INTERNATIONAL EVIDENCE ON COINTEGRATION BETWEEN CONSUMPTION, INCOME, AND WEALTH

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Abstract. Data from 26 countries suggest that there is little evidence for the existence of a stable cointegrating relationship between (i) consumption, labor income and wealth, or (ii) consumption and disposable income.

1. Introduction

How should central banks respond to changes in asset prices? The answer to this question depends to an important extent on how much of an impact movements in asset prices have on the real economy. A major channel through which stock prices influence the real sector is the effect wealth has on consumption (the "wealth effect"). A simple form of the permanent income hypothesis implies that consumption is proportional to the total value of current assets. When the value of consumer's assets increases, consumption should rise in proportion. The simplest and the most frequently used method of estimating the marginal propensity to consume from wealth (MPCW) is running the regression of consumption on labor income and wealth (see Lettau and Ludvigson, 2004 and Davis and Palumbo, 2001). Lettau and Ludvigson claim that they, based on the permanent income hypothesis and the intertemporal budget constraint, provide theoretical support for the validity of this method of estimating the MPCW.

However, there are severe problems, both empirical and theoretical, that render this method unsatisfactory. This paper focuses on the empirical relevance of the cointegrating relationship between consumption, labor income and wealth. If the estimates of the MPCW obtained from the above method are to be taken seriously, the existence of a stable cointegration between consumption, labor income, and wealth is a vital prerequisite. I find that the evidence for the existence of a valid and stable cointegrating vector between consumption, labor income and wealth is weak.

I would like to thank Christopher Carroll for many helpful comments and suggestions and Carol Bertaut for data on wealth. The data and programs used for this paper are posted on
http://www.econ.jhu.edu/people/slacalek/research/cointegrationArchive.zip.

In addition, I investigate the empirical evidence for an alternative, less restrictive, formulation of the permanent income hypothesis (PIH) which implies that consumption and disposable income are cointegrated and saving is stationary. I construct a data set of 26 industrial countries to test this hypothesis. The data indicate that the support for this hypothesis is also quite weak. Finally, as implied by the permanent income hypothesis, I find evidence for the relationship between the stability of saving rates and the existence of cointegration between consumption and disposable income. In particular, saving rates tend to be stationary for the countries where cointegration exists.

The plan of the paper is as follows. Section 2 reviews the current state of research on the implications of the permanent income hypothesis for the wealth effect and the relationship between consumption and disposable income. Furthermore, the econometric procedures testing for the existence of cointegration are briefly presented. Section 3 summarizes empirical results. Section 4 concludes. Finally, the Appendix describes in detail how the data were obtained and constructed.

2. Current Research

2.1. Permanent Income Hypothesis and the Wealth Effect.

Interest of policy-makers in the role of asset prices and their interactions with monetary policy was spurred by the US and European stock market bubbles of the late 1990s. These developments were a strong impulse for empirical and theoretical research in the optimal monetary policy when the asset prices are rising excessively (more than implied by market fundamentals) and the channels through which stock market affects the real economy. The two most important channels are the firms' balance sheets and household wealth effect.[1] This paper focuses on the latter.

The wealth effect consists of the impact of changes in households' net worth (wealth) on consumption. Theoretical foundations for a widespread method to estimate the MPCW were laid out by Lettau and Ludvigson (2004), (LL). Based on Campbell and Mankiw (1989), Lettau and Ludvigson derive the following log-linear approximation of the household's intertemporal budget constraint,

(1)
$$c_t - \omega a_t - (1-\omega) y_t \approx \mathbf{E}_t \left[\sum_{i=1}^{\infty} \rho_w^i \left(\omega r_{a,t+i} + (1-\omega) r_{h,t+i} - \Delta c_{t+i} \right) \right] + (1-\omega) z_t,$$

where c_t is the log of consumption, a_t is the log of the household's net worth, y_t is the log of labor income, $r_{a,t}$ and $r_{h,t}$ are returns on non-human and human capital, respectively. ρ_w is the steady state ratio of new investment

[1] The former effect consists of an increase in firms' investment when the value of their equity rises. This happens since it is easier and cheaper for firms to borrow financial resources. The wealth effect consists of an increase of consumption expenditure when the value of households' assets grows.

to total wealth, $(W-C)/W$, z_t is a stationary zero mean variable and ω is a constant between zero and one. Finally, $\mathbf{E}_t \cdot$ denotes the expectation given time t information. Equation (1) can be estimated by the OLS regression

$$c_t = \beta_0 + \beta_y y_t + \beta_a a_t + \varepsilon_t. \tag{2}$$

Since consumption, income, and wealth are non-stationary (I(1)), if they are cointegrated, the OLS estimators of (2) will in general be super-consistent but inefficient. A simple way to obtain efficient estimates of β_y and β_a is to apply the dynamic least squares (DLS) estimator. The DLS estimator consists of estimating by OLS an augmented regression

$$c_t = \beta_0 + \beta_y y_t + \beta_a a_t + \sum_{i=-p}^{p} \gamma_i^y \Delta y_{t+i} + \sum_{i=-p}^{p} \gamma_i^a \Delta a_{t+i} + \varepsilon_t \tag{3}$$

given some value of p, the number of leads and lags of independent variables.

LL claim that their derivation provides a theoretical foundation for the empirical estimation of equations (2) and (3). In particular, they stress that the derivation of (1) is obtained without any assumptions on preferences and requires only weak stationarity assumptions on returns and income growth. However, there are serious empirical and theoretical problems with estimating cointegrating relationships such as (2) between consumption, labor income and wealth.

One line of critique focuses on the structural instability of the cointegrating relationship between consumption, labor income, and wealth. There is no reason for (1) to provide a satisfactory approximation to the budget constraint if some of the variables assumed to be stationary are not. In particular, the approximations in LL, such as (1), are not valid if there are permanent changes in the productivity growth rate, and their validity is doubtful even if productivity growth is highly serially correlated. Empirically, there is strong evidence for the persistent changes in the mean of productivity growth in the US. The average US productivity growth was almost twice as high before 1973 and after 1995 compared to the 1973–1995 period.[2]

Empirical evidence for structural instability of the relationship is mixed. Hahn and Lee (2001) find evidence for structural instability. Lettau and Ludvigson (2004) on the other hand argue that the cointegration is stable.

Even more importantly, Rudd and Whelan (2002) argue that when the series are constructed appropriately there is no evidence for cointegration in the US data. Rudd and Whelan point out that there are two considerable problems with the way LL construct data. First, LL deflate the consumption series with a different deflator from labor income and wealth. The consumption series is deflated with the nondurables and services (NDS) deflator. The wealth and labor income series, in contrast, are deflated using the deflator

[2]The average productivity growth in the non-farm business sector was 2.7% in 1955–1972, 1.3% in 1973–1994 and 2.4% in 1995–2002.

for total personal consumption expenditure (PCE). This appears to be an error in LL's treatment of the data, since economic theory provides no reason to deflate the dependent and independent variables by different price indexes.

Second, Rudd and Whelan claim that the consumption series LL use, consumption of nondurables and services excluding exenditure on shoes and clothing, is not consistent with the wealth series. In particular, if expenditure on shoes and clothing is excluded from consumption, it should be added to the stock of wealth. A further problem with LL's use of the consumption series is the assumption that NDS consumption is a good proxy for the total utility flows from durable and non-durable goods. This approximation is only good as long as the ratio of real nondurables to real total PCE is roughly constant. This is not the case in the US data; the ratio has fallen substantially over the last 40 years (from about 0.96 in 1960 to 0.86 in 2000, using real 1996 dollars). For this reason Rudd and Whelan use the PCE measure of consumption and deflate all three series by the PCE deflator. It turns out that when the relevant series are constructed properly, statistical procedures do not detect any cointegration—the regression is spurious.

