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Intertemporal Substitution, Risk Aversion, and Private Savings in Mexico

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and
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Private savings in Mexico have fallen dramatically since 1982. The drop could be linked to a substantial increase in public savings, more than to uncertainty or real interest rate developments.

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The decline in private savings since 1982 is arguably the most important problem in high-debt countries. A reversal of the trend is essential if growth is to be restored. Understanding the determinants of private savings behavior is thus of more than academic interest.

Three factors predominate: (1) the extent of intertemporal substitution, (2) attitudes toward risk, and (3) private/public savings interaction. These factors lie at the core of Arrau and van Wijnbergen's research. It tests the issue of debt neutrality — whether future taxes are recognized as an offset for the value of any government debt held — and the response of private savings to real interest rates and uncertainty.

The authors estimated two configurations of a joint portfolio-choice/savings model. First they included equity, domestic bonds, and flight capital. In the second configuration they eliminated flight capital.

The second configuration, which eliminated the possibility of double counting of assets, yielded substantially better, more intuitive results. Among the authors' conclusions:

- The intertemporal approach to consumption is supported by the data.

- The results imply rejection of the traditional, expected-utility approach.

- Risk aversion is significant but lower than many have argued from analysis of static versions of the Capital Asset Pricing model.

- Results on the intertemporal substitution elasticity are much weaker.

- Domestic bonds issued by the government probably are considered as part of private wealth, although significantly less than one for one, thus rejecting debt neutrality.

The results suggest that the large increase in volatility of asset returns has lowered the risk-adjusted rate of return on savings and may therefore have lowered private savings. This effect must, however, have been offset to some extent by the sharp increase in real rates of interest.

The authors then suggest that some of the decline in private savings could more plausibly be related to the substantial increase in public savings that took place during the period.

Intertemporal Substitution, Risk Aversion, and Private Savings in Mexico

by
Patricio Arrau
and
Sweder van Wijnbergen*

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1 INTRODUCTION

The decline in private savings since 1982 is arguably the most important problem in high debt countries. This decline has significantly exacerbated the direct impact on growth of the reduction in net external transfers that has taken place since the debt crisis. A reversal of this trend is essential if growth is to be restored, since renewed external transfers at the scale customary before 1982 are unlikely for the foreseeable future. Understanding the determinants of private savings behavior is thus of much more than academic interest.

Three factors seem predominant. First, many countries have seen periods of extremely high real interest rates. For example, ex post real interest rates in Mexico exceeded 40% for most of 1988 and 1989. Second, uncertainty has increased substantially. The continuing threat of balance of payment crises and attendant exchange rate response implied large potential relative price changes in the future; stock market returns often became much more variable; and finally, uncertainty about future debt service translates into uncertainty about future taxes. Third, from a policy point of view, the impact of public sector deficits on private sector savings is important. In the absence of debt neutrality, cutting public sector deficits is the most direct way of increasing national savings. If however the private sector offsets changes in public sector deficits one for one, as debt neutrality implies, fiscal deficits per se would have no impact on national savings. The three factors mentioned, the extent of intertemporal substitution, attitude towards risk and private/public savings interaction, are at the core of the research presented below.

There is an extensive literature on the first and the last point. Traditional approaches, linking private consumption to measures of real income and interest rates have by and large produced inconclusive results. Early claims about the negative impact of real interest rates on private consumption turned out impossible to replicate (Giovannini, 1983). Individual country exercises sometimes showed a significant negative impact of real interest rates on private consumption (e.g. van Wijnbergen (1982), using kerb market rates in Korea), but a comprehensive attempt by Giovannini (1985) failed to establish a significant impact of real interest rates on private consumption.[1]/

More recently, the theoretical basis for such exercises has come under attack. As an alternative, empirical work based on estimation of equations derived from the first order conditions of a representative consumer's optimal consumption problem have been tried out. This research program has not been very successful. Typically, overidentifying restrictions implied by the theory were violated (e.g. Hansen and Singleton, 1982; Bernanke, 1985; Mankiw et. al., 1985). Some have argued that liquidity constraints are to blame for this (Hayashi, 1987; Campbell and Mankiw, 1989). Others have reported success with an approach explicitly incorporating money into the framework (Arrau (1990), Koenig (1990)). But by and large attempts to test intertemporal theories of consumption behavior explicitly have not been successful.

A new line of research has recently questioned the use of expected utility as a criterion by which consumers would rank different consumption streams (see in particular Epstein and Zin, 1989, 1991; Farmer, 1990; and Weil, 1990). Expected utility maximization implies a rigid inverse link between the elasticity of intertemporal substitution and risk aversion. But it is clearly unsatisfactory to impose such a link between entirely different attributes of consumer preferences by choice of utility function, rather than establish any link there might be empirically. An axiomatic basis for a more general theory is provided by Kreps and Porteus (1978), who relax the indifference with respect to resolution of uncertainty about consumption streams implied by expected utility maximization. This approach has been implemented and applied empirically by Epstein and Zin (1989,1991), called henceforth EZ. The main attraction of this approach is the ability to separately address risk aversion and intertemporal substitution. Since we just argued that both are likely to feature prominently in any explanation of the recent slowdown in private savings in many developing countries, we adopt the Epstein-Zin approach.

This leaves the third factor, the link between private savings and public deficits. This too has spawned a large literature (cf Bernheim (1988)

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[1] See Balassa (1990) for a survey of the sensitivity of savings to the interest rate in developing economies.

for a critical survey plus extensions). Part of this literature is closely related to our concerns, and focuses on the impact of deficits on private consumption. If private consumption equations show equal coefficients, but of opposite sign, on disposable income and deficits, income net of Government expenditure influences consumption. This is typically interpreted as support for Ricardian equivalence. Most studies reject strict Ricardian equivalence, although they fall short of supporting the strict Keynesian view that only after-tax income matters (cf for example van Wijnbergen (1986)). This literature must be considered suspect, however; if the conditions for Ricardian equivalence would hold, such consumption functions, linking current consumption to measures of current income, would clearly not obtain, at least not for plausible processes generating income and asset returns.

In this paper, we propose an alternative approach, directly testing whether Government bonds are net wealth in the intertemporal optimization framework presented by Epstein and Zin. If they are, even partially, strict Ricardian equivalence must be rejected and Government deficits and more generally the timing of taxes may influence private consumption decisions.

One final point. There is special merit in testing tenets about private savings behavior in developing countries. Especially over recent years, swings in interest rates and more generally asset prices have been much larger in say Mexico than in the US. Similarly, one can observe substantially large ings in public sector deficits. With so much more variation in the relevant variables, one should expect more success in empirical testing. We have chosen Mexico with this point in mind; real interest rates went from minus 5% in 1987 to almost plus 45% in 1988 and around 30% in 1989; stock market returns showed a large variance in the eighties; and the public sector transformed a 7% of GDP non-interest deficit in 1981 into a 8.4 % of GDP surplus in 1989.

The remainder of the paper is organized as follows. In section 2 we briefly review the formal theory and derive the equations estimated. Section 3 describes results, while Section 4 summarizes and discusses directions for future research.

2 THE MODEL: CONSUMPTION, UNCERTAINTY AND ASSETS RETURNS

The model used is the Epstein and Zin (1987) implementation of the preference structure laid out in Kreps and Porteus (1978). Thus, consumers maximize current utility, which is a non-linear function of current consumption and a certainty-equivalent measure of next period utility. Next period utility, in turn, is a function of next period consumption and utility in the period beyond next period, and so on. This leads to the following recursion formula for utility (with a C.E.S aggregator):

$$V_t = [c_t^\rho + \beta[\tilde{V}_{t+1}]^\rho)^{\frac{1}{\rho}} \tag{1}$$

where the "~" indicates the certainty equivalent value of next period utility V_{t+1}. The certainty equivalent value, when defined using a value function of the Constant Relative Rate of Risk Aversion (CRRA) class, can be expressed as follows:[2]

$$\tilde{V} = (E\, V^{1-\alpha})^{\frac{1}{1-\alpha}} \quad \text{for } \alpha \neq 1 \tag{2a}$$

$$\log(\tilde{V}) = E\log(V) \quad \textit{for } \alpha = 1 \tag{2b}$$

with E the expected value operator defined over the distribution of $\tilde{V}$.

(1) is maximized subject to the current budget constraint:

$$A_{t+1} = \sum_{i=1}^{n} \epsilon_{i,t} R_{i,t+1} (A_t - c_t); \qquad \sum_{i=1}^{n} \epsilon_i = 1 \tag{3}$$

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[2] Using a CRRA value function v $(v(V) = V^{1-\alpha})$ leads to the following certainty equivalent value:

$$\tilde{V} = \arg_x \{ v(x) = E\, v(V) \} = v^{-1}(E\, v(V)) = \left(E\, V^{1-\alpha}\right)^{\frac{1}{1-\alpha}}$$

which clarifies why we interpret α as the RRA parameter. By taking log and applying L'Hopital rule to evaluate the limit we can go from (2a) to (2b).

c_t is private consumption in period t; A_t is the stock of wealth at the end of period t, $R_{i,t+1}$ is return of asset i between end-of-period t and end-of-period t+1 (n assets); $\epsilon_{i,t}$ is the share of wealth in asset i at the end of period t. Since we use a representative consumer model, individual shares of assets equal market shares. Therefore the market return is:

$$R_{M,t+1}=\sum_{i=1}^{n} \epsilon_{i,t} R_{i,t+1} \tag{4}$$

The timing conventions are as follows. At the end period t, the consumer receives the asset returns on the assets held over from the previous period. These returns bring his wealth to A_t, of which he chooses to consume c_t. The remainder, $A_t - c_t$, is allocated over the n assets available to him. As already indicated, we label the share allocated to asset i "ϵ_{it}". This allocation choice problem has to be solved <u>before</u> the returns on the n assets ($R_{i,t+1}$ for i=1...n) are known (i.e. there is <u>no</u> safe asset).

For $\alpha \neq 1$, maximizing (2a) subject to (3) leads to the following set of Euler equations (Epstein, 1988; Epstein and Zin 1989):

$$E_t \left[\beta^{\gamma} \left(\frac{c_{t+1}}{c_t} \right)^{\gamma(\rho-1)} R_{M,t+1}^{\gamma} - 1 \right] = 0 \tag{5}$$

$$E_t \left[\beta^{\gamma} \left(\frac{c_{t+1}}{c_t} \right)^{\gamma(\rho-1)} R_{M,t+1}^{(\gamma-1)} (R_{i,t+1} - R_{1,t+1}) \right] = 0 \qquad \text{for } i=2,\dots,n. \tag{6}$$

where $\gamma = (1-\alpha)/\rho$, and ρ is related to the intertemporal elasticity of substitution σ: $\sigma = 1/(1-\rho)$. Similarly, the coefficient of relative risk aversion equals $\alpha = 1 - \rho\gamma$. (5) is the Euler equation for consumption and (6) the Euler equations for portfolio decisions. Notice that, as mentioned by Epstein and Zin (1989) and Giovannini and Weil (1989), and unlike in the static CAPM model, the path of future consumption affects today's portfolio decisions. Multiplying equation (6) by the share of asset i, for all i, summing over i, and combining with (5), the n-equation system (5)-(6) can be expressed as the n-equation system

$$E_t\left[\beta^\gamma\left[\frac{c_{t+1}}{c_t}\right]^{\gamma(\rho-1)} R_{M,t+1}^{(\gamma-1)} R_{i,t+1} - 1\right] = 0 \qquad \text{for } i=1,\ldots,n. \tag{7}$$

Notice that when the CRRA coefficient α is equal to the inverse of the intertemporal elasticity of substitution σ ($\alpha = 1/\sigma$), then $\gamma = 1$ and the system of equations (7) take the familiar form from "expected utility" theory.

In system (7), the intertemporal elasticity σ (function of ρ above) is not identified when α approaches 1 (γ goes to 0), as Epstein and Zin (1991) point out. Since in the empirical application presented below we cannot reject the hypothesis $\alpha = 1$, we are interested in finding the first order conditions which relate asset returns and consumption for the restricted model with $\alpha = 1$. These first order conditions are (see appendix C for the derivation):

$$E_t\left[\log(\beta\left[\frac{c_{t+1}}{c_t}\right]^{(\rho-1)} R_{M,t+1})\right] = 0 \tag{8}$$

$$E_t\left[\frac{(R_{i,t+1} - R_{1,t+1})}{R_{M,t+1}}\right] = 0 \qquad \text{for } i=2,\ldots,n. \tag{9}$$

Unlike the case of $\alpha \neq 1$ (cf equation (6) above), for $\alpha = 1$ portfolio decisions are independent of consumption (cf equation (9)). As noted by Giovannini and Weil (1989), the logarithmic case implies "rational myopia" in portfolio decisions, in the sense that the future does not matter for those decisions.

Multiplying equation (9) by the share of asset i, for all i, summing over i, and using (3b), allows us to express the portfolio decisions as

$$E_t \left[\frac{R_{i,t+1}}{R_{M,t+1}} \right] = 1 \qquad \text{for } i=1,\ldots,n. \tag{10}$$

which are the static CAPM equilibrium expressions for risk premia. Neither (9) nor (10) are useful to estimate utility parameters, although they provide excess returns equations which can be exploited to obtain traditional CAPM "β" estimations (Giovaninni and Weil, 1989). However, it is still possible to estimate σ in this case by using equation (8).

In the next section, we present empirical estimates of the unrestricted and restricted models. Specifically, we estimate the system of equations (7) (unrestricted model), and the Euler equation for consumption (8) (restricted model) to obtain the parameters of the utility function.

Before turning to those results, however, one more issue. The assets included in our estimate of private wealth are: (i) Government bonds held by the private sector; (ii) interest earning, Mexican owned assets held abroad; (iii) equity in Mexico. Of course, Government bonds are only net wealth (and therefore included in the market return) to the extent that the private sector ignores the discounted value of the future taxes needed to service the bonds. The question whether future taxes are recognized as an offset for the value of any Government debt held (i.e. is there "debt neutrality"?) is at the core of the question raised in the introduction: what is the impact of Government savings on private savings? In this paper, we allow the data to decide. This is done by scaling the stock of domestic bonds by a factor $\pi \in [0,1]$ when computing the weights ϵ_i of every asset in the market return.[3]/ Clearly, strong assumptions are needed about the form future Government policy will take to justify such a simple parametrization; we feel that the alternative of ignoring the issue is worse.

$\pi = 0$ would indicate a full "Ricardian" recognition by households of the future taxes necessary to service the current stock of domestic bonds, in which case, bonds are not net wealth. $\pi = 0$ implies that private consumers fully ignore the future tax burden associated with future debt service on the current stock of bonds; in that case the full value of domestic bonds is considered net wealth by households.

Previous estimations either invoke Ricardian equivalence and do not consider domestic bonds as part of households' net wealth (Epstein and Zin, 1991), or completely discount future taxes to zer and include the stock of domestic bonds as part of net wealth (Bufman and Leiderman, 1990). Both cases are likely to be extremes assumptions. In the results presented below, we estimate this "tax discounting " parameter directly from the data available.

3 ESTIMATION

In this section we estimate the two model versions mentioned above. The first model is the unrestricted system of equation (7), where all utility parameters are estimated. The second is the logarithmic model, with the CRRA parameter restricted to be equal to one. In this case only the Euler equation for consumption (8) is useful.

We estimate both models in two different configurations. We first include all three assets, equity, domestic bonds and Mexican deposits in

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[3] The weights in budget constraint (3) are computed as

$$\epsilon_{i,t} = \frac{A_{i,t}}{A_{1,t}+A_{2,t}+\pi A_{3,t}} \qquad \text{for } i=1,2$$
$$\epsilon_{3,t} = \frac{\pi A_{3,t}}{A_{1,t}+A_{2,t}+\pi A_{3,t}} \tag{1}$$

where we identify the last return as government bonds, and A_{it} is the stock of wealth held in asset i.

foreign banks (flight capital). In the second configuration, flight capital is excluded, resulting in two assets, for reasons explained below.

There are several reasons to also consider the second, restricted set up, with asset choice restricted to equity and bonds only. The Bank of International Settlements (BIS) data used to obtain measures of Mexican owned cross-border bank deposits excludes deposits made by Mexican banks, but otherwise does not distinguish between corporate and non-corporate owners. This could introduce double counting: the value of deposits made by companies listed on the Mexican stock exchange should be reflected in the stock market valuation of the depositing firm and thus be excluded from the wealth definition. Since the value of all listed firms is included in the measure of private wealth, including deposits made by listed firms when computing wealth and the market return would thus result in double counting. Since we have no information about the share in total non-bank cross border deposits outside Mexico (but owned by Mexicans) that is owned by Mexican corporations, there is little one can do about this problem. We therefore simply present two sets of estimates, one based on the assumption that all deposits are by unlisted firms or individuals (and should thus be fully counted); and one based on the opposite assumption that all deposits are made by listed firms. The first assumption justifies a three equation system, while the second justifies excluding the foreign asset from the market return.

A second reason to exclude the foreign asset is the well known "peso problem" in Mexico. In Figure 4 we plot the real return of foreign assets in peso terms. We can see 3 unusually large returns in 1982-83 and another in 1985 (of the order of 30% quarterly real returns). They are associated with large discrete devaluations, which were almost certainly unexpected, at least in terms of magnitude. Such large returns could distort the estimation seriously for our sample size, if distributional assumptions about the probability of such events are not explicitly modelled. Because we are using an econometric procedure (GMM) without explicit distributional assumption, we also provide the estimations of the 2-equation system as a way to control for this problem.

In each case, the model parameters are estimated using the Generalized Method of Moments estimator (Hansen, 1982; Hansen and Singleton, 1982). The estimation period is 1980.1 to 1989.4. The econometric procedure is briefly described in Appendix C.

3.1 Data

A description of the data sources and details about transformations performed can be found in Appendix B. The series of consumption is quarterly consumption of the private sector, which unfortunately cannot be separated between durable and non-durable consumption goods.[4]/ The return to equity is the total market return series from the Emerging Capital Markets database maintained by the International Finance Corporation. The series includes both capital gains and dividends and is corrected for non-cash dividends, stock splits and so on. For the return to domestic bonds we used the 28 days Mexican treasury bill rate (CETES); and the return to foreign assets is the 360 days CD rate in the United States. The free exchange rate was used to transform dollar interest rates in peso equivalents. The national CPI was used as the consumption deflator.

The three equations of system (7) were estimated with the following set of instruments: the unitary vector, the growth rate of consumption and the three individual returns; the consumption growth rate and rate of returns are included both lagged once and lagged twice, for a total of 9 instruments. The 2-equation system is estimated with the same instrument sets.

All the series used in the estimations below are plotted in Figures 1 to 7 (market return plotted with full weight to domestic bonds only).

3.2 Results

Table 1 shows the results of estimating the three equation system (equity, domestic bonds and flight capital), and Table 2 lists the results of estimating the 2 equation system (equity and domestic bonds). We present the results of the parameters actually estimated (γ, ρ and β^7) and, next to them,

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[4] The series of imported consumer goods is not available dissagregated between durables and non-durables. There is a series of consumer purchases of domestically produced industrial durable goods; leaving this series out of the definition of consumption, so as to proxy for non-durable consumption, did not lead to significant changes in the results.

the implied estimates and asymptotic standard errors for the rate of time preference δ, the intertemporal elasticity σ and the relative rate of risk aversion α. The tables also gives the minimized objective function and the value for the overidentifying restriction test statistic. The estimates were obtained for a whole grid of values for π, with π running from 0 to 1 at steps of 0.1. For the three equations system, we present the results for the extremes values 0 and 1, and for the value of π at which the objective function was minimized. For the 2 equations system, π=0 makes the market return identical to the return on equity, so we provide the estimation for π = 0.1 instead.

Consider first Table 1 (the 3 equations estimation). In all cases the test for overidentifying restrictions is passed with high degree of confidence. The CRRA parameter α is around 1.5 for all values of π and is very significantly different from zero (high t-statistics). The time preference implied by this set of estimates is positive and not implausible at around 2% on a quarterly basis. The objective function is minimized for π=0, which would imply complete tax discounting (i.e. supports Ricardian equivalence). However, in all cases the intertemporal substitution parameter is outside the theoretically acceptable range. This elasticity cannot be negative, which implies that ρ has to be smaller than 1. The point estimates for ρ are clearly above one, however, which would imply convexity of the utility function. These results are unsatisfactory on a priori grounds; we therefore reject this set of results, although ρ is admittedly estimated very imprecisely.

Eliminating bank deposits held abroad from the menu of assets, for the reasons outlined in the preceding Section, leads to substantially better, more intuitive results. In Table 2, the estimates for the resulting 2 equation system are presented. The test for overidentifying restrictions is once again passed with a high degree of confidence. The relative rate of risk aversion is around one (between 0.85 and 1.03), and estimated with high precision. The tax discounting parameter now indicates very imperfect awareness of future tax liabilities: the objective function is minimized at 0.6, indicating that bonds are close to being considered net wealth.

Also, and possibly most importantly, the intertemporal elasticity is estimated with much greater precision and more reasonable point estimates: it ranges between 0.8 and 1.4 as the tax discounting parameter goes from zero to one, with $\sigma = 1.2$ at the "best" estimate for the tax discounting parameter. Moreover, at that value, and with the standard error listed in the Table, σ easily passes a one tailed 5% test against zero.[5] We thus accept the hypothesis of a positive intertemporal substitution elasticity, contrary to for example Hall (1988).

Finally, Table 2 also indicates that our estimate of γ is significantly less than 1. This implies rejection of the expected utility framework, in favor of the non-expected utility framework employed in this paper.

Tables 3 and 4 provide the estimation of the Euler equation for consumption (8), when all three assets are considered to compute the market return (Table 3), and when the foreign assets is excluded (Table 4). In both sets of estimates, the CRRA is restricted to equal 1, so we can only use (8) to extract information about σ. Not surprizingly, precision suffers a great deal as we rely on one equation only. Table 3 shows very high but extremely imprecise estimates of the intertemporal elasticity of substitution, to the point of being entirely uninformative. Also, the rate of time preference seems rather high for quarterly data. Once again eliminating deposits abroad from the asset portfolio improves results, but less so than in the case where α was left free. Table 4 yields convexity of the utility function for the Ricardian equivalence corner solution $\pi=0$, but more meaningfull results for higher values of π. Time preference yields plausible values, but the estimates of σ, while large, are very imprecise. Overall we get the same pattern as emerges from the unrestricted estimation, but with much higher standard errors. The higher standard errors are probably due to the lower efficiency of the 1-equation estimation relative to the 2-equation system.

The conclusion one can draw from the results reported in Table 3 and 4 is that the imprecision of the intertemporal elasticity in the unrestricted estimation (Tables 1 and 2) does not seem to stem from the point that σ is more difficult to identify as α approaches one. The restricted model, which allows estimation of σ even though α is restricted to be equal to 1, also

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[5] One tailed since we test $\sigma=0$ against the alternative $\sigma>0$.

yields the same imprecision in the intertemporal elasticity.

5 CONCLUSIONS

In the introduction we raised the question of why Mexican private savings has fallen so much since 1982. This paper provides evidence on a number of issues that could contribute to an answer. It does so by carefully assessing private consumption behavior and asset returns in Mexico. Although the results are not always as one would wish, some preliminary conclusions seem to emerge.

(i) The intertemporal approach to consumption is supported by the Mexican data analyzed in this paper. The overidentifying restriction tests which could have led to rejection of this approach, are satisfied in all results presented.

(ii) The results reported in Table 2 clearly imply rejection of the traditional, expected utility approach to choice under uncertainty, in favor of the non-expected utility approach developed by Kreps and Porteus (1978), Selden (1988) and, in particular, Epstein and Zin (1989,1991).

(iii) Risk aversion is significant, but lower than many have argued from analysis of static versions of the Capital Asset Pricing model. We found that estimates of the CRRA parameter cluster robustly around one.

(iv) Our results on the intertemporal substitution elasticity (which in the approach to consumer choice followed in this paper can be analyzed separately from the risk aversion parameter) are much weaker, however. In our central set of equations we do find that intertemporal substitution elasticity is significantly larger than zero, contrary to for example the results reported in Hall (1988). In fact the point estimate exceeds one, an important benchmark for a variety of important questions, but the precision is generally too low to make the latter claim with any significant degree of confidence. We also found that that lack of precision is not due to the fact that the CRRA parameter is close to one. We developed a configuration of the first order conditions that gets around the problems created by a CRRA parameter close to one but find that the lack of precision in the intertemporal elasticity persists.

(v) We present evidence in favor of the claim that deficits do matter; although the evidence is admittedly weak. The estimation results suggest that domestic bonds issued by the Government are considered as part of private wealth, although less than one for one.

So what do these results tell us about the decline in savings? With all the caveats in place because of the econometric problems mentioned, we put forward the following suggestions. First, the large increase in volatility of asset returns has lowered the risk adjusted rate of return on savings and may therefore have lowered private savings, since our best estimate of σ, the intertemporal elasticity of substitution, is above one (see Weil, 1990 for this point). However, by the same token, this effect must have been offset to some extent by the sharp increase in real rates of interest over the period considered.

Any conclusions must be qualified by pointing out that while the point estimate was higher than one, the estimate was not very precise. We estimate σ to be significantly larger than 0, but cannot claim it is significantly larger than 1 at standard test sizes. Of course, even if the increased rate of return uncertainty did not have a major impact on aggregate private savings, it most likely did have an impact on portfolio choice.

Finally, our evidence does suggest that some of the decline may be due to the fact that the private sector tends to partially offset public savings. At least in Mexico public savings has increased substantially. While we reject strict Ricardian equivalence, under which private savings would have fallen one for one with public improvements in saving, we do find evidence in favor of incomplete offset. Thus some of the decline in private savings could be related to the substantial increase in public savings that took place over the same period.

Further research is clearly necessary to narrow the range of uncertainty about the value of the intertemporal elasticity of substitution. Several factors may be behind the low precision with which σ has been estimated. Among the non-destructive ones we mention the need to introduce seasonal shifts in preferences (Miron, 1986), a possibly important issue as we use seasonally unadjusted, quarterly data. Another explanation could be that we neglect some other variables that affect consumption, or which are determined jointly with consumption. High in our agenda is the need to introduce money into the set up as recent research seems to suggest that this line of research could be fruitful (Koenig, 1990; Arrau, 1990). Most importantly, but also most difficult to handle, is the issue of liquidity constraints. If substantial parts of the population would have been liquidity constrained during the period of high interest rates, higher asset returns should be expected not to lead to intertemporal shifts in consumption until the shifts in desired consumption are such that the constraints cease to bind.

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Appendix A: Econometric Methodology

The econometric methodology used to estimate the system of equations is the Generalized Method of Moments introduced in economics by Hansen (1982) and Hansen and Singleton (1982). The method is briefly described below for the 3 equation estimation. The reader is also referred to Gallant (1987) as the exposition below somewhat differs from Hansen-Singleton's.

Let us define $q_t = q(\theta, x_t)$ as the 3x1 functional vector in square brackets in the system (4) in the text. θ is the column vector of the 3 parameters to be estimated and x_t is the vector of the growth of consumption, market return and individual returns.

Let z_t be a column vector of k instruments which are known as of period t. Therefore (4) in the text implies the 3k orthogonality conditions

$$E(q_t \otimes z_t) = 0 \tag{A.1}$$

which are the focus of the estimation procedure.

The estimate for θ is obtained by minimizing the objective function

$$f(\theta, \Omega) = \left(\sum_{t=1}^{n} q_t \otimes z_t\right)' \Omega^{-1} \left(\sum_{t=1}^{n} q_t \otimes z_t\right) \tag{A.2}$$

where Ω is an estimate of the variance-covariance matrix of the random variable $(q_t \otimes z_t)$ equal to

$$\Omega = \sum_{t=1}^{n} \left[\left(q(\hat{\theta}, x_t) \otimes z_t\right) \left(q(\hat{\theta}, x_t) \otimes z_t\right)' \right] \tag{A.3}$$

The estimation proceeds in two steps. The first step estimator of θ is obtained from the following minimization:

$$\hat{\theta} = \underset{\theta}{argmin}\ f\left(\theta, I \otimes \sum_{t=1}^{n} z_t z_t'\right) \tag{A.4}$$

Finally the variance-covariance matrix of the estimates is

$$Var(\hat{\theta}) = \left[\left(\sum_{t=1}^{n} \frac{\partial q_t}{\partial \theta'} \otimes z_t\right)' \Omega^{-1} \left(\sum_{t=1}^{n} \frac{\partial q_t}{\partial \theta'} \otimes z_t\right)\right]^{-1} \tag{A.5}$$

As it is well known (Hansen, 1982), the minimized objective function

$$f(\hat{\theta}, \Omega) \tag{A.6}$$

is distributed asymptotically as a $\chi(3k-p)$ where p is the number of parameters to be estimated (3 in our case). This is the critical value for the overidentifying restrictions test.

Appendix B: Data Sources

The data sources employed in the paper are as follows.

Consumption:

Quarterly index of total consumption, Indicadores Economicos, Banco de Mexico (Central Bank).

Consumption Deflator:

National CPI, Indicadores Economicos, Banco de Mexico. The quarter index is the average of the months of the quarter.

Domestic Bond Return:

28 days treasury bonds (CETES). For the period January 1980 to July 1982 28 days CETES is not available and we use 90 day CETES instead (both rates are very similar during the period they overlap). The basic data is available monthly and the return is annualized. The nominal quarterly return is the composite of the returns of the months. The real return in quarter t times the price index of quarter (t-1) divided by the price index of quarter t.

Equity Return:

Total market return (dividend plus capital gains) from the Emerging Markets Data set, International Financial Corporation, The World Bank. The basic data is available monthly. The nominal quarterly return is the composite of the returns of the months. The real return is obtained as in domestic bond above.

Return on Mexican owned Deposits in Banks outside Mexico:

360 days Certificate of Deposits in the USA. International Financial Statistics, International Monetary Fund. The basic data are the annualized data available monthly. The nominal quarterly return is the composite of the returns of the months, where the free exchange rate is used to get the return in pesos. The real return is obtained as in domestic bond above.

Stock of equity:

Total market capitalization (in US dollar), Emerging Markets Data set, International Financial Corporation, The World Bank. From December 1985 the series is available monthly and we took the end of quarter figure. For the period 1980-85, the series is available at the end of the year. We use the following procedure to interpolate the other months. We first compute a series of end of year real capital by dividing the end of year value by the end of year stock price. Then we interpolate, geometrically, the real capital for every two consecutive end-year figure. Finally we obtain the monthly series of market capitalization by multiplying the interpolated series by the monthly stock price index, which is available for the whole sample period. Our method is a good interpolation if most of the variation of the market capitalization series is due to stock prices.

Stock of Domestic Bonds:

Include the following government instruments: CETES, PAGAFES, Bonos de Desarrollo, Petrobonos and BIBS. The free exchange rate series was use to convert the figures to US$.

Stock of Cross-border deposits by Mexican Nationals (flight capital):

Cross-border deposits of Mexicans in the U.S., International Financial Statistics, International Monetary Fund. The series is available quarterly starting the (end of) forth quarter 1981. For the other quarters in 1980-81, we interpolate linearly the end of year estimate provided by Robert Cumby and Richard Levich, Table 3B.3 ("On the Definition and Magnitude of Recent Capital Flight" in Donald Lessard and John Williamson (eds.) Capital Flight and Third World Debt). The interpolated series was adjusted to the level provided by IFS on cross-border deposits for the forth quarter of 1981.

Appendix C: Individual optimization when RRA = 1

When the RRA parameter is equal to 1, the individual maximizes (1) with respect to consumption and the portfolio shares, subject to (2) (second expression) and (3). To characterize the solution at a given period, let us define the value function V as

$$V(A_t) = \max_{\{c_t, \epsilon_t\}} \left[c_t^{\rho} + \beta \left(\exp(E_t \log V(A_{t+1}) \right)^{\rho} \right]^{1/\rho} \quad \text{s.t. (3) in text} \tag{C.1}$$

At the risk of some confusion we define the following notational conventions,

$$V_t = V(A_t); \qquad V_t' = \frac{\partial V(A_t)}{\partial A_t} \tag{C.2}$$

The confusion could arise because we are redefining V_t with respect to the text. In (1) V_t is more generic in the sense that it is also defined for non-optimal choices, eventhough both are equal for the optimum choice. But, because we are only interested in the optimum solution, the difference does not matter.

Using (4) in the text, the first order conditions of problem (C.1) are

$$c_t^{\rho-1} = \beta \exp(E_t\ \rho\ \log(V_{t+1})) \left[E_t\ \frac{V_{t+1}'}{V_{t+1}} R_{M,t+1} \right] \tag{C.3}$$

$$E_t\ \frac{V_{t+1}'}{V_{t+1}} (R_{i,t+1} - R_{1,t+1}) = 0 \qquad \text{for } i=2,\ldots,n \tag{C.4}$$

We follow Giovannini and Weil (1989) and Weil (1990) in the solution of the model. Guess the solution for consumption and the value function as linear functions of wealth:

$$V_t = \lambda_t W_t; \qquad c_t = \mu_t W_t \tag{C.5}$$

It is clear from the homothetic characteristic of the problem (C.1) that both choices are mutually consistent. Unlike Giovannini and Weil (1989) and Weil (1989), the value function is homogeneous of degree one in wealth because we use Epstein-Zin specification (1), which put the certainty equivalent value for V_{t+1} in the C.E.S. aggregator function.

Next we derive expression (8) in the text.

Substituting the guesses in the value function (C.1) and in the Euler equation for consumption (C.3), an after some manipulation, we obtain respectively

$$\lambda_t = \left[\mu_t^{\rho} + \beta\ (1-\mu_t)^{\rho} \exp(E_t\ \rho\ \log(\lambda_{t+1} R_{M,t+1})) \right]^{1/\rho} \tag{C.6}$$

$$\mu_t^{\rho-1} = \beta\,(1-\mu_t)^{\rho-1}\exp(E_t\,\rho\,\log(\lambda_{t+1}R_{M,t+1})) \tag{C.7}$$

Solving (C.7) for exp(·), substituting in (C.6), and eliminating terms we have

$$\lambda_t = \mu_t^{(\rho-1)/\rho} \tag{C.8}$$

Leading the expression above one term forward, using the guesses (C.5) and (3)-(4) in the text, we can express λ_{t+1} as

$$\lambda_{t+1} = \left(\frac{c_{t+1}}{c_t}\right)^{\frac{\rho-1}{\rho}} R_{M,t+1}^{\frac{1-\rho}{\rho}} \left(\frac{\mu_t}{1-\mu_t}\right)^{\frac{\rho-1}{\rho}} \tag{C.9}$$

Equation (8) in the text is obtained by substituting (C.9) into the Euler equation (C.7), eliminating terms, and taking log in both sides.

Equation (9) in the text is simply obtained by substituting the guesses in (C.5) and (3)-(4) in the text into (C.4), and taking certain terms out of the expectations operator.

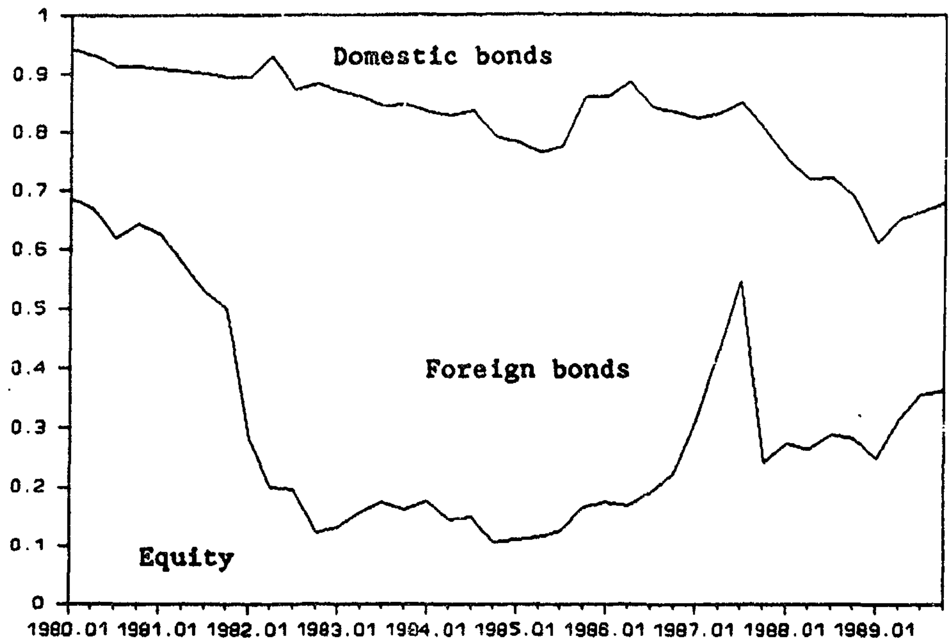

Figure 1: Share of Equity, Domestic Bonds and Foreign Bonds (Flight Capital) in Household's Wealth

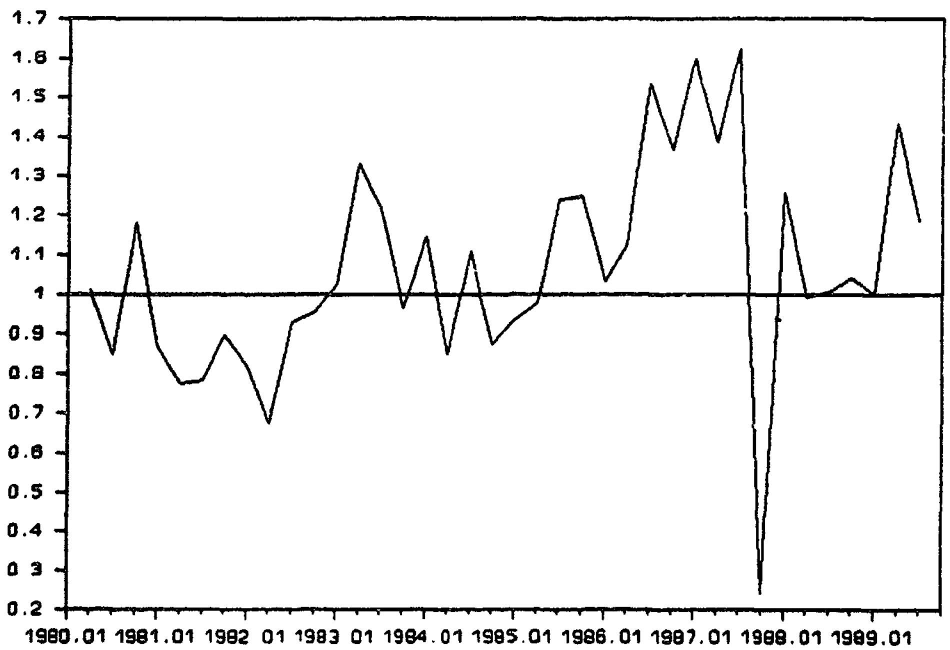

Figure 2: Real Return of Equity

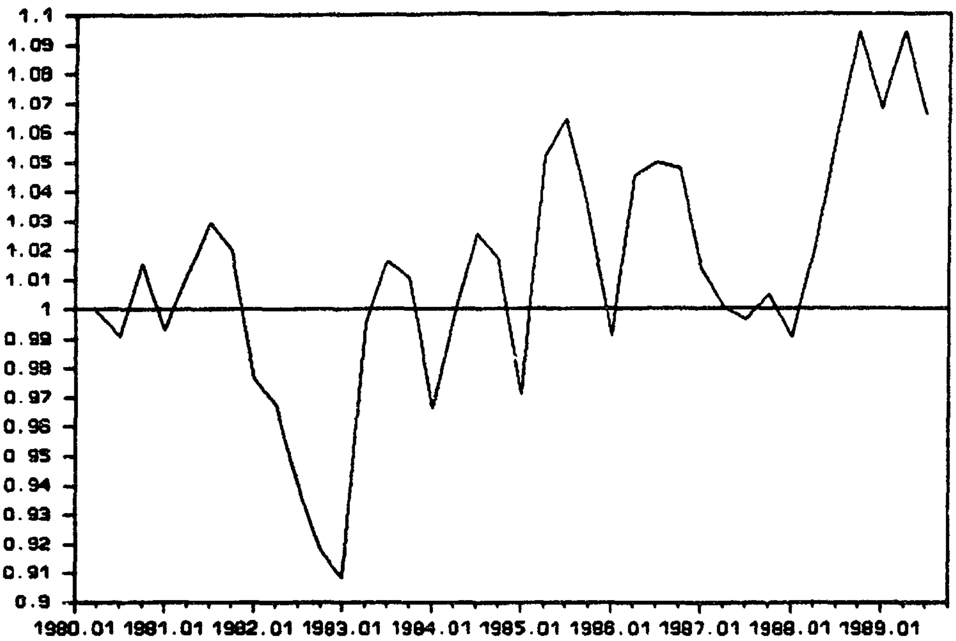

Figure 3: Real Return of Domestic Bonds

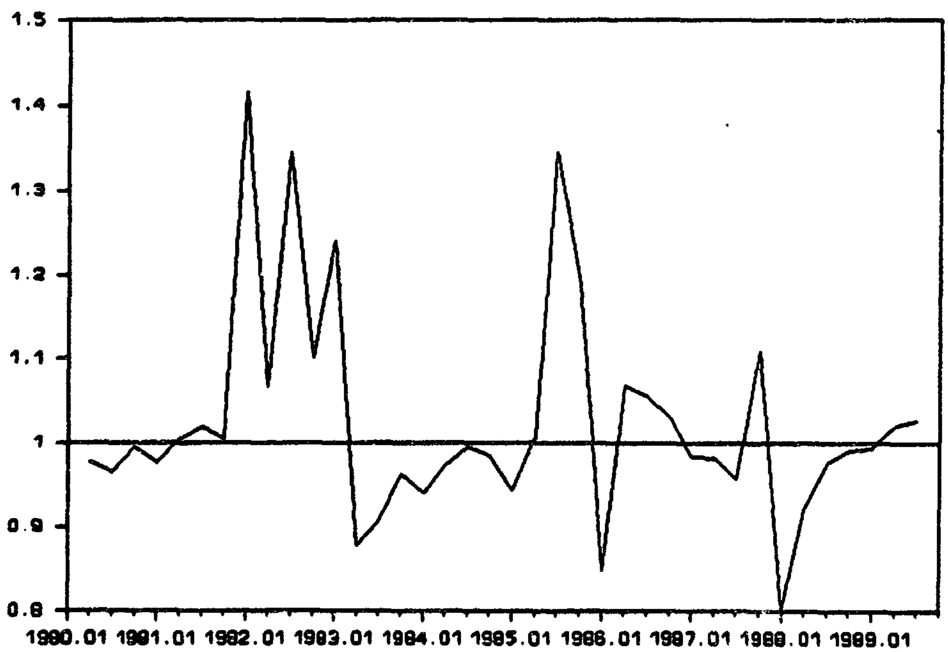

Figure 4: Real Return of Foreign Bonds

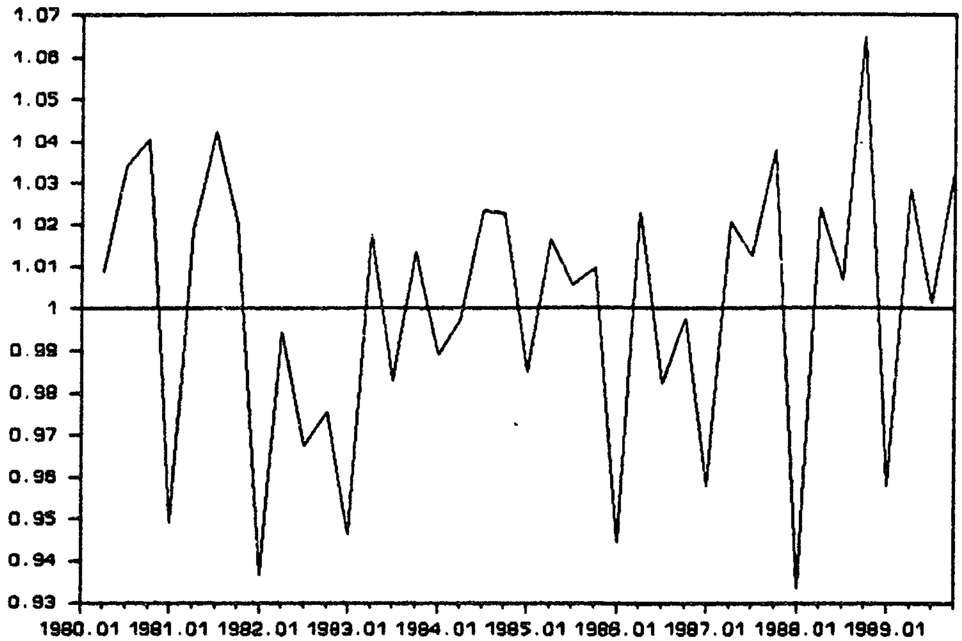

Figure 5: Growth in Consumption per capita (c_{t+1}/c_t)

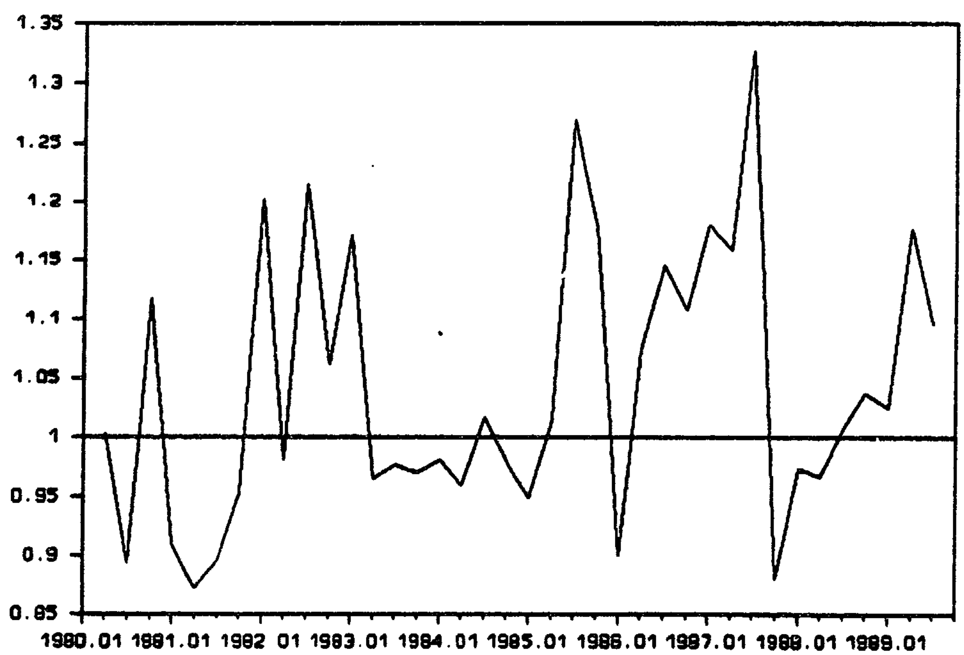

Figure 6: Real Market Return including Foreign Bonds

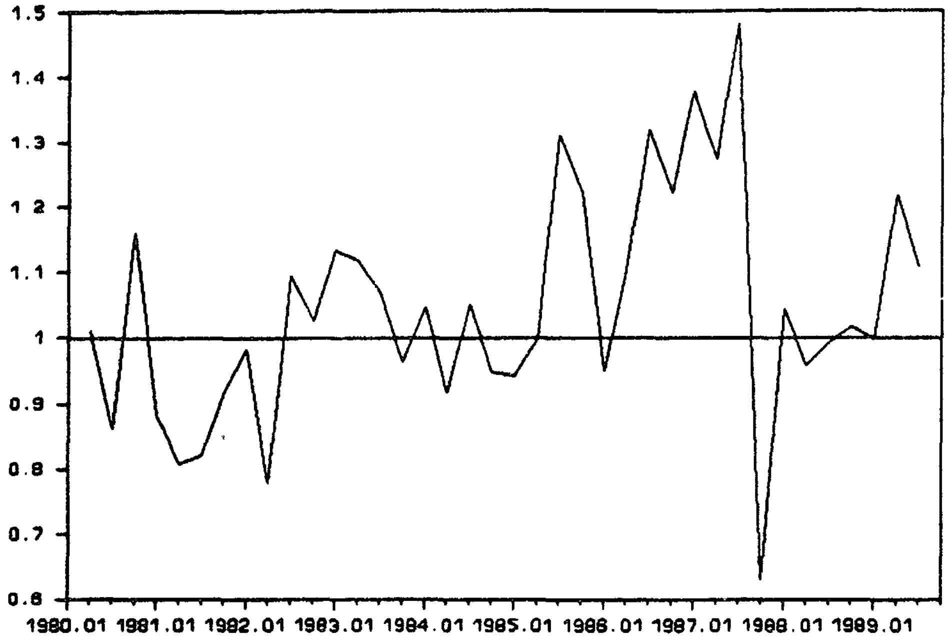

__Figure 7:__ **Real Market Return Excluding Foreign Return**

Table 1: Estimation of the 3 equation System 1980.1-1989.3

π	Estimated Parameters β^{γ}	ρ	γ	δ	σ	α	Minimum Objective Function (ORT)
0.0*	1.0015 (0.006)	4.573 (2.85)	-0.0967 (0.083)	0.0161 (0.058)	-0.280 (0.223)	1.438 (0.183)	24.88 (0.588)
1.0	1.0071 (0.007)	1.869 (0.534)	-0.287 (0.106)	0.0251 (0.024)	-1.150 (0.707)	1.536 (0.186)	25.34 (0.612)

Note: Standard errors in parenthesis. Column 2 to 4 are the parameters actually estimated. From them we compute $\delta = 1/\beta - 1$; $\alpha = 1 - \gamma\rho$, and $\sigma = 1/(1-\rho)$; where δ is the time preference parameter, α is the RRA parameter and σ the intertemporal substitution parameter. In last column, ORT stands for the Overidentifying Restriction Test ($\chi_n(f)$ where f is the minimum of the objective function and n is the number of orthogonality conditions minus the number of parameters estimated). The parameter π is a factor of adjustment of the weight of domestic bonds in the market return. We present the estimations with the extremes values of 0 and 1 for π, and an "*" indicates the value of π that minimizes the objective function.
Instrument sets: 2 lags of consumption growth and individual returns. See section 3.1 for more details.

Table 2: Estimation of the 2 equation System (Equity, Domestic Bonds), 1980.1-1989.3.

	Estimated Parameters β^{γ}	ρ	γ	δ	σ	α	Minimum Objective Function (ORT)
0.1	0.985 (0.003)	0.293 (0.299)	0.500 (0.024)	0.0032 (0.007)	1.415 (0.598)	0.853 (0.149)	18.90 (0.782)
0.6*	0.990 (0.003)	0.162 (0.438)	0.256 (0.027)	0.0407 (0.013)	1.193 (0.623)	0.959 (0.112)	18.07 * (0.741)
1.0	0.990 (0.003)	-0.229 (0.868)	0.141 (0.029)	0.075 (0.026)	0.813 (0.574)	1.032 (0.121)	18.61 (0.768)

Note: See note in Table 1. For π equal to zero, the system collapses into one equation estimation. The estimation for $\pi = 0.1$ is provided instead. An "*" indicates the value of π that minimizes the objective function.
Instrument sets: 2 lags of consumption growth and individual returns. See section 3.1 for more details.

Table 3: Estimation of Restricted Euler Equation for Consumption ($\alpha = 1$), 1 equation (Equity, Domestic Bonds and foreign bond in market return), 1980.1-1989.3.

	Estimated Parameters				Minimum Objective Function
	β	ρ	δ	σ	(ORT)
0.0	0.965 (0.018)	0.992 (1.024)	0.0360 (0.0193)	122.0 (**)	6.773 (0.547)
0.2*	0.965 (0.018)	0.981 (1.004)	0.0360 (0.0191)	52.8 (**)	6.768 (0.547)
1.0	0.966 (0.016)	0.902 (0.872)	0.0351 (0.017)	10.19 (91.0)	6.90 (0.561)

Note: See note in Table 1. An "*" indicates the value of π that minimizes the objective function. An "**" indicates an estimated standard error greater than 100.
Instrument sets: 2 lags of consumption growth and individual returns. See section 3.1 for more details.

Table 4: Estimation of Restricted Euler equation for Consumption ($\alpha = 1$), 1 equation (Equity and Domestic Bonds in market return), 1980.1-1989.3.

	Estimated Parameters				Minimum Objective Function
	β	ρ	δ	σ	(ORT)
0.0	0.989 (0.029)	1.033 (1.111)	0.011 (0.030)	-30.4 (**)	12.82 (0.923)
0.7*	0.988 (0.022)	0.771 (0.835)	0.012 (0.023)	4.37 (15.9)	12.44 (0.913)
1.0	0.989 (0.021)	0.702 (0.768)	0.0110 (0.021)	3.35 (8.62)	12.49 (0.914)

Note: See note in Table 1. An "*" indicates the value of π that minimizes the objective function. An "**" indicates an estimated standard error greater than 100.
Instrument sets: 2 lags of consumption growth and individual returns (excluding foreign return). See section 3.1 for more details.

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