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## Inflation and the Savings Rate

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## Inflation and the Savings Rate

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# Inflation and the Savings Rate

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## Abstract

In this paper, we examine two explanations of the observed positive relationship between inflation rates and savings rates in Canada and the United States. Several models are estimated using quarterly time-series data from both countries, and the best of these are subjected to a variety of tests. One of the two explanations appears to be broadly consistent with the data. It is that the observed relationship arises primarily because, in times of inflation, measured income and measured savings overstate the corresponding real and perceived quantities.

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## 1. Introduction

The denial to economics of the dramatic and direct evidence of the ‘crucial’ experiment does hinder the adequate testing of hypotheses; but this is much less significant than the difficulty it places in the way of achieving a reasonably prompt and wide consensus on the conclusions justified by the available evidence. It renders the weeding-out of unsuccessful hypotheses slow and difficult. They are seldom downed for good and are always cropping up again.

Milton Friedman (1953, p. 11)

It should be a principal objective of empirical work in any science to keep to a minimum the number of competing theories which reasonable people can regard as tenable. Yet econometrics often fails to do this, as Milton Friedman points out in the above quotation. Empirical work frequently serves merely to multiply the number of models that are superficially attractive, without eliminating unsatisfactory models in any convincing fashion.

It has often been observed, especially in recent years, that high rates of inflation tend to be associated with high rates of personal savings. As usual in economics, numerous theories have been proposed to explain this phenomenon, and none of them has been conclusively eliminated. In this paper, therefore, we examine two principal competing theories of how inflation affects the savings rate, in order to see whether either or both of them can be shown to be false.

The first explanation that we shall consider is that the observed relationship between inflation and the savings rate is largely a statistical mirage. The observed relationship arises because, in times of inflation, measured income and measured savings, even when deflated by the appropriate price index, tend to overestimate real income and real savings, as perceived by consumers. Income, as measured in the national accounts, includes interest payments on financial assets. The higher the rate of inflation, the higher is the fraction of these payments which is not really income at all, but simply compensation to the asset-holder for the decline in the real value of his or her assets due to inflation. If asset-holders understand this, they will recognize that part of their interest and dividend income (in times of high inflation perhaps a very large part) is simply an inflation premium, and hence cannot be used to finance consumption if asset-holders wish to maintain the real value of their wealth. Thus measured savings, which is the difference between measured income and consumption, will tend to rise with the rate of inflation. This explanation has been suggested by several economists, including Siegel (1979) and Jump (1980). Using UK data, Hendry and von Ungern-Sternberg (1980) find evidence to support it.

The other explanation we shall consider was put forward by Deaton (1975), who proposed a disequilibrium model of aggregate demand in the presence of unanticipated inflation. The basic idea is very simple. Since no consumer is ever aware at any one instant of the prices which prevail for all of the goods and services that he or she sometimes purchases, and since consumer price indices are always published after a delay and may not be relevant to individual consumers anyway, it is possible to mistake an increase in the general price level for an increase in some relative prices. Such a

mistake will cause consumers to respond to what they perceive to be increased relative prices by purchasing less of everything, intending to purchase more of substitute commodities at a later date. Thus unanticipated inflation will result in involuntary saving. Deaton presents empirical work, using data for both the UK and the US, which seems to support this hypothesis. However, the model he estimates takes no amount of the inflation-induced overmeasurement of savings, and it may therefore attribute to involuntary savings movements in the savings rate which are really due to this overmeasurement.

The plan of the paper is as follows. In Section 2, we derive a simple but plausible model of savings, which can be modified to incorporate both the overmeasurement hypothesis and the involuntary savings hypothesis. In Section 3, using both Canadian and American quarterly time-series data, we estimate this model and numerous generalizations of it. The objective is to obtain estimating equations which appear to be consistent with the data, so that we can then draw valid inferences about the effect of inflation on savings rates. For both countries, we find that the overmeasurement hypothesis has strong empirical support, but that there is little evidence to support the involuntary savings hypothesis.

