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The Intertemporal Approach to the Current Account: Evidence from Argentina

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Abstract

In this paper, an intertemporal model is used to analyze the current account and test whether it accounts for the evolution of the Argentinean current account over the period extending from 1855 to 2002. The intertemporal model presented here takes into account several sources of external shocks for small economies such as a change of the real interest rate and the real exchange rate. Evidence shows that the intertemporal model does not pass the statistical tests and does not explain the Argentinean experience. More specifically, if the Argentinean current account was to behave as the model predicts, one would observe the opposite movement to that observed for the actual current account. Our main conjecture about the weak performance of the model is related to i) the fact that one of its most important assumption is violated for some part of the period under consideration (1931 - 1989); and ii) that the balance of payments' crises and stop and go cycles may have altered the relation between the variables suggested by the model. To cope with this problem, we have estimated a model for the period 1885-1930 (a period with relatively high capital mobility and with neither currency crises nor stop and go cycles) and found some evidence in favour of this result. A general conclusion to be drawn is that, in contrast to other Latin American countries, an intertemporal current account model can not appropriately account for the dynamics of the current account of Argentina, even thought there is some evidence in favour of the model for the period 1885-1930.

1 Introduction

A country's current account balance over any time period is the increase in residents' claims on foreign incomes or outputs, less the increase in similar foreign-owned claims on home income or output. A great part of the field of international macroeconomics deals precisely with the concerns that arise when the current account is in disequilibrium and with the existence of automatic adjustment mechanisms and policies concerning the balance of payments. Many theories have been developed over time concerning these topics. In particular,

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we can distinguish the "old" or traditional view, which studies the specific determinants of trade and financial flows, and the "new" or modern view (called the intertemporal approach to the current account), that highlights the importance of saving-investment decisions taken by forward-looking optimizing agents in the determination of the international flow of commodities and financial capital. In the simpler intertemporal models, a country's current account surplus should be equal to the present value of expected future declines in output, net of investment and government purchases (called net output). In these papers there is no room for a variable real interest rate and for the real exchange rate. More recent papers expand earlier models precisely by considering the role played by those variables in the determination of the current account.

For the case of Argentina the few papers that exist on the subject use mostly the "old view" to analyze the current account. In particular, Musalem (1984 and 1985) estimates econometrically an equation for the determination of the trade balance including as explanatory variables the real exchange rate and the international interest rate. On the other hand, Wynne (1997) makes an analysis of the determinants of aggregate savings and its impact on growth. In this context, the author studies the sustainability of the Argentinean current account during the 90s.

In this paper we use an intertemporal model to the current account and test it both formally and informally to see whether it can account for the evolution of the Argentinean current account during the period 1885 - 2002. In particular, we know that the current account of Argentina has exhibited large fluctuations through time. Particularly, during the last part of the XIXth century and the beginning of the XXth century (Belle Epoque), the country had access to the international financial market that allowed it to finance important current account deficits (of approximately 6% of the GDP per year during 1885-1931). Since then, the international environment has changed drastically. Firstly with the occurrence of the big crises of the 30s and secondly with the Second World War. The international trade has slumped and protectionary policies were applied world wide. The country could not maintain the huge current account imbalances of the past and we observed an almost equilibrated current account until the beginning of the 90s (-0,1% of GDP). Since 1990 and as a consequence of the rise in external funds available to developing countries, Argentina could once again run important current account imbalances of the order of 3.4% of GDP during the period 1992-2001. A good question would then be to know whether an intertemporal current account model may account for the dynamics in the current account of Argentina since the last part of the XIXth century. In accordance with the simpler intertemporal theory, the periods 1885-1930 and 1991-2002 should have been periods in which agents anticipated a rising net output while in the period 1931-1990 agents should have expected a decline in net income. Given that the end of the XIXth and the beginning of the XXth century were very affluent times and that the opposite case applies for the period 1931-1991, it seems that in principle the theory should track the long run evolution of the current account in Argentina reasonable well.

The paper is organized as follows. It first presents the intertemporal ap-

proach by enhancing the theoretical and empirical elements that favored its creation (Section 2). Section 3 briefly exposes the theory of "present value models" which underlies all the empirical work made on the intertemporal approach. This section also makes a revision of the applied literature, an important observation is that the majority of the papers applied a "simple" version of the current account model where only the future evolution of the "net output" (gross domestic product less investment and government expenditures) was relevant. An important extension of these models that also considers a variable interest rate and the real exchange rate in the determination of the current account is presented in Section 4 (The Theoretical Model). The precise econometric method used to test the theory is presented in Section 5. This is just an application to the current account of the concepts and methods developed in Section 3. The construction of the data needed to test this theory for the case of Argentina is presented in Section 6. Various sources of data were combined to finally build the long time series needed to test the theory (the working-age population, the real exchange rate, nominal interest rates and so on for the period 1885 - 2002). Section 7 exposes the empirical results, first checking that the time series have the necessary properties to be included in the model and estimating a Vector Auto Regression Model (VAR). We then combine some key parameters of the theory (the intertemporal discount factor, the share of non tradables on total private consumption, etc.) and the results from the VAR to obtain the formal and informal results for the validity of this model for the case of Argentina. Section 8 concludes.

2   The Intertemporal Approach and its Origins

Intertemporal analysis of the current account balance became common in the early 1980s when researchers begun to explore the implications of modeling the current account based on assumptions of representative individuals that made forecasts of the relevant variables in a rational expectations context. Buiter (1981) and Sachs (1981a and 1981b), Obstfeld (1982), Greenwood (1983) and Svensson and Razin (1983) have developed such models highlighting these features. This was the result from both theoretical advances and from economic events at the international level (Obstfeld and Rogoff, 1994).

On the one side, the Lucas's Critique of econometric policy evaluation was one important theoretical motivation for an intertemporal approach. His insistence on grounding policy analysis in the actual forward-looking decision rules of economic agents suggested that open-economy models might yield more reliable policy conclusions if demand and supply functions were derived from the optimization problem of households and firms rather than specified to match reduced-form estimates based on ad hoc econometric specifications.

On the other side, further impetus to develop an intertemporal approach came from events in the world capital market, especially the substantial current-account imbalances that followed the sharp world oil-price increases of 1973-74 and 1979-80 in developed and non oil developing countries. The divergent pat-

terns of current account adjustments by industrialized and developing countries raised the inherently intertemporal problem of characterizing the optimal response to external shocks. Similarly, the explosion in bank lending to developing countries after the first oil shock sparked fears that borrowers' external debt levels might become unsustainable. The need to evaluate developing-country debt levels again led naturally to the notion of an intertemporally optimal current-account deficit.

One might of course wonder whether this theory that was created as a response to precise international events during a certain period of time could be applied to examine other cases and circumstances. Even if not of the same nature and with some qualifications, some of the characteristics of the financial markets turmoil in the 70s were also seen during the 90s and even, over the last part of the nineteenth century. In particular, for the last part of the nineteenth century we know that it was a period of very high capital mobility, with resources flowing from the Old World (mainly England) to the New world (see Williamson et al., 1994; Obstfeld et al., 2002; and Taylor, 2002). As for the 70s and 90s we know that the proportion of private to official capital inflows to less developed countries has grown substantially, the international money market has expanded dramatically, and capital controls have been liberalized in many developing countries (for an analysis of the 70s period see Sachs, 1981b). As a consequence, most Latin American countries exhibited current account imbalances. This was also the case for the biggest economy in the world (the US) which raised again some concerns over the sustainability of these imbalances (see Mann, 2002).