Nevertheless, much empirical research employs equations such as (2) and (3) to estimate the magnitude of the wealth effect in the US and elsewhere. Bertaut (2001) estimates the MPCW of about 0.03–0.11 for various specifications for six major countries (Australia, Canada, France, Japan, the United Kingdom, the United States). The conventional wisdom is that the magnitude of the MPCW for the US is about 0.025–0.05. Fernandez-Corugedo *et al.* (2003) examine the implications of the Lettau and Ludvigson method for the UK; their estimate of the British MPCW is 0.05. Macklem (1994) and Pichette and Tremblay (2003) investigate the consumption–wealth link for Canada and bring inconclusive evidence for the existence of cointegration between consumption, income and wealth. Byrne and Davis (2003) examine the data from G7 countries (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States) and claim to "have evidence of a cointegrating long-run relationship between our variables [total consumption, personal disposable income and financial wealth] for each of the G7 countries using the Johansen (1988) Trace test." Byrne and Davis (2003), p. 206. The difference between the results presented below and those of Byrne and Davis is caused by the fact that Byrne and Davis test for cointegration between consumption, personal disposable income and gross financial wealth. This is wrong since Byrne and Davis are double counting wealth, which appears in both the interest component of disposable income and in their wealth measure. Furthermore, what matters according to the theory is net worth, not financial wealth. LL's approximations imply that one should test for cointegration between the properly deflated consumption, labor income and net worth.

In sum, the evidence for cointegration between consumption, income and wealth is mixed. The purpose of this paper is to apply a consistent and uniform methodology of testing for cointegration to as many countries as possible, to see whether cointegration analysis is a reliable and robust method for studying macroeconomic consumption behavior.

2.2. **Permanent Income Hypothesis and the Consumption–Income Relationship.** It is well-known that the permanent income hypothesis combined with the assumption of quadratic utility implies that consumption and disposable income are cointegrated. This result holds even when the assumptions necessary for validity of approximation (1) and the existence of cointegration between consumption, labor income and wealth may not hold. Another reason it is preferable to investigate the implications of the PIH for cointegration between consumption and disposable income rather than the wealth effect is that the former does not require data on wealth. Consequently, these implications are testable for a wider range of countries.

The relationship between consumption and disposable income is summarized in Campbell's (1987) "saving for a rainy day" equation

$$S_t = -\sum_{k=1}^{\infty} R^{-k}\, \mathbf{E}_t \Delta y^d_{t+k}, \tag{4}$$

where $S_t \equiv y^d_t - c_t$ is saving, y^d_t disposable income and $R \equiv 1 + r$ where r is the interest rate. Combining the definition of saving with equation (4) yields

$$c_t = y^d_t + \sum_{k=1}^{\infty} R^{-k}\, \mathbf{E}_t \Delta y^d_{t+k}. \tag{5}$$

Assuming that the last term, $\sum_{k=1}^{\infty} R^{-k}\, \mathbf{E}_t \Delta y^d_{t+k}$, is stationary, equation (5) implies that consumption and disposable income are cointegrated. In addition, equation (4) implies a relationship between the stationarity of savings and the existence of cointegration between consumption and disposable income. If the saving rates are stationary, cointegration exists.

This derivation of course hinges on the validity of the permanent income and the random walk hypotheses. However, there is a large literature on excess smoothness and excess sensitivity that documents that the random walk hypothesis is not a satisfactory description of the aggregate consumption dynamics. Consequently, the implications of the PIH, including the existence of a stable cointegration between consumption and disposable income, may not hold.

The empirical literature on the cointegrating relationship between consumption and disposable income is even larger than the literature on the wealth effect reviewed above. This literature, however, also fails to give a conclusive answer on the existence and stability of a cointegrating relationship between consumption and disposable income. The results vary depending on the country and the time frame considered. Campbell (1987)

and Campbell and Clarida (1988) reject the lack of cointegration in the US and Canadian data. Attfield *et al.* (1990) and Campbell and Clarida (1988) on the other hand find that consumption and disposable income in the UK are not cointegrated. Jin (1995) reports that the Phillips–Ouliaris tests do not find much evidence for cointegration between private consumption and disposable income in most of the OECD countries he examines. The panel cointegration test does reject the lack of cointegration.

Similarly to the wealth effect, the empirical literature on the relationship between consumption and disposable income is inconclusive. This paper adds to the existing literature a systematic examination of the consumption and income data for a wide range of industrial countries.

2.3. **Tests for Cointegration.** Whether the estimates of the MPCW obtained by the DLS regression of consumption on income and wealth (3) are correct hinges on the existence and stability of cointegration between the variables. If the relationship is spurious or unstable, then it obviously does not make much sense to use it to infer the MPCW, since the OLS (or DLS) estimator is not consistent. There exists well-developed econometric theory testing for the existence of a valid cointegrating relationship against spurious regression. The tests fall into two categories: residual-based and maximum-likelihood-based (see e.g. Hamilton, 1994, or Watson, 1994).

The residual-based tests investigate whether residuals from the OLS regression of integrated (I(1)) variables are stationary. Stationarity of the residuals is an implication of the definition of cointegration. To test the order of integration of the residuals standard unit-root tests (such as ADF) can be used. However, since the cointegrating residuals are not directly observed but rather estimated, critical values have to be adjusted following Phillips and Ouliaris (1990).

The maximum-likelihood-based procedures are based on a different implication of cointegration. The null hypothesis is that the $n \times 1$ vector y_t consists of variables that are cointegrated with h cointegrating relationships. If the null hypothesis holds, y_t has the vector error correction representation (VECM)

$$\Delta y_t = \zeta_0 y_{t-1} + \sum_{i=1}^{p-1} \zeta_i \Delta y_{t-i} + \varepsilon_t, \tag{6}$$

where ζ_0 can be decomposed as $\zeta_0 = -BA'$ for B an $n \times h$ matrix and A' an $h \times n$ matrix. This implies that only h linear combinations of y_{t-1} can be used on the right-hand side of (6). Under the alternative that there are n cointegrating relationships, no restrictions are imposed on ζ_0. Johansen showed that the null of h cointegrating relationships can be tested against the alternative of n cointegrating relationships using the max statistic

$$\lambda_{\max} = -T \sum_{i=h+1}^{n} \log(1 - \hat{\lambda}_i),$$

where T is the sample size and $\hat{\lambda}_i$ is the i^{th} largest eigenvalue of a certain matrix, described in Hamilton (1994), p. 637. To test the null of h cointegrating relationships against $h+1$, the trace statistic

$$\lambda_{\text{tr}} = -T \log(1 - \hat{\lambda}_{h+1})$$

is used. These statistics have non-standard limiting distributions.

As explained in Watson (1994), pp. 2885–7. the residual-based and Johansen cointegration tests are based on different implications of cointegration. The residual-based (Phillips–Ouliaris) tests focus on the persistence in the residuals from the cointegrating regression. If the residuals from a regression of I(1) series are stationary, the series are cointegrated. If the residuals are I(1), the regression is spurious. In contrast, the Johansen tests focus on the VECM representation of the cointegrated system (6). Under the null hypothesis the matrix ζ_0 can be decomposed as $\zeta_0 = -BA'$ for B an $n \times h$ matrix and A' an $h \times n$ matrix. The Johansen tests are likelihood ratio tests for the ranks of matrices A and B.

