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Consumption, Real After Tax Interest Rates and Income Innovations.

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Abstract

The empirical evidence concerning the behavior of consumption is not totally conclusive regarding the response to changes in interest rates. Also it often shows that the predictions of the joint hypothesis of permanent income and rational expectations are not fully corroborated by the data. Excess sensitivity of consumption to innovations in income and/or to its predictable component are common findings.

Panel data is an appropiate framework for this kind of analysis, since it avoids aggregation biases and allows differences in behavior according to individual characteristics. Our approach to the measurement of the intertemporal elasticity of substitution of consumption allows for individual variability of interest rates, through individual marginal tax rates. However, measurement errors are important in these kind of data, and ours is not an exception. A considerable effort is put into trying to minimize such errors.

Our results, reproduce some of the usual findings in the literature, particularly regarding the excess sensitivity phenomena. However, there seems to be enough evidence in favor of a positive relationship between interest rates and the consumption ratio. We also obtain some conclusions regarding differences in behavior according to individual characteristics.

1 INTRODUCTION

The theoretical model developed below is quite general, since both interest rates and incomes are uncertain.

Progress in the analysis of the effects of the returns of savings upon the consumption ratio is likely to come from the differentiation of individual returns, since otherwise it is not possible to separate the influence upon consumption of the evolution of real interest rates from other macroeconomic events. Our set of data, a panel of spanish income tax payers from 1982 to 1988, permits us to define individual real after taxes rates of return of savings.

The purpose of the analysis is therefore to supply new microeconomic evidence both to the joint hypothesis of permanent income- rational expectations, and to the significance in this framework of the intertemporal elasticity of substitution of consumption to real after taxes interest rate.

1.1 Consumption in a certain world

The time path of consumption for each individual is considered to be the result of a process of maximization of utility across his life horizon. As will be seen below, if future incomes are perfectly known, and tastes and other individual characteristics are constant, consumption is expected to follow a constant trend if interest rates are constant, and to deviate from it in front of changes -expected or not- in interest rates. The sensitivity of consumption to changes in interest rates provides a measure of the intertemporal elasticity of substitution of consumption with respect to its relative price.

Assuming that decisions of labor supply and consumption are separable, the objective function for each consumer who expects to live T periods is:

$$u(c) = u(c_1, c_2, \ldots, c_T) \tag{1}$$

If we also assume that utility is time separable and preferences are stable and defined through a rate of pure time preference δ, we can write:

$$u(c) = \sum_{t=1}^{T} \left(\frac{1}{1 + \delta} \right)^{t-1} v(c_t) \tag{2}$$

Individuals maximize (2) subject to their intertemporal budget constraints:

$$A_t = (1 + r_{t-1})A_{t-1} + y_{t-1} - c_{t-1} \qquad (3)$$

$$A_{T+1} = 0 \qquad (4)$$

The value of assets at the beginning of t, A_t, equals those at (t-1) plus their revenues, plus the difference between labor income and consumption during the period. The terminal condition assumed for simplicity is that individuals do not transfer assets to future generations.

First order conditions for the maximization of (2), subject to (3) and (4) , expressed in real terms, are the following:

$$\lambda(t) = u_c'(t) \qquad (5)$$

$$\lambda(t)/\lambda(t-1) = \left(\frac{1 + \delta}{1 + r_{t-1}}\right) \qquad (6)$$

Expression (5) says that, in each period, marginal utility of wealth equals in equilibrium marginal utility of consumption. Expression (6) is the Euler equation which establishes the equality of the ratio of marginal utilities to the ratio of the rate of time preference to the rate of interest.

To make this conditions operational we need to define a utility function. Let's take a quite general one, a member of the "constant relative risk aversion" class: $u_c(t) = 1/(1+\alpha)c_t^{(1+\alpha)}$

Marginal utility is then:

$$u_C'(t) = c_t^{\alpha} \qquad (7)$$

where α has to be negative to guarantee negativity of the second derivative.

Substituting (7) into (5) and (6), we can write:

$$c_t^{\alpha} \;/\; c_{t-1}^{\alpha} = \left(\frac{1+\delta}{1+r_{t-1}}\right), \quad \text{and}$$

$$c_t/c_{t-1} = \left(\frac{1+\delta}{1+r_{t-1}}\right)^{1/\alpha} \qquad (8)$$

Expression (8) permits us to derive the well known following implications for the time behavior of consumption under certainty, for a well behaved utility function ($\alpha < 0$):

(a) For a given constant rate of interest, consumption is constant, increasing or decreasing across time according to whether interest rate is equal, higher or lower than the "impatience" rate.

(b) If the interest rate increases (decreases), the ratio of consumption will increase (decrease). The magnitude of this effect will be determined by ($1/\alpha$), the intertemporal elasticity of substitution.

1.2 Uncertainty

In a world where legacies as well as life duration are known, two sources of uncertainty may still be present: the evolution of wages and of interest rates. The existing literature usually faces only one of the two problems: either future income is known and uncertainty is placed in the evolution of interest rates or, more frequently, interest rates are considered known (and constant), and the analysis focuses on the effects of non- expected income.

On the other hand, as far as the behavior of individuals in front of uncertainty is assumed to be rational, both theoretical and empirical results concerning the evolution of consumption refer to the joint hypothesis of permanent income- rational expectations.

When interest rates are the only uncertain element, Hall (1978) demonstrated that the only contemporaneous information that helps to predict future consumption is present consumption, and that only non- expected changes in interest rates can move consumption away from its deterministic path.

In our analysis we consider future interest rates uncertain, but we do not differentiate between expected and unexpected changes, which amounts to consider that the whole change is unexpected. This simplifying approach is justified for two reasons. First, because changes are small and they are a weighted mean of three independent components: nominal interest rates, prices and tax rates. And second and more substantial, because Hall's propositions do not preclude the fact that anticipated changes in interest rates can influence the ratio of consumption, although the influence is already incorporated in the deterministic (and variable as a consequence of changing interest rates) trend.

