Consumption Smoothing in Latin America: An Empirical Assessment of Present Value Models

Dissertation presented to the Graduate School of Economics of the Getulio Vargas Foundation in partial fulfillment of the requirements for the Master’s degree in Economics

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Abstract

The study aims to assess the empirical adherence of the permanent income theory and the consumption smoothing view in Latin America. Two present value models are considered, one describing household behavior and the other open economy macro-economics. Following the methodology developed in Campbell and Schiller (1987), Bivariate Vector Autoregressions are estimated for the saving ratio and the real growth rate of income concerning the household behavior model and for the current account and the change in national cash flow regarding the open economy model. The countries in the sample are considered separately in the estimation process (individual system estimation) as well as jointly (joint system estimation). Ordinary Least Squares (OLS) and Seemingly Unrelated Regressions (SURE) estimates of the coefficients are generated. Wald Tests are then conducted to verify if the VAR coefficient estimates are in conformity with those predicted by the theory. While the empirical results are sensitive to the estimation method and discount factors used, there is only weak evidence in favor of the permanent income theory and consumption smoothing view in the group of countries analyzed.
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1 Introduction

The notion of consumption smoothing is widely used in explaining aggregate consumer behavior. The view emerged with the concepts of life cycle and permanent income and the subsequent idea that individuals take into account not only current but also lifetime income when allocating their resources between consumption and saving. In macroeconomics, the idea is embedded in many models ranging from household behavior to open economies and has been widely tested in the context of present value models.

Models that incorporate the Permanent Income Hypothesis (PIH) presuppose that consumption is proportional to permanent income. One implication of this, brought up by CAMPBELL (1987), is that consumption should be higher than current income when the latter is relatively low and is expected to rise and below it when individuals expect a fall in earnings, allowing them to smooth consumption intertemporally. Hence, if the PIH holds and expectations are confirmed, dissaving should precede a rise in income while saving should anticipate reductions in income levels. In other words, “People save for a rainy day”. As a result, one implication of models that incorporate the PIH is that saving Granger causes changes in income. In other words, the course of future changes in income should be explained by current saving behavior.

In an open economy, the presence of high capital mobility enables agents to smooth consumption in the presence of shocks to national cash flow, defined as output less investment less government spending. The means by which this is done is through the current account which represents a form of adjusting the country’s capital flows to fulfill its consumption decisions. Following the same rationale governing household behavior, the country finds it optimal to borrow resources from abroad, running a current account deficit when national cash flow is expected to rise over time and run a current account surplus when national cash flow is thought to fall.

This paper studies the empirical validity of Present Value Models incorporating the PIH and the consumption smoothing view for a group of Latin American countries. Two PVMs are object of investigation, one describing household behavior and the other open economy macroeconomics. Although the literature on the subject is relatively vast, deserving mentioning Campbell (1987) and Campbell and Deaton (1989) treating household behavior and Ghosh (1995) and Ghosh and Ostry (1995) on open economy macroeconomics, just to name a few, the present study adds a contribution to the empirical literature by analyzing the
impact of the estimation method on the results obtained. Individual system estimation, treating each country separately, and joint system estimation, incorporating all countries simultaneously in the estimation process are conducted before testing the empirical adherence of the PVMs following the methodology developed in Campbell and Shiller (1987). Ordinary Least Squares (OLS) and Seemingly Unrelated Regressions (SURE) estimates are also generated and the impact of each on the empirical results is also addressed.

This study is structured in the following manner. Section 2 provides an overview of the theory and main implications of Present Value Models and describes two such models, one concerning household behavior and the other open economy macroeconomics. The methodology adopted in the analysis is also presented in this section. Section 3 describes the data used. Section 4 presents the empirical results and section 5 concludes.

2 Theory and Testable Implications

2.1 Theory

2.1.1 Household Behavior Present Value Model

Consumption smoothing in the context of household behavior is analyzed based on the theoretical developments present in Campbell (1987) and Campbell and Deaton (1989). Campbell (1987) derives the following expression describing the behavior of saving

\[ s_t = -\left(\frac{r}{1 + r}\right) \sum_{i=0}^{\infty} \left(\frac{1}{1 + r}\right)^i \left[ E_t y_{t+i} - y_t \right] \]

\[ = -\sum_{i=1}^{\infty} \left(\frac{1}{1 + r}\right)^i E_t \Delta y_{t+i} \]