The relative power of the residual-based and Johansen cointegration tests in general depends on the specific application and differs case by case. In particular, as noted by Watson (1994), the performance of the two alternative testing procedures depends on the direction in which the application in question departs from the definition of cointegration (e.g. on how well-conditioned the matrix ζ_0 really is and the serial correlation properties of disturbances).

3. Empirical Results

As explained above, one has to be careful to construct the required series correctly. I follow the recommendations of Rudd and Whelan (2002). Because the theory behind the consumption–labor income–wealth relationship is based on the intertemporal budget constraint, Rudd and Whelan suggest that the right consumption series to use is the total personal consumption expenditure. For the income series one should ideally use labor income. Finally, the wealth series is a measure of household net worth. It is important that all series are deflated by the same deflator, the personal consumption expenditure deflator, and expressed in per capita terms.

Work with international data presents some additional challenges. First, it is relatively hard to obtain reliable wealth data. For that reason the results for the consumption–labor income–wealth cointegration are reported for a subset of six countries. Moreover, since countries other than the US do not report detailed statistics necessary to construct labor income, I proxy labor income with wages and salaries.[3]

The data for this paper come from various sources (for further description see the Appendix):

[3]For a description of the relationship between wages and salaries and labor income see the Appendix.

(1) Data where the wealth series is available: Australia, Canada, France, Japan, the United Kingdom and the United States.
(2) OECD and World Bank data: 26 industrial countries.

Primarily, I use quarterly and annual data from the DRI International database combined with the wealth series from national statistical offices. Annual data for a broad set of industrial countries are available from the OECD's Annual National Accounts Database and the World Bank's World Saving Database.

3.1. **Data Set 1: Consumption, Labor Income, Wealth.** The results of cointegration tests between consumption, labor income and wealth for six major countries (Australia, Canada, France, Japan, the United Kingdom and the United States) are reported in Tables 1–8.

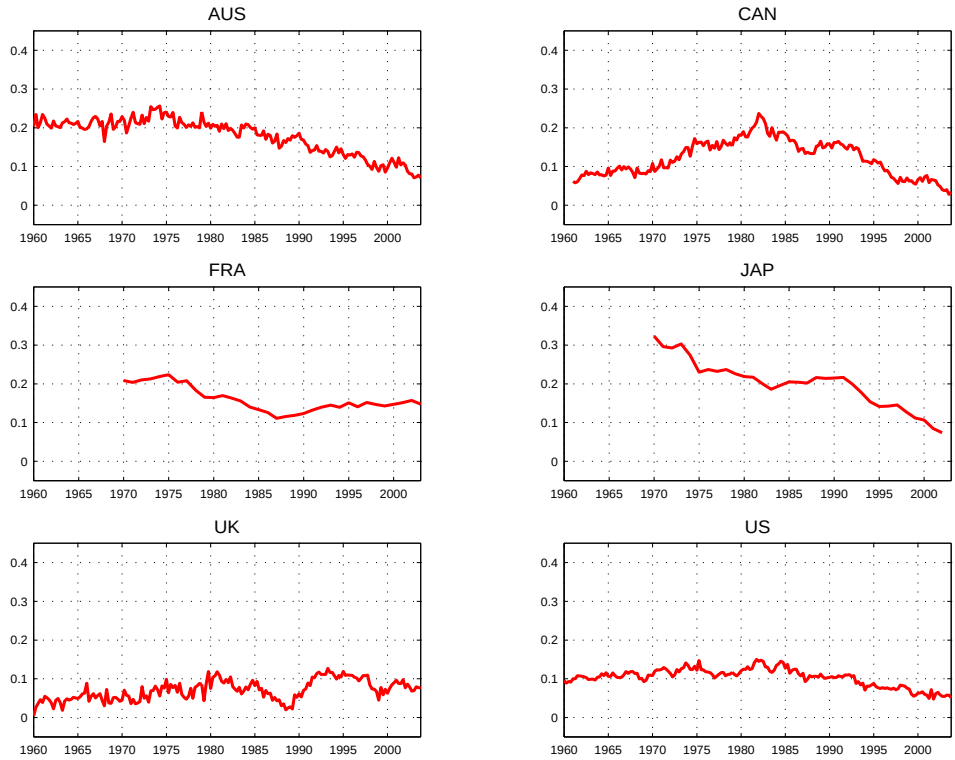
Following Lettau and Ludvigson (2004) and Rudd and Whelan (2002), (appropriately deflated per capita) labor income is the correct measure of income to use in the relationship between consumption, income and wealth. Labor income is preferable because this extension of the permanent income hypothesis distinguishes between two sources of income: labor income and return on wealth. In contrast, as explained above, it is wrong to test for cointegration between consumption, disposable income and wealth since disposable income already includes the return on wealth (non-labor income). Unfortunately, statistics for international countries are not disaggregated enough to make it possible to construct labor income directly (in particular, DRI International does not contain a measure of government transfers). For that reason I replace labor income with its proxy: wages and salaries.

For the hypothesis of a stable cointegration between consumption and income, the right measure of income to be used in empirical tests is a measure of total household income, or personal disposable income.

Saving rates—the fraction of disposable income that is saved—in the six countries are shown in Figure 1. Saving rates in these countries have recently been around 10%, but have fallen substantially in some countries (Australia, Canada, and especially Japan) in the last 20 years or so.

Tables 1, 3, 5 and 7 display results of various specifications of the Dickey–Fuller tests for the stationarity of saving rates and the Phillips–Ouliaris cointegration tests. Tables 2, 4, 6 and 8 present the Johansen trace and max statistics for cointegration between (i) consumption, labor income and (ii) wealth and consumption and disposable income. Tables 1–8 differ in the frequencies of investigated data and the time frames. Tables 1, 2, 5 and 6 report results with quarterly data for four countries: Australia, Canada, the United Kingdom and the United States. Tables 3, 4, 7 and 8 summarize the results of annual data for all six countries. Tables 1–4 report the test statistics for the longest available ranges of the data, specified in the second columns. Tables 5–8 show the results for the longest *common* time frames, 1971–1999 for quarterly data and 1978–1997 for annual data. In all tables significance of the test statistics is emphasized by the number of stars (∗):

FIGURE 1. Saving Rates—International Data, Six Major Countries



Notes: Quarterly data: Australia, Canada, UK, US; annual data: France, Japan. Gross personal saving rates: Australia, Canada, France, UK, US; net national saving rate: Japan.

one star denotes a statistic significant at 10% significance level, two stars 5% level and three stars 1% level.

The third columns of Tables 1, 3, 5 and 7 display the Dickey–Fuller statistics for the stationarity of the saving rates. For all countries except Australia, the null of the unit root cannot be rejected. Thus the Dickey–Fuller tests indicate that the saving rates are likely to be integrated (I(1)) in Canada, the UK and the US. In contrast, the Australian saving rate is stationary.

The remaining columns of Tables 1, 3, 5 and 7 report the Dickey–Fuller (Phillips–Ouliaris) tests on the residuals of the cointegrating regressions of consumption on (i) labor income and wealth and (ii) disposable income. The results for the benchmark specification for Australia, Canada, the United Kingdom and the United States are reported in Tables 1 and 2, and for France and Japan in Tables 3 and 4. Irrespective of the frequency of the

data or the time range there is no evidence that the residuals are stationary. Consequently, the data do not object against the absence of a stable cointegrating relationship between consumption, labor income and wealth. The results are similar for the consumption–disposable income relationship. Except for Australia, the Phillips–Ouliaris tests detect no evidence for a stable cointegration between the two variables.