As already mentioned, evidence with respect to the role of interest rates on the intertemporal allocation of consumption is not clear. There are many difficulties to obtain robust estimators of the elasticity of substitution, given that individual interest rates are roughly observed and in most studies too close to zero and to stable to expect any substantial reaction. But, apart from empirical shortcomings, not even the theory is conclusive in this point since a variation on interest rates induces a substitution effect, but also an income effect in the opposite direction and a wealth effect.

If income is the variable that has an stochastic component, the predictions of the theory are that an unexpected change in income (an innovation in income) induces a revision of consumption in all future periods (a change once for all in the level, but not in the slope of the consumption trend), and that the present value of the revision in wealth equals the present value of the revision of consumption.

Evidence concerning the role of changes in income upon the ratio of consumption, suggest in general that the predictions of the theory are only partially fulfilled. In Flavin's (1981) study using aggregate data an excess sensitivity (non-zero coefficient) of the ratio of consumption to predictable changes in income is found. In individual studies,- and referring also to a well-known one -, Hall and Mishkin (1982) found an excess sensitivity of consumption to innovations on income in a subset of the population observed.

Those findings do not necessarily imply a rejection of the theory. In fact, some arguments have been put forward and tested, which reconcile the empirical findings with the theoretical predictions. One of the more powerful argument in this line is that there is a fraction of the population that does not follow the model because they are submitted to credit restrictions. For the people whose borrowing capacity is limited, consumption follows income more closely than in the ideal case of perfect capital markets.

Precautionary saving is the other important argument, but one that has received less attention in the literature up to now. If the utility function is one of constant relative risk aversion, as the one defined above, (marginal utilities decrease at an increasing and not at a constant rate - as would be the case if the utility function was one of constant absolute risk aversion -), then individuals that face uncertainty about their future income may wish to hold a certain amount of precautionary saving as a buffer to prevent a decrease in future consumption if they go through a negative shock of income. Obviously, this argument is closely related to the former, since only people who is liquidity constrained is compelled to reduce consumption according to income. In fact, both hypothesis combined offer a picture where, in front of uncertainty, credit restrictions justify to hold a certain amount of savings, in which case credit restrictions may not even be operative or binding (see Deaton, 1991).

It has also frequently being argued that the failure to fully corroborate the theory in empirical work is due to shortcomings of the tests. Measurement errors in data, inadequate distinction between consumption of durables and non- durables, etc.

2 THE MODEL

2.1 Theoretical framework

The steps followed in this section to obtain an expression for the ratio of consumption under uncertainty are basically the same followed above for the certainty case, under the assumption that individuals in front of uncertainty behave according to the hypothesis of rational expectations.

In a context of uncertainty the consumer typically maximizes expected utility across time, subject to his budget constraints, which can be affected by economic policy.

The arguments of the utility function are consumption, leisure and taste shifts, which can be specified as a random component (Altonji and Siow, 1987), or as a function (generally linear) of familiar characteristics (Zeldes, 1989a). Given the partial equilibrium context, some of the variables are exogenous: wages, interest rates, taxes and prices.

Since we do not have data on hours worked, we have to assume separability in each period between consumption and leisure in the utility function: $u(c(t), h(t), z(t)) = u(c(t), z(t)) + u(h(t), z(t))$, where $c(t)$ is consumption at t, $h(t)$ are hours worked at t, and $z(t)$ is a parameter for changes in tastes at t.

Time horizon is finite and equal to T periods. We assume for convenience in empirical work that utility is strongly separable across time, and that the consumer discounts the value of future utility through the parameter δ, or pure rate of time preference.

We follow McCurdy (1983) to set up a very general framework of reference, allowing for the presence of different assets, although in the empirical work we consider one single asset. The consumer can then hold any combination of g different assets. The variables $A_j(t)$ and $A_j^*(t)$ denote the nominal value of asset j at the beginning and at the end of period t. The difference between them are the savings done by the agent during period t in this asset: $S_j(t) = A_j^*(t) - A_j(t)$. Non human wealth is the sum of assets before taking any decision about consumption (or savings) in t: $\sum_{j=1}^{g} A(t)$. Wealth once the decisions have been taken is consequently $\sum_{j=1}^{g} A_j^*(t)$. Total savings in t are $S(t) = \sum_{j=1}^{g} S_j(t)$.

If $r_j(t)$ is the revenue during t of each unit of asset j, capital income at the end of t is: $Y^A(t) = r_j(t)A^*_j(t)$; $Y^L(t) = w(t)h(t)$ denote in turn labor income during t. Both income source may be totally or only partially known when the individual decides about its consumption.

We assume that taxes on income of period t ($M(t)$) are paid at the beginning of period (t+1), and that are determined according to the following function: $M(t) = M(Y^L(t), Y^A(t), \phi(t))$, where $\phi(t)$ is a vector of parameters of the tax function which include deductions, exemptions, marginal tax rates, etc.. The function M(t) satisfies an assumption of temporal separability in the sense that tax paid depend only on income of the corresponding period. In the analysis that follows we assume $M(\cdot)$ to be continuously differentiable in his first argument, so as the marginal rate associated to labor income always exist.

Vectors $\{ v(t') = (z(t'+1), p(t'), w(t'), r_1(t'), \ldots, r_g(t'), \phi(t'+1)), t' \geq t \}$, contain all the variables which are totally or partially uncertain at the beginning of t, when we assume for convenience that consumption decisions are taken.