## 2. Modeling the Savings Rate

Let  $S(t)$  denote the flow of real savings at time  $t$ ,  $Y(t)$  denote the flow of real disposable income, and  $s(t) \equiv S(t)/Y(t)$  denote the savings rate. Following Friedman (1957), we expect that, in the long run,  $s = 1 - k$ , where  $k$ , a constant, is the long-run propensity to consume out of permanent income. For a dynamical theory of consumption, it is necessary to adjoin to this (very simple) specification of long-run equilibrium, an adjustment mechanism whereby equilibrium may be approached. We suppose that the flow of real consumption,  $C \equiv Y - S$ , is subject to a partial adjustment process of the usual sort:

$$\dot{C} = \gamma(kY - C),$$

which may also be written as

$$\dot{S} = \dot{Y} + \gamma((1 - k)Y - S), \tag{1}$$

where  $\gamma$  determines the speed of adjustment.

It seems preferable to rewrite this equation in terms of the savings rate, since it is surely more plausible that errors of constant variance should adhere to the savings rate than to the level of savings. Equation (1) thus becomes

$$\dot{s} = \gamma(1 - k) - \gamma s + (1 - s)\dot{Y}/Y. \tag{2}$$

In order to model exogenous random shocks to the savings rate, we add a Brownian process,  $w(t)$ , to the right-hand side of equation (2). Then, letting  $h$  denote the length

of time over which data are aggregated, we integrate the stochastic version of equation (2) between  $t - h$  and  $t$ , retaining terms only to first order in  $h$ . This yields

$$s(t) = (1 - k\gamma h) + (1 - \gamma h) \left( \frac{Y(t-h)}{Y(t)} s(t-h) - \frac{Y(t-h)}{Y(t)} \right) + \varepsilon_t, \quad (3)$$

where

$$\varepsilon_t = \int_{t-h}^t w(t) dt$$

is a normally distributed, serially independent random variable with mean zero and variance proportional to  $h$ .

If  $S_t$  and  $Y_t$  denote, respectively, the accumulated real savings and income in the time interval  $(t - h, t)$ , then equation (3) can be interpreted as

$$s_t = b_0 + b_1 \frac{S_{t-1} - Y_{t-1}}{Y_t} + \varepsilon_t, \quad (4)$$

where  $b_0 = 1 - k\gamma h$  and  $b_1 = 1 - \gamma h$ . We shall henceforth refer to the model given in equation (4) as Model I. It is interesting to observe that, if this model is expressed in terms of the flow of consumption,  $C_t$ , we obtain the familiar consumption model associated with Duesenberry (1949) and Brown (1962):

$$C_t = (1 - b_0)Y_t + b_1 C_{t-1} + v_t, \quad (5)$$

where  $v_t$  is an error term with standard deviation proportional to  $Y_t$ . Thus Model I has a long and honorable history.

The specification of Model I does not allow inflation to have any effect on savings rates. We now consider how this model can be modified to take account of the systematic overmeasurement of savings and income due to inflation which was discussed in the introduction. Let  $W_t$  denote the average real wealth held in the form of financial assets by consumers during period  $t$ . Then, if  $r_t$  is the average nominal rate of interest during that period on a representative portfolio, the real value of interest and dividend payments made in period  $t$  will be

$$I_t \cong r_t W_t, \quad (6)$$

where the approximation in equation (6) is clearly more than good enough for our purposes if the time period is not too long. However, if the average inflation rate during period  $t$  is  $\pi_t$ , the real value of financial assets will have been eroded to the extent of, approximately,  $\pi_t W_t$ . Thus the real income actually generated by financial wealth should in fact be  $I_t - \pi_t W_t$  rather than  $I_t$ , the figure given in the national accounts. Since  $S_t \equiv Y_t - C_t$ , real savings will also be smaller by  $\pi_t W_t$  than the figure given in the national accounts. Data on wealth are not available for all countries. When they are not, we may estimate  $\pi_t W_t$  by  $\pi_t I_t / r_t$ , using equation (6). We henceforth

denote the quantities  $\pi_t W_t$  or  $\pi_t I_t / r_t$  by  $Z_t$ ; the way  $Z_t$  is actually measured will depend on the availability of data.

For the purposes of introducing an adjustment for the overmeasurement of income and savings into Model I, it is desirable to introduce two additional complications. First of all, it is clear that the inflation rate which should enter into the computation of  $Z_t$  is not the actual inflation rate in the current period, but rather the inflation rate perceived by consumers. We believe that the latter, which we will denote by  $\pi_t^*$ , is likely to be a weighted average of the actual inflation rates in the current period and in the recent past. Secondly, instead of simply subtracting  $Z_t$  from  $Y_t$  and  $S_t$ , we shall subtract  $\alpha Z_t$ , where  $0 < \alpha < 1$ . The introduction of the parameter  $\alpha$  serves two purposes. First of all, not all financial assets lose value in times of inflation. Consumers may expect that some assets, notably common stocks, will rise in value with the rate of inflation, and hence be justified in regarding all payments on such assets as being real income. Secondly, not all consumers may understand the effect of inflation on the real value of their financial assets; certainly, the politicians who set tax laws seem not to understand it. In that case, some consumers may make the same error as national income accountants and overestimate their real incomes. Thus  $\alpha Z_t$  equals the amount by which consumers, in the aggregate, perceive their income to be overmeasured.