The "saving for a rainy day" equation (4) and the definition of saving imply that according to the PIH if consumption and disposable income are cointegrated, the saving rate is stationary. I find that this regularity holds in the data. Of the six countries investigated, only in Australia is the saving rate stationary and only in Australia are consumption and disposable income cointegrated.

Tables 2, 4, 6 and 8 report the conclusions of the Johansen trace and max cointegration tests. Overall, for both data sets, the Johansen tests are more likely than the Phillips–Ouliaris test to reject the lack of cointegration between both consumption, labor income and wealth and consumption and disposable income. The lack of a stable cointegrating vector between consumption, labor income, and wealth is consistently rejected for Canada and Japan. In contrast, in most specifications there is little evidence that the three variables are cointegrated in Australia, France, the United Kingdom and the United States.

The evidence from the Johansen procedure in favor of a stable cointegration is somewhat stronger for consumption and disposable income. Cointegration between these two variables seems to exist for the benchmark specifications for Australia, Canada, and possibly Japan. In the benchmark specifications for France, the UK and the US consumption and disposable income are not cointegrated. Alternative specifications consistently favor the existence of a stable cointegration between consumption and income for Australia and its lack for the UK and the US. The evidence from Canada, France and Japan is mixed.

The results in Tables 1–8 replicate previous findings of researchers reported for slightly different data sets and time frames. Rudd and Whelan (2002) report that once the data on consumption, labor income and wealth are appropriately constructed, neither the Phillips–Ouliaris nor the Johansen tests reject the hypothesis that cointegration is absent in the US. Similarly, Fernandez-Corugedo *et al.* (2003) find that the Johansen tests do not object against the lack of cointegration for the UK.[4] Bertaut (2001) displays results of the Johansen tests and finds evidence against the null of no cointegration for all countries except for Japan. Unfortunately, Bertaut's results are

[4]Rudd and Whelan (2002), p. 15–17, report the value of the ADF statistic of −3.08 and the Johansen's trace and max statistics of 22.44 and 17.61, respectively, with the US quarterly data 1952Q4–1998Q3. This compares to the US results in Tables 1 and 2 of −3.11, 24.13 and 13.10. Fernandez-Corugedo *et al.*'s (2003), p. 25, the Johansen trace and max statistics for the UK, 1975Q1–2001Q2, are 28.46 and 19.44, compared to mine of 26.40 and 16.42.

not directly comparable to mine for two reasons. First, the findings she reports in Table A2 for Canada, Japan and the US only test for cointegration between consumption, income and financial and non-financial wealth, not consumption, income and total wealth as I do. Second, for several countries (Australia, France, the UK, and the US) Bertaut uses personal *disposable* income in the regression of consumption on income and wealth.

3.2. **Data Set 2: Consumption and Disposable Income.** In this section I investigate evidence for the existence of a stable cointegration between consumption and disposable income for an extended set of countries.

The data consist of annual series on consumption and disposable income for 26 countries provided by OECD and the World Bank. As opposed to the previous data set, the data are on *national, not personal,* consumption and disposable income. Consequently, government is included.

The consumption series is the final consumption, the sum of household and government consumption expenditures. The income variable in this data set is measured as net national disposable income for the OECD data and gross national disposable income for the World Bank data. As a result, the saving rates considered differ depending on whether or not they are net of depreciation. The calculated OECD saving rate is the *net* national saving rate; the saving rate based on the World Bank data is the *gross* national saving rate.

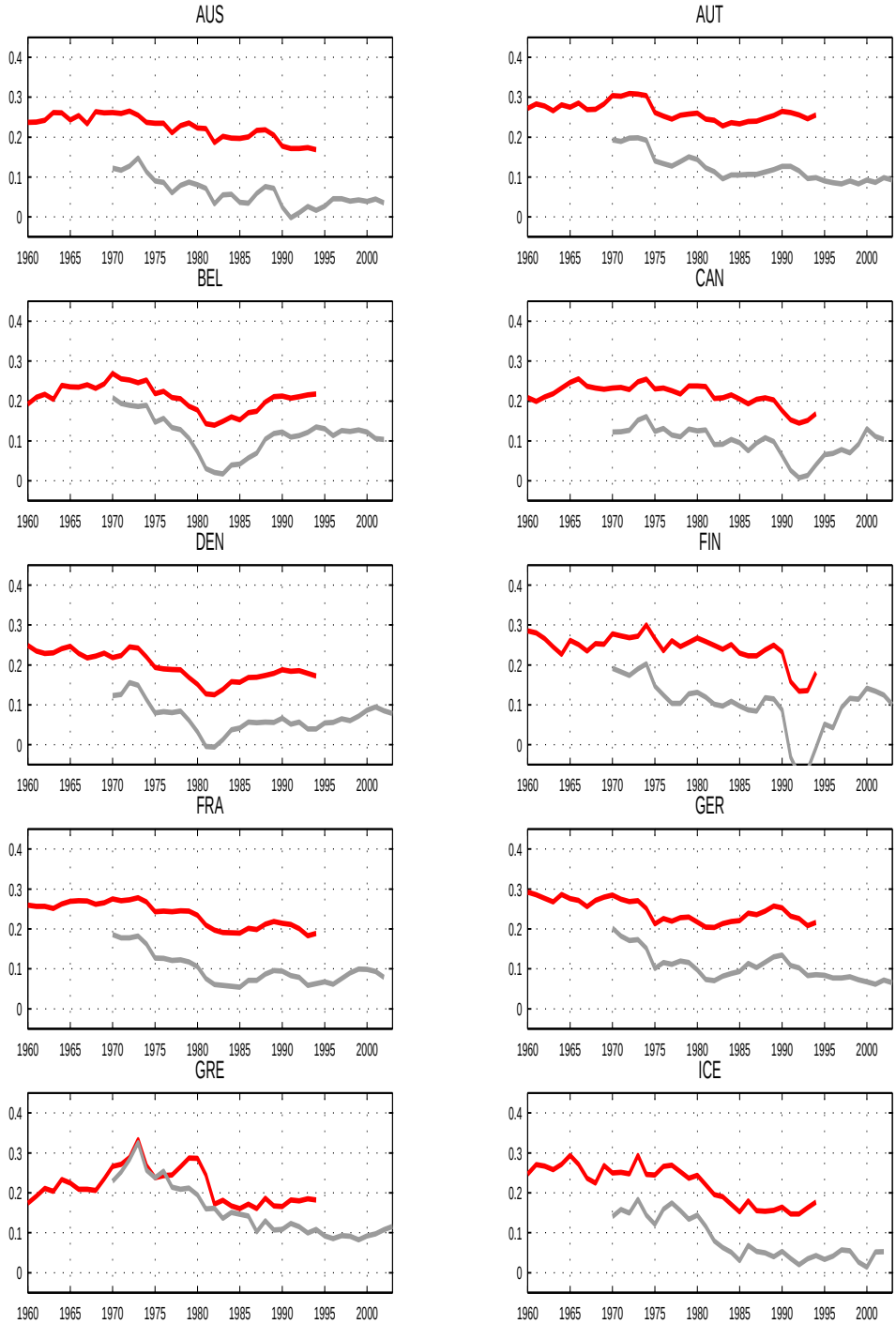
Both saving rates for all countries are compared in Figures 2–4. The saving rates evolve similarly for most countries with the net saving rate being below the gross saving rate by about 10% on average.