3 How to Test the Theory

To test this theory, "present value" models are used by recent papers. In these type of studies, one variable is written as a linear function of the present discounted value of other variables.[1] These analysis rely heavily on the modern theory of time series and on vector auto regressive models. One of their most important virtues is that they make use of the theoretical model's structure to derive testable hypothesis.

The first articles that applied this technique over current account data appeared in the early 90s. In these simple versions of the intertemporal model the objective was to expand the idea of Campbell (1987) that consumers "save for a rainy day", to an open economy. In particular in the earlier literature, a country's current account surplus was equal to the present value of expected future declines in output, net of investment and government purchases (called directly the net output). The analogy to household savings is instructive: households save when they expect their future labor income to decline. The key element that is being introduced by using this type of test is how one proxies for pri-

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[1]In formal terms a present value model for two variables y_t and Y_t states that the last variable can be written as: $Y_t = \sum_{i=0}^{\infty} \delta^i E_t y_{t+i}$; where δ is the discount factor, E_t denotes mathematical expectation, conditional on a full public information set.

vate agents' expectations of future values of the relevant variables. The basic insight is that as long as the information set used by the econometrician does not contain all the information available to private agents, then past values of the current account should contain information useful in constructing estimates of agents' expectations of future values of the relevant variables (net output in these early models and interest rates and the real exchange rate in the more modern models, as we will see later). Another important feature of these models is that the international real interest rate is considered to be constant and there is no room for non tradable goods.

The pioneering paper on the subject is the one by Sheffrin and Woo (1990a). The authors study the case of Belgium, Canada, Denmark and the UK for the period 1955-1985. They found evidence in favor of the theory only in the case of Belgium. Later on, other case studies have appeared: Otto (1992) considered the case of US and Canada using quarterly data for the period 1950:1 to 1988:4. For both countries, the formal restrictions implied by the present-value relationship for the current account are strongly rejected, finding only some "informal" evidence in favor for the US case. Ghosh (1995) studied the case of Japan, Germany, the US, Canada and the UK using quarterly data for the period 1960 : 1 - 1988 : 4. He concludes that the model performs extremely well in characterizing the direction and turning points of the current accounts of the countries studied even if the theory can not be rejected only in the case of US. More recently, McDermott et al. (1999) wrote a paper for France using quarterly data for the period 1970: 1 to 1996:4 finding that the model explains the fluctuations of the current account balance fairly well, even for a period during which France experienced large external shocks and there were restrictions on overseas capital transactions.

One thing to note is that papers for developing economies are by far less common. For Latin America and to our knowledge, there are only two studies that applied the simple version of the model: one for Colombia and the other for Peru. For the first country, Suarez Parra (1998) tests this simpler version of the intertemporal model using annual data over the period 1950 - 1996 and for the second economy, Arena and Tuesta (1999) do the same thing using annual data for the period 1960 - 1996. For both countries the intertemporal model seems to track quite well the effective movement in the actual current account.

A somewhat general finding in all these articles is that the actual current account is in fact more volatile than the "theoretical" current account, except in the case of the US.[2] As noted by Bergin and Sheffrin (2000), this is surprising since the assumptions of the theory seem to be more appropriate for small open economies than for big ones. This result naturally leads to the idea that there were some missing variables not included in the model that should have been considered to explain the current account.

A likely explanation already advanced by Sheffrin and Woo (1990a) but not developed, is that small economies may be affected strongly by external

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[2]That is, capital flows to and from these countries have been much more volatile than would have been justified by expected changes in national net output.

shocks not passing through changes in net output -a factor not considered in the simple version of the model. To explain the current account behavior of small economies it may be important not only to consider shocks to domestic output but also shocks arising in the world in general. These external shocks will generally affect the small economy via movements in the interest rates and exchange rates. Ten years later, Bergin and Sheffrin (2000) developed and constructed a model that precisely incorporated in the model, a moving interest rate and the real exchange rate, following a proposal by Dornbusch (1983). The idea was that an anticipated raise in the relative price of internationally traded goods can raise the cost of borrowing from the rest of the world when interest is paid in units of these goods. As a result, changes in the real exchange rate can induce substitution in consumption between periods, and thus can have intertemporal effects on a country's current account similar to those of changes in the interest rate. In addition to these intertemporal effects, exchange rate changes of course can also have more standard *intratemporal* effects by inducing substitution between internationally-traded goods and nontraded goods at some point in time. The authors tested the model for Australia, Canada and the UK and concluded that the incorporation of these variables may help explain the evolution of the current account in the case of the two first countries over the simpler intertemporal models used in earlier tests. This model was also tested for Chile using quarterly data from 1960:1 to 1999:4, concluding that with the inclusion of both a variable real interest rate and the expected appreciation of the exchange rate, the performance of the model improves a lot over the case where these variables were not included (Landeau, 2002).

It is considered that this constitutes an important improvement to the intertemporal theory since it takes into account two other sources of possible external shocks which may in principle be very important for small developing economies. This is the case since as it is widely known, interest rates and the exchange rate are more volatile in developing countries than in developed ones. In what follows we will present this model in detail and test its functioning for the case of Argentina.

4   The Theoretical Model

As aforementioned, we consider the model developed by Bergin and Sheffrin (2000) in which a small country produces traded and nontraded goods. The country can borrow and lend with the rest of the world at a time-varying real interest rate. The representative household solves an intertemporal maximization problem, choosing a path of consumption and debt that maximizes the expected discounted lifetime utility:

$$\max E_t \sum_{s=t}^{+\infty} \beta^{s-t} U\left(C_{Ts}, C_{Ns}\right)$$

$$\text{s.t. } Y_t - \left(C_{Tt} + P_t C_{Nt}\right) - I_t - G_t + r_t B_{t-1} = B_t - B_{t-1}, \tag{1}$$

where $U(C_{Tt}, C_{Nt}) = \dfrac{1}{1-\sigma}\left(C_{Tt}^a C_{Nt}^{1-a}\right)^{1-\sigma}$

$$\sigma > 0, \ \sigma \neq 1, \ 0 < a < 1$$

E_t denotes expectations conditional on agents' time t information set. Consumption of the traded good is denoted C_{Tt}, and consumption of the nontraded good is C_{Nt}. Y_t denotes the value of current output, I_t is investment expenditure, and G_t is government spending on goods and services, all measured in terms of traded goods. The relative price of home nontraded goods in terms of traded goods is denoted P_t. The stock of external assets at the beginning of the period is denoted B_t. Finally, r_t is the net world real interest rate in terms of traded goods, which may vary over time. The lefthand side of this budget constraint may be interpreted as the current account. We may express total consumption expenditure in terms of traded goods as $C_t = C_{Tt} + P_t C_{Nt}$.