Now let us suppose that equation (4) holds, not for measured savings and income,  $S_t$  and  $Y_t$ , but for the perceived quantities  $S_t - \alpha Z_t$  and  $Y_t - \alpha Z_t$ . This yields:

$$s_t = b_0 + (1 - b_0)\alpha \frac{Z_t}{Y_t} + b_1 \frac{S_{t-1} - Y_{t-1}}{Y_t} + \frac{Y_t - \alpha Z_t}{Y_t} \varepsilon_t. \quad (7)$$

We shall ignore the implied heteroskedasticity of the error term in equation (7) because it is quantitatively unimportant (since  $(Y_t - \alpha Z_t)/Y_t$  is never greatly different from unity); because it would greatly complicate both estimation and making comparisons with alternative models; and because it has no very strong theoretical justification anyway (after all, there is no real reason why the error should not adhere directly to measured savings rates rather than to perceived savings rates). The model given in equation (7), with an error term assumed homoskedastic, will henceforth be referred to as Model Ia.

The next model to be derived incorporates Deaton's involuntary savings hypothesis. Deaton (1977) begins with an equation similar to equation (1) but without the  $\dot{Y}/Y$  term. He then goes on to establish a relationship between the realized, partly involuntary, savings rate  $s(t)$  and the intended or planned savings rate,  $s^*(t)$ . Next, he describes the mechanisms by which price and income expectations are generated. Combining these three elements, he obtains a differential equation for  $s$ , which is then converted into an estimable equation in the same way that we obtained Model I. If we follow Deaton's procedure, starting from equation (2), we obtain:

$$s_t = a_0 + b_1 \frac{S_{t-1} - Y_{t-1}}{Y_t} + d_1 \log \frac{Y_t}{Y_{t-1}} + d_2 \pi_t + \varepsilon_t. \quad (8)$$

This equation will be referred to as Model Ib. It has two more parameters than Model I,  $d_1$  and  $d_2$ , both of which are expected to be positive.

There is no reason why the overmeasurement and involuntary savings hypotheses should be mutually exclusive. There can be numerous models which incorporate both hypotheses, depending on which effect we incorporate first and what simplifications and approximations we make. Since Deaton's model is in terms of planned or realized quantities, as perceived, it seems appropriate first to incorporate the involuntary savings effect and then take amount of overmeasurement. This yields the nonlinear model

$$s_t = a_0 + (1 - a_0)\alpha \frac{Z_t}{Y_t} + b_1 \frac{S_{t-1} - Y_{t-1}}{Y_t} + d_2 \left(1 - \alpha \frac{Z_t}{Y_t}\right) \pi_t + d_1 \left(1 - \alpha \frac{Z_t}{Y_t}\right) \log\left(\frac{Y_t - \alpha Z_t}{Y_{t-1} - \alpha Z_{t-1}}\right) + \varepsilon_t. \quad (9)$$

It will surely be the case, however, that  $1 - \alpha Z_t/Y_t = (Y_t - \alpha Z_t)/Y_t$  varies much less than  $\pi_t$  or  $\log(Y_t/Y_{t-1})$ . Thus equation (9) should be well approximated by the much simpler linear model

$$s_t = a_0 + (1 - a_0)\alpha \frac{Z_t}{Y_t} + b_1 \frac{S_{t-1} - Y_{t-1}}{Y_t} + d_1 \log\left(\frac{Y_t}{Y_{t-1}}\right) + d_2 \pi_t + \varepsilon_t, \quad (10)$$

which will be referred to as Model Iab.