The unit root and cointegration tests for the second data set are displayed in Tables 9 and 10. The second and fourth columns in both tables show findings for the OECD data (denoted by "1"); the third and fifth columns show the World Bank data (denoted by "2"). All countries, except for Portugal, have relatively small ADF statistics (in absolute values) for saving rates.

The Phillips–Ouliaris test statistics for the consumption–disposable income relationship are reported in the fourth and fifth columns of Table 9. Similarly to the first data set, the ADF tests detect the relationship between the stationarity of the saving rates and the existence of cointegration between consumption and disposable income. As indicated in Table 9, the only country in the second data set with a stationary saving rate, Portugal, also has cointegrated consumption and disposable income.

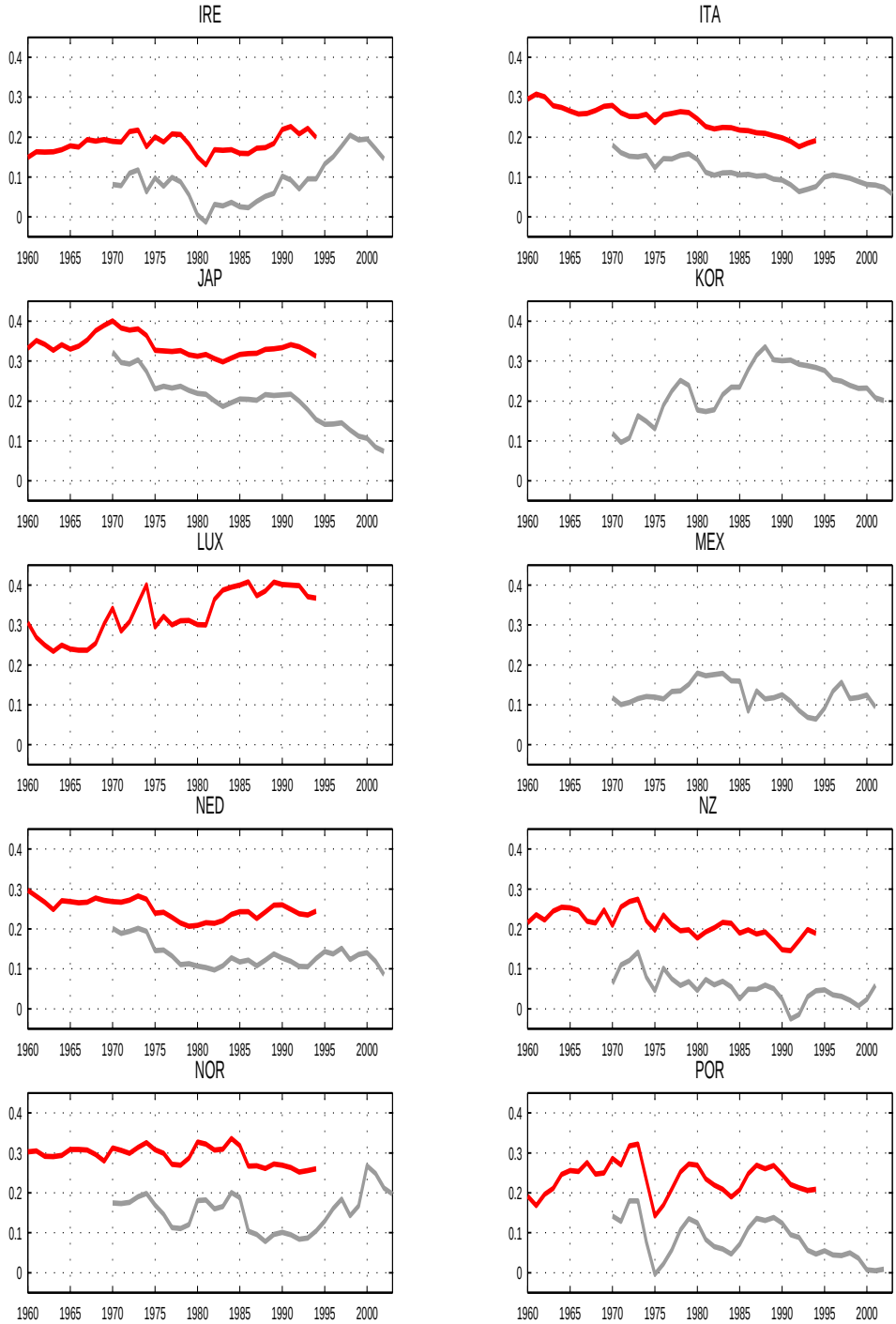
As with the first data set, the Johansen tests of Table 10 tend to reject the absence of stable cointegration more often than the Phillips–Ouliaris test. Of 26 countries considered, for 10 there is no stable cointegration found in both data sets, for 12 the results are mixed and 4 countries show consistent evidence for a stable consumption–income cointegration across the data sets. Cointegration is consistently rejected for Canada, Denmark, Ireland, Italy, Korea, Mexico, the Netherlands, Switzerland, Turkey and the

FIGURE 2. Saving Rates—Annual Data I.



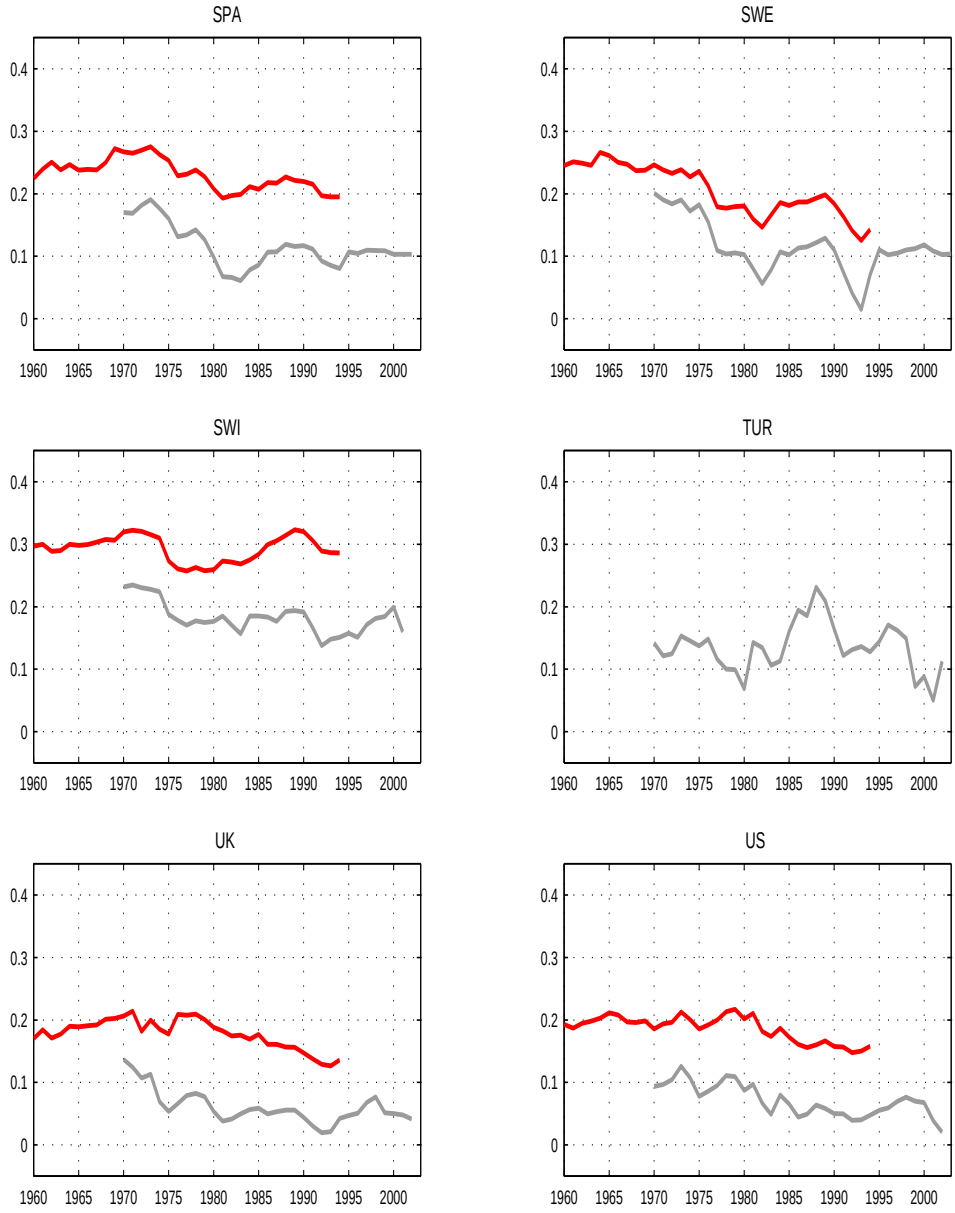
Note: Red/dark: Gross National Saving Rates (World Bank); Grey/light: Net National Saving Rates (OECD).

