

**AN ALTERNATIVE TEST
FOR RICARDIAN EQUIVALENCE**

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Abstract

Recent empirical work on the validity of the Ricardian equivalence proposition (REP) using the "consumption function approach" has produced sharply conflicting evidence. This paper develops an alternative but simple test for the REP. The test exploits the idea that a permanent shock in public sector savings implies testable restrictions on the long-run joint behavior of private consumption and two income series suitably defined. More concrete, given a permanent shock in public savings private consumption should not be cointegrated with conventionally defined disposable income as implied by the permanent income hypothesis but should be cointegrated with an appropriately redefined income concept suggested by the REP. In this sense, the test exploits the information contained in the low frequency part of the macroeconomic time series involved.

The empirical analysis of the paper is based on Austrian and US-data. The REP is rejected by Austrian data. US-data for the time period 1949-84 appear to be non-informative for judging the validity of the REP.

1. INTRODUCTION

The empirical validity of Barro's (1974) forceful restatement of the Ricardian equivalence proposition (REP) is currently a controversial issue in macroeconomics. A recent comprehensive survey by Modigliani (1987) concludes that the REP is rejected by time series data for the USA and Italy as well as by a cross-section data set comprising 33 countries. The same conclusion for US-data was reached by Feldstein (1982) and Reid (1985). Other authors, however, have found that the REP holds up well for US-data (e.g. Kormendi (1983) and Aschauer (1985)) and should therefore be considered as a serious hypothesis for predicting the effects of changes in public savings and debt.

The basic approach to testing the REP in the papers mentioned consists in estimating a general consumption function including among its regressors public activity variables like taxes, transfers, public expenditures, etc. Restrictions on the parameters of these variables are then employed to test whether consumers behave in a Ricardian or non-Ricardian manner. Kormendi and Meguire (1986) point out that the issue of specification in levels vs. differences is of fundamental importance for valid applications of the "consumption function approach" to testing the REP. In their empirical work they favor first differencing as the appropriate specification. It is well known, however, that this

transformation leads to a loss of the long run information in the data. On the other hand, as pointed out by the literature on cointegrated processes (see Engle (1987) for a survey), proceeding with a level specification as favored e.g. by Modigliani (1987) will in general lead to an inappropriate specification. This problem will become specially severe if variables with different non-stationarity characteristics like income flows and asset stocks are included among the regressors.

In this paper, I take the REP to imply that private sector savings behavior offsets permanent shocks in public savings independently of whether the shocks arise from the expenditure or revenue side of the budget. The concentration on permanent shocks makes it possible to exploit restrictions on long-run time series properties using the concept of cointegration. Additionally, this interpretation yields insights into the question whether a specific data set is actually informative for a test of the REP. A disadvantage of the test procedure suggested in this paper is that the REP is strictly applicable only if the permanent shock in public savings is due to a change in the mix between tax and bond financing of a given expenditure stream.

For Austrian data, I reach the conclusion that the REP does not hold. For US-data, the results support the conclusion that data up to 1984 are not informative with respect to the validity of the REP.

The paper proceeds as follows: The next section outlines the theoretical framework and discusses the test procedure. Section 3 reports results of implementing the test for Austrian and US-data. A conclusion follows in section 4.

2. THEORETICAL FRAMEWORK

I start by assuming that the standard life cycle-permanent income hypothesis with infinite horizon and rational expectations describes private consumption behavior

$$(1) \quad C_t = \Gamma(r/(1+r)) \left[A_t + \sum_{i=0}^{\infty} (1/(1+r))^i E_t(Y_{t+i} - T_{t+i}) \right]$$

In (1), C_t is real private consumption, A_t real non-human assets including real public debt, Y_t real gross labor income, T_t taxes net of transfers, r is the after-tax real interest rate assumed to be constant and Γ is a proportionality factor. E_t denotes the mathematical expectations operator conditional on full public information. Equation (1) is assumed to describe the decision rule for private consumption if the private sector exhibits non-Ricardian behavior.¹

The REP implies that private agents take into account the government budget constraint when deciding on consumption and saving according to (1)

¹ As discussed by Campbell (1987), this decision rule for private consumption is based on a set of problematic microeconomic assumptions. Jaeger and Neusser (1987) present an explicit derivation of equation (1).

$$(2) \quad B_t = \sum_{i=0}^{\infty} (1/(1+r))^i T_{t+i} - \sum_{i=0}^{\infty} (1/(1+r))^i G_{t+i}$$

Here B_t denotes real public debt and G_t real government consumption. This equation can be derived by iterating the government budget identity forward in time and imposing a solvency constraint.