Testing the overmeasurement and involuntary savings hypotheses would now seem to be very easy. If the overmeasurement hypothesis is true,  $\alpha$  should lie between zero and one; if the involuntary savings hypothesis is true,  $d_1$  and  $d_2$  should both be positive. It is not certain, however, that simply estimating Model Iab and looking at the relevant  $t$  statistics will tell us what we want to know. For one thing,  $Z_t/Y_t$  is likely to be almost collinear with  $\pi_t$ . For another, it is not clear that  $d_1$  is really expected to be nonzero. Deaton (1977) started from an adjustment equation rather simpler and less plausible than equation (2), which omits the  $\dot{Y}/Y$  term. He then introduced such a term through the relationship between planned and realized savings and the mechanism by which income expectations are formed. It may well be that the  $\log(Y_t/Y_{t-1})$  term in Deaton's model really plays exactly the same role as the  $-Y_{t-1}/Y_t$  term which implicitly appears in Model I and all its variants. If so,  $d_1$  might well be insignificantly different from zero, but the involuntary savings hypothesis might still be true. On the other hand, Deaton explicitly assumed that the expected rate of inflation is constant, so that essentially all inflation is unanticipated. It certainly would not do violence to the spirit of the involuntary savings hypothesis to suppose that only inflation which is not perceived causes involuntary savings. If perceived inflation is measured by  $\pi_t^*$ , then unperceived inflation is measured by  $\pi_t - \pi_t^*$ , and this is the regressor which should be added to Model Ia to test the involuntary savings hypothesis.



### 3. Empirical Results

The models discussed above, and numerous generalizations of them, were estimated using two sets of data: American and Canadian quarterly time series for 1954:1 to 1979:4, a total of 104 observations. Data sources and definitions of variables are discussed in the Appendix.

All the data we used were not seasonally adjusted. There is good reason to believe that the process of seasonal adjustment distorts econometric relationships (see Wallis, 1974). Moreover, comparisons of the raw and seasonally adjusted data suggested to us that the official adjustment processes were removing a lot of variation which could not reasonably be described as seasonal. Because we used raw data, it was necessary to include seasonal dummy variables. Since there is every reason to believe that seasonal patterns change gradually over time, we included several sets of seasonal dummy variables multiplied by various powers of time, each set being constrained to sum to zero over each year. Thus the first quarter dummies for the  $i^{\text{th}}$  power of time would have the form:  $1, 0, 0, -1$ ;  $2^i, 0, 0, -2^i$ ;  $3^i, 0, 0, -3^i$ , and so on. We found that, for the United States, it was necessary to include seasonal dummy variables up to the second order in time, and that for Canada it was necessary to include them up to the fourth order. Thus the US regressions contain nine seasonal dummies, and the Canadian regressions contain fifteen. This may seem like a lot, but the higher-order seasonal dummies added significantly to the explanatory power of the regressions. The effects, and appropriateness, of this method of modeling seasonality will be discussed further below.

We also included time-trend variables to capture the effects of gradual, long-term changes in demographic structure, pension institutions, and tax laws. Both linear and quadratic trend terms were generally significant for Canada, while only the linear term was usually significant for the US. In view of the limited variation of time-series data and the extreme complexity of tax laws, demography, and so on, it seems to us preferable to include time trends as we have done rather than to try to model these things explicitly. It is perhaps interesting that, for Canada, the linear trend invariably has a negative coefficient and the quadratic trend a positive one, with the effect of the latter outweighing that of the former since the mid-1960s. The upward trend in recent years may reflect the impact of a variety of tax incentives to save which have been introduced in Canada during the past fifteen years. No such incentives have been introduced in the US, and the effect of the trend term for that country is always to reduce savings over time.

The inflation adjustment variable,  $Z_t$ , was defined differently for the two countries. For both countries, the rate of inflation for the current quarter is

$$\pi_t = \log P_t - \log P_{t-1}. \quad (11)$$

It does not seem reasonable that asset-holders should perceive the rate of inflation correctly and at once without a lag. Accordingly, we defined the perceived rate of inflation as

$$\pi_t^* = 0.25\pi_t + 0.30\pi_{t-1} + 0.25\pi_{t-2} + 0.20\pi_{t-3}. \quad (12)$$

The weights in equation (12) were chosen *a priori* to avoid multicollinearity; the implied restrictions will be tested below. For the United States, we defined  $Z_t$  as  $\pi_t^* W_t$ , where  $W_t$  is net financial assets of households. For Canada, wealth data are not available, and so we defined  $Z_t$  as  $\pi_t^* I_t / r_t$ , where  $I_t$  is interest and dividend payments. For further details, see the Appendix.