where \( s_t \) is defined as \( s_t = y_t - c_t / \gamma \) and \( y_t \), total disposable income, is given by \( y_t = y_{kt} + y_{lt} \). \( c_t \) is real consumption, \( y_{lt} \) real labor income and \( y_{kt} \) real capital income. All variables are expressed in per capita terms. It is worth mentioning that \( s_t \) is the conventional measure of saving when \( \gamma \), the proportionality factor between consumption and Hicksian income, is set equal to one. From equation (1) it can be seen that saving may be interpreted as the expected present value of future declines in labor income. According to this model, saving will be positive only in the case that income exceeds its permanent level and is consequently
expected to decline. If the PIH holds, saving is the optimal forecast of future declines in labor income. As a result, the forecast of this present value based on an unrestricted VAR should equal saving.

Campbell and Deaton (1989), on the other hand, derive similar expressions for the PIH working with logarithms. The basic idea developed is to work with the proportion of saving and consumption in income. Equation (1), stating that saving anticipates future declines in labor income has a similar form in logarithms in which the saving ratio anticipates future declines in the real growth rate of income,

\[ \frac{s_t}{y_t} \approx - \sum_{i=1}^{\infty} \rho^i E_t \Delta \log y_{t+i} - \kappa \]  

(2)

where \( \kappa \) is a constant.

The present value relation captured in (2) underlies the PVM tested in this study concerning household behavior.

### 2.1.2 Open Economy Present Value Model

The PVM in which consumption smoothing is analyzed in the context of an open economy is based on the intertemporal approach to current account determination. The original article on the subject is due to Sachs (1982). The approach adopts the assumptions of perfect capital mobility between countries and consumption smoothing on behalf of the representative agent. According to this view, the country bases its saving (and dissaving) decisions, expressed in the movements of its current account, on future changes in national cash flows. In the framework developed, the current account acts as a mean of smoothing consumption amidst shocks faced by the economy e.g. shocks to national product, investment and government spending.

The reasoning underlying the model can be described as follows. Based on the assumption of perfect capital mobility, the optimal path of consumption describing the representative agent is defined. The consumption path defines simultaneously the evolution of the debts contracted by the agent, determining the dynamics of the economy’s current account. The path of indebtedness can be associated with two factors. The first refers to a trend in consumption derived from differences between the discount factor (in which individuals weigh intertemporal utility) and international interest rates. The second factor is associated with debts contracted with the intent of adjusting consumption to changes in permanent income,
comprising the consumption smoothing component. The approach adopted in this study focuses on the consumption smoothing aspect of the current account.

The current account expresses the evolution of the country’s net foreign assets with the rest of the world and is given by

$$ CA_t = B_{t+1} - B_t = Y_t + rB_t - G_t - I_t - C_t $$  \(3\)

where \(B_t\) represents the country’s net foreign assets, \(C_t\) aggregate consumption, \(G_t\) government spending, \(I_t\) total investment, and \(r\) the interest rate. The current account associated with consumption smoothing, on the other hand, is defined as

$$ CA^*_t = Y_t + rB_t - G_t - I_t - \theta C^*_t $$  \(4\)

where the parameter \(\theta\) removes the trend in consumption and \(C^*_t\) is optimal consumption obtained when solving the representative agent’s intertemporal utility optimization problem.

National cash flow \(Z_t\) is defined as

$$ Z_t = Y_t - G_t - I_t $$  \(5\)

Substituting the appropriate expression for optimal consumption in (4), Ghosh and Ostry (1995) arrive at the following present value relation between the current account and changes in national cash flow:

$$ CA^*_t = -\sum_{j=1}^{\infty} \left( \frac{1}{1+r} \right)^j E_t [\Delta Z_{t+j}] $$  \(6\)

Equation (6) indicates that the optimal current account is equal to minus the present value of expected changes in national cash flow. For example, if agents expect an increase in government spending, a negative variation in national cash flow arises, inducing a current account surplus. The equation above is analogous to (1) for private consumption in which individuals save in anticipation of a fall in the present value of their earnings i.e. “saving for a rainy day”. In similar fashion, it indicates that agents save by accumulating foreign assets when expecting a reduction in national cash flow.

Equation (6) reflects the present value relation between the current account and national cash flow that underlies the PVM describing open economy macroeconomics that is object of empirical investigation in this study.
Sections 2.2 and 2.3 describe the mechanics behind PVMs in general and the testable implications that can be derived from them.