Those components can be contemporaneously or temporarily correlated. Formally, the problem of the consumer in each period is:

$$\underset{c(k),A_1^*(k),...,A_g^*(k)}{\text{Max}} \quad E_t\left\{\sum_{k=1}^{T}\left(\frac{1}{1+\delta}\right)^{k-t} u(k)\right\} =$$

$$= \underset{c(k),A_1^*(k),...,A_g^*(k)}{\text{Max}} \quad u(t) + \frac{1}{1+\delta} E_t\left\{\sum_{k=t+1}^{T}\frac{1}{(1+\delta)^{k-t-1}} u(k)\right\}$$

subject to:

$$S(k) = \sum_{j=1}^{g}(A_j^*(k) - A_j(k)) = w(k)h(k) - p(k)c(k) - M(k-1) \qquad (10)$$

$$A_j(k+1) = A_j^*(k)\ (1+r_j(k)) \quad k = t,t+1,...,T \qquad (11)$$

$A_1(t),...,A_g(t)$ are predetermined. We assume, for simplicity the terminal condition $A_j(T+1) = 0$, for $j = 1,2,...g$. E_t is the operator of the mathematical expectation conditioned to the information set of the agent at instant t.

Fist order conditions for this problem are:

$$u_c(t) = \lambda(t)p(t) \qquad (12)$$

$$-u_h(t) = \lambda(t)(1-m(t))w(t) = \lambda(t)\omega(t) \qquad (13)$$

$$\lambda(t-1) = (1/(1+\delta)) \ E_{t-1}(\lambda(t)(1+R_j(t-1)) \qquad (14)$$

where $m(t) = \delta \ M(t)/\delta \ Y^L(t)$, the marginal tax rate on labor income and

$$R_j(t) = r_j(t) \left[1-\frac{\partial M(t)}{\partial Y_j^A(t)}\right]$$

the after tax marginal interest rate.

The Euler equation (14) says that in equilibrium the composition of assets hold by a consumer is such that marginal utilities of the last monetary unit ($\lambda(k)$) invested in each asset are equal.

2.2 Parameterization of the model

We assume that utility is defined by a constant relative risk aversion function, so that the expression for the marginal utility of individual i is $u_c'(i,t) = c(i,t)^{\alpha} \exp(\mu(i,t))$.

We write expression (14) in the form:

$$(1/(1+\delta))\ \lambda(t)\ (1+R_j(t-1)) = \lambda(t-1) + \varepsilon(t) \qquad (15)$$

where $\varepsilon(t)$ is a forecast error orthogonal to any variable belonging to the set of information of the family in period (t-1). Since $\varepsilon(t)$ is not correlated with any variable known at the moment (t-1) or before, it is non predictable before (t).

The forecast error is interpreted as the revision of the marginal utility of wealth of agents at the beginning of period (t), depending on unpredicted facts or "surprises" in the realization of the vector of random variables v(t') in (t).

The logarithmic expression of (15) is:

$$\ln \lambda(i,t) + \ln\ (1+R(i,t-1)) = \ln\ (1+\delta) + \ln(\lambda(i,t-1)+\varepsilon(i,t)) =$$
$$= \ln\ (1+\delta) + \ln \lambda(i,t-1) + \varepsilon(i,t)/\lambda(i,t-1) \qquad (16)$$

Notice that interest rate is different for each individual and period, even considering a single riskless asset with a fixed nominal interest rate, since taxes are individual.

Substituting (12) into (16), and using the utility function defined above we obtain:

$$\ln c(i,t) = (1/\alpha) \ln (1+\delta) + (1/\alpha) (\ln p(t)- \ln p(t-1)-(1/\alpha)\ln (1+R(i,t-1)) + \ln c(t-1) - (1/\alpha) (\mu(t)-\mu(t-1))+\xi(i,t) \qquad (17)$$

where $\xi(i,t) = (1/\alpha) \varepsilon(i,t) / \lambda(i,t)$

Rearranging terms, we rewrite (17) as :

$$\Delta \ln c(i,t) = (1/\alpha) \ln (1+\delta)- (1/\alpha) \ln [(1+R(i,t-1))\cdot p(t-1)/p(t)] - (1/\alpha) \Delta\mu(i,t) + \xi(i,t) \qquad (18)$$

Denoting as $R^*(i,t-1)$ the term in brackets in the former expression, we obtain a more compact equation:

$$\Delta \ln c(i,t) = (1/\alpha) \ln (1+\delta) - (1/\alpha) \ln [R^*(i,t-1)] - (1/\alpha) \Delta\mu(i,t) + \xi(i,t) \qquad (19)$$

The value $\xi(i,t)$ is a forecast error which depends on the innovations produced in the after tax labor and capital income.

Expression (19) has the following economic interpretation. At the beginning of period (t-1) individual decide the amount of savings of the period as a function of $R^*(t-1)$ (which can be partially unobserved), and the corresponding allocation between present and future consumption. Given the hypothesis of temporal separability in the utility function, we can focus in the allocation between c(t-1) and c(t). The planned value of c(t) can nonetheless suffer a revision at the beginning of t, after the income innovations in t are known.

The expected sign of $R^*(t-1)$ in the estimations is therefore positive, since higher values of $R^*(t-1)$ are expected to induce higher savings in (t-1) and consequently higher values of consumption in t with respect to (t-1). A high value of the coefficient indicates that the elasticity of substitution is high, or that risk aversion is small, and so that interest rates are strongly explanatory, as a consequence of a very lineal (or slowly decreasing) marginal utility, and vice versa.

The expected sign of the constant is negative, since α is negative and δ positive, although we can not expect to estimate it with enough precision.