Inserting (2) in (1) we get

$$(3) \quad C_t = \Gamma(r/(1+r)) [(A_t - B_t) + \sum_{i=0}^{\infty} (1/(1+r))^i E_t(Y_{t+i} - G_{t+i})]$$

Equation (3) is the decision rule for consumption of private households if the REP holds. The crucial difference between equations (1) and (3) is that Ricardian consumers do not consider the public debt as net private wealth and they deduct consumption of real resources by the public sector from gross income instead of taxes.²

This theoretical set-up for distinguishing Ricardian and non-Ricardian behavior of private households is based on some questionable assumptions. Intuitively, the assumption of an

² Modigliani and Sterling (1987) stress that equation (3) is the limiting form of a more general life cycle model if the planning horizon of households is infinite and their discount rate is equal to the discount rate in the government budget constraint.

infinite horizon for non-Ricardian consumers seems to be inconsistent with the assumption that they ignore the government budget constraint.³ This problem can not easily be dismissed. But one could argue that for empirical purposes the assumption of an infinite horizon even for non-Ricardian consumers is not too restrictive. A further problem of the theoretical framework is the assumption of constant real interest rates in the case of non-Ricardian consumers. This assumption might be defensible in the case of a small open economy like Austria, where the interest rate is exogeneously given, but is certainly questionable in the case of the USA. Other features stressed by recent authors but missing in the set-up (1) to (3) are liquidity constraints (see Campbell and Mankiw (1987)), distortionary taxation (see Frenkel and Razin (1987)) and the assumption that government consumption does not enter the representative household's utility function (see Aschauer (1985)).

The test for Ricardian equivalence suggested in this paper can be derived from the decision rules (1) and (3). I identify disposable income of private households (YD) as conventionally measured with the following expression

$$(4) \quad YD_t = (r/(1+r))A_t + Y_t - T_t$$

³ A new branch of the literature testing the REP follows Blanchard's (1985) formalization of non-Ricardian consumer behavior as being due to finite horizons of private households. For a testing framework nesting the finite and infinite horizon assumption see Leidermann and Razin (1987).

Similarly, I define a measure of "Ricardian disposable income" (YD^*)

$$(4)' \quad YD^*_t = (r/(1+r))(A_t - B_t) + Y_t - G_t$$

Multiplying (4) and (4)' by the proportionality constant Γ and subtracting these expressions from (1) and (3) respectively, results after some algebraic manipulations in the following equations

$$(5) \quad C_t - \Gamma YD_t = \Gamma \sum_{i=1}^{\infty} (r/(1+r))^i E_t[\Delta Y_{t+i} - \Delta T_{t+i}]$$

and

$$(5)' \quad C_t - \Gamma YD^*_t = \Gamma \sum_{i=1}^{\infty} (r/(1+r))^i E_t[\Delta Y_{t+i} - \Delta G_{t+i}]$$

Equations of the type (5) and (5)' are called "rainy days equations" by Campbell (1987). This apt term is due to the fact that the right hand side of these equations is a measure of expected income changes whereas the left hand side can be interpreted as a measure of savings. If consumers expect decreases in future incomes they will signal these expectations of "rainy days" via their current consumption behavior.

If the changes in gross labor income, taxes and government consumption are stationary, the right hand side of equations (5) and (5)' will be stationary. Under this assumption the left hand side of the equations will also be stationary. If the consumption variable and the two income variables are themselves stationary after first differencing, the implication from the equations is that C_t is cointegrated with YD_t as well as YD_t^* in the sense of Engle and Granger (1987).⁴

Now, public savings (in the following alternatively called public deficit or surplus) are defined via the government budget identity as

$$(6) \quad D_t = T_t - G_t - (r/(1+r))B_t.$$

I assume that D_t is the sum of a permanent component (D_t^P) and a transitory component (D_t^t)

$$(7) \quad D_t = D_t^P + D_t^t.$$

⁴ Engle and Granger (1987) call a variable X_t integrated of order one if it is stationary after first differencing. Two variables X_t and Y_t are called cointegrated if they are (i) individually integrated of order one but (ii) a linear combination between the two variables is integrated of order zero. For a more exact definition see Engle and Granger (1987, pp. 252-53).