2.2 Present Value Models: An Overview

A general present value model is presented in Campbell and Shiller (1987) for two variables, \( y_t \) and \( Y_t \), in which the latter is a linear function of the present discounted values of the former:

\[
Y_t = \theta (1 - \delta) \sum_{i=0}^{\infty} \delta^i E_t y_{t+i} + c
\]

where \( c \) is a constant, \( \theta \) the coefficient of proportionality and \( \delta \) the discount factor. \( Y_t \) and \( y_t \) represent the economic variables of interest.

As pointed out by Campbell and Shiller, several problems emerge when testing equation (7). First of all, there are many forms of testing it and it is not absolutely clear as to how the different approaches are related to each other. Secondly, it may be difficult to give an economic interpretation to a rejection of (7). It is perfectly possible to reject the model at the 5\% level and yet have the expected discounted value of \( y_t \) explaining most of the variation in \( Y_t \). Finally, the variables \( y_t \) and \( Y_t \) usually require some sort of transformation before the theory of stationary stochastic processes can be applied given that one of the variables may have a unit root.

Taking into account this last point, Campbell and Shiller developed a method of verifying the validity of the present value relation between \( y_t \) and \( Y_t \) when the variables are stationary in first differences. The central idea consists in testing a set of restrictions imposed on the Vector Autoregression when the model is used to make an optimal forecast implicit in (7). An advantage of this approach is that despite the fact that it is not possible to observe the information set available to the individuals, the econometric method employed permits a summarization of the relevant information by means of the variables used in the construction of the VAR.

The two PVMs tested in this study are represented by equations (2) and (6) regarding consumption smoothing in a household and open economy setting. In the first case, \( Y_t \) and \( y_t \) represent the saving ratio \( s_t/y_t \) and the real growth rate of labor income \( \Delta \log y_t \), respectively, while in the second case the corresponding variables are the current account
and changes in national cash flow $\Delta Z_t$, respecting the same order.

### 2.3 Testable Implications

The econometric approach developed in Campbell and Shiller (1987) to test PVMs is based on the estimation of Vector Autoregressions. In order to apply this methodology to time series, it is necessary that the series used in the Vector Autoregression (VAR) are stationary. Let the variables $S^i_t$ and $\Delta y^i_t$, both assumed stationary, be described by the following present value relationship

$$ S^i_t = \lambda E_t \sum_{j=0}^{\infty} \beta^j (\Delta y^i_{t+j}) $$

(8)

Consider the following representation for a VAR containing $S^i_t$ and $\Delta y^i_t$, where $i$ indexes each country throughout the study

$$
\begin{bmatrix}
\Delta y^i_t \\
S^i_t
\end{bmatrix}
= 
\begin{bmatrix}
a^i(L) & b^i(L) \\
c^i(L) & d^i(L)
\end{bmatrix}
\begin{bmatrix}
\Delta y^i_{t-1} \\
S^i_{t-1}
\end{bmatrix}
+ 
\begin{bmatrix}
\xi^i_{1t} \\
\xi^i_{2t}
\end{bmatrix}
$$

(9)

and $a^i(L), b^i(L), c^i(L)$ and $d^i(L)$ are polynomials of lag order $p$ in the lag operator for $i = 1, ..., N$. This model can be used to predict $\Delta y^i_t$ multiple periods ahead and includes $S^i_t$ which is the optimal forecast of the present value of future changes in $y^i_t$. The VAR(p) can be written as a VAR(1) in the following manner:

$$
\begin{bmatrix}
\Delta y^i_t \\
\vdots \\
\Delta y^i_{t-p+1}
\end{bmatrix}
= 
\begin{bmatrix}
a^i_1 & \cdots & a^i_p & b^i_1 & \cdots & b^i_p \\
0 & \ddots & 0 & 1 & \cdots & 0 \\
0 & \cdots & 0 & 1 & \ddots & \cdots \\
0 & \cdots & \cdots & \cdots & \cdots & 1
\end{bmatrix}
\begin{bmatrix}
\Delta y^i_{t-1} \\
\vdots \\
\Delta y^i_{t-p}
\end{bmatrix}
+ 
\begin{bmatrix}
\xi^i_{1t} \\
\vdots \\
\xi^i_{2t}
\end{bmatrix}
$$

(10)

or more compactly as

$$ z^i_t = A^i z^i_{t-1} + u^i_t $$

(11)
where $A_i$ is the companion matrix of the VAR and $u_i^t$ is a vector of shocks. A forecast of $z_i^t$ $j$ periods ahead takes the form of

$$E(z_{t+j}^t / H_t) = A_{ij}^t z_i^t$$

where $H_t$ is the information set containing current and past values of $z_t$.