From the first-order conditions for this problem we can derive the following optimal consumption profile (see Appendix A):

$$1 = E_t\left[\beta\left(1+r_{t+1}\right)\left(\frac{C_t}{C_{t+1}}\right)^\sigma\left(\frac{P_t}{P_{t+1}}\right)^{(1-\sigma)(1-a)}\right] \tag{2}$$

Assuming joint log normality and constant variances and covariances, condition (2) may be written in logs as:

$$E_t\Delta c_{t+1} = \gamma E_t r_{t+1}^* \tag{3}$$

where $\gamma = 1/\sigma$ is the intertemporal elasticity of substitution and r_{t+1}^* is a consumption-based real interest rate defined by:

$$r_{t+1}^* = r_{t+1} + \left[\frac{1-\gamma}{\gamma}(1-a)\right]\Delta p_{t+1} + \text{constant term}$$

We also define $\Delta c_{t+1} = \ln C_{t+1} - \ln C_t$ and $\Delta p_{t+1} = \ln P_{t+1} - \ln P_t$. For the world real interest rate (defined in terms of traded goods) we use the approximation: $\ln(1+r_{t+1}) \approx r_{t+1}$. The constant term at the end of the expression will drop out of the empirical model when we later demean the consumption-based real interest rate. See Appendix B for a derivation of these equations.

This condition characterizes how the optimal consumption profile is influenced by the consumption-based real interest rate, r_t^*, which reflects both the interest rate r_t and the change in the relative price of nontraded goods, p_t. Previous empirical studies of the intertemporal approach to the current account have not allowed for these variables. Such models imply a consumption profile where the expected change in consumption is zero; households always try to smooth consumption over time by borrowing and lending with the rest of the world. In contrast, the representative consumer here may be induced to alter the consumption profile and "unsmooth" consumption in the face of changes in the terms of such borrowing and lending. First consider the interest rate. An

increase in the conventional real interest rate, r_t, makes current consumption more expensive in terms of future consumption foregone, and induces substitution toward future consumption.

A similar intertemporal effect can result from a change in the relative price of nontraded goods. If the price of traded goods is temporarily low and expected to raise, then the future repayment of a loan in traded goods has a higher cost in terms of the consumption bundle than in terms of traded goods alone. Thus the consumption-based interest rate r^* raises above the conventional interest rate r, and lowers the current total consumption expenditure. In addition to this intertemporal substitution, a change in the relative price of nontraded goods also induces intratemporal substitution. Again if the price of traded goods is temporarily low relative to nontraded goods, households will substitute toward traded goods by the intratemporal elasticity, which is unity under a Cobb-Douglas specification. This intratemporal effect will be dominated by the intertemporal effect if the intertemporal elasticity (γ) is greater than unity.

The representative agent optimization problem above entails an intertemporal budget constraint (equation (1)) that may be rewritten as:

$$B_t = NO_t - C_t + (1 + r_t) B_{t-1}$$

where we define net output as follows: $NO_t = Y_t - I_t - G_t$. Net output is random and the source of uncertainty in the model. Define also $R_{t,S}$ as the market discount factor between S and t so that (for $S > t$):

$$R_{t,S} = \frac{1}{\prod\limits_{j=t+1}^{S} (1 + r_j)}$$

with the convention that $R_{t,t} = 1$ Summing and discounting over all periods of the infinite horizon, and imposing the following transversality condition:

$$\lim_{T \to +\infty} R_{t,T} B_T = 0$$

we may write an intertemporal budget constraint:

$$\sum_{s=0}^{+\infty} R_{t,t+s} C_{t+s} = \sum_{s=0}^{+\infty} R_{t,t+s} NO_{t+s} + B_t^{'} \tag{4}$$

where $B_t^{'}$ is the initial net foreign assets. We log linearise this intertemporal budget constraint to get:

$$-\sum_{s=1}^{+\infty} \beta^s \left[\frac{\Delta no_{t+s}}{\Omega} - \Delta c_{t+s} + \left(1 - \frac{1}{\Omega} \right) r_{t+s} \right] = \frac{1}{\Omega} no_t - c_t + \left(1 - \frac{1}{\Omega} \right) b_t^{'} +$$

$$+ \text{ constant term} \tag{5}$$

where lower case letters represent the logs of upper case counterparts, except in the case of the world real interest rate, where we use again the approximation that $\ln(1 + r_t) \approx r_t$. Here Ω is a constant grater than one, $\Omega = 1 + \frac{B}{\Psi}$, where B is the steady state value of net foreign assets and Ψ is the steady state value of the present value of net output. Next, take expectations of this equation and combine it with the log-linearized Euler equation (3) to write:

$$-E_t \sum_{s=1}^{+\infty} \beta^s \left[\frac{\Delta no_{t+s}}{\Omega} - \gamma r^*_{t+s} + \left(1 - \frac{1}{\Omega}\right) r_{t+s} \right] = \frac{no_t}{\Omega} - c_t + \left(1 - \frac{1}{\Omega}\right) b'_t +$$

$$+ \text{ constant term}$$

The right hand side of this equation is similar to the definition of the current account $(CA_t = NO_t - C_t + r_t B_{t-1})$, except that its components are in log terms and there appears Ω and a constant term in it. We label this transformed representation of the current account as CA^*_t. We will follow the convention of choosing the steady state around which we linearize to be the one in which net foreign assets are zero $(B = 0)$. In this case, $\Omega = 1$ and the condition above may be written:

$$CA^*_t = -E_t \sum_{s=1}^{+\infty} \beta^s \left(\Delta no_{t+s} - \gamma r^*_{t+s} \right) \tag{6}$$

where $CA^*_t \equiv no_t - c_t$ and where we neglected the constant term since in the empirical model we will demean all the variables.[3] See Appendix C for a derivation of the intertemporal budget constraint and its log-linearization. This condition says that if net output is expected to fall, the current account will rise as the representative household smooths consumption. But the condition also says that aside from any change in domestic output, a rise in the consumption-based interest rate will raise the current account by inducing the representative household to lower consumption below its smoothed level. Then, the agent may also be willing to "unsmooth" consumption because of changes in the consumption based real interest rate. For comparison, we also test two simpler versions of the intertemporal model. In the first one, the consumption-based interest rate is assumed to be constant, and consequently only the first of the two effects described above will occur. This amounts to testing a condition similar to (6) above, where the second term in the brackets is not present. The second version is one in which we only allow for a variable real interest rate, the real exchange rate being constant in the expression of the consumption based real interest rate. The objective in the first case is to see whether an expanded model can improve upon the simpler versions developed in the early literature and in the second one, if any, to try to determine the source of this improvement.

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[3]With the assumption that $\Omega = 1$ our measure of the current account is in fact the trade balance. So, we will be dealing with the trade balance even if we call it the current account.

5 The Econometric Method

To test the restriction that the current account depends on expected future values of net output and the consumption based interest rate, we must first have proxies for these two sets of expected values. The simplest approach would be to project every single variable (the net output, the real interest rate and the exchange rate appreciation) on past values of itself. As noted by Ghosh (1995), this is unlikely to be adequate since individual agents will in general have a much richer information set on which base their expectations. Nowadays, the standard procedure for generating expectations of the net output and the consumption based real interest rate is to project these variables forward on the basis of past data using a VAR framework in which the past values of all of the series intervene in the expectation formation. As noted in all of the papers already mentioned on the subject, this is equivalent to regarding conditional expectations as equivalent to linear projections on the information set. In turn, as noted in Campbell and Shiller (1988), one possibility would be to consider the expression $\Delta no_{t+s} - \gamma r^*_{t+s}$ as a single variable from which we make expectations, in which case we would have to estimate just a two variable VAR. As Bergin and Sheffrin (2000) do, another option is to consider Δno_{t+s} and r^*_{t+s} as separate variables and estimate a three variable VAR. Instead, the option that we follow here is to consider the change in net output, the real interest rate *and* the appreciation rate of the real exchange rate as separate variables. The advantage over the other possibilities is that in this fashion, one can judge the relative importance of every variable, if any, on the current account If the model performs well, we would then be able to see which of the three variables is more important in determining the evolution of the current account.