The panel data set used in this research contains serious problems for the measurement of consumption, since we have to approach it through the difference between disposable income and "observable" savings. "Observable" savings are the class of savings which are tax deductible. If upper index "d" and "nd" indicate the part of savings which are deductible and non deductible, respectively, we can write:

$$\Delta \ln c(i,t) = \Delta \ln (yd(i,t) - s(i,t))$$

and

$$\Delta \ln (yd(i,t) - s(i,t)) = \Delta \ln (yd(i,t) - s^{d}(i,t)) + \ln (c(i,t)/ (c(i,t) + s^{nd}(i,t))$$

Therefore:

$$\Delta \ln (yd(i,t) - s^{d}(i,t)) = (1/\alpha) \ln(1+\delta) - (1/\alpha) \ln[R^{*}(i,t-1)] --(1/\alpha) \Delta\mu(i,t) + \xi(i,t) - - \Delta \ln(c(i,t)/(c(i,t) + s^{nd}(i,t)) \qquad (20)$$

The last three terms of expression (20) are a composite error containing revisions in consumer tastes, forecast errors and the measurement error that follows from the incomplete observation of savings.

We consider that part of this error consist on a time component equal across individuals, determined by the impact of macroeconomic shocks, business cycle, changes in the fiscal policy of government, or changes in the risk premium of different assets, (which can induce substitution among deductible and non deductible classes of assets).

Certain family characteristics, like the source of income, size of the family, and so on can also help to reduce the magnitude of the composite error, as far as they discriminate among groups of individuals with different consumption time paths. The modified specification to take both facts into account is the following:

$$\Delta \ln (yd(i,t) - s^d(i,t)) = (1/\alpha) \ln (1+\delta) - (1/\alpha)\ln[R^*(i,t-1)] + \nu(t) + a_k x_k(i,t-1) + w(i,t) \quad (21)$$

where $\nu(t)$ is a time dummy and $x_k(i,t-1)$ is the k characteristic of family i in period (t-1).

2.3 Innovations

Revisions of the marginal utility of wealth depend, as has been stated above, on the "surprises" or "innovations" produced in the vector of uncertain variables. Those revisions imply a reevaluation of the plans for future consumption. The time profile of consumption will be unaffected, since it depends on the rate of interest, but the level will change.

Given our utility function, we can rewrite (15) (after eliminating the individual notation for simplicity) for a given interest rate as follows:

$$c(t)^{\alpha} = \left(\frac{1+\delta}{1+r}\right) c(t-1)^{\alpha} + \left(\frac{1+\delta}{1+r}\right) \varepsilon(t) \qquad (22)$$

or

$$c(t) = (\psi\ c(t-1)^{\alpha} + \psi\ \varepsilon(t))^{(1/\alpha)}$$

where $\psi = ((1 + \delta)/(1 + r))$

Following a Taylor expansion around $\varepsilon(t) = 0$, we get:

$c(t) = \psi^{(1/\alpha)}\ c(t-1) + (1/\alpha)(\psi\ c(t-1)^{\alpha})^{((1/\alpha)-1)}\psi\cdot$ $\cdot\varepsilon(t)$, plus other higher order elements. Substituting $\xi(t)$ for the last term of the former equation, and defining $\vartheta = \psi^{(1/\alpha)}$ we can write:

$$c(t) = \vartheta\ c(t-1) + \xi(t) \qquad (23)$$

Notice that an unexpected increase in income, for instance, will reduce marginal utility of wealth, so that $\varepsilon(t)$ will be negative. $\xi(t+1)$ will nonetheless be positive, since α is negative to guarantee a well behaved utility function, and consequently consumption will suffer an upward revision.

The relationship between the revisions of consumption and innovations is established through the equalization of the present value of the revisions, between (t-1) and t, of expected income flows and consumption flows. Considering that labor income is the only random variable that remains, once assumed that after taxes revenues from capital are known, we can formalize the problem as follows:

$$\eta(t) = \sum_{\tau=0}^{T-t}(1+r)^{-\tau}(E_t\ y(t+\tau) - E_{t-1}\ y(t+\tau)) \qquad (24)$$

Furthermore, the budget constraint condition implies that $\eta(t)$ equal the present value of the changes in expected consumption

$$\eta(t) = \sum_{\tau=0}^{T-t}(1+r)^{-\tau}(E_t\ c(t+\tau) - E_{t-1}\ c(t+\tau)) \qquad (25)$$

Considering that $E_{t+s-1}c(t+s) = \vartheta^s\ c(t)$, we obtain:

$$\eta(t) = \Sigma\ (1+r)^{-\tau}\ (\vartheta^\tau\ c(t) - \vartheta^{\tau+1}\ c(t-1)) =$$

$$= \xi(t) \Sigma ((1+r)^{-\tau}\vartheta^{\tau})$$

and therefore

$$\xi(t) = \beta(t)\eta(t) \quad \text{with} \quad \beta(t) = 1/ \Sigma (1+r)^{-\tau}\vartheta^{\tau} \quad (26)$$

The link between the innovation and the forecast error is much more complicated when interest rates are stochastic, so that to take a linear approximation is fully justified.

In summary, income shocks will influence consumption through a function $\beta(t)$ of the present value of the revision of expected income. The functional form of the revision of expected future incomes depends on the characteristics of time persistence of the shocks, as explained below.

The final equation to estimate, which differ from the former in that it has an specific term for innovations in the income process is the following:

$$\Delta\ln (yd(i,t) - s^{d}(i,t)) = (1/\alpha) \ln (1+\delta) - $$
$$- (1/\alpha) \ln [R^{*}(i,t-1)] ++\nu(t) + \Sigma a_{k} x_{k}(i,t-1) +$$
$$b\hat{\eta}(t) + \omega(i,t) \quad (27)$$

where $\hat{\eta}(t)$ are the estimated values of the revisions in the logarithmic income process. In the composition of the remaining error term w(i,t), on the other hand, together with changes in tastes and measurement error, we have now the estimation error of the income process and the error given by the fact of considering certain the evolution of future real after taxes interest rates.