Furthermore, D^P_t is assumed to be stationary after first differencing whereas D^t_t is stationary but possibly correlated over time.⁵ The left hand side of (5)' can be rewritten as

$$(8) \quad C_t - \Gamma YD^*_t = C_t - \Gamma [YD_t + D^P_t + D^t_t]$$

From equation (8) we see that if there is a permanent shock in the deficit variable, the two income series will differ by a permanent component.

These results suggest the following test of the REP: Given the life cycle-permanent income hypothesis and the REP are valid, $\{C_t\}$ and $\{YD^*_t\}$ should be cointegrated according to (5)'. Does this imply that $\{C_t\}$ and $\{YD_t\}$ can not be cointegrated? Yes, but only if there was a permanent deficit shock in the period under observation. If that was the case, it is intuitively clear that $\{C_t\}$ can not be cointegrated both with $\{YD_t\}$ and $\{YD^*_t\}$.

In summary, four possibilities arise for the test of the REP:

(i) $\{C_t\}$ is cointegrated with $\{YD_t\}$ as well as $\{YD^*\}$. The data

⁵ Basically the same definitions for permanent and transitory shocks are used as in Brunner, Cukierman und Meltzer (1980), except that the assumption that the transitory component is uncorrelated does not seem plausible in view of the business cycle. I am aware of some philosophical perplexities associated with this definition.

generated by this economy will not permit any conclusion concerning the validity of the REP.

(ii) $\{C_t\}$ cointegrates with $\{YD_t\}$ but not $\{YD^*\}$. Reject the REP.

(iii) $\{C_t\}$ cointegrates with $\{YD^*\}$ but not with $\{YD_t\}$. Do not reject the REP.

(iv) $\{C_t\}$ neither cointegrates with $\{YD_t\}$ nor $\{YD^*\}$. The assumed behavioral hypothesis for long run consumption behavior is rejected and we can infer nothing concerning the validity of the REP within the testing framework of this paper.

3. EMPIRICAL RESULTS

In this section, I report empirical results for the cointegration tests suggested in section two. The empirical analysis is based on Austrian and US-data. Proceeding from the theoretical framework outlined in the previous section to testing the REP, the researcher is faced with the severe non-uniqueness of the mapping from the theoretical variables to empirical quantities. This non-uniqueness problem is especially persuasive in this context because official measurements of public sector activities suffer from a number of nonsensical accounting conventions.⁶

The data for the USA are taken from Modigliani and Sterling (1986). These authors perform several adjustments of the official data as described in the data appendix of their paper. The Ricardian measure of income employed in this paper was constructed by simply deducting their deficit variable from the conventionally defined income variable.

The Austrian data were constructed as follows: The income variable corresponds to the disposable income of private households. The

⁶ Eisner (1986) discusses these problems in depth. Non-adjustment of public deficits for inflation, non-revaluation of the public debt for interest rate changes and non-distinction of capital expenditures and current expenditures are the most prominent examples discussed by Eisner. The last point of criticism is, however, not applicable in the case of the national income account data used in this paper.

Ricardo definition of income corresponds to the sum of conventional disposable income and public savings as reported in the national income accounts. This definition effectively pools private and public savings behavior.⁷ The consumption concept is total private consumption. The deflator of total private consumption was used to convert nominal into real magnitudes.

As a first step, in table 1 I report results of Dickey-Fuller tests for unit roots in the time series used for testing cointegration. The null-hypothesis of non-stationarity in levels of the three variables in lines (1) to (3) for both countries can not be rejected (results are not reported). Lines (1) to (3) contain test statistics for unit root tests after first differencing of the variables. A comparison of the statistics with the critical values listed at the bottom of table 1 reveals that all variables can be judged stationary after first differencing with high confidence.⁸

In lines (5) and (6), Dickey-Fuller tests for the level as well as the first difference of the fiscal surplus variable (D_t) are

⁷ This procedure of defining Ricardian disposable income is similar as in Blinder and Deaton (1985). A problem of the definition of disposable income of private households in the Austrian case is that retained earnings of the corporate sector are excluded from household income. Further, as already pointed out, the whole testing framework tacitely assumes that government consumption has no effect on the marginal utility of private consumption.