In order to do that, we rewrite equation (6) using the expression for the consumption based real interest rate that takes into account that r^*_{t+s} is a function of r_{t+s} and Δp_{t+s} :

$$CA^*_t = -E_t \sum_{s=1}^{+\infty} \beta^s \left[\Delta no_{t+s} - \gamma r_{t+s} - (1-\gamma)(1-a)\Delta p_{t+s} \right] \qquad (7)$$

As will be said in the next section, as Argentina suffered from exchange rate controls in their international transactions during some periods of time, it is convenient to split the appreciation of the real exchange rate (Δp_{t+s}) into two components. One component corresponds to the appreciation of the real exchange rate calculated using a "commercial" exchange rate and the other, to one corresponding to a "market" exchange rate. The first one corresponds to a regulated exchange rate used for exports and imports while the second one is the "free market" exchange rate determined in the black or free market.[4] We will then call Δp^C_{t+s} the appreciation of the commercial real exchange rate and Δp^M_{t+s} the appreciation of the market real exchange rate. We are now able to rewrite equation (7) as (where b is a weighting parameter):

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[4]Of course, these series do coincide when there are no exchange rate controls.

$$CA_t^* = -E_t \sum_{s=1}^{+\infty} \beta^s \left[\Delta no_{t+s} - \gamma r_{t+s} - (1-\gamma)(1-a) \left[b\Delta p_{t+s}^C + (1-b)\Delta p_{t+s}^M \right] \right]$$
(8)

Under the null hypothesis of this last equation, the current account itself should incorporate all of the interest rate, devaluation rate and net output changes specified in that equation.[5] This leads us to estimate a five variable VAR to represent consumers' forecasts:

$$
\begin{bmatrix}
\Delta no \\
CA^* \\
r \\
\Delta p^C \\
\Delta p^M
\end{bmatrix}_t
=
\begin{bmatrix}
a_{11} & a_{12} & a_{13} & a_{14} \\
a_{21} & a_{22} & a_{23} & a_{24} \\
a_{31} & a_{32} & a_{33} & a_{34} \\
a_{41} & a_{42} & a_{43} & a_{44} \\
a_{51} & a_{52} & a_{53} & a_{54}
\end{bmatrix}
\begin{bmatrix}
\Delta no \\
CA^* \\
r \\
\Delta p^C \\
\Delta p^M
\end{bmatrix}_{t-1}
+
\begin{bmatrix}
u_1 \\
u_2 \\
u_3 \\
u_4 \\
u_5
\end{bmatrix}_t
$$
(9)

Or written more compactly: $z_t = Az_{t-1} + u_t$, where $E(z_{t+s}) = A^s z_t$. This may easily be generalized for higher orders of VAR. A test of the simpler model that holds interest and devaluation rates constant would involve a VAR that omits the third, fourth and fifth equations and the third, fourth and fifth variables. Of course, a model that considers the appreciation rate of the real exchange rate to be constant is one that omits the forth and fifth equations and variables in the VAR system.

Using (9), the restrictions on the current account in (8) can be expressed as:

$$CA_t^* = h'z_t = -\sum_{s=1}^{+\infty} \beta^s \left[g_1' - \gamma g_2' - (1-\gamma)(1-a)g_3' \right] A^s z_t$$
(10)

where $g_1' = [1\ 0\ 0\ 0\ 0]$, $g_2' = [0\ 0\ 1\ 0\ 0]$, $g_3' = [0\ 0\ 0\ b\ 1-b]$, and $h' = [0\ 1\ 0\ 0\ 0]$ (again this can be generalized for a larger number of lags). If the VAR is stationary, it is possible to write (10) as:

$$CA_t^* = \left[-\left[g_1' - \gamma g_2' - (1-\gamma)(1-a)g_3' \right] \beta A \left(I - \beta A \right)^{-1} \right] z_t$$

With the estimated parameters of the VAR and some values for the parameters β, γ, a and b it is possible to find the estimated optimal current account:

$$\overset{\wedge}{CA_t^*} = k'z_t$$

where:

$$k' = -\left[g_1' - \gamma g_2' - (1-\gamma)(1-a)g_3' \right] \beta \widehat{A} \left(I - \beta \widehat{A} \right)^{-1}$$

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[5] Note that what matters for the determination of the current account is the agent's *expactations* of the shocks to the economy, rather than the shocks themselves. Suppose that people expect a raise in the real interest rate. The model then predicts an immediate current account surplus even if later the increase in the rate never takes place.

where $\widehat{A}$ is the matrix of estimated parameters from the VAR. This expression gives a model prediction of the current account variable consistent with the VAR and the restrictions of the intertemporal theory. Note that $k'z_t$ is not a forecast of the current account in the conventional sense, but rather a representation of the model's restrictions (Bergin and Sheffrin, 2000).

In addition, if the restrictions of the theory were consistent with the data, such that $\widehat{CA}_t^* = CA_t^*$ except for an innovation, then the vector k' should equal [0 1 0 0 0]. This implies that the model may then be tested statistically by using the delta method to calculate a χ^2 statistic for the hypothesis that $k' = [0\ 1\ 0\ 0\ 0]$. If we write the estimated vector of VAR coefficients as π, the estimated variance-covariance matrix of these coefficients as V, and the vector of deviations of the estimated system from the theoretical model as $\widetilde{k}$ (the difference between the actual k and the hypothesized value), then $\widetilde{k}' \left((\partial k/\partial \pi) \, V \, (\partial k/\partial \pi)' \right)^{-1} \widetilde{k}$ will be distributed chi-squared with degrees of freedom equal to the number of restrictions (the number of elements of $\widetilde{k}$, five in this case).[6]

6 Data Construction

In this section we proceed to construct the series that we will use to test the model. We had to use annual data since the National Institute of Statistics did not report quarterly data for private consumption before 1993. In any case, this is not problematic at all since this model of the current account determination seems to be more a statement of longer-run tendencies than of short run dynamics (Sheffrin and Woo, 1990b). We had to combine lots of sources of information to build the relevant series for the period 1885 - 2002, as will be seen below.

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[6]To see what the expressions of V and $\frac{\partial k}{\partial \pi}$ look like, let's consider a two variable VAR with only one lag : $\begin{pmatrix} x_{1t} \\ x_{2t} \end{pmatrix} = \begin{pmatrix} a_1 & b_1 \\ a_2 & b_2 \end{pmatrix} \begin{pmatrix} x_{1t-1} \\ x_{2t-1} \end{pmatrix} + \begin{pmatrix} \epsilon_{1t} \\ \epsilon_{1t} \end{pmatrix}$. If we call the vector of estimated parameters of the VAR $\pi' = \begin{bmatrix} a_1 & b_1 & a_2 & b_2 \end{bmatrix}$, then, the estimated variance - covariance matrix of these coefficients is given by : $V = \begin{bmatrix} \sigma_{a_1 a_1} & \sigma_{a_1 b_1} & \sigma_{a_1 a_2} & \sigma_{a_1 b_2} \\ \sigma_{b_1 a_1} & \sigma_{b_1 b_1} & \sigma_{b_1 a_2} & \sigma_{b_1 b_2} \\ \sigma_{a_2 a_1} & \sigma_{a_2 b_1} & \sigma_{a_2 a_2} & \sigma_{a_2 b_2} \\ \sigma_{b_2 a_1} & \sigma_{b_2 b_1} & \sigma_{b_2 a_2} & \sigma_{b_2 b_2} \end{bmatrix}$.
This matrix is estimated as $\Sigma \otimes (Z'Z)^{-1}$, where Σ is the $2x2$ variance - covariance matrix of the residuals and Z is the matrix $\begin{bmatrix} x_{11} & x_{21} \\ \vdots & \vdots \\ x_{1T-1} & x_{2T-1} \end{bmatrix}$.