A weak implication of the model is that $S_i^t$ Granger-causes $\Delta y_i^t$ since the former is the optimal forecast of a weighted sum of future values of $\Delta y_i^t$ conditional on agents’ information set. In this context, if individuals are able to forecast $\Delta y_i^t$ taking into account information beyond that contained in its past values, $S_i^t$ will have additional explanatory power for future $\Delta y_i^t$. A second implication of the model is a set of restrictions imposed on (10). In order to derive such restrictions, take the expectation of (8) conditional on information set $H_t$. The left hand side of (8) remains the same since $S_i^t$ is contained in $H_t$ and the following expression can be obtained

$$g' z_i^t = \lambda \sum_{j=1}^{\infty} \beta^j h' A_i^j z_i^t$$

where $g'$ and $h'$ are vectors of dimension $2p \times 1$ in which all elements are zeros except for the first element of $h'$ and the $p+1st$ element of $g'$, both of which are unity. For this expression to hold it should be the case that

$$g' = \lambda \sum_{j=1}^{\infty} \beta^j h' A_i^j = \lambda h' \beta A_i (I - \beta A_i)^{-1}$$

Given the assumed stationarity of variables $S_i^t$ and $\Delta y_i^t$, the infinite sum in the middle of (14) is limited and can be expressed as the term to the right of it. Postmultiplying both sides of (14) by $(I - \beta A_i)$ the following identity is obtained

$$g' (I - \beta A_i) = \lambda h' \beta A_i$$

In terms of the individual coefficients of matrix $A_i$, restrictions (15) can be written as

$$c_i^j = -\lambda a_i^j, \quad j = 1, ..., p$$
$$d_i^1 = \beta^{-1} - \lambda b_i^1$$
$$d_i^j = -\lambda b_i^j, \quad j = 2, ..., p$$

(16)
Otto (1992) summarizes the implications of the PVM in the following manner:

1. The variable $S_t$ is stationary in levels. In our study, this means the stationarity of the saving ratio $s_t/y_t$ in the household setting PVM and of the current account $CA_t^*$ in the open economy model.

2. $S_t$ Granger-causes $\Delta y_t$. In the present analysis, this implies the presence of Granger causality running from the current account $CA_t$ to changes in national cash flow $\Delta Z_t$ and from the the saving ratio $s_t/y_t$ to the real growth rate of labor income $\Delta \log y_t$.

3. The restrictions imposed by (16) should be statistically valid. The appropriate set of restrictions for both PVMs analyzed in this study can be easily obtained by substituting the appropriate values of $\beta$ and $\lambda$ implied by (2) and (6) into (16).

4. The actual series $S_t$ should coincide with the series implied by the estimated VAR and the present value relationship. In our study, this implies that the actual saving ratio and current account series should be in conformity with the series obtained by means of the estimated VAR.

The present analysis concentrates on testing the formal implication of PVMs represented by the set of restrictions in (16) by means of Wald Tests on the coefficient estimates. The estimation method adopted is described in the following section.

### 2.4 Estimation Method

The Vector Autoregressions were estimated using two methods: Ordinary Least Squares (OLS) and Seemingly Unrelated Regression Equations (SURE). The purpose of using both methods is to verify the influence of each form of estimation on the empirical results.

A counterpart for Generalized Least Squares (GLS) when estimating a system of equations is SURE Estimation. Just as GLS provides a gain in efficiency when compared to OLS in single equation regression analysis, so is the case with SURE comparatively with OLS when treating a system of equations. Therefore, generally speaking, SURE has the advantage of yielding more efficient estimates than those obtained through OLS as will be shown in section 2.4.1 treating joint system estimation.

It should be noted that if the regressors of all the equations contained in the system coincide, the SURE and OLS estimators are identical\(^1\). This is the case when estimating the system of equations that compose the VAR for each country separately using both methods.

\(^1\)For a proof of this result, see HARVEY (1993).
Despite arriving at the same coefficients, SURE grants the benefit of yielding estimates with smaller variance. In the following subsection, the process underlying joint system estimation considering both OLS and SURE is presented.