⁸ A possible exception from this statement is the US-consumption series.

reported. If permanent shocks in this variable occurred during the observation period, one would expect $\{D_t\}$ to be non-stationary in levels. This is the case for the Austrian time series. Figure 1 plots the measure of Austrian fiscal surplus. This variable appears to have been shocked upwards at the beginning of the 70s and downwards permanently after the first oil shock. In contrast to the Austrian case, the US fiscal surplus appears to be stationary in levels according to the test statistics in line 5.9 This conclusion is supported by the plot for the US-fiscal surplus in figure 2.

The results of the tests for cointegration in table 2 can be summarized as follows: For the Austrian data, consumption is cointegrated with conventionally defined disposable income (equation 1) but not with the Ricardian definition of income (equation 2). From the regressions for the US-data (equation 3 and 4) the conclusion emerges that cointegration seems to hold for both income concepts.

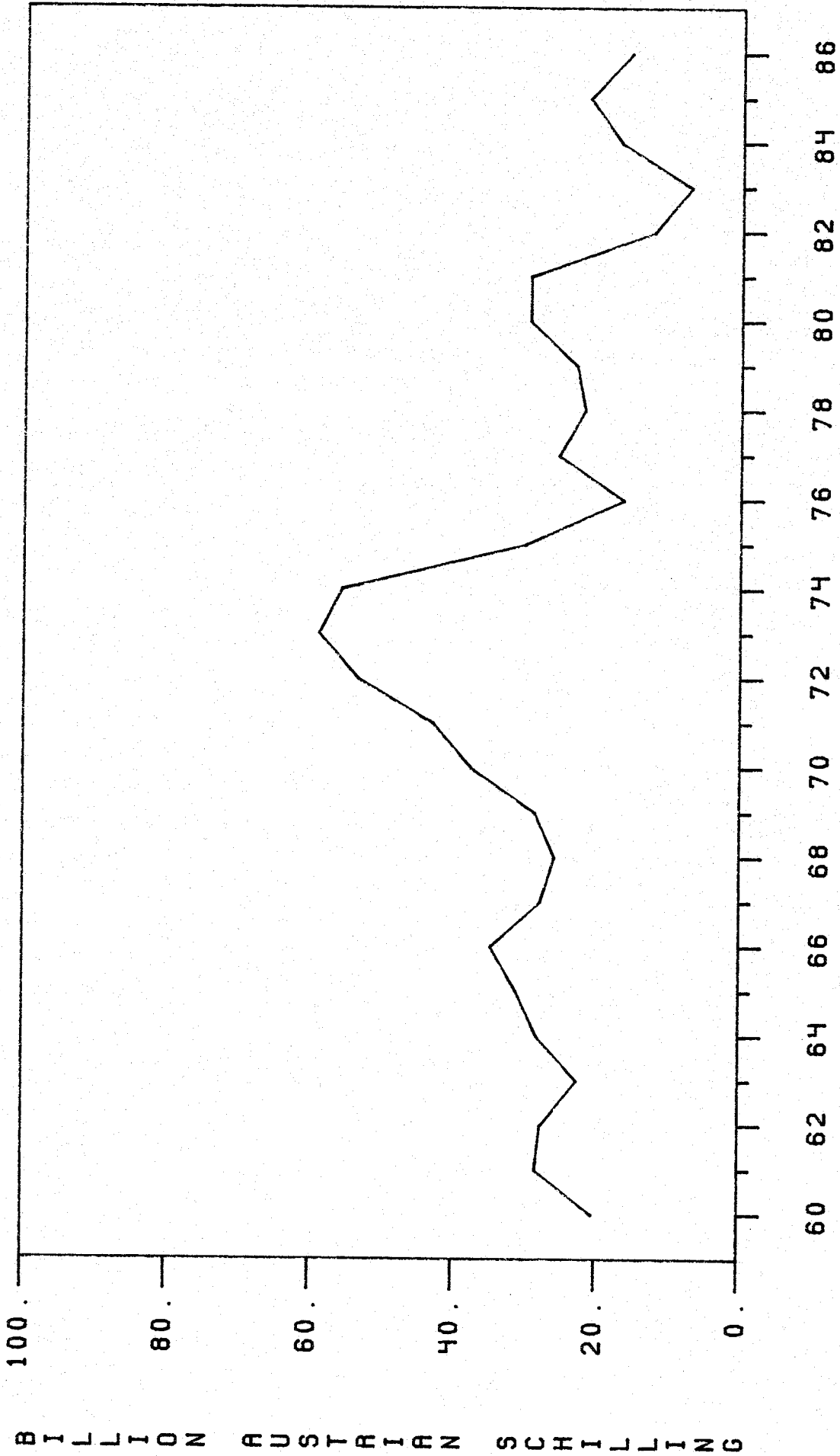
A visual illustration of these results is given by figures 3 and 4. In these figures, the saving rates of the private sector implicit in the conventional and the Ricardian definition of income are plotted. Intuitively, from the theoretical framework

9 This conclusion for the USA is consistent with the results reported in the literature on testing whether the US government's budget deficit is "out of control". These studies typically find that the real budget deficit variable for the USA is integrated of order zero in level. See for example Hakkio and Rush (1986).

outlined in section 2, one would expect the saving rate in the Ricardian definition to be stationary in the mean if the REP holds. The message of the plots for Austria (figure 3) is that the Ricardian definition of the saving rate appears to be non-stationary whereas the conventional saving rate is stationary. The plots for the USA (figure 4), however, give the impression that both saving rates are stationary.

I summarize the evidence: The empirical results for Austria lead to the conclusion that the REP has to be rejected. The permanent fiscal shocks at the beginning of the 70s were not compensated by changes in private savings as predicted by the REP. The results for US-data indicate that the data are not informative for a conclusion concerning the validity of the REP. This conclusion might well be altered when more recent observations on the Reagan-fiscal experiment become available.

AUSTRIAN FISCAL SURPLUS



FIGUR 1



US-FISCAL SURPLUS

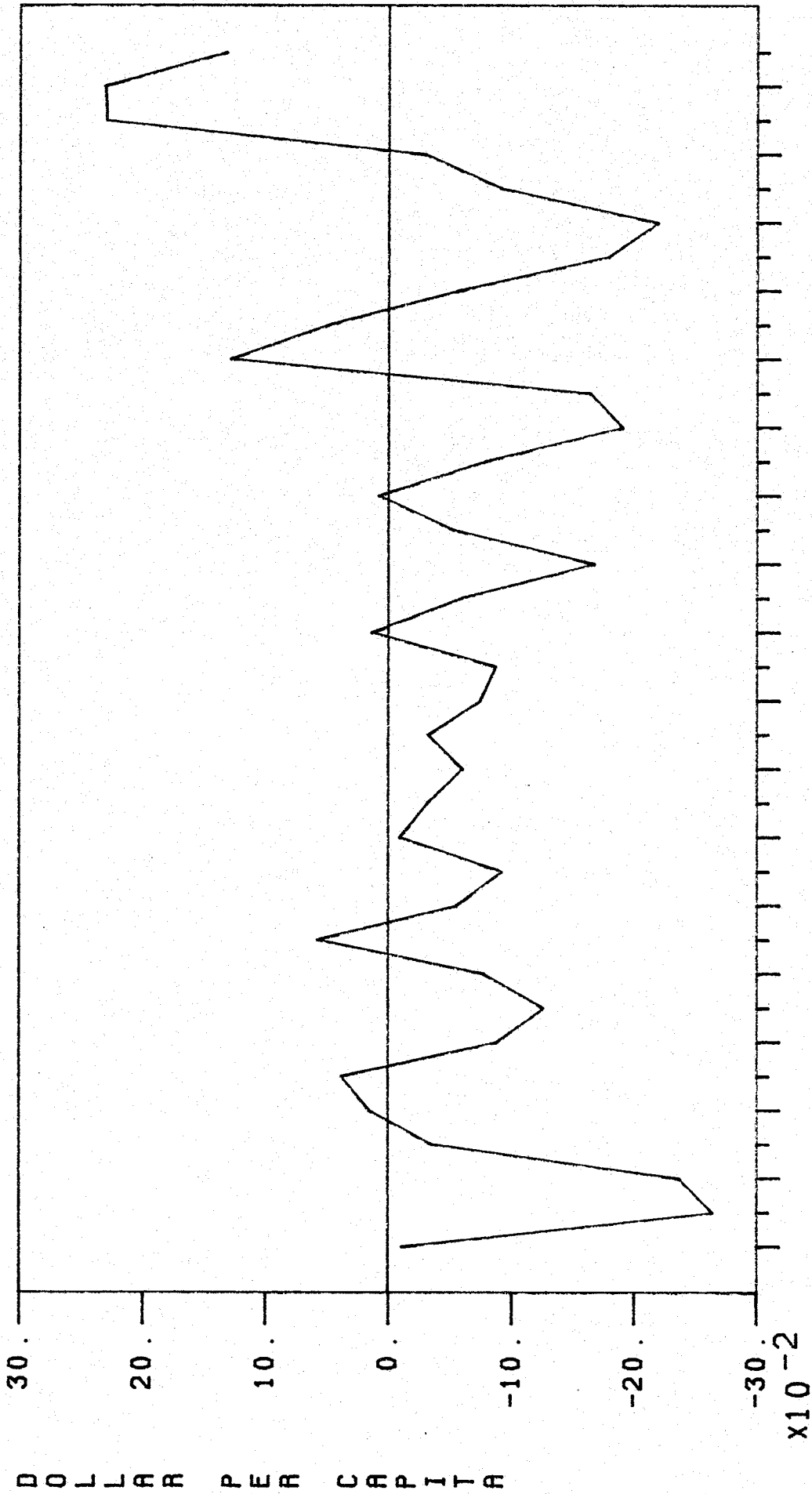


FIGURA 2

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Table 1: Dickey-Fuller tests for unit roots*

		<u>Country/Test Statistic</u>			
		<u>Austria 1960:86</u>		<u>USA 1949:84</u>	
	Variable	DF	ADF	DF	ADF
(1)	ΔC_t	-6.00	-3.62	-2.84	-3.19
(2)	ΔYD_t	-4.51	-4.38	-5.47	-3.76
(3)	ΔYD_t^*	-3.73	-3.05	-5.31	-4.71
(4)	D_t	-1.73	-2.35	-3.16	-4.99
(5)	ΔD_t	-3.72	-4.53	-	-

* These tests are based on the regression

$$\Delta X_t = \mu + \alpha X_{t-1} + \sum_{i=1}^n \beta_i \Delta X_{t-i}.$$

The Dickey-Fuller test

(DF) assumes $n=0$ and uses the t-statistic on α . The augmented Dickey-Fuller tests (ADF) were performed setting $n=1$ and again use the t-statistic on α . Critical values from Fuller (1976) are: 1% -3.75; 5% -3.0; 10% -2.63; (sample size = 25).

Table 2: Cointegration tests*

Austria 1960:86

$$(1) \quad C_t = 5.746 + .892 YD_t \quad R^2 = .997$$

(4.219) (.010)

$$DW = 1.59 \quad DF = -4.02 \quad ADF = -3.37$$

$$(2) \quad C_t = -27.541 + .910 YD_t^* \quad R^2 = .984$$

(10.252) (.023)

$$DW = .45 \quad DF = -2.02 \quad ADF = -2.19$$

USA 1949:84

$$(3) \quad C_t = -.201 + .976 YD_t \quad R^2 = .990$$

(.058) (.017)