The estimated $k - vector$ will, in this case, be a $1x2$ vector where each component is a function of the parameters in the VAR (and, of course, of the other parameters -β, γ, etc.) : $k' = \begin{bmatrix} k_1(a_1, b_1, a_2, b_2) & k_2(a_1, b_1, a_2, b_2) \end{bmatrix}$. Then, the expression $\frac{\partial k}{\partial \pi}$ will be a $2x4$ matrix of the form : $\frac{\partial k}{\partial \pi} = \begin{bmatrix} \frac{\partial k_1}{\partial a_1} & \frac{\partial k_1}{\partial b_1} & \frac{\partial k_1}{\partial a_2} & \frac{\partial k_1}{\partial b_2} \\ \frac{\partial k_2}{\partial a_1} & \frac{\partial k_2}{\partial b_1} & \frac{\partial k_2}{\partial a_2} & \frac{\partial k_2}{\partial b_2} \end{bmatrix}$.

6.1 Population and Working-age Population

All the models of the intertemporal approach to the current account express the net output and the current account in per capita terms (using total population) with the explicit goal to mimic the theoretical assumption of a representative agent. In our case, the representative agent is a person of working age and not a person in the general population . This difference may have an effect on the dynamic of the variables since in the long run the working-age population may have a different dynamic than that of the total population.

The total population for the period 1980 - 2002 was taken from CEPAL (2002). To construct the series for the period 1914 - 1979, we applied the "regression" method using data from Maddison (1995). That is, we ran a regression in logs (natural logarithms) for the period of superposition of data (1980 - 1994) and then employed the coefficient resulting from the regression and the data from Maddison to extend CEPAL's data overt the past.[7]

The data for the years that go from 1885 to 1913 was constructed using the method of "the rate of variation". More precisely, we took the variations for the data from Vázquez-Presedo (1971) and applied them to the data previously constructed.

The population composition by age was elaborated using data from Vázquez-Presedo (1971), Vázquez-Presedo (1976) and the National Institute of Statistics and Censuses of Argentina (INDEC). From the first author we got the composition by ages for the years 1869, 1895 and 1914 (which correspond to the first, second and third National Census). From the second author we got information for the years 1915, 1920, 1925, 1930, 1935 and 1940 (statistics published by the Oficina de Migraciones). Finally, from INDEC we also got quinquennial data for the period 1950 - 2005. Using this data we calculated the share of people between 15 and 60 years in total population (considered to be our measure of population in working age). Then, the missing values (the years for which we did not have information) were replaced with the linear interpolation between the observed values.

Finally, combining the series for total population and the share of people of working age, we constructed the series for the working - age population.

6.2 The Real Exchange Rate

The real exchange rate for the period 1900 - 1993 corresponds to that of Winograd and Véganzonès (1997) and is measured in australes (the national currency before the peso) of 1985. As was said before, we will use two series of the real exchange rate constructed by these authors since Argentina faced exchange rate

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[7]Suppose that y_t is a series that goes to T and x_t is a series that starts in H with $H < T$. The objective is to extend y_t to the future, using the values of x_t for $t > T$. Then, we just run a simple regression of the form $\ln(y_t) = \alpha + \beta \ln(x_t) + \varepsilon_t$ for $t \in [H, T]$. For the period $T + 1$ the estimated value of (the log of) y_{T+1} will be $\ln(\widehat{y}_{T+1}) = \widehat{\alpha} + \widehat{\beta} \ln(x_{T+1}) + \widehat{\varepsilon}_T$, which may be rewritten as $\ln(\widehat{y}_{T+1}) = \widehat{\beta} [\ln(x_{T+1}) - \ln(x_T)] + \ln(y_T)$. Then, for any $s > 1$, we'll have $\ln(\widehat{y}_{T+s}) = \widehat{\beta} [\ln(x_{T+s}) - \ln(x_{T+s-1})] + \ln(\widehat{y}_{T+s-1})$.

controls in their international transactions beginning in the 1930s and lasting until the beginning of the 1990s. One corresponds to a commercial real exchange rate, created using the regulated nominal exchange rate for exports and imports. The other is a "free market" real exchange rate, using the black or free exchange rate. Of course, these series do coincide when there are no exchange rate controls (until the 30s and since the 90s). To extend these series over the past, we used the method of the "rate of variations" since we did not have a superposition period to run a regression. In order to do that, we constructed a multilateral real exchange rate for the period 1885 - 1900 as a weighted average of the bilateral exchange rates between Argentina and some countries with which Argentina held strong commercial relationships. The main partners of Argentina during the last twenty years of the nineteenth century were Germany, England, United States, France and Belgium. In spite of that, we only considered the three first countries since we did not have enough information about France and Belgium.

For every year, we used as weights, the share of each country's trade (exports to that country and imports from that country) over the total trade with the three countries. The series of the origin of imports and the destination of exports were taken from Vázquez-Presedo (1971). The real bilateral exchange rate with every country was calculated as: $BRER = NER * WPI^*/WPI$; where $BRER$ is the bilateral real exchange rate, NER is the nominal exchange rate between both countries (national currency per unit of foreign currency), WPI^* is the wholesale price index of the foreign country, and WPI is the wholesale price index for the home country.

In computing the bilateral exchange rates the following information was used :

Price index of Argentina and nominal exchange rate (per U.S. dollar): we used the wholesale price index and the nominal exchange rate (pesos per US dollar) presented in Della Paolera and Taylor (2003). The base for the price index is 1885 = 100.

Price index of USA: we constructed the annual wholesale price index as an average of monthly values. The source is the NBER Macrohistory Data Base. The base for the price index is 1885 = 100.

Price index of Germany and Nominal exchange rate between the peso and the Deutsch mark: The price index is an annual wholesale price index. The source is the NBER Macrohistory Data Base. The base for the price index is 1885 = 100. For the period 1885-1888 we used the monthly nominal exchange rate between the Deutsch mark and the French franc and of the French franc and the US dollar to construct the exchange rate between the Deutsch mark and the US dollar. We calculated the annual exchange rate as an average of the monthly values. For the period 1888-1900 we used a monthly exchange rate between the Deutsch mark and the US dollar to construct the annual exchange rate. In all of the cases the source was the NBER Macrohistory Data Base. We then used the nominal exchange rate between the peso and the US dollar to construct the exchange rate between the peso and the Deutsch mark.