2.4.1 Joint System Estimation

The joint system is constructed by stacking the group of equations that compose the VAR characteristic of each country expressed in (9) on top of each other in the following manner:

\[
\begin{bmatrix}
\Delta y^i_t \\
S^i_t
\end{bmatrix} =
\begin{bmatrix}
a^i(L) & b^i(L) \\
\epsilon^i(L) & d^i(L)
\end{bmatrix}
\begin{bmatrix}
\Delta y^i_{t-1} \\
S^i_{t-1}
\end{bmatrix} +
\begin{bmatrix}
\epsilon^i_{1t} \\
\epsilon^i_{2t}
\end{bmatrix}, \; i = 1, ..., N
\]  

(17)

Define \( Z^i_t = \begin{bmatrix} \Delta y^i_t \\ S^i_t \end{bmatrix} \), \( X^i_t = \begin{bmatrix} \Delta y^i_{t-1} \\ \vdots \\ \Delta y^i_{t-k_i} \\ S^i_{t-1} \\ \vdots \\ S^i_{t-k_i} \end{bmatrix} \), \( \beta^i = \begin{bmatrix} a^i_1 \\ \vdots \\ a^i_{k_i} \\ b^i_1 \\ \vdots \\ b^i_{k_i} \\ c^i_1 \\ \vdots \\ c^i_{k_i} \\ d^i_1 \\ \vdots \\ d^i_{k_i} \end{bmatrix} \), and \( \epsilon^i_t = \begin{bmatrix} \epsilon^i_{1t} \\ \epsilon^i_{2t} \end{bmatrix} \).

Then the system of equations in (17) can be represented as

\[ Y_t = X_t \beta + \epsilon_t \]  

(18)
where \( X_t = \begin{pmatrix} X_t^{1'} & 0 & \cdots & 0 \\ 0 & X_t^{1'} & 0 & \cdots & 0 \\ \vdots & 0 & X_t^{2'} & 0 & \cdots & 0 \\ \vdots & \vdots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & X_t^{N'} & 0 \\ 0 & 0 & \cdots & 0 & X_t^{N'} \end{pmatrix}_{(2N \times 4K)} \) \quad \beta = \begin{pmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_N \end{pmatrix}_{(4K \times 1)} \quad \text{and } \epsilon_t = \begin{pmatrix} \epsilon_1^t \\ \epsilon_2^t \\ \vdots \\ \epsilon_N^t \end{pmatrix}_{(2N \times 1)}

It should be noted that \( \sum_{i=1}^N k_i = K \). The \( \epsilon_t \)'s have mean zero and are serially uncorrelated with covariance matrix given by \( E(\epsilon_t \epsilon_i') = \sigma^2 \). Stacking the \( T \) equations given by (20) in the usual way, it can be shown that the covariance matrix of the disturbances \( u^* = (\epsilon_1^t, ..., \epsilon_T^t) \) is

\[
E(u^* u'^*) = \begin{bmatrix} 0 & \cdots & 0 \\ 0 & 0 & \cdots & 0 \\ \vdots & \ddots & \ddots & \vdots \\ 0 & \cdots & 0 & 0 \end{bmatrix}
\]

The GLS estimator of \( \beta \) is then given by

\[
\tilde{\beta} = \left( \sum_{t=1}^T X'_t X_t^{-1} \right)^{-1} \left( \sum_{t=1}^T X'_t X_t^{-1} y_t \right)
\] (19)

The variance of this estimator in the case where \( E(\epsilon) = 0 \) and \( E(\epsilon \epsilon') = \sigma^2 \) is

\[
VAR(\tilde{\beta}) = \sigma^2 \left( \sum_{t=1}^T X'_t X_t \right)^{-1}
\] (20)

When \( \sigma^2 \) is unknown, as is usually the case, this expression cannot be applied directly. The estimator can be obtained, however, by applying OLS to each equation separately. If \( \epsilon_i \) is
a $T \times 1$ vector containing the residuals of the $i$th equation estimated by OLS, an estimate of the $ij$th element of $\hat{\beta}$ is given by

$$\hat{\omega}_{ij} = \frac{e_i'e_j}{T}, \quad i, j = 1, ..., N$$ (21)

