) processes even if transitory consumption is identically zero, and measurement error is white noise; or even if transitory consumption is white noise, and measurement error is identically zero.

In the next section, it will be shown that transitory consumption and measurement error cannot be both identically zero, which is, in fact, precisely the assumption made by Flavin (1981), among others. It is important to emphasize that the results summar-
ized by the three propositions are strictly based on the property that under TA, and for any value of the sampling ratio m, a random walks process and an IMA(1,1) process are indistinguishable, as both become IMA(1,1) processes.

3. The empirical evidence

In this section, the theoretical results of the previous section are compared with the following empirical findings (Ermini [1989b]):

(i) the best univariate model to fit monthly consumption data is the IMA(1,1) model ($t$-statistics in parenthesis) \(^1\)

\[
\Delta \hat{C}_t = 0.095 + w_t - 0.221 w_{t-1}
\]

(0.004) (-4.03) \hspace{1cm} (14)

The corresponding estimate of the first-order autocorrelation is $\hat{\rho}_m = -0.211$, with 95% confidence interval (-0.30, -0.11). The important feature to emphasize here is the negative sign of $\hat{\rho}_m$. A similar result is reported in Wheatley [1988], although not directly comparable with (14) as Wheatley uses log consumption. Note that $\hat{C}_t$ is used here to indicate "observed" monthly consumption. If measurement errors are identically zero, then $\hat{C}_t = \hat{C}_t$, and if the sampling ratio m is equal to 1, then $\hat{C}_t = \hat{C}_t$ or $C_t$, according to whether the generation of monthly consumption by the agent is corrupted by measurement error or not.

(ii) the best univariate model to fit quarterly consumption data is the IMA(1,1) model

\[
\Delta \hat{C}_t = 0.06 + w_t + 0.211 w_{t-1}
\]

(0.002) (2.67) \hspace{1cm} (15)

with the corresponding estimate of the first-order autocorrelation $\hat{\rho}_m = 0.202$, (0.051, 0.326). Note the change of sign of the first-order autocorrelation from monthly to quarterly data. Similar results are also found in Christiano et al [1987].

Note, first, that through (13) the estimate of the quarterly $\hat{\rho}_m$ is consistent with the estimate of the monthly $\hat{\rho}_m$. In fact, from (13) a value $\hat{\rho}_m = -0.211$ yields a "theoretical" value $\hat{\rho}_m = 0.137$, with a 95% confidence interval (0.075, 0.180). Based on the estimated model (15), this theoretical value is not rejected at the 5% level, nor are the two estimated values of the 95% confidence interval.

One important implication of these empirical results follows from Proposition 2: as both monthly and quarterly data appear to be generated as IMA(1,1) processes, then whichever term is present in the data (transitory consumption and/or measurement error) must be white noise.

Another important implication comes from the negative sign of the first-order autocorrelation for monthly data: it excludes the possibility that both transitory consumption $u_t$ and measurement error $\varepsilon_t$ can be identically zero. If $u_t$ is identically zero, consumption in (4) would be generated as a random walk, which under temporal aggregation to monthly intervals would turn into an IMA(1,1) process with positive first-order autocorrelation (Working [1960]). It follows that, since monthly consumption displays a negative first-order autocorrelation, measurement errors cannot be identically zero as well.

This leaves the three possibilities: (a) $u_t = \varepsilon_t = 0$; (b) $u_t$ is white noise, and $\varepsilon_t = 0$; (c) $u_t$ and $\varepsilon_t$ are both white noise. Consider these three cases in turn:

(a) $u_t = \varepsilon_t = 0$. In this case, consumption is generated by the representative agent as a random walk, at any interval of length between zero and a month (the former corresponding to continuous-time consumption decisions). Then, monthly consumption without measurement error would follow an IMA(1,1) process with first-order autocorrelation given by (Working [1960]):

\[
\hat{\rho}_m = \frac{m^{-1} - 1}{2(m^2 + 1)}
\]

that is, with a first-order autocorrelation anywhere between zero (for $m = 1$) and 0.25 (for $m = \infty$). The corresponding MA coefficient $h$ varies between 0 and 0.268, and between 3.732 and $\infty$. Incidentally, note that (16) can also be obtained as a special case of (8), as $\hat{\rho}(h) = 0$ for consumption generated as a random walk.

Using (12), we see that with an estimated $\hat{\rho}_m = -0.211$ for monthly data, and with $h$ between 0, and 0.268, monthly data are consistent with the present case for a range of signal-to-noise ratios between 2.74 (for $h = 0$) and 1.17 (for $h = 0.268$). In fact, considering the 95% confidence interval for the estimated $\hat{\rho}_m$, the range of signal-to-noise ratios for $h = 0$ becomes (1.33, 7.09), and for $h = 0.268$, (0.68, 2.02). It follows that the overall range of ratios expands to (0.68, 7.09).

Regarding the possibility $h \geq 3.732$, the estimate $\hat{\rho}_m$ would entail a signal-to-noise

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\(^1\) The data sets correspond to US monthly and quarterly, per capita, seasonally adjusted consumption of non-durables and services. Several different ARIMA models were unsuccessfully compared with this IMA(1,1).
ratio between zero (for \( k = \infty \)) and 0.084 (for \( k = 3.732 \)). As these values are implausibly low (for example, \( SN = 0.084 \) implies a variance of the measurement error 12 times greater than the variance of consumption innovations), the case \( k \geq 3.732 \) can be safely ruled out.

(b) \( \epsilon \) is white noise; \( \sigma = 0 \). In this case, consumption is generated by the representative agent as an IMA(1,1), at any interval of length between zero and a month, and with first-order autocorrelation \( \rho(\epsilon) \) as in (6). Now (8) holds for observed monthly consumption. Note, first, that with \( \rho = -0.5, \rho_m = -0.5 \) also, for all values of \( m \). This is not surprising, as \( \rho = -0.5 \) means that consumption in (4) is generated with a unit root in the MA component, that is, is overdifferenced. This implies that \( C_t \) is stationary, and thus so remains under temporal aggregation.

From (8) it is easily verified that as \( m \) goes to infinity, the limit of \( \rho_m \) goes to 0.25, for all values of \( \rho \) (except, of course, \( \rho = -0.5 \)). Since the estimates \( \rho_m \) are -0.211, negative, it follows that \( m \) cannot be infinite, that is, consumption cannot be generated in continuous time (cfr. also Ermini [1989b]). Finally, by rewriting (8) as

\[
\rho_m = \frac{20(m^2 + 1)\rho_m - (m^2 - 1)}{2m^2 + 2} \tag{17}
\]

it is clearly seen that \( \rho_m \) negative implies \( \rho \) negative as well. Thus, monthly data suggests that if consumption is generated as an IMA(1,1), then the MA coefficient must be negative.

(c) \( \epsilon \) and \( \epsilon \) are both white noise. In this case observed monthly consumption obeys (9)-(10). The range of possibilities is significantly expanded, in comparison to the previous two cases. As measurement errors are not zero, the restrictions found in case (b) no longer apply. As transitory consumption is not zero, the ranges of signal-to-noise ratios found in case (a) are greatly expanded by the possibility that \( \rho \) can now be negative.

To summarize, \( \rho(\epsilon) \) can assume any value in \([-0.5, 0.5]\). Under temporal aggregation \( \rho_m(\epsilon) \) increases monotonically with the sampling ratio \( m \) from any \( \rho \) in \([-0.5, 0.25]\) to the limit of 0.25; and it decreases monotonically from any \( \rho \) in (0.25, 0.5] to the same limit 0.25. Although, as \( m \to 1 \), the range of values for \( \rho_m \) diminishes, we must consider the whole spectrum (0.5, 0.5] for lack of any plausible hypothesis about the true value of the sampling ratio \( m \). Consequently, we must consider the entire real