FIGURE 3. Saving Rates—Annual Data II.



Note: Red/dark: Gross National Saving Rates (World Bank); Grey/light: Net National Saving Rates (OECD).

FIGURE 4. Saving Rates—Annual Data III.



Note: Red/dark: Gross National Saving Rates (World Bank); Grey/light: Net National Saving Rates (OECD).

US. In contrast, I find that a stable cointegrating vector is likely to exist for Belgium, Finland, Greece and Iceland.

All in all, using the Johansen tests there is rather mixed evidence for the existence of a stable cointegrating relationship between consumption and disposable income. Cointegration probably exists for fewer countries than not; the score is 4 vs. 10.

Perhaps the most serious critique of the unit root and cointegration tests is that they have weak power. They tend to have a hard time discriminating between the null and alternative hypotheses and reject the null rarely. Therefore, it is often recommended that researchers use as long time span of data as possible. Due to limitations, the data investigated in this paper cover a period of 30–40 years, which may seem rather short. However, this may not be such a substantial problem for two reasons. First, longer time spans of data are likely to contain structural breaks whose appropriate treatment would further reduce the power of the tests. Second, the Phillips–Ouliaris statistics are overwhelmingly insignificant. Consequently, based on these statistics it would be hard to conclude anything else other than the lack of a stable cointegrating relationship between the variables in question.

4. Conclusion

This paper systematically investigates the evidence for the existence of cointegration between (i) consumption, labor income and wealth and (ii) consumption and disposable income in international data. I find little evidence of a stable cointegrating vector between consumption, labor income and wealth. Depending on the testing procedure, a stable cointegration between the three variables is rejected for at least four of the six countries examined, including the US. The evidence for a stable consumption–disposable income relationship is a bit more ambiguous. Of the 26 countries I investigate a stable cointegration probably exists in four and is not likely to exist in ten. In the remaining twelve countries the data do not allow me to reach a clear conclusion. Finally, cointegration between consumption and disposable income tends to exist in the countries with stationary saving rates (Australia and Portugal).

My findings have important implications for the empirical research on the effects of asset prices on the real economy. In the absence of a stable cointegrating relationship it is of course not meaningful to estimate by cointegration techniques objects such as the marginal propensity to consume from wealth. Instead it is necessary to look for alternative methods which are better grounded in economic theory. One step in that direction is the technique recently proposed by Carroll (2004).

My results of the consumption–disposable income cointegration tests provide yet another falsification of the permanent income hypothesis. Since the PIH is built on restrictive assumptions, there are many possible reasons for the apparent lack of a stable cointegration including time non-separability of

preferences, costly information updating or parameter instability. Further research is needed to determine which of these cause(s) the gap between the theoretical implications and empirical findings.

Appendix: Data Construction

Data Set 1: Consumption, Income and Wealth. The first data set collects series on consumption, income and wealth for six countries: Australia, Canada, France, Japan, the United Kingdom and the United States. The consumption and disposable income series are from the DRI International database (codes: CP@AS, CP@CN, CP@FR, CPH@UK, YD@AS, YD@CN, YD@FR, YD@UK). The wealth series for all countries except the US were provided by the national statistical offices and central banks.[5] Wages and salaries are from DRI International (codes: WS@AS, WS@CN, WS@FR, WS@UK). The US consumption and income series were provided by NIPA tables on the BEA web site. Following, Lettau and Ludvigson (2001, 2004) and Rudd and Whelan (2002), the US labor income was constructed as: Wages and salaries + Transfer payments + Supplements to wages and salaries − Contributions for government social insurance − Labor taxes. Labor taxes are: (Wages and salaries/(Wages and salaries + Proprietors' income + Rental income + Personal dividend income)) × Personal tax and non-tax payments. The US wealth series comes from the Flow of Funds tables provided by the Board of Governors web site. Some series were seasonally adjusted using the X–12 method. All series were deflated by PCE deflators (PCP@AS, PCP@CN, PCP@FR, PCP@UK) and expressed in per capita terms (divided by population, N@AS N@CN, N@FR, N@JP, N@UK). PCE deflator and population series are available from DRI International. The US deflator and population series are from NIPA. The consumption, wages and salaries, disposable income and PCE deflator series for Japan were taken from the OECD's Annual National Accounts database.

The following series were used in calculations for Tables 1–8.

Australia: consumption (C)—personal consumption, labor income (L)—wages and salaries, wealth (W)—total household sector wealth, disposable income (D)—personal disposable income.

Canada: consumption (C)—personal consumption, labor income (L)—wages and salaries, wealth (W)—total household sector wealth, disposable income (D)—personal disposable income.

France: consumption (C)—personal consumption, labor income (L)—wages and salaries, wealth (W)—financial wealth, disposable income (D)—personal disposable income.

Japan: consumption (C)—final consumption expenditure (household and government), labor income (L)—wages and salaries, wealth (W)—financial wealth, disposable income (D)—net national disposable income.

[5] I thank Carol Bertaut for these series.

United Kingdom: consumption (C)—personal consumption, labor income (L)—wages and salaries, wealth (W)—total household sector wealth, disposable income (D)—personal disposable income.

United States: consumption (C)—personal consumption, labor income (L)—labor income, wealth (W)—household net worth, disposable income (D)—personal disposable income.

Data Set 2: Consumption and Income. The data on consumption and income come from two alternative sources: OECD National Accounts and the World Bank's World Saving Database.

The OECD data set collects annual data on 25 (mostly) developed countries, 1970–2003: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Korea, Mexico, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The data were obtained from OECD's Annual National Accounts database.[6] Consumption is (sum of household and government) final consumption expenditure (C). Income is measured as net national disposable income ($NNDI$). The saving rates were calculated as $(NNDI - C)/NNDI$ and are the *net* national saving rate (depreciation is subtracted). Wages are total compensation of employees. PCE deflators were calculated as ratios of nominal household final consumption expenditure to real final consumption expenditure (1995 prices). The population series were the same as in data set 1, source: DRI International.

From the World Bank data set annual series, 1960–1995, on the following 23 industrial countries were collected: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States.[7] The *gross* national saving rates were calculated $(GNDI - Cetc)/GNDI$, where $GNDI$ denotes the gross national disposable income, $Cetc$ is consumption (including statistical discrepancies). The World Saving Database (WSD) contains also data on the consumer price indexes (originally taken from the IMF's International Financial Statistics) and population used to construct per capita real consumption and income measures. All series come from the WSD come from Module 1, except for population, which is in Module 4. The data are available from
http://www.worldbank.org/research/projects/savings/data.htm.

References

1. Attfield, C. L. F., D. Demery and N. W. Duck (1990), "Saving and Rational Expectations: Evidence for the UK," *The Economic Journal,* 1269–76.

[6] Excerpts are available at
http://www.oecd.org/document/28/0,2340,en_2825_495684_2750044_1_1_1_1,00.html,
Tables 1–4.

[7] The World Saving Data Base is described in detail in Loyaza *et al.* (1998).

2. Bertaut (2002), Carol, "Equity Prices, Household Wealth, and Consumption Growth in Foreign Industrial Countries: Wealth Effects in the 1990s," IFDP #724, Board of Governors.
3. Byrne, Joseph P. and E. Philip Davis (2003), "Disaggregate Wealth and Aggregate Consumption: an Investigation of Empirical Relationships for the G7," *Oxford Bulletin of Economics and Statistics* **65(2),** 197–220.
4. Campbell (1987), John Y., "Does Saving Anticipate Declining Labor Income? An Alternative Test of the Permanent Income Hypothesis," *Econometrica* **55,** 1249–73.
5. Campbell, John Y., and Richard H. Clarida (1988), "Saving and Permanent Income in Canada and the United Kingdom," in Elhalan Helpman *et al.*, eds.: *Economic Effects of Government Budget,* MIT Press, Cambridge, MA.
6. Campbell, John Y. and N. Gregory Mankiw (1989), "Consumption, Income and Interest Rates: Reinterpreting the Time Series Evidence," in Olivier J. Blanchard and Stanley Fischer, eds.: *NBER Macroeconomics Annual*, MIT Press, Cambridge, MA.
7. Carroll (2004), Christopher D., "Housing Wealth and Consumption Expenditure," mimeo, Johns Hopkins University.
8. Davis, Morris A. and Michael G. Palumbo (2001), "A Primer on the Economics and Time Series Econometrics of Wealth Effects," FEDS working paper #9, Board of Governors.
9. Fernandez-Corugedo, Emilio, Simon Price and Andrew Blake (2003), "The dynamics of consumers expenditure: the UK consumption ECM redux," working paper #204, Bank of England.
10. Hahn, Jaehoon and Hangyong Lee (2001), "On the Estimation of the Consumption-Wealth Ratio: Cointegrating Parameter Instability and its Implications for Stock Return Forecasting," working paper, Columbia University.
11. Hamilton (1994), James D., *Time Series Analysis,* Princeton University Press.
12. Jin (1995), Fuchun, "Cointegration of Consumption and Disposable Income: Evidence from Twelve OECD Countries," *Southern Economic Journal,* 77–88.
13. Johansen (1988), Søren, "Statistical Ananlysis of the Cointegration Vectors," *Journal of Economic Dynamics and Control* **12,** 231–54.
14. Lettau, Martin, and Sydney Ludvigson (2001), "Consumption, Aggregate Wealth, and Expected Stock Returns," *Journal of Finance* **56(3),** 815–849.
15. Lettau, Martin, and Sydney Ludvigson (2004), "Understanding Trend and Cycle in Asset Values: Reevaluating the Wealth Effect on Consumption," *American Economic Review.*
16. Loayza, Norman, Humberto Lopez, Klaus Schmidt-Hebbel and Luis Serven (1998), "The World Saving Data Base," mimeo, The World Bank.

17. Macklem, R. Tiff (1994), "Wealth, Disposable Income and Consumption: Some Evidence for Canada," working paper, Bank of Canada.
18. Phillips, Peter C. and Sam Ouliaris (1990), "Asymptotic Properties of Residual Based Tests for Cointegration," *Econometrica* **58,** 165–193.
19. Pichette, Lise and Dominique Tremblay (2003), "Are Wealth Effects Important for Canada?," working paper #30, Bank of Canada.
20. Rudd, Jeremy and Karl Whelan (2002), "A Note on the Cointegration of Consumption, Income, and Wealth," FEDS working paper #53, Board of Governors.
21. Watson (1994), Mark W., "Vector Autoregressions and Cointegration," in Robert F. Engle and Daniel L. McFadden, eds.: *Handbook of Econometrics,* Vol. IV, Elsevier Science.

TABLE 1. Unit Root and Cointegration Tests—Consumption, Income and Wealth

Country	Period	S	CLW	CD
Australia	1971–1999	-3.80^{**}	-1.50	-3.63^{*}
Canada	1962–2001	-0.72	-2.47	-0.22
United Kingdom	1968–2000	-2.48	-3.00	-2.40
United States	1960–2003	-2.26	-3.11	-2.07

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. Significant test statistics reject the null hypothesis of unit root/lack of cointegration.
The capital letters in column headers stand for: S—saving rate, C—consumption, L—labor income, W—household wealth, D—personal disposable income.
Quarterly data; time frames: longest available spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices.

TABLE 2. Johansen Cointegration Tests—Consumption, Income and Wealth

Country	Period	CLW Trace	CLW Max	CD Trace	CD Max
Australia	1971–1999	29.47^{*}	17.54	18.82^{**}	18.30^{**}
Canada	1962–2001	32.40^{**}	27.16^{***}	14.65^{*}	14.62^{**}
United Kingdom	1968–2000	26.40	16.42	15.02^{*}	15.02^{**}
United States	1960–2003	24.12	13.10	8.62	8.38

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. The null hypotheses in the Johansen trace and max tests are: there is no cointegrating vector among the series. Significant test statistics reject the null.
The letters in column headers stand for: C—consumption, L—labor income, W—household wealth, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
Quarterly data; time frames: longest available spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices.

TABLE 3. Unit Root and Cointegration Tests—Consumption, Income and Wealth

Country	Period	S	CLW	CD
Australia	1972–1999	-3.41^{*}	-1.93	-4.11^{**}
Canada	1962–2001	-1.04	-3.35	-0.69
France	1978–1997	-0.66	-0.47	-1.14
Japan	1970–2000	-2.10	-1.36	-2.09
United Kingdom	1968–2000	-2.98	-2.50	-3.05
United States	1960–2003	-1.38	-3.12	-1.20

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. The null hypotheses in the Johansen trace and max tests are: there is no cointegrating vector among the series. Significant test statistics reject the null.
The letters in column headers stand for: C—consumption, L—labor income, W—household wealth, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
Annual data; time frames: longest available spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices, OECD National Accounts.

TABLE 4. Johansen Cointegration Tests—Consumption, Income and Wealth

Country	Period	CLW Trace	CLW Max	CD Trace	CD Max
Australia	1972–1999	28.64^{*}	18.13	21.76^{***}	19.05^{***}
Canada	1962–2001	31.96^{**}	20.14^{*}	7.22	7.21
France	1978–1997	22.38	15.09	16.55^{**}	11.28
Japan	1970–2000	37.50^{***}	30.84^{***}	26.07^{***}	22.74^{***}
United Kingdom	1968–2000	21.42	13.52	11.07	10.99
United States	1960–2003	35.24^{**}	25.30^{**}	13.02	12.76^{*}

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. The null hypotheses in the Johansen trace and max tests are: there is no cointegrating vector among the series. Significant test statistics reject the null.
The letters in column headers stand for: C—consumption, L—labor income, W—household wealth, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
Annual data; time frames: longest available spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices, OECD National Accounts.