All models were estimated using single-equation techniques. There is no strong reason to expect significant simultaneity in quarterly models of this type, and other authors (Davidson *et al.*, 1978; Hendry and von Ungern-Sternberg, 1980) have not found any evidence of it.

Although the dynamic specification of Model I and its derivatives seems plausible, it is clearly very restrictive. Before we attempt to use these models for inference, this structure should be thoroughly tested. Such tests could be carried out for Models I, Ia, Ib, or Iab, but we have chosen to perform them only for Model Ia. As will be seen below, Model I is clearly false, and since, according to the involuntary savings hypothesis, lagged values of inflation should not affect current savings, there is no point in testing Model Ib rather than Model I or Model Iab rather than Model Ia.

In order to test the dynamic specification of Model Ia, we first added  $Y_{t-1}/Y_t$  and  $Z_{t-1}/Y_t$  as additional regressors; then  $Y_{t-2}/Y_t$ ,  $C_{t-2}/Y_t$ , and  $Z_{t-2}/Y_t$  as well; then all of the above regressors plus the corresponding third-order lag terms; and so on up to sixth-order lags. The results of those estimations are shown in Table 1. The loglikelihood of the various equations is shown under “log  $L$ ”. The significance level of an  $F$  statistic for the newly added regressors is shown under “Signif. 1”, while the significance level of an  $F$  statistic for all of the regressors that are not in Model IA is shown under “Signif. 2”. These significance levels are simply the upper tail probabilities associated with the calculated values of the  $F$  statistics, which are more easily interpreted than the statistics themselves. They were calculated using IMSL subroutine ‘MDFDRE’.

For the United States, Model Ia cannot be rejected against any of the more general models at the 0.05 level, since none of the numbers under “Signif. 2” is less than 0.05. However, there is evidence of some significant coefficients at lag 2. Closer inspection reveals that  $Y_{t-2}/Y_t$  is significant at the 0.05 level and that  $C_{t-2}/Y_t$  is almost significant. Moreover, the coefficients on those variables are very similar in magnitude and opposite in sign. This suggests that Model Ia should be modified by the inclusion of  $S_{t-2}/Y_t$ . Although there is no strong theoretical reason to make such a modification, it seems plausible that savings lagged two periods should affect current savings, and there seems no good reason not to accept the modified model, which we will refer to as Model IIa. Detailed results for this model will be presented below.

For Canada, Model Ia can never be rejected against any of the more general models, and there is nothing to suggest that a more complicated model is appropriate. Detailed results for this model will be presented below.

The regressions reported in Table 1 include either six or twelve trending seasonal dummies for the United States and Canada, respectively. This is an unusual feature,

and one which some econometricians might disagree with; see, for example, Davidson *et al.* (1978). Certainly, models which include any sort of trend must be used with caution for forecasting purposes. But, in this case, there seems to be no doubt that the trending seasonals belong in the equation. Consider Table 2, which presents the same results as Table 1, except that the trending seasonals have been omitted (three ordinary seasonal dummies are still included). For the United States, there now appear to be significant coefficients at lags four and five, while for Canada there seem to be strikingly significant coefficients at lags three and four. But these results are certainly false and misleading, for the regressions on which they are based fit much worse than the ones which include trending seasonals. Even when all six lags are included, the hypotheses that the trending seasonals may be omitted can be rejected at better than the 0.0005 level for both countries. Thus, if seasonal factors change gradually over time, as these results and casual observation suggest, there is apparently some danger of erroneously concluding that a model should have more and longer lags than are in fact appropriate.

Estimates of Models Ia, Ib, and Iab, for Canada, and of Models IIa, IIb, and IIab, for the United States, are presented in Table 3. These estimates are, for the most part, self-explanatory. The estimates of  $\alpha$  and of its standard error were derived in the usual way from the estimates of  $b_0$  and the coefficient of  $Z_t/Y_t$ . The numbers reported beside AR(1), AR(4), and AR(1, 2, 3, 4) are the significance levels of tests for first-order, simple fourth-order, and first-to-fourth-order serial correlation, utilizing a variant of Durbin's (1970) "alternative procedure". In parentheses below them are the signs of the estimated autoregressive parameters.

The results for Canada are quite clear-cut. Model Ia substantially outperforms Model Ib, and the coefficients  $\hat{d}_1$  and  $\hat{d}_2$  in Model Iab are individually and jointly insignificant, while  $\hat{\alpha}$  retains its sign and significance. The estimate of  $\alpha$  lies between zero and one, as expected, and is significantly different from both. Thus the Canadian data appear to be entirely consistent with the overmeasurement hypothesis, and they provide no evidence at all to support the involuntary savings hypothesis. The only disquieting thing about the results for Canada is that  $\hat{b}_1$  is rather small in magnitude, implying that consumption adjusts very rapidly to changes in income.