To obtain a measure of the revisions of the income process we specify a model of behavior for the ln of disposable income:

$$\ln y(i,t) = H(i,t-1)\Omega + \beta_1 \ln y(i,t-1) + \beta_2 \ln y(i,t-2) + u(i,t) \qquad (28)$$

The model is an AR(2) with a trend influenced by individual characteristics, where u(i,t) denotes the forecast error in t. The model can be inverted and transformed in a moving average of infinite order. Focusing for the moment only in the AR terms of the equation [1] :

$$\ln y_t = \frac{\beta_0}{1-\beta_1-\beta_2} + \sum_{\tau=0}^{\infty}\left\{\left(\frac{\lambda_1}{\lambda_1-\lambda_2}\right)\lambda_1^{\tau} - \left(\frac{\lambda_2}{\lambda_1-\lambda_2}\right)\lambda_2^{\tau}\right\} u_{t-\tau} \qquad (29)$$

where

$$\lambda_1 = \frac{2\ \beta_2}{-\ \beta_1 + \sqrt{\beta^2_1 + 4\beta_2}} \quad \text{and} \quad \lambda_2 = \frac{2\ \beta_2}{-\ \beta_1 - \sqrt{\beta^2_1 + 4\beta_2}}$$

Our estimation of the income process yielded $\beta_1 = 0.730481$ and $\beta_2 = 0.177084$, therefore $\lambda_1 = 0.92245197$ and $\lambda_2 = -0.19197092$.

The moving average terms become

$0.7305u_t + 0.71069u_{t-1} + 0.6485u_{t-2} + 0.5996u_{t-3} + 0.5528u_{t-4} + 0.5100u_{t-5} + \ldots + 0.3406u_{t-10} + \ldots + 0.2275u_{t-15} + \ldots + 0.1520u_{t-20} + \ldots + 0.0678u_{t-30}$

As we can see, the degree of persistence is very large, since income 20 periods ahead still influences current income.

This, which is true for the logarithmic process, is also true for the process $y_t = e^{\beta_0} y_{t-1}^{\beta_1} y_{t-2}^{\beta_2} e^{u_t}$

which can also be expressed as

$$y_t = e^{(\beta_0/(1-\beta_1-\beta_2))} \prod_{\tau=0}^{\infty} e^{\{(\lambda_1/(\lambda_1-\lambda_2))\lambda_1^{\tau} - (\lambda_2/(\lambda_1-\lambda_2))\lambda_2^{\tau}\}u_{t-\tau}}$$

Calculating the present value of the revisions in that process is rather complicated, but the interpretation of the b coefficient in the consumption function is straightforward.

The values obtained by assuming that the remaining life length of our representative agent is instead 30 years, for instance, would differ very little from the ones given for an infinite horizon, since the additional terms are very small, and also because we apply the same hypothesis when we discount income than when we discount consumption.

Equation (27) contains also a matrix H(i,t-1) with a constant, time dummies, and the same group characteristics dummies included in the consumption equation.

3 DATA AND ECONOMETRICS

The data source is the Instituto de Estudios Fiscales panel of income tax payers in the fiscal years 1982-1988. We work with a pure sample of 1021 declaring individuals with positive observable savings every year.

All the information used is obtained in the panel, except the nominal rate of interest for each year and the consumption price index. In Table 1 we define all the variables used. Consumption is the difference between available income and observable savings. This last variable in turn is obtained by addition of the three classes of deductible savings: real state (SVIV), securities (SP) and life insurance (SSG). The value of each class of savings is the quantity of the deduction divided for the rate of deduction established for each fiscal year. In Table 2.1 yearly information is given about the types of deductible assets, the rates of deduction and their limits.

This measure of savings presents some problems. First, it is an incomplete measure, since it does not cover all types of savings. The fact that we observe only a part of total wealth accumulation poses the problem that its share of total savings can differ across individuals and through time. Second, the changing composition of the different categories of deductible savings through time complicates the problem, since it adds a new source of substitutability. And third, in the original data observable savings is a variable with a double limit of observability. Negative values of savings are put at zero, and there is an upper bound for deduction.

Former work (Lasheras, Monés y Salas 1991) treat the observability problem by performing Tobit and Probit regressions with average savings as the dependent variable. However, while these techniques are readily implemented when the equations to estimate are in levels, they become very difficult to deal with when the dependent variable is a ratio of two double limited consumptions. There are nine regions in which the value of the ratio can lay and ordered probit or logit regressions are not possible.

Our results are based on GMM, taking only the sub sample of observations where savings are positive and not bounded upwards in two years. This, of course, introduces some sample bias (see table 2.2, where we compare mean values for this sample and for an alternative one in which this kind of bias does not exist).

We do not renounce (in future work) to correct sample bias through the adoption of Heckman's two-stage estimation techniques or other suitable methods.

Real after taxes interest rate (LRDIL) has been obtained on the basis of a nominal interest rate (the revenues of Bank accounts between six month and one year), the consumption price index, and the individual marginal tax rate in each year. The rest of nominal variables are also deflated by the consumption price index.

4 RESULTS

The main block of results contains the standard model developed in the paper (Table 3.1), an extension of it to include as extra variable the predicted increases in income: DYPRED (3.2), and two reduced forms. One omitting the term of innovations, but leaving DYPRED (3.3), and the other excluding both unpredicted and predicted changes in real disposable income (3.4).

Estimation of the income process is shown in Table 3.6. As far as we use this equation to decompose unpredicted from predicted changes in individual income, we are assuming that macroeconomic shocks (time dummies) enter the set of information of agents. This leads to an undervaluation of individual innovations, which can influence the value of the coefficients of the income variables in the consumption equation.

Our results point to a significant role of real after tax interest rates upon intertemporal allocation of consumption. Leaving aside some exceptions, like Mankiw, Rotenberg & Summers (1985), most available empirical evidence is not conclusive on this point, and values of the coefficient are normally below one.

Three reasons can help to explain these differences. First, the evidence based on macro data probably underestimate the effect of interest rates due to aggregation bias (Attanasio & Weber, 1987). Second, a sample of individuals of medium and high income levels (this is the bias of our sample, since we have selected individuals with positive saving) is likely to show a higher elasticity than a representative sample (Lawrence, 1991). And third, elasticity of total consumption is expected to be higher than that of consumption of non durables. It is consequently important to take into account that the validity of our results is limited to its particular context.