TABLE 5. Unit Root and Cointegration Tests—Consumption, Income and Wealth

Country	Period	S	CLW	CD
Australia	1971–1999	-3.80^{**}	-1.50	-3.63^{*}
Canada	1971–1999	-2.01	-2.13	-0.54
United Kingdom	1971–1999	-2.30	-2.92	-2.22
United States	1971–1999	-2.39	-2.74	-2.45

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. Significant test statistics reject the null hypothesis of unit root/lack of cointegration.
The capital letters in column headers stand for: S—saving rate, C—consumption, L—labor income, W—household wealth, D—personal disposable income.
Quarterly data; time frames: longest *common* spans, indicated in column two.
The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices, OECD National Accounts.

TABLE 6. Johansen Cointegration Tests—Consumption, Income and Wealth

Country	Period	CLW Trace	CLW Max	CD Trace	CD Max
Australia	1971–1999	29.47^{*}	17.54	18.82^{**}	18.30^{*}
Canada	1971–1999	44.42^{***}	38.53^{***}	36.98^{***}	36.66^{***}
United Kingdom	1971–1999	30.03^{**}	18.40	14.92^{*}	14.59^{**}
United States	1971–1999	20.44	12.87	6.61	6.60

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. The null hypotheses in the Johansen trace and max tests are: there is no cointegrating vector among the series. Significant test statistics reject the null.
The letters in column headers stand for: C—consumption, L—labor income, W—household wealth, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
Quarterly data; time frames: longest *common* spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices, OECD National Accounts.

TABLE 7. Unit Root and Cointegration Tests—Consumption, Income and Wealth

Country	Period	S	CLW	CD
Australia	1978–1997	−3.32*	−2.83	−3.01
Canada	1978–1997	−2.27	−3.06	−1.04
France	1978–1997	−0.66	−0.47	−1.14
Japan	1978–1997	−2.28	−1.55	−2.37
UK	1978–1997	−2.30	−1.61	−2.37
US	1978–1997	−3.46*	−3.01	−2.28

Notes: Significance level: ∗ 10%, ∗∗ 5%, ∗ ∗ ∗ 1%. Significant test statistics reject the null hypothesis of unit root/lack of cointegration.
The capital letters in column headers stand for: S—saving rate, C—consumption, L—labor income, W—household wealth, D—personal disposable income.
Annual data; time frames: longest *common* spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices, OECD National Accounts.

TABLE 8. Johansen Cointegration Tests—Consumption, Income and Wealth

Country	Period	CLW Trace	CLW Max	CD Trace	CD Max
Australia	1978–1997	10.74	7.23	13.13	12.63*
Canada	1978–1997	24.40	19.56*	7.07	7.07
France	1978–1997	22.38	15.09	16.55**	11.28
Japan	1978–1997	50.09***	27.88***	8.95	8.91
UK	1978–1997	34.29**	20.19*	10.50	10.16
US	1978–1997	19.24	15.01	12.86	10.84

Notes: Significance level: ∗ 10%, ∗∗ 5%, ∗ ∗ ∗ 1%. The null hypotheses in the Johansen trace and max tests are: there is no cointegrating vector among the series. Significant test statistics reject the null.
The letters in column headers stand for: C—consumption, L—labor income, W—household wealth, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
Annual data; time frames: longest *common* spans, indicated in column two. The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: DRI International, national statistical offices, OECD National Accounts.

TABLE 9. Unit Root and Cointegration Tests—Consumption and Income

	S 1	**S 2**	**CD 1**	**CD 2**
Australia	−2.91	−3.01	−3.15	−1.90
Austria	−2.45	−2.06	−2.93	−2.17
Belgium	−1.69	−1.26	−1.77	−1.34
Canada	−2.24	−3.17	−2.21	−2.10
Denmark	−2.23	−2.24	−2.46	−2.55
Finland	−2.67	−2.87	−2.69	−2.57
France	−2.02	−2.55	−2.83	−2.21
Germany	−2.55	−2.10	−2.54	−2.47
Greece	−1.37	−2.35	−2.74	−1.86
Iceland	−1.77	−2.35	−2.53	−1.88
Ireland	−1.66	−2.26	−1.90	−2.27
Italy	−2.71	−3.48*	−3.25	−2.85
Japan	−1.75	−1.97	−1.60	−1.85
Korea	−1.74	–	−1.75	–
Luxembourg	–	−3.09	–	−3.25
Mexico	−2.18	–	−1.64	–
Netherlands	−2.01	−2.10	−2.06	−2.33
Norway	−2.37	−3.53*	−2.53	−2.59
New Zealand	−3.70**	−3.11	−2.65	−2.90
Portugal	−4.16***	−4.62***	−4.35***	−4.12***
Spain	−2.04	−2.17	−2.21	−1.75
Sweden	−2.64	−2.87	−2.75	−2.73
Switzerland	−2.78	−2.27	−2.99	−2.31
Turkey	−2.33	–	−2.40	–
United Kingdom	−3.26*	−1.54	−3.28	−1.47
United States	−3.06	−2.60	−3.36	−2.24

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. Significant test statistics reject the null hypothesis of unit root/lack of cointegration.
Columns denoted "1" use data from OECD National Accounts, "2" World Saving Database.
The letters in column headers stand for: S–saving rate, C—consumption, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: OECD National Accounts, Annual Data 1970–2003; World Bank, World Saving Database, Annual Data 1960–1995.

TABLE 10. Johansen Cointegration Tests—Consumption and Income

	CD 1 Trace	**CD 1 Max**	**CD 2 Trace**	**CD 2 Max**
Australia	13.15	13.01*	22.27***	15.96**
Austria	22.22***	16.46**	14.68*	11.88
Belgium	17.72**	16.87**	25.74***	22.25***
Canada	11.90	8.98	13.10	9.89
Denmark	8.01	6.33	16.09**	9.31
Finland	26.81***	20.54***	16.95**	10.22
France	15.74**	14.69**	17.45**	14.35**
Germany	15.41**	12.07*	38.73***	33.22***
Greece	27.63***	20.93***	12.04	6.64
Iceland	11.38	7.63	19.29**	15.01**
Ireland	8.31	8.25	6.58	5.09
Italy	16.72**	12.03	8.31	7.38
Japan	20.76***	17.73**	15.42**	10.52
Korea	9.95	8.84	–	–
Luxembourg	–	–	26.39***	22.66***
Mexico	8.00	5.79	–	–
Netherlands	7.27	7.03	15.28*	14.00*
Norway	7.18	6.71	19.00**	15.20**
New Zealand	9.11	8.69	15.97**	11.86
Portugal	19.09**	18.28**	12.63	7.37
Spain	12.04	11.49	20.97***	20.64***
Sweden	17.12**	15.48**	10.42	7.52
Switzerland	13.70*	12.79**	13.19	8.64
Turkey	10.85	7.40	–	–
United Kingdom	17.83**	17.80**	7.97	7.55
United States	12.15	12.11*	12.83	11.67

Notes: Significance level: $*$ 10%, $**$ 5%, $***$ 1%. The null hypotheses in the Johansen trace and max tests are: there is no cointegrating vector among the series. Significant test statistics reject the null.
Columns denoted "1" use data from OECD National Accounts, "2" World Saving Database.
The letters in column headers stand for: C—consumption, D—personal disposable income, Trace—Johansen trace test, Max—Johansen max test.
The number of lags in the tests was set to 1; the results are robust to different choices.
Sources: OECD National Accounts, Annual Data 1970–2003; World Bank, World Saving Database, Annual Data 1960–1995.