The results for the United States are not quite so clear-cut. Model IIa looks satisfactory and outperforms Model IIb, but not dramatically. Although the estimate of  $\alpha$  retains its sign and significance in Model IIab, while both  $\hat{d}_1$  and  $\hat{d}_2$  are jointly and individually insignificant, the  $t$  statistic on  $\hat{\alpha}$  is not so large, nor that on  $\hat{d}_2$  so small, that one would unhesitatingly accept Model IIa and reject Model IIb. Thus the US data are certainly consistent with the overmeasurement hypothesis, and they provide little support for the involuntary savings hypothesis, but they are not inconsistent with the latter having some validity. The estimate of  $b_1$  for the US seems more plausible than the estimate for Canada, and the only disquieting thing about the US results is that all the models seem to suffer from a little fourth-order serial correlation. Adding more trending seasonals does not cure this, and the extra regressors are insignificant. The curious thing about this serial correlation is that the estimated autoregressive parameter is

negative, implying that the residuals tend to change signs in successive years. This may simply be a statistical artifact, and because the potential gain from correcting for it is very small (see Table 1), we did not attempt to do so.

At this point, it is perhaps worthwhile noting that the results from Canada and the US really do provide independent evidence. The correlation between the residuals from the “a” models for the two countries is only 0.142, with a  $t$  statistic of 1.45, so that we can safely treat test statistics from the two sets of data as being independent. Moreover, there would appear to be no appreciable gain in efficiency if we were to estimate the equations for the two countries simultaneously.

The above results suggest that the “a” models are quite satisfactory for both countries. Before accepting this conclusion, however, we should subject them to a few more tests. For example, the weights in equation (12), which relate  $\pi_t^*$  to current and past values of  $\pi_t$ , were chosen *a priori*, and the implied restrictions should be tested. The significance levels of the appropriate  $F$  tests are 0.7362 and 0.2298 for Canada and the US, respectively, indicating that the restrictions certainly cannot be rejected.

The way we constructed  $Z_t$  for Canada may seem a trifle suspect. One way to check the validity of our procedure is to do the same thing for the United States (that is, construct  $Z$  as  $\pi^*I/r$ ) and compare the results with those already obtained.<sup>1</sup> The simple correlation between the two measures of  $Z/Y$  turns out to be 0.9675, and when Model IIa is re-estimated with the alternative definition of  $Z_t$ , the results hardly change:  $\hat{\alpha}$  drops slightly from 0.3935 to 0.3758, and  $\log L$  drops slightly from 380.04 to 379.74. This certainly suggests that the procedure used to construct  $Z_t$  for Canada is entirely reasonable.

In order to check for parameter constancy over time, we estimated the two “a” models separately over both halves of the sample (i.e., 1954 to 1966 and 1967 to 1979) and performed Chow tests. The significance levels of these tests were 0.6427 for the US and 0.4544 for Canada, so that the hypothesis of parameter constancy is easily retained. More interesting, perhaps, is the fact that, for both countries,  $\hat{\alpha}$  retained its sign and significance in both halves of the sample, suggesting that inflation-induced overmeasurement of income and savings has always been important, not merely in recent years when inflation rates have been particularly high.

The “a” models exclude a number of variables which, according to various theories, should influence savings rates. The effects of including some of these variables, one at a time, are shown in Table 4, which tabulates the coefficient and  $t$  statistic of the additional regressor, and also those of  $Z_t/Y_t$ . According to many theories, for example, savings should depend directly on wealth, and  $Z_t/Y_t$  may simply be serving as a proxy for the ratio of wealth to income. But when this ratio (or, in the case of Canada, a proxy for it) is added to the regression, it is totally insignificant, and the significance of  $Z_t/Y_t$  is hardly affected.

<sup>1</sup> Unfortunately, the data we used for interest and dividend payments for the United States were seasonally adjusted; raw data appeared to be unobtainable. For our present purposes, it is unlikely that this matters very much.