Comparing the results concerning the interest rate across the different Tables, we observe that the coefficient and significance decreases substantially when the innovation term is excluded from the equation. This is reasonable, since the omision of the most significant variable from the equation leads to a very imprecise estimation of the whole model.

The second main concern of this paper is to analyse the effect of income upon consumption. Unexpected income changes shows a high significance, as expected. Predicted increases in income (see Table 3.2) seem to be also slightly *significant, although it is most likely due to the* already mentioned definition of this variable, which overestimate the information of the agent. An alternative test, similar to that of Flavin (1981) is provided in Table 3.5, where DYPRED is substituted for DYDLAG. The significance of DYDLAG is similar to that of DYPRED, as one could expect given the income process.

With respect to the presence of excess sensitivity of consumption to unexpected income changes, the theory says that, to satisfy the intertemporal budget constraint, transitory income surprises must have a smaller effect on consumption than more permanent ones. Therefore the value of the coefficient of the innovation terms depends on the degree of persistence of the income shocks. A constant elasticity of consumption to income innovations implies a decreasing average and marginal propensities to consume out of unexpected income. Leaving aside this restriction imposed by our utility function choice, the coefficient obtained is -apparently- suggesting excess sensitivity of consumption. But persistence in our income process is high: the present value of the stream of the revised income that follows to one unit of current unexpected increase in income is around 2.4.

The coefficient of the innovation term in the consumption equation is the elasticity of the revision of consumption in t that follows an income shock in t. The proposed income process (simplified) is

$$\ln y_t = \beta_0 + \beta_1 \ln y_{t-1} + \beta_2 \ln y_{t-2} + u_t$$

which implies

$$y_t = e^{\beta_0} (y_{t-1}^{\beta_1}) (y_{t-2}^{\beta_2}) e^{u_t}$$

Let $y_t^P = e^{\beta_0} (y_{t-1}^{\beta_1}) (y_{t-2}^{\beta_2})$,

then[2] $u_t = \ln(y_t / y_t^P)$

We do not think that our results (specially those in Table 3.2) necesarily contradict the predictions of the theory, taking into account the presence of a part of savings in the measure of consumption, which inflates the coefficient,and the decomposition of income changes among predicted and unpredicted. Moreover, some degree of excess sensitivity does not question the model, specially if the income process shows a high degree of uncertainty (Deaton, 1991), measured through the standard error of innovations, as in our case (the innovations of the log-income process range between 0.226 in 1983 to 0.31 in 1988).

In fact, in this context the principle of "certainty equivalence" does no presumably hold, allowing for the presence of "precautionary savings". Although our sample is biased towards rich people, and therefore one can not argue that credit restrictions reinforce the tendency of having a cushion in case of sharp or long lasting income cuts, it is reasonable to assume that individuals in our sample hold a certain amount of assets to face future surprises.

Apart from time dummies, we find that some personal characteristics are significant to explain the time profile of consumption. Married people increase their consumption less (has a higher saving ratio) than the rest of the population. With respect to main sources of income only agriculture show a higher ratio of consumption than the excluded cathegory, labor income. The remaining variables considered do not show explanatory power: number of children, other family charges, age above 70, medical expenditures in (t-1), etc.

We conclude summarizing the results from our income process estimation (3.6). With respect to the excluded socioprofessional class, employees, all the rest show a steeper trend. This is observed also for dividend perceivers. The income profile of people that in the former period realized capital gains, as well as of the elder group of individuals, is on the contrary flatter than that of the rest.

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TABLE 1

DCONS :	Change of the logarithm of consumption between t and t-1
LRDIL :	Logarithm of the real after-tax interest rate
D83 A D88:	Time dummies, excluding 1982
DRNCM :	Dummy for negotiable capital as major source of income relative to labor income.
DRNCI :	Dummy for real estate capital as major source of income.
DRNP :	Dummy for professional activities as major source of income.
DRNE :	Dummy for managerial activities as major source of income.
DRNA :	Dummy for agricultural activities as major source of income
D70 :	Dummy for old age, equal to 1 for those individuals that are 70 years old in any of the years of the panel or before.
DDM :	Dummy for married couples joint declaration
HIJOS :	Number of children
PRNT2 :	Percentage of income earned by the second perceiver
ASCEN :	Number of ancestors earning less than 600000 ptas., living with the declaring.
ENFER:	Dummy of illness. Equals one if the deduction for illness expenditures is greater than 16000 ptas from 1987.
DDIV :	Dummy for dividends perceptions.
DINV :	Dummy for handicapped.
DINVEMP:	Dummy de investments in own firms.
LYDL :	Log. disposable income in constant (1987) ptas.
INCPATL :	Net real changes in patrimony.
DYPRED :	Change in real predicted income between t and t-1.
UAR2 :	Residuals from the income process regression.

TABLE 2.1

DEDUCTIONS FOR SAVINGS IN THE IRPF QUOTA

	1982-84	1985-86	1987	1988
HABITUAL	15%	15%	15%	15%
A) HOUSING				
NO HABIT.	-	17%	17%	10%
FIXED INCOME		15%	-	-
B) SECURITIES	15%			
VARIABLE INCOME		17%	10%	*
(stocks)				
C) ASSURANCES				
PREMIUM	15%	15%	10%	10%

Note:

- in 1982 there was no limitation to house deduction; the limit to securities discounts was 25% of taxable income, and 45000 pesetas for the assurance premium. The later stays in 1983 and 1984, when the joint limit for housing and securities becomes 30% of taxable income.

- after 1985, the joint limit for A, B and C is 30% of taxable income.

- between 1985 and 1987 the 17% deduction is applied no non habitual housing and also to new houses.