line as the set of values for \( \rho \) at monthly level. However, for an estimated \( \rho_m = -0.211 \), the signal-to-noise ratio \( SN \) in (12) is monotonically decreasing from \( \infty \) to 0 for \( k \geq 0.223 \), and monotonically increasing from 0 to \( \infty \) for \( k \leq -4.52 \); and remains negative for \( k \) between -4.52 and -0.223. Therefore, as \( SN \) cannot be negative, and ruling out low values of \( SN \), say \( SN \leq 0.4 \), as they would imply too large variances of the measurement errors compared to consumption innovations, the plausible range of values of the monthly MA coefficient \( \rho \) reduces to \([-5.74, -4.52], [-0.223, 1]\). Further, \( \rho \) is negative for \( SN > 7.24 \).

Under the working hypothesis that \( \rho_m = -0.211 \) is the "true" value of the first-order autocorrelation of observed monthly consumption changes, the following results can be derived:

(i) for \( 1.17 \leq SN \leq 7.24 \), \( \rho_m = -0.211 \) is compatible with \( 0 \leq \rho \leq 0.258 \). In turn, these values of \( \rho \) are compatible with consumption generated, at any sampling ratio \( m \geq 1 \), as a random walk or as an IMA(1,1) with any first-order autocorrelation \( 0 \leq \rho \leq 0.25 \). These values are also compatible with consumption generated as IMA(1,1) at \( \rho = 0 \), but only if the sampling ratio is large enough to convert the original negative MA coefficient into the positive MA coefficient of monthly data.

(ii) for \( 0.4 \leq SN < 1.17 \), \( \rho_m = -0.211 \) is compatible with \( 0 \leq \rho \leq 1 \). In turn, these values of \( \rho \) are only compatible with consumption generated, for any sampling ratio \( m \geq 1 \), as an IMA(1,1) with any positive first-order autocorrelation \( 0.25 \leq \rho \leq 0.5 \).

(iii) for \( SN > 7.24 \), \( \rho_m = -0.211 \) is compatible with \( -0.223 \leq \rho \leq 0 \). In turn, these values of \( \rho \) are only compatible with consumption generated as an IMA(1,1) with any negative first-order autocorrelation \( -0.5 \leq \rho \leq 0 \), but at a sampling ratio not greater than \( \infty \), where \( \infty \) is the value of \( m \) such that

\[
\rho = \frac{1-\rho_m^2}{2(m^2 + 2)}.
\]

Thus, if the original process has a positive first-order autocorrelation, a large error variance (hence a low value for \( SN \)) is needed to reduce it to the negative observed
value. On the other hand, a negative first-order autocorrelation is compatible with the observed value for low variances of the measurement errors. These effects are complicated by the fact that temporal aggregation increases the first-order autocorrelation in proportion to the sampling ratio, if initially this autocorrelation is less than 0.25, and decreases it if greater than 0.25.

Finally, further restrictions on the signal-to-noise ratios and on the values of the initial first-order autocorrelation can be obtained, if one is prepared to advance specific plausible values for the sampling ratio m. For example, Ermini [1988] argues that, under the assumption that agents react fully and immediately to any income innovation, the "true" consumption decision interval should be less than (but in the vicinity of) a month, as income in organized economies is regularly received on average every month or less.

4. Conclusions

Using empirical evidence that combines both monthly and quarterly data, it is shown that the error term in the equation defining the permanent income hypothesis cannot be identically zero. That is, at least a transitory consumption generated by the agent or a measurement error must be present in the generating mechanism of consumption data. It is also shown that monthly and quarterly data are consistent, under different ranges of signal-to-noise ratios, with the presence of both transitory consumption and measurement errors, as well as with the presence of only transitory consumption, or of only measurement errors. Moreover, it is found that in all three cases the only acceptable representation for either transitory consumption or measurement error is a white noise process. These results are essentially based on the property that under temporal aggregation a random walk process and an IMA(1,1) process are indistinguishable, and on the empirical evidence that both monthly and quarterly consumption follow IMA(1,1) processes.