As we remarked in Section 2, it seems entirely consistent with the spirit of the involuntary savings hypothesis to suppose that only unperceived inflation causes involuntary savings. If so, then adding the regressor  $\pi_t - \pi_t^*$  to the “a” models is a reasonable way to test that hypothesis. The results of doing so are shown in Table 4, and these speak for themselves.

Some economists would argue that savings should depend on the real interest rate, such dependence usually being asserted to be positive. In fact, when  $r_t - \pi_t^*$  is added to the “a” models as a reasonable proxy for the real rate of interest, its coefficient turns out to be negative and insignificant for both countries. For Canada, incidentally,  $Z_t/Y_t$  entirely loses its significance when this is done. We believe that this is a consequence of the way the inflation adjustment variable was constructed for Canada, since  $Z_t = \pi_t^* I_t / r_t$ . Alternatively, one would have to conclude that savings in Canada bear a strong, inverse relationship to real interest rates, which we find implausible.

Finally, it has recently been argued that savings may depend directly on perceived rather than unanticipated inflation; see Bulkley (1981). But the results in Table 4 provide no support for the hypothesis that  $\pi_t^*$  belongs in the regression.

#### 4. Conclusion

We believe that the empirical results presented in Section 3 allow us to draw the following tentative conclusions:

- a) There is little evidence to support Deaton’s hypothesis that unanticipated inflation leads to involuntary savings.
- b) There is quite a lot of evidence to support the hypothesis that inflation leads to higher measured savings rates because income from financial assets is measured incorrectly, although consumers do not increase saving enough to completely offset the overmeasurement of their incomes.

These results must remain tentative because, like all applied workers in econometrics, we do not really know what model generated the data. Although we have subjected the models we estimated to a battery of specification tests, even the best of them do have a few unsatisfactory features. Thus it is quite conceivable that future investigators, more ingenious than we are, may be able to come up with better models, and that these better models may suggest different conclusions.

#### Appendix

In this appendix, we describe the data used in this study. Except as noted, all data were not seasonally adjusted.

##### *Canada*

$CN$  = personal consumption expenditure in current dollars, CANSIM D40043.

$CR$  = personal consumption expenditure in constant 1971 dollars, CANSIM D40562.

$P = CN/CR$

$YN$  = personal disposable income in current dollars, CANSIM D40057.

$$Y = YN/P.$$

$SN$  = personal savings excluding change in farm inventories, CANSIM D40055.

$$S = SN/P.$$

$IN$  = interest, dividends, and miscellaneous investment income, CANSIM D40036.

$r$  = quarterly averages of the McLeod, Young, Weir 40 bond yield average, CANSIM B14031 (monthly), divided by 400.

$$\pi_t = \log P_t - \log P_{t-1}.$$

$$\pi_t^* = 0.25\pi_t + 0.30\pi_{t-1} + 0.25\pi_{t-2} + 0.20\pi_{t-3}.$$

$$Z = \pi^* I/r.$$

TREND = 1 in 1950:1, increasing by 1 each quarter.

### *United States*

Because of the limited availability of seasonally unadjusted data for the US, data were taken from a variety of sources.

$P$  = Consumer Price Index, All Items, All Urban Consumers, supplied by the Bureau of Labor Statistics, quarterly average of monthly figures.

$YN$  = Personal disposable income, taken from a computer printout of Flow of Funds Accounts data, originally supplied by the Board of Governors of the Federal Reserve System.

$SN$  = Personal savings, NIA basis, also from the Flow of Funds Accounts.

$WN$  = Total financial assets of households minus total financial liabilities of households, also from the Flow of Funds Accounts.

$$W = WN/P.$$

$$Z = \pi^* W.$$

$r$  = Quarterly averages of the yield on Aaa corporate bonds, from the Federal Reserve Bulletin.

$IN$  = the sum of interest and dividends seasonally adjusted at annual rates from the Survey of Current Business and Business Statistics, US Department of Commerce.

$$I = 0.25 IN/P.$$

$\pi$ ,  $\pi^*$ ,  $Y$ ,  $S$ , and TREND are defined in the same ways as for Canada.