Substituting (21) in (19), the feasible SURE estimator of $\hat{\beta}$ is obtained

$$\hat{\beta}^* = \left( \sum_{t=1}^{T} X_t'\hat{X}_t^{-1} X_t \right)^{-1} \sum_{t=1}^{T} X_t'\hat{X}_t^{-1} y_t$$ (22)

with variance given by

$$Var(\hat{\beta}^*) = \sigma^2 \left( \sum_{t=1}^{T} X_t'\hat{X}_t^{-1} X_t \right)^{-1}$$ (23)

The OLS estimator, on the other hand, is given by

$$\hat{\beta} = \left( \sum_{t=1}^{T} X_t'X_t \right)^{-1} \sum_{t=1}^{T} X_t'X_t y_t$$ (24)

and variance

$$Var(\hat{\beta}) = \sigma^2 \left( \sum_{t=1}^{T} X_t'X_t \right)^{-1} \sum_{t=1}^{T} X_t'X_t \left( \sum_{t=1}^{T} X_t'X_t \right)^{-1}$$ (25)

The difference between (25) and (20) is a positive semidefinite matrix and can be expressed as

$$Var \left( \hat{\beta} \right) - Var(\hat{\beta}) = \sigma^2 \eta' \eta,$$

where $\eta = \left( \sum_{t=1}^{T} X_t'X_t \right)^{-1} \sum_{t=1}^{T} X_t' - \left( \sum_{t=1}^{T} X_t'\hat{X}_t^{-1} X_t \right)^{-1} \sum_{t=1}^{T} X_t' - 1$ indicating the gain in efficiency of SURE estimators relative to their OLS counterpart.

The following two sections describe the data used and the empirical results obtained when estimating VARs for the countries separately and as a group. Both OLS and SURE estimates were generated before testing the restrictions imposed by the PVM. The implications of each method of estimation can then be assessed in evaluating the empirical adherence of the model.
3 Data

3.1 Household Behavior Present Value Model

The data used in the empirical analysis of the household behavior PVM were obtained from the World Bank - World Development Indicators. The series represent eleven countries (listed in Table 6) and are composed of annual data ranging from 1960 to 1999.

The two basic series used reflect the saving ratio $s_i^t/y_i^t$ and the real growth rate of income $\Delta \log y_i^t$ and were constructed as follows. Savings $s_i^t$, the numerator in the ratio, was defined following CAMPBELL & DEATON (1989) as $s_i^t = z_i^t - c_i^t$ where $z_i^t$ is total real income and $c_i^t$ is real per capita consumption. The measure of $s_i^t$ was obtained directly from the database as gross national savings (including net current transfers) in constant local currency unit. The measure of income used $y_i^t$ reflects national disposable income per capita\(^2\). It was constructed as Gross National Savings plus Final Consumption Expenditure, both in constant local currency unit. The income measure is stated in per capita terms.

3.2 Open Economy Present Value Model

The data used in the analysis of the Open Economy PVM were also obtained from the World Bank. The series covering the current account $CA_i^t$ and the change in national cash flow $\Delta Z_i^t$ represent annual data covering the period ranging from 1975 to 1996. The countries included, also covering Latin America, form two samples. The first consists of eight countries in South America plus Mexico and the other is a subset of it, comprised of six countries. All countries included in the present analysis were also object of investigation in Ghosh and Ostry (1995), permitting a comparison of the results obtained in both studies. The two samples of countries are listed in Table 6.

\(^2\)Although the literature uses labor income, such a measure is not available in the database. As a result, the measure of income adopted throughout the empirical work is national disposable income.
4 Empirical Results

4.1 Household Behavior Present Value Model

An important step in the empirical analysis consisted in determining the number of lags to be incorporated in each Vector Autoregression estimated. A set of Information Criteria and Diagnostic Tests were carried out in the selection process. In determining the lag length of the VAR, the following criteria were used: the Sequential Modified Likelihood Ratio Test, Akaike Information Criteria, Schwarz Criteria, and Hannan and Quinn Criteria. In most cases, the criteria were unanimous in indicating the number of lags to be used in each VAR. The lag choice was also supplemented by Diagnostic Tests to discard the presence of autocorrelation and heteroskedasticity in the residuals and attest that the model was correctly specified. The results of these tests are presented in Tables 1 and 2\textsuperscript{3}.

<table>
<thead>
<tr>
<th>Countries</th>
<th>Number of Lags</th>
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<tr>
<td>Argentina</td>
<td>4</td>
</tr>
<tr>
<td>Bolivia</td>
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<tr>
<td>Brazil</td>
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<tr>
<td>Chile</td>
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<tr>
<td>Colombia</td>
<td>2</td>
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<tr>
<td>Ecuador</td>
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<td>Mexico</td>
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<td>Paraguay</td>
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</tr>
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<td>Peru</td>
<td>5</td>
</tr>
<tr>
<td>Uruguay</td>
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</tbody>
</table>

\textsuperscript{3}White Heteroskedasticity Tests were conducted and ruled out the presence of heteroskedasticity. The results are not reported and are available upon request.
Once the number of lags to be included in each VAR was determined, estimates of the coefficients were generated. Two forms of estimation were conducted: Ordinary Least Squares (OLS) and Seemingly Unrelated Regressions (SURE) in order to verify if the VAR coefficient estimates are in conformity with those predicted by the theory.

### 4.1.1 Wald Restriction Test

As mentioned previously, the Wald Test consists in assessing if the coefficients estimated for the following system of equations, representing the VAR characteristic for each country

\[
\Delta \log y_t^i = \sum_{j=1}^{p} \left( a_j^i \Delta \log y_{t-j}^i + b_j^i \frac{s_{t-j}^i}{y_{t-j}^i} \right) \\
\frac{s_{t}^i}{y_t^i} = \sum_{j=1}^{p} \left( c_j^i \Delta \log y_{t-j}^i + d_j^i \frac{s_{t-j}^i}{y_{t-j}^i} \right)
\]  

(26)
satisfies the set of restrictions obtained when substituting the values of $\beta = \rho$ and $\lambda = -1$ implied by (2) into (16)

\[
\begin{align*}
a_j^i &= c_j^i \text{ for } j = 1, \ldots, p \\
b_j^i &= d_j^i \text{ for } j = 2, \ldots, p \\
d_1^i - b_1^i &= \rho^{-1}
\end{align*}
\]

The results depend evidently on the method of estimation (OLS or SURE), the discount factor ($\rho$) and the level of statistical significance established. Four different values of $\rho$ were considered, ranging from 0.9 to 1. Although the empirical literature tends to adopt a discount factor bearing one, the wider range of values assumed in this study represents a form of assessing the robustness of the empirical results.

In the case of OLS estimation, the results indicate wide acceptance of the Household Behavior PVM (Table 3 - Appendix). In nine of the eleven countries considered, the restrictions imposed by the PIH cannot be rejected. For only two countries - Chile and Paraguay, is the empirical adherence of the theory put in check. And still, the results for these two countries are not so convincing. In the case of Paraguay, the restrictions are rejected only at the 10% level for $\rho=0.9$. Chile, on the other hand, while rejecting the theory at the 10% level for three of the four $\rho$ values adopted, for only one ($\rho=0.9$) is it done at the 5% level. As a result, basing the analysis solely on OLS estimation yields a promising prognosis for the permanent income model as to its capacity of accommodating consumption behavior in the Latin American countries taken individually. This result is also confirmed when considering the group as a whole by estimating the system of equations representing all the countries at once and testing the restrictions imposed by each together. In this case, all values indicate that the restrictions set by the theory are satisfied i.e. cannot be rejected based on the Wald Test (line labeled ALL in Table 3).

SURE estimation, on the other hand, casts more doubt as to the empirical adherence of the Permanent Income Model. When adopting this method of estimation which, as seen previously is generally more efficient than OLS, the restrictions on the coefficients imposed by the theory can be rejected for seven of the eleven countries considered. With the exceptions of Argentina, Brazil, Ecuador and Mexico, all other countries admit rejection of the consumption smoothing view at the 10% level for at least a portion of the values of $\rho$ considered. And excluding Paraguay from this group, all others admit rejection of the PIH restrictions at the 5% level. Furthermore, joint estimation of the VARs and testing simul-
taneously the restrictions imposed on each country using SURE estimation produces results incompatible with the permanent income model. For all parameter values, the model was rejected at the 0% level.

4.2 Open Economy Present Value Model

In the case of the open economy PVM, joint system estimation of Vector Autoregressions were conducted for the Latin American countries. The order of the VAR characteristic of each country was specified in accordance with Ghosh and Ostry (1995), who adopted a 1-lag VAR specification for all countries. In the present analysis, VARs of lag length 2 were also considered. The values of $\theta$, used to isolate the consumption smoothing aspect of the current account, were either set equal to one or to the values obtained in Ghosh and Ostry. However, the lack of data available to calculate the optimal current account $\text{CA}^*_t$ for each country led us to the adoption of a slightly different procedure than that described previously. Instead of $\text{CA}^*_t$, the VARs were estimated using the observed current account $\text{CA}_t$ and the corresponding set of restrictions was calculated. The new set of restrictions are arrived at by substituting for optimal consumption $C^*_t$ into equation (3), determining the current account

$$\text{CA}_t = -\sum_{j=1}^{\infty} \left( \frac{\theta - 1}{\theta} + \frac{1}{\theta (1 + r)^j} \right) E_t [\Delta Z_{t+j}] + r \left( \frac{\theta - 1}{\theta} \right) B_t. \quad (27)$$

It can be shown that equation (27) implies the following set of restrictions as a function of $\theta$

$$c^j_i = \left[ \theta + r (\theta - 1) \right] a^j_i, \quad j = 1, ..., p \quad (28)$$

$$1 - \frac{d^j_1}{\theta (1 + r)} = -\frac{\theta + r (\theta - 1)}{\theta (1 + r)} b^j_1$$

$$d^j_j = \left[ \theta + r (\theta - 1) \right] b^j_j, \quad j = 2, ..., p$$

The method of estimation adopted was SURE. Table 5 summarizes the results obtained. In all cases analyzed, the restrictions imposed by the theory are rejected at the 0% level, indicating that the permanent income model and consumption smoothing view are not supported by the data.

The results obtained contrast with those arrived at previously by Ghosh and Ostry. The former study finds acceptance of the permanent income model and consumption smoothing
view for eleven of the sixteen Latin American and Caribbean countries analyzed. Among
the countries common to both studies, for only three - Paraguay, Uruguay, and Venezuela,
does the previous study put the model into check. As a result, Ghosh and Ostry, treating
each country separately in the estimation process, find wide support for the consumption
smoothing view in Latin America. Our results, on the other hand, find evidence in the
opposite direction when adopting SURE as the estimation method.

5 Conclusions

This study conducts an analysis of consumption smoothing in Latin America by testing the
empirical adherence of Present Value Models. Two models are considered, one describing
consumption smoothing in a household setting and the other in an open economy. For
the household behavior PVM, bivariate VARs containing the saving ratio $s_t/y_t$ and the
real growth rate of income $\Delta \log y_t$ are estimated for each country separately and for the
group as a whole by means of joint system estimation. Two estimation methods are used:
Ordinary Least Squares (OLS) and Seemingly Unrelated Regression Equations (SURE). In
the analysis of the open economy PVM, bivariate VARs incorporating the current account
$CA_t$ and changes in national cash flow $\Delta Z_t$ are estimated for all countries jointly under
SURE.

Wald Tests are then conducted to test the restrictions imposed by the permanent income
model on the VAR coefficient estimates. The empirical results obtained are highly sensi-
tive to the estimation method adopted. The Wald Tests under OLS estimation produced
favorable results for the permanent income model concerning household behavior. For only
two of the eleven countries (Chile and Paraguay), are the restrictions imposed by the theory
rejected, depending on the discount factor and the level of statistical significance consid-
ered. Even then though, the results against the model are not so convincing. In the case of
Paraguay, for example, rejection occurs for only one value of the discount rate ($\rho = 0.9$) and
at the 10% level. Joint system estimation of the equations characterizing all eleven countries
and simultaneous testing of the restrictions imposed by each also provides evidence in favor
of the consumption smoothing model.

When considering SURE estimation, on the other hand, the Household Behavior PVM
does not perform so well. In this case, the theory is rejected for seven of the eleven countries.
When turning to joint system estimation, the theory is also rejected on the basis of Wald Tests.

With respect to the Open Economy PVM, the results obtained differ substantially from those presented by Ghosh and Ostry (1995). While the former study finds evidence indicating that roughly 2/3 of the countries in Latin America have been able to fully smooth consumption by means of current account movements, our results point in the opposite direction. The Wald Tests conducted in the present analysis reject the consumption smoothing view under SURE joint system estimation for both samples of countries considered.

The results in favor of the permanent income theory and consumption smoothing view in Latin America are therefore weak, depending heavily on the estimation method and the values of the parameters adopted.
Table 3
Test of Restrictions on Coefficients - WALD (OLS)

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<tr>
<th>Countries</th>
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### Table 5

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<tr>
<td>South America &amp; Mexico 2</td>
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G-O: Ghosh and Ostry (1995)

### Table 6

<table>
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References