- * here "Retirement plans" are included. The securities deduction disappears.

[1] See , for example, the chapter on lag operators in "Macroeconomics", by Thomas Sargent.

[2] The elasticity, ε, is

$$\frac{d\ln(c_t/c_{t-1})}{d\ln(y_t/y^P_{t-1})}=\frac{y_t/y^P_{t-1}}{c_t/c_{t-1}}\frac{d\,c_t/c_{t-1}}{d\,y_t/y^P_{t-1}}=\frac{y_t/y^P_t}{c_t}\frac{d\,c_t}{d\,y_t/y^P_t}=0.77$$

If, for example, no surprise in income was expected, the ratio $y_t/y^P{}_t$ would be equal to 1. Suppose predicted income is 1000000 pesetas, but a shock rises it to 1100000. Then the change in $y_t/y^P{}_t$ is 0.1. If consumption was, say, 900000 pesetas, the change in consumption will be 900000x0.1x0.77 = 69300 pesetas.

An alternative expression for the elasticity is $(y_t/c_t)(dc_t/dy_t)$.

Table 2: 2 **Some sample means: positive savings**

VARIABLE	1982	1983	1984	1985	1986	1987	1988
TM	0.2252	0.2391	0.2548	0.2798	0.2879	0.2931	0.3081
CONSL	1703188	1700307	1677629	1733515	1757816	1884223	2043997
LRDIL	-	-0.0377	-0.004884	0.0038	-0.0108	0.0109	0.0145
LCONSL	14.1884	14.2145	14.2248	14.2576	14.2628	14.3283	14.3930
DCONS	-	0.0260	0.0104	0.0328	0.0052	0.0655	0.0647
YDL	2026279	1978352	1922749	1965413	2006223	2089832	2231213
LYDL	14.3986	14.3805	14.3623	14.3817	14.3929	14.4296	14.4812
INCPATL	-2290	-14351	-16371.7	5278	24361	17530	27883
SPL	46692	56110	62440	78431	94431	26268	4452
SSGL	53680	44629	13862	14016	17044	30206	29742
SVIVL	222720	177306	168818	139451	136932	149135	153022
STOTL	323091	278045	245119	231898	248407	205609	187216

Table 2: 3 **Some sample means: alternative sample**

VARIABLE	1982	1983	1984	1985	1986	1987	1988
TM	0.2063	0.1624	0.1864	0.2130	0.2267	0.2292	0.2240
CONSL	1343770	1314784	1279925	1286424	1270725	1333660	1503929
LRDIL	-	-0.0356	0.0037	0.0114	-0.0043	0.0161	0.0198
DCONS	-	0.0157	0.0231	0.0399	0.0179	0.0285	0.0952
YDL	1527334	1475619	1393272	1402566	1404973	1454019	1608161
LYDL	14.0781	14.0447	13.9778	13.9918	13.9736	13.9890	14.0631
INCPATL	-5056	-3413	-687212	6923	17626	23395	45162
SPL	29661	36451	38595	46546	62104	18784	4266
SSGL	55335	46610	7847	6161	8595	14968	18340
SVIVL	98567	77774	66905	63435	63549	86606	81626
STOTL	183564	160835	113348	116141	134248	120358	104232

In tables 3.1 to 3.5 we present some GMM estimations. The number of instruments is 13 for each period. There are 4 periods. The dependent variable is the difference of the logarithm of consumption between periods t and t-1. In table 3.6 we present the estimated income process. The dependent variable is the logarithm of real disposable income.

Table 3: 1

	PARAMETERS	ST. ERRORS	T-STATISTICS
CONSTANT	-.0026866	.0225643	-.1190662
DRNCM(t-1)	-.2219460	.4179118	-.5310834
DRNEA(t-1)	.0796678	.0258178	3.0857704
DRNP(t-1)	.0628986	.0486396	1.2931565
DRNCI(t-1)	6.3108179	3.9990057	1.5780967
DDM(t-1)	-.0371802	.0201203	-1.8478961
EDAD3	.0161544	.0168202	.9604194
HIJOS(t-1)	.0027078	.0032400	.8357648
ASCEN(t-1)	-.0178602	.0112248	-1.5911385
ENFER(t-1)	.0000213	.0248898	.0008576
DINVEMP(t-1)	-.1014004	.0767095	-1.3218750
DDIV(t-1)	.0215820	.0153000	1.4105871
DINV(t-1)	-.0246355	.0888543	-.2772570
LRDIL	16.1262053	1.8761396	8.5954189
U	1.0845565	.1475459	7.3506365
DUMMY86	.2053409	.0283333	7.2473449
DUMMY87	-.0893496	.0150392	-5.9411310
DUMMY88	-.1460252	.0216433	-6.7469175
TEST	D. F.	VALUE	PROB $\leq$
χ^2	34	47.8702331	0.94230
Wald (all)	18	476.998134	1
Wald (time)	3	54.142041	1

Table 3: 2

	PARAMETERS	ST. ERRORS	T-STATISTICS
CONSTANT	.0263543	.0103952	2.5352464
DRNCM(t-1)	.0301017	.0509371	.5909575
DRNEA(t-1)	.1061090	.0206329	5.1427036
DRNP(t-1)	.1126921	.0353247	3.1901756
DRNCI(t-1)	.9677842	2.6761380	.3616347
DDM(t-1)	-.0211230	.0094532	-2.2344746
EDAD3	.0044645	.0099016	.4508854
HIJOS(t-1)	-.0002652	.0015340	-.1728723
ASCEN(t-1)	-.0151701	.0063336	-2.3951668
ENFER(t-1)	.0195440	.0167608	1.1660578
DINVEMP(t-1)	.0125940	.0266554	.4724752
DDIV(t-1)	.0049192	.0086452	.5690108
DINV(t-1)	-.0078663	.0166170	-.4733896
LRDIL	8.0637433	1.4088158	5.7237740
U	.7753008	.0992704	7.8099869
DYPRED	-.4273481	.1798944	-2.3755499
DUMMY86	.0869920	.0202188	4.3025323
DUMMY87	-.0204801	.0130855	-1.5651019
DUMMY88	-.0430703	.0139177	-3.0946459
TEST	D. F.	VALUE	PROB $\leq$
χ^2	33	32.3043111	0.49844
Wald (all)	19	781.049176	1
Wald (time)	3	31.213778	1