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**Table 1. Tests of Model Ia**

	United States			Canada		
Added variables	$\log L$	Signif. 1	Signif. 2	$\log L$	Signif. 1	Signif. 2
None	375.20			343.92		
$(Y, Z)_{t-1}/Y_t$	375.63	0.6977	0.6977	344.31	0.7341	0.7341
$(Y, C, Z)_{t-2}/Y_t$	381.56	0.0196	0.0577	346.74	0.2941	0.4979
$(Y, C, Z)_{t-3}/Y_t$	382.89	0.5464	0.1227	349.48	0.2576	0.3909
$(Y, C, Z)_{t-4}/Y_t$	384.17	0.5748	0.2039	351.09	0.5192	0.4716
$(Y, C, Z)_{t-5}/Y_t$	385.67	0.5268	0.2746	351.72	0.8363	0.6567
$(Y, C, Z)_{t-6}/Y_t$	386.75	0.6712	0.3870	355.11	0.2215	0.5264

**Table 2. Tests of Model Ia, Trending Seasonals Omitted**

	United States			Canada		
Added variables	$\log L$	Signif. 1	Signif. 2	$\log L$	Signif. 1	Signif. 2
None	339.53			295.44		
$(Y, Z)_{t-1}/Y_t$	339.58	0.9602	0.9602	296.19	0.5105	0.5105
$(Y, C, Z)_{t-2}/Y_t$	346.59	0.0059	0.0265	297.09	0.6625	0.7113
$(Y, C, Z)_{t-3}/Y_t$	347.69	0.5950	0.0715	311.71	0.0000	0.0004
$(Y, C, Z)_{t-4}/Y_t$	354.70	0.0086	0.0058	323.69	0.0002	0.0000
$(Y, C, Z)_{t-5}/Y_t$	359.66	0.0466	0.0018	324.06	0.8980	0.0000
$(Y, C, Z)_{t-6}/Y_t$	363.78	0.0951	0.0011	325.64	0.4913	0.0000



**Table 3. Estimates of Various Models**

	United States			Canada		
	IIa	IIb	IIab	Ia	Ib	Iab
$a_0$ or $b_0$	0.6476 (0.0452)	0.6728 (0.0650)	0.6310 (0.0662)	0.2485 (0.0437)	0.4861 (0.0785)	0.2976 (0.0830)
$b_1$	0.6387 (0.0464)	0.6669 (0.0670)	0.6209 (0.0686)	0.2179 (0.0453)	0.4594 (0.0820)	0.2690 (0.0859)
$\alpha$	0.3935 (0.1019)		0.2708 (0.1230)	0.5339 (0.0722)		0.5909 (0.1151)
$d_1$		0.0228 (0.0534)	0.0528 (0.0539)		-0.2603 (0.0882)	-0.0683 (0.0910)
$d_2$		0.7202 (0.1503)	0.3223 (0.2296)		0.8077 (0.2127)	-0.1641 (0.2932)
Coef. on $t/1000$	-0.1721 (0.0412)	-0.1541 (0.0398)	-0.1911 (0.0423)	-0.3550 (0.1716)	-0.3535 (0.1938)	-0.3264 (0.1755)
Coef. on $T^2/100000$				0.4036 (0.1368)	0.4230 (0.1584)	0.3722 (0.1438)
$\log L$	380.04	378.95	381.88	343.92	333.65	344.65
Std. Error	0.00673	0.00684	0.00669	0.00986	0.01095	0.00991
AR(1)	0.9213 (+)	0.4193 (+)	0.5968 (-)	0.9490 (+)	0.0128 (-)	0.2727 (-)
AR(4)	0.0382 (-)	0.0286 (-)	0.0201 (-)	0.5923 (-)	0.8144 (-)	0.4497 (-)
AR(1, 2, 3, 4)	0.2339 (-----)	0.1982 (+-----)	0.1444 (-----)	0.7504 (++++-)	0.1495 (---+-)	0.6214 (-++-)

Note: Numbers in parentheses are standard errors.

**Table 4. Adding Additional Regressors to “a” Models**

Regressor	United States		Canada	
	Added regressor	$Z_t/Y_t$	Added regressor	$Z_t/Y_t$
$W_t/Y_t$	-0.000444 (0.58)	0.1347 (4.78)		
$I_t/(r_t Y_t)$			0.00146 (0.88)	0.4099 (7.35)
$\pi_t - \pi_t^*$	0.3345 (1.28)	0.1392 (5.12)	-0.1654 (0.59)	0.4033 (7.31)
$r_t - \pi_t^*$	-0.3278 (0.90)	0.1013 (2.03)	-1.632 (1.60)	0.1078 (0.56)
$\pi_t^*$	0.2199 (0.58)	0.1063 (1.71)	-0.4664 (0.55)	0.4971 (2.73)

Note: Numbers in parentheses are absolute  $t$  statistics.