$$DW = .911 \quad DF = -3.36 \quad ADF = -3.14$$

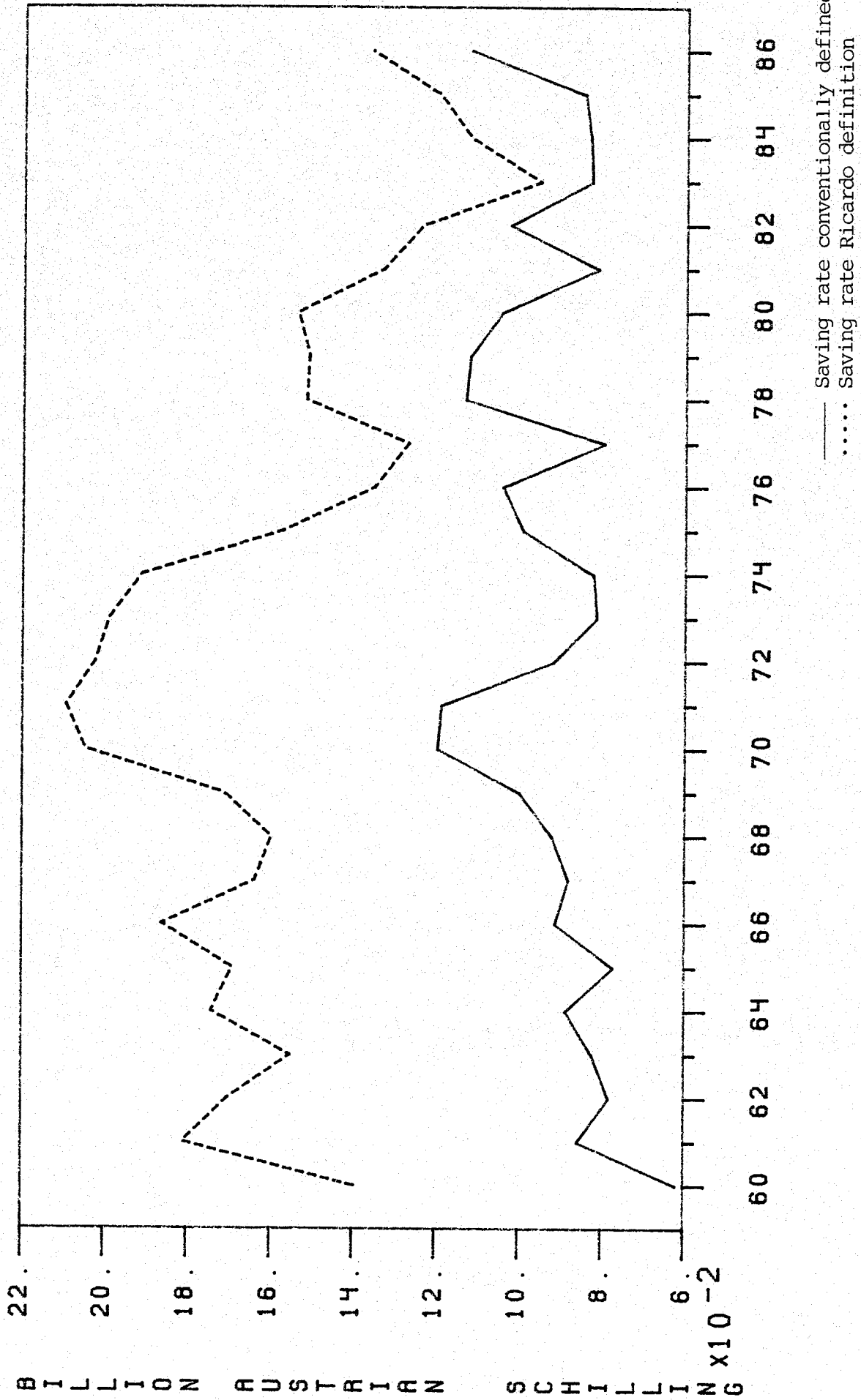
$$(4) \quad C_t = -.319 + .997 YD_t^* \quad R^2 = .969$$

(.108) (.031)