References


Ermini L., 1989a, Cointegration and the Permanent Income Hypothesis, discussion paper no. 123, University of Sydney.


Substitutability of 'Buy Local' Policy for Tariff Protection in Small Economies; January 1985
Analysis of the 1980 Sydney Survey of Work Patterns of Married Women; Further Results; January 1985
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2. T.G. Sharpe & R.G. Walker

3. N.V. Lam
   New Zealand Economic Papers, Vol. 10, 1976
   Economic Record, Vol. 53, No. 143, September 1977
   Australian Journal of Management, April 1978
   Economic Papers, No. 55, The Economic Society of Australia and New Zealand
   Economics Letters, 2, 1979

9. W.F. Hogan
    Kredit und Kapital, Vol. 12, No. 1, 1979

10. D. Burt

11. P.A. Volker
    Journal of Banking and Finance, 4, 1980
    The Australian Monetary System in the 1970s, M. Porter (ed.), Supplement to the Economic Board 1978
    Economic Record, Vol. 56, No. 152, March 1980
    Australian Journal of Management, October 1979
    Malayan Economic Review, Vol. 24, No. 1, April 1979
    Australian Economic Papers, Vol. 19, No. 34, June 1980
    Economics Letters, 6 (1980)
    Economics Letters, 7 (1981)

14. W.P. Hogan
    Australian Economic Papers, Vol. 18, No. 33, December 1979
    Australian Economic Papers, Vol. 21, No. 39, December 1982
    Journal of the Operational Research Society 33, 1982

13. W.J. Merrillles

14. W.P. Hogan

15. F. Gill
    Economic Record, Vol. 59, No. 166, September 1983
    Economic Papers, Special Edition, April 1983
    Australian Quarterly, Vol. 56(3), Spring 1984
    Economic Record, Vol. 59, No. 166, September 1983
    Economics Letters, 12, 1983
    Energy Economics, Vol. 8, No. 2, April 1986
    Australian Economic Papers, Vol. 23, No. 43, December 1984
    Australian Quarterly, Vol. 56 (2), Winter 1984
    Economics Letters, 20, 1986
    Economic Record, Vol. 62, No. 178, September 1986
    Australian Bulletin of Labour, Vol. 11(4), September 1985
    Australian Economic Papers, Vol. 27, No. 50, W.P. June 1988
    Public Sector Economics - A Reader, P. Hare (ed.), Basil Blackwell, 1988
    Prometheus, Vol. 6, No. 2, December 1988

46. W.J. Merrillles

50. U.R. Kohli

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56. P. Saunders

57. W.F. Hogan

61. D.F. Ross

65. A.J. Philp

67. V.B. Hall

69. V.B. Hall

70. F. Gill

71. W.J. Merrillles

73. J. Yates

74. V.B. Hall

75. S.S. Joson

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82. P. Groenewegen

85. E.M.A. Gross, Hogan & I.G. Sharpe

94. W.P. Hogan

97. P. Gill

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101. J. Piggott

107. B.W. Ross

108. S.S. Joson

112. J. Yates

113. V.F. Hogan

114. W.J. Merrillles

115. W.P. Hogan

116. I.G. Sharpe & P.A. Volker

117. W.P. Hogan

118. W.P. Hogan

119. I.G. Sharpe & P.A. Volker

120. W.P. Hogan

121. R.W. Bailey, V.B. Hall & F.C. Phillips

122. P.A. Volker

123. R.W. Bailey, V.B. Hall & F.C. Phillips

124. E.M.A. Gross, Hogan & I.G. Sharpe

125. W.P. Hogan

126. R.W. Bailey, V.B. Hall & F.C. Phillips

127. R.W. Bailey, V.B. Hall & F.C. Phillips

128. U.R. Kohli

129. W.J. Merrillles