Table 3: 3

	PARAMETERS	ST. ERRORS	T-STATISTICS
CONSTANT	.0193510	.0187345	1.0329044
DRNCM(t-1)	-.0400156	.1095443	-.3652913
DRNEA(t-1)	.0942182	.0343344	2.7441317
DRNP(t-1)	.1080934	.0683343	1.5818321
DRNCI(t-1)	-2.2969892	2.2374412	-1.0266143
DDM(t-1)	.0016845	.0166896	.1009312
EDAD3	-.0244254	.0183809	-1.3288456
HIJOS(t-1)	-.0002946	.0035236	-.0835969
ASCEN(t-1)	-.0038692	.0122882	-.3148680
ENFER(t-1)	.0438081	.0314302	1.3938220
DINVEMP(t-1)	.0139631	.0468028	.2983384
DDIV(t-1)	.0187179	.0147478	1.2692059
DINV(t-1)	-.0299036	.0353999	-.8447359
LRDIL	4.7223726	1.9659034	2.4021387
DYPRED	-.5222754	.2542852	-2.0538961
DUMMY86	.0324031	.0277947	1.1657997
DUMMY87	.0102372	.0155474	.6584471
DUMMY88	-.0054956	.0221440	-.2481770
TEST	D. F.	VALUE	PROB $\leq$
χ^2	34	39.6935249	0.76888
Wald (all)	18	185.512836	1
Wald (time)	3	4.662376	0.788718

Table 3: 4

	PARAMETERS	ST. ERRORS	T-STATISTICS
CONSTANT	.0287639	.0158758	1.8118061
DRNCM(t-1)	-.0465347	.0833395	-.5583751
DRNEA(t-1)	.0603739	.0259750	2.3243079
DRNP(t-1)	.0618233	.0442414	1.3974081
DRNCI(t-1)	-4.1717557	3.6468390	-1.1439374
DDM(t-1)	-.0108438	.0141220	-.7678658
EDAD3	-.0099577	.0144172	-.6906806
HIJOS(t-1)	.0008778	.0027935	.3142484
ASCEN(t-1)	-.0155993	.0097361	-1.6022138
ENFER(t-1)	.0068851	.0242079	.2844155
DINVEMP(t-1)	.0430940	.0454670	.9478081
DDIV(t-1)	.0108893	.0121775	.8942166
DINV(t-1)	-.0368468	.0281325	-1.3097600
LRDIL	3.0128872	1.4129437	2.1323477
DUMMY86	.0142637	.0221789	.6431178
DUMMY87	.0135118	.0140499	.9616985
DUMMY88	-.0053590	.0197139	-.2718380
TEST	D. F.	VALUE	PROB $\leq$
χ^2	35	41.4594357	0.79038
Wald (all)	17	245.053888	1
Wald (time)	3	3.834754	0.710453

Table 3: 5

	PARAMETERS	ST. ERRORS	T-STATISTICS
CONSTANT	.0183838	.0116990	1.5713933
DRNCM(t-1)	.0342956	.0472074	.7264876
DRNEA(t-1)	.0992481	.0178729	5.5529879
DRNP(t-1)	.0944874	.0281576	3.3556647
DRNCI(t-1)	1.4535456	2.9521019	.4923765
DDM(t-1)	-.0247153	.0086573	-2.8548464
EDAD3	.0087972	.0085710	1.0263924
HIJOS(t-1)	-.0001160	.0013647	-.0849754
ASCEN(t-1)	-.0153818	.0059271	-2.5951457
ENFER(t-1)	.0028837	.0121330	.2376740
DINVEMP(t-1)	.0211695	.0259216	.8166721
DDIV(t-1)	.0021300	.0075522	.2820418
DINV(t-1)	-.0071366	.0143409	-.4976426
LRDIL	7.7089186	1.1358565	6.7868774
U	.8296935	.0989260	8.3870125
DYDLAG	-.2950714	.1104965	-2.6704136
DUMMY86	.0961302	.0202966	4.7362735
DUMMY87	-.0176530	.0085236	-2.0710719
DUMMY88	-.0364218	.0116752	-3.1195734
TEST	D. F.	VALUE	PROB $\leq$
χ^2	33	33.1091620	0.53807
Wald (all)	19	796.308299	1
Wald (time)	3	23.886200	1

Table 3: 6

	PARAMETERS	ST. ERRORS	T-STATISTICS
CONSTANT	1.313830	0.104839	12.532
D85	0.035564	0.009909	3.589
D86	0.036608	0.010144	3.609
D87	0.062856	0.010144	6.197
D88	0.084321	0.010164	8.296
DRNCM	0.006581	0.041585	0.158
DRNCI	-0.003728	0.079454	-0.047
DRNP	0.035480	0.027790	1.277
DRNE	0.079356	0.021147	3.753
DRNA	0.369972	0.158312	2.337
DDM	-0.012973	0.011800	-1.099
DINV	0.002582	0.026134	0.099
DINVEMP	-0.041542	0.031269	-1.329
INCPATL	-3.377477E-8	0.000000	-3.677
ENFER	0.027109	0.015578	1.740
HIJOS	0.001488	0.002661	0.559
ASCEN	-0.009590	0.010732	-0.894
PRNT2	0.006566	0.024280	0.270
YDLAG	0.730481	0.017435	41.897
YDLAG2	0.177084	0.017222	10.282
R^2	0.7848		

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