$$DW = .818 \quad DF = -2.86 \quad ADF = -3.33$$

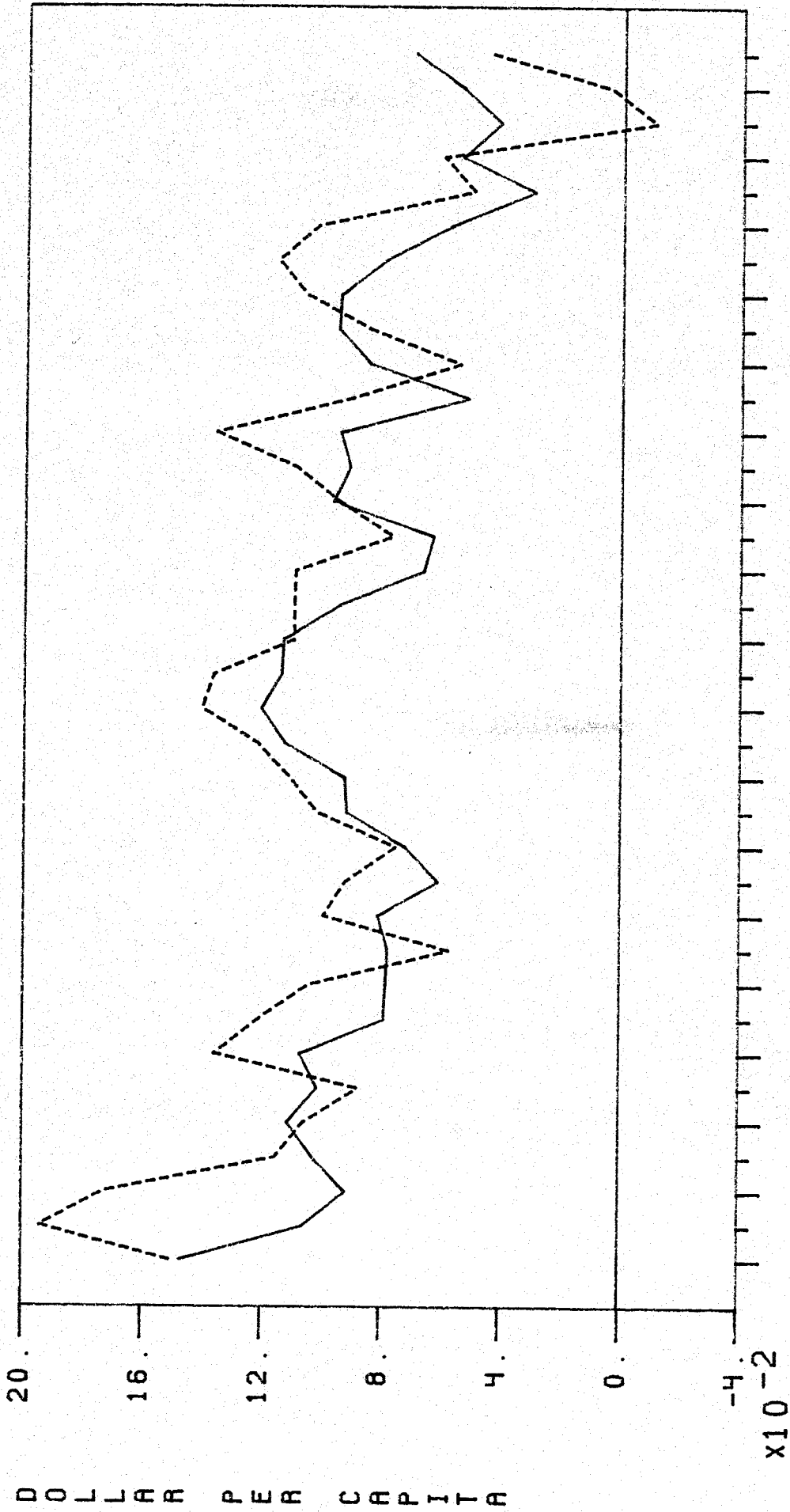
* The Engle and Granger (1987, p.269) critical values for the null hypothesis of no cointegration are Durbin-Watson (DW) 1% .511, 5% .386, 10% .322; Dickey-Fuller (DF) 1% -4.07, 5% -3.37, 10% -3.03; Augmented Dickey-Fuller (ADF) 1% -3.77, 5% -3.17, 10% -2.84. These critical values are based on sample sizes of 100. Engle and Yoo (1987) present critical values for cointegration tests for sample sizes of 50. Their values are only slightly below those listed above.

AUSTRIAN SAVING RATES: CONV. AND RICARDIAN



FIGUR 3

US-SAVING RATES: CONVENTIONAL AND RICARDIAN



FIGUR 4

4. CONCLUSION

This paper developed an alternative test for the REP concentrating on the long run properties of consumption and two differently defined income variables. I found that Austrian data reject the implications of the REP whereas US-data must be judged uninformative relative to the test proposed in this paper.

Further research based on these results should be directed towards the following topics: First, are there more general theoretical frameworks to generate the implications tested in this paper? The assumptions of the standard life cycle-permanent income hypothesis are probably unduly restrictive. In principle, any theory of consumption behavior implying cointegration between consumption and income suitably defined should be sufficient. A more general theoretical framework should also loosen the restriction that government consumption does not affect private marginal utility from consumption. Second, are the empirical results robust with respect to different empirical measures of the theoretical variables involved? Especially in the case of Austria various adjustments of the official data would be desirable to get economically more meaningful data. Third, what are the relevant small sample properties of the tests employed in this paper? The fact that the sample size is typically limited with 25 to 40 annual observations for empirical investigations of the REP makes

the inferences from cointegration tests questionable. Monte Carlo experiments for the test situations encountered in this paper should shed more light on this question.

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