Price index of England and Nominal exchange rate between the peso and the sterling pound: We constructed the annual wholesale price index as an average of monthly values. The source was the NBER Macrohistory Data Base. The base for the price index was 1885 = 100. For the nominal exchange rate, we used a monthly series of the exchange rate between the sterling pound and the US dollar. We calculated the annual exchange rate as an average of the monthly values. Then, we used the nominal exchange rate between the peso and the US dollar to construct the exchange rate between the peso and the sterling pound.

For the period 1994 - 2002 we used the "regression method" to construct the real exchange rate. In particular, we ran a regression for the overlapping period 1980 - 1993 between the two real exchange rates of Winograd and Véganzonès (1997) and that calculated for the Center of International Economics (Ministry of Foreign Relationships, Argentina). This is a multilateral real exchange rate calculated using the wholesale price indexes of the countries and following the methodology presented in Ott (1997). We then used the coefficient from this regression and the data from the Center of International Economics to extend the series to 2002 as explained in an earlier footnote.

Using these series we constructed the appreciation of the commercial and market real exchange rate, first by taking the inverse of the real exchange rates, then taking their natural logarithm and finally, taking the difference with the preceding value of the variable (remember that $\Delta p_{t+1} = \ln P_{t+1} - \ln P_t$).

6.3   The Wholesale Price Index

In constructing the wholesale price index we made use of three series. First of all, we used the wholesale price index published by Della Paolera and Taylor (2003) for the period 1885 - 1900. The second one was the series by Winograd and Véganzonès (1997) that was used to extend the later series for the years 1901 - 1993. And the last one was the one by the National Institute of Statistics and Censuses of Argentina (INDEC), from which we calculated the index for the last period 1994 - 2002. We applied the "rate of variations" method to construct the final index since we found no differences in the evolution of the series during the overlapping periods.

The wholesale price index will then be used to deflate the consumption, the net output and to construct the real interest rate. This is the case since in the theoretical model the variables are expressed in terms of tradable goods whose price is supposed to be reflected quite well by this type of price index. Surprisingly, the entire literature on the subject uses the GDP deflator to deflate the nominal consumption and the net output and the consumer price index to construct the real interest rate, knowing that both indexes have an important component of non-tradable goods.

6.4   Nominal and Real Interest Rates

As we have already mentioned, the simpler intertemporal current account model considers a constant interest rate which was generally fixed between 2% and 6% (Sheffrin and Woo, 1990a; Ghosh, 1995; Suarez Parra, 1998, McDermott et al., 1999). On the other hand, since the real interest rate in the model considered here is not held fixed, the question then arises of how to construct an international real interest rate to conduct the analysis The traditional view consists of building an ex-ante interest rate following the method of Barro and Sala i Martin (1990). This method consists of collecting data on nominal interest rates and inflation (calculated from the consumer price index) for the G-7 economies. The expected inflation is calculated as a forecast using an ARMA model. The nominal interest rate in each country is then adjusted by inflation expectations to compute an ex-ante real interest rate. An average real interest rate is then computed using time-varying weights for each country based on its share of GDP in the G-7 total. We do not follow this procedure since in our view it does not seem to be applicable to a case like Argentina, that will usually pay a by far greater rate if it has access to the international financial market and will display far more volatility than the G-7 rate. Unfortunately, a series does not exist for the cost of capital in the international financial market for a country like Argentina. In such an event, even if it is not entirely satisfactory, we prefer to use an internal interest rate to the alternative of using an international interest rate as stated above.[8]

The nominal interest rate that we consider here is an average of a passive and active rate. The nominal active and passive rates for the period 1900 - 1993 are those presented in Winograd and Véganzonès (1997). For the period 1885 - 1899 we made use of the series of Della Paolera and Taylor (2001) which is respectively taken from Cortes Conde (1998). This corresponds to the implicit yield on an internal government bond (fondos públicos nacionales). To extend the series by Winograd and Véganzonès (1997) to the years 1994 - 2002 we applied the "regression method" to our own calculations of these rates for the overlapping interval 1991 - 1993. Our active rate corresponds to an average of an active rate of the Banco Nación (tasa de descuento de documentos) and that of loans granted between local financial institutions (the source of this data is the Central Bank of Argentina). On the other hand, our passive rate is an average of the deposit rate measured by the IMF (2003) and that measured by the Central Bank of Argentina (interest rates on ordinary saving account deposits and time deposits). We then used the wholesale price index to obtain the real ex - post interest rate using the formula: $r_t = (1 + i_t)\frac{P_t}{P_{t+1}} - 1$, where r_t is the real interest rate between period t and $t + 1$, i_t is the nominal interest rate between period t and $t + 1$ and P_t is the price index for period t.

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[8]Surprisingly, even for the case of a small economy like Chile, Landeau (2002) follows the traditional view in constructing the international interest rate as a wheighted average of G-7 countries.

6.5 Consumption and Net Output

To construct the series for consumption and net output we first took the data for the nominal National Accounts presented in IEERAL (1986) for the period 1914 - 1980. The net output was calculated as the gross domestic product less investment and public expenditures. We then extended these series over the future using data from INDEC. In particular, we used the nominal National Accounts (methodology 1986) to construct the net output and add it to the later using the rate of variation method for the period 1981 - 1993. The same procedure was repeated to construct the consumption variable. The source for this data was INDEC (1993).

An equal thing was done with the nominal National Accounts (methodology 1993) for the period 1994 - 2002 for both consumption and net output (the source of the data is the web page of the Direction of National Accounts, INDEC).

To extend the series over the past (1885 - 1913), we used information from Taylor (1997), Vázquez-Presedo (1971) and IEERAL (1986). From the first author we got the nominal GDP, nominal investment and the nominal total consumption (private plus public consumption). To be able to split total consumption into private and public consumption we first took the share of public consumption of total consumption for the year 1914 calculated from IEERAL (1986) and applied it to the data from Taylor (1997). Then, we used the evolution of the expenditures of the federal government provided by Vázquez-Presedo (1971) to reconstruct the evolution over the past for the public consumption. Note that by doing that, we neglected the evolution of the public expenditures of the local governments, which are included in the National Accounts. This didn't seem to be a problem since by that time the local governments represented only 16% of the total public expenditures (federal plus provincial governments). See Porto (2003) on this subject. The private consumption was then obtained as the difference between total and public consumption. Finally, we were already able to compute the net output and to chain both series using again, the method of the rate of variation. Once with the series of nominal net output and consumption in hand, we used the wholesale price index to make the conversion into australes of 1985 and we expressed them in terms of the population in working age.

Using the series for net output and consumption, we calculated the modified current account as $CA_t^* \equiv no_t - c_t$ and using net output we calculated the change in net output as $\Delta no_t = no_t - no_{t-1}$. The series for net output, private consumption and the level of the commercial and market real exchange rate are presented in Figure 1 while in Figure 2 we expose the modified current account, the change in net output, the ex-post real interest rate and the appreciation rate of the commercial and market real exchange rate (CRER and MRER, respectively in that Figure). These figures are presented at the end of the text.

7 Empirical Results

7.1 Checking the Stationarity of the Series

Before estimating the VAR model, we have to check that the variables that appear in it are stationary (the change in net output, the current account, the real interest rate and the appreciation of the real exchange rates). In order to do this, we first look at the correlograms of the series which are presented in Figure 3. Note that we included in Figure 3, not only the variables just mentioned, but also the levels of net output and of the inverse of the commercial and market exchange rate. Testing the stationarity of these series is a very important step. This is so because the estimation of a VAR such as the one presented before, for variables that are integrated of order one and cointegrated, would result in the loss of very valuable information. A more appropriate representation would in this case be a Vector Error Correction Model.[9] Surprisingly, in the paper that first presented the model used here (Bergin and Sheffrin, 2000) and in later applications (Landeau, 2002) this point is not even mentioned. Observing Figure 3, we see that the only correlogram that shows a strong persistence is the one for the log of net output. This would be initial evidence that all of the series but the log of net output are stationary, because the correlogram for non-stationary variables shows a slow linear decay, while that of a stationary variable decays exponentially towards zero. To see whether this is the case we must then proceed to more formal tests.

In particular, we tested for the presence of unit roots in the series using the Elliott-Rothenberg-Stock methodology. We chose this test because it is the most powerful; it is more capable of discerning a near unit root from a unit root. We proceeded as follows: first, the series that presented a trend were detrended and those that did not have a trend were demeaned to remove the deterministic components of the series.[10] Based on a visual inspection of Figures 1 and 2, we demeaned the current account, the change in net output, the ex-post real interest rate, the appreciation rate of the market and commercial real exchange rate and the levels of the commercial and market real exchange rate. On the other hand, the net output was detrended. The next step consists of performing an ADF test to the series without constant or time trend, as explained in Salanie (1999).[11] In order to choose the lags to be included in the ADF test we computed the Schwarz information criteria (SIC) for every variable and up to 5 lags which seems very reasonable for annual data. We chose two lags for the test for the

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[9]The idea is that a principal feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. After all, if the system is to return to the long run equilibrium, the movements of the variables must respond to the magnitude of the disequilibrium. As such, when variables are cointegrated their appropiate representation is a vector error correction and not just a VAR in differences. Estimating just a VAR model would entails in this case a misspecification error.

[10]Note that the terms "demeaned" and "detrended" are not used here in the conventional sense. See Salanie (1999) for a detailed explanation of this procedure.

[11]Remember that an ADF test without constant or time trend for any variable x_t is a test of the form $\triangle x_t = \alpha x_{t-1} + \sum_{i=1}^{p} \beta_i \triangle x_{t-i} + \varepsilon_t$ where we test whether the coefficient α is negative and significantly different from zero.

current account and only one for the other variables. We cannot reject the null hypothesis that the series contain a unit root only for the level of the net output. For the rest of the variables we can reject at 5% (for the current account) and at 1% (in the other cases) that the series contain a unit root in favor of the alternative that the series are stationary.

However, before these results are accepted, it is necessary to determine whether the error terms from the estimated equations satisfy the assumptions of the Dickey-Fuller test. In particular, we tested for autocorrelation using the Breusch-Godfrey LM test statistic (that regress the residuals on the original regressors and lagged residuals) and for autoregressive conditional heteroskedasticity using the ARCH LM test (that regress the squared residuals on a constant and lagged squared residuals). We performed both tests starting with 5 lags and then reducing the number of lags to 4, 3, 2 and 1, finding no evidence of autocorrelation in every variable and for any lag (see Table 1). The same table shows that heteroskedasticity is a problem for some of the regressions. This is the case for the ex-post real interest rate, the appreciation of the market real exchange rate, the inverse of the market real exchange rate and the net output, where we can reject the null hypothesis of absence of conditional heteroskedasticity.

Following Trehan and Walsh (1991) we will also test for unit roots using the Phillips - Perron (PP) test for the variables that present conditional heteroskedasticity in the residuals of the ADF regressions.[12] Even if this test is less powerful than the ERS test, we will apply it to the ex-post real interest rate, the appreciation of the market real exchange rate, the inverse of the market real exchange rate and the net output because this test is robust to the presence of conditional heteroskedasticity in the error terms. To make the results comparable with those of the ERS test, we first demeaned the series that did not not have a time trend. This was the case for the ex-post real interest rate, the appreciation rate of the market real exchange rate and the inverse of the market real exchange rate. As with the ERS test, for these series we would like to reject the null hypothesis that the series contain a unit root (this is, they are a random walk without drift) against the alternative in which they are stationary around zero. The PP test is then performed without a constant term or time trend invoking the Newey-West automatic truncation lag selection, which is four for every variable.[13] The results show that we can reject the null hypothesis that the series have a unit root in favor of the alternative for all of the variables at the 1% significance level. For the log of the net output, we computed the PP test with a constant but not a time trend, so that under the null, the series is a random walk with drift. Again, we invoked the Newey-West automatic truncation lag selection, which is again four, finding that we cannot reject the presence of a unit root.

We can then conclude that the variables to be included in the VAR are stationary and that the level of the commercial and market real exchange rates are

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[12]Their study concerns the sustainability of the US federal Buget and the US current account during the second half of the twentieth century.

[13]This selection is based solely on the number of observations used in the test regression and consists of choosing the largest integer not exceeding the argument : $4\left(\frac{T}{100}\right)^{2/9}$.

also stationary and so, they can not be cointegrated with the net output. We then have that the appreciation rate of both real exchange rates are overdifferenced. We will have to take this result into account in the following section at the moment of estimating the VAR system.

7.2 Estimation of the VAR System

In this section we present the methodology used to estimate the VAR model and the residual's analysis. To estimate the VAR we first demeaned all the variables to be included in it. We will work with the demeaned variables, since our model restricts only the dynamic interrelation between the variables but not their mean values. Then, the redefinition of variables as deviations from means enables us to drop the constant terms present in the VAR model. The variables that are included in the VAR and that were demeaned are the change in net output, the current account, the ex-post real interest rate and the appreciation rate of the commercial and market real exchange rate. We also demeaned the levels of the inverse of the commercial and market real exchange rates which are also included in the system since they are already stationary in levels. These variables will be included in the system with a two period lag.[14]

The next step in the estimation of the system consists of choosing an appropriate lag length for the VAR. The criterion that we will use here consists of choosing the most parsimonious VAR which has multivariate white noise errors. In particular, we sequentially computed VARs of the order 5 to 1, and checked at each time whether their residuals were white noises in the multivariate sense.[15] Once we do that, we choose the smallest VAR (the most parsimonious) for which the residuals are white noise. To test for multivariate white noise in the errors we apply the Portmanteau test for orders that goes from $p+1$ to 10, where p is the order of the VAR.[16] When estimating the five VARs, we found that residuals were white noise in the multivariate sense for the VAR with one, two and four

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[14]To see why this is the case, consider an univariate time series y_t, and suppose that we are willing to write its first difference as a function of their past differences. In order to do so start by rewriting the stochastic process using evident notation as $\phi(L)y_t = \epsilon_t$. After some calculations we can easily show that the process can be rewritten as $(1 - \phi^*(L))\triangle y_t = \epsilon_t - \phi(1)y_{t-1}$. For expositional porposes, suppose that $(1 - \phi^*(L)) = (1 - \phi L)$, so that the process becomes $\triangle y_t = \phi\triangle y_{t-1} - \beta y_{t-1} + \epsilon_t$ where $\beta = \phi(1)$. Again, after some manipulation we have $\triangle y_t = (\phi - \beta)\triangle y_{t-1} - \beta y_{t-2} + \epsilon_t$. In this expression we have the first difference of the variable as a function of its difference lagging by one period and the level of the variable lagging by two periods. This is what is being said in the text.

[15]VAR models for the current account usually involve a few lags. Obsfeld and Rogoff use a one lag VAR in their study of Grait Britain with annual data. Sheffrin and Woo (1990a) use a 2 VAR model with annual data from 1955 to 1985 to test a basic model of the intertemporal approach and Suarez Parra (1998) uses up to 5 lags when testing for the optimal lag in his VAR for Colombia.

[16]In particular, call $\widehat{\Gamma_\epsilon(h)}$ the residual cross-covariance matrix of order h. Then, the expression $T\sum_{j=1}^{h} Tr\left(\widehat{\Gamma_\epsilon(j)}\,'\,\widehat{\Gamma_\epsilon(0)}^{-1}\widehat{\Gamma_\epsilon(j)}\widehat{\Gamma_\epsilon(0)}^{-1}\right)$ has approximately a chi-square distribution with $n^2(h-p)$ degrees of freedom, where n is the number of variables and p is the order of the VAR. In our case, we considered $h = p+1, ..., 10$ when testing for multivariate white noise for every VAR.

lags. That is, we found that we could not reject the null hypothesis of multivariate white noise for all of the orders of the Portmanteau test going from $p + 1$ to 10. In the other cases we were able to reject the null hypothesis of multivariate white noise for some orders of the Portmanteau test. Applying the criteria just mentioned, we will keep the first order VAR for the five variables case. The results for the multivariate test and some statistics concerning the estimation of every equation in the VAR are presented in Tables 2 and 3, respectively. In particular we can see that every residual does not have autocorrelation of the first order using the DW statistic[17] and that all of the variables in every equation are jointly significative using an F test. We also checked that the VAR(1) itself is stationary by calculating all the eigenvalues of the companion matrix of the VAR written in compact form. Since the modulus of the eigenvalues are less than one we conclude that the VAR(1) is stationary.[18]

As mentioned before, we will also compare the performance of the extended (full) model just estimated with one in which only the real interest rate is allowed to vary (but not the appreciation of the exchange rates) and the other in which both the real interest rate and the appreciation rates are constant. In the second case the idea is to see whether the extension of the model improves over the simpler intertemporal model and, if such is the case, the first case is used in order to determine the source of this improvement.

In order to accomplish this goal we start by estimating a VAR model that includes the change in net output, the current account and the real interest rate (but not the appreciation rate of the real exchange rates). As before, the criterion used to choose the lags to include in the VAR consists of selecting the most parsimonious VAR such that its residuals are multivariate white noise. We then estimated VARs from 5 to 1 lags, finding that the residuals can be considered multivariate white noise for every order of the Portmanteau test only for three lags (again, going form $p + 1$ to 10). For the other cases we were able to reject the null for some orders of the test. We will then keep the VAR(3) as our preferred model in a system that includes the three variables. Tables 4 and 5 present the results for the Portmanteau test and some basic statistics for the estimation. We then went on to estimate a VAR with only the current account and the change in net output, which is the simplest version of the intertemporal model. We successively estimated a VAR with 5 to 1 lags finding, as before, that only for the VAR with three lags the residuals are white noise in multivariate sense. For the other orders of the VAR, we were able to reject the null of the multivariate white noise. Results for the multivariate Portmanteau test and some statistics for the estimated equations are presented in Tables 6 and 7. For both of the chosen models (with three and two variables) we also

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[17]Remember that the DW statistic is no longer valid when there are lagging values of the explained variable. In any case and as is usual in the literature, we use it as a rough indicator of first order autocorrelation in the residuals.

[18]Remember that the condition for the modulus of all of the eigenvalues of the companion matrix of the VAR in compact form te be less than one is equivalent to the condition that all of the roots lie outside the unit circle in the determinant of $\Phi(L) = I - \Phi_1 L - ... - \Phi_P L^P$ for the VAR $\Phi(L)X_t = \mu + \varepsilon_t$.

have that the modulus of the eigenvalues of the companion matrices are less than one, leading us to conclude that these VARs are stationary.

7.3   Evaluating the Performance of the Model

As was already said several times, we will test equation (8) using annual data for Argentina. In order to do so, we must first have values for the parameters that appear in that equation: the discount factor (β), the intertemporal elasticity of substitution (γ), the share of tradables over total private consumption (a) and the coefficient of the appreciation of the real exchange rates (b). Of course, when testing the simpler version of the intertemporal model that includes only the change in net output (called the benchmark-model in this section), we need to deal only with the first of these parameters. While estimating the model that also includes the real interest rate, we have to consider also the second of the parameters. Using these parameters and the coefficients of the VAR systems already estimated in the last section for every type of model (the benchmark-model, the model with only real interest rate and the full-model) we are able to compute the k' vector and then the χ^2 statistics to test for the validity of the model.

Concerning the discount factor (β), from equation (2) we can see that the model implies that in the steady-state we must have that $\beta = \frac{1}{1+r}$, where r is the steady-state value of the real interest rate. Since in our data set the value for the sample mean of the real interest rate for the period 1885 - 2002 is negative, implying a value for β grater that one, we will rely on the literature as a guideline to chose the value of β. Sheffrin and Bergin (2000) compute a value of 0.94 in their study of the intertemporal approach for Canada, Australia and the UK. Landeau (2002) computes a value of 0.95 when doing the same exercise for Chile. Vegh and Riascos (2003) and Uribe (2001) use a bit greater parameter. The first authors use a β of 0.97 when calibrating their model to explain the prociclicity of public expenditures in developing countries and the second author uses a value of 0.984 when calibrating his model when studying the relation between private consumption and exchange rate behavior in stabilization plans using data for Argentina. Since the last author uses data from Argentina and for reasons that will be made clear later, we are more sympathetic towards a value of 0.98 for the discount factor.

Regarding the share of traded goods in private final consumption, it was calculated using data from Martinez (1998) on the decomposition of GDP in nine sectors for the Argentine economy over the period 1901 -1997. In particular, we follow Stockman and Tesar (1995) in considering that the share of tradable goods over total private consumption is the same as that of tradable output over total output. We will also follow these authors in categorizing the sectors of the GDP so as to have a measure of the production of tradable and non tradebles goods. In particular, we include agriculture, manufacturing, mining, retail and transportation in the traded - goods sector and public utilities (such as water and electricity), construction, personal services and banks in the non - traded sector. Figure 4 at the end of the paper shows the evolution of the share

of traded goods (a) using this decomposition, finding that the average for the period 1901 - 1997 is about 0.5 with no evident trend to raise or fall. This result is consistent with the findings of Stockman and Tesar (1995) in their sample for developed economies.

The intertemporal elasticity of substitution is the most problematic of the parameters. Sheffrin and Bergin (2000) use values for γ ranging form 0.022 to 1, depending on the country. Uribe (2001) uses a value of 0.2 for Argentina in analyzing the relation between private consumption and exchange rate behavior. Landeau (2002) and Kydland and Zarazaga (2000) use a value of 0.5 for Chile in the first case and for Argentina in the second case.[19] In what follows and in order to reflect the probable uncertainty regarding this parameter, we will present the results concerning the estimations made with values for the intertemporal elasticity of substitution of 0.2, 0.5, 0.9 and the value that makes the predicted current account match the variance for the actual current account.

For the value of b, we find no reason to chose any other value than 0.5 so that we will keep this value in computing the results that follow. Of course, knowing that the test of the equation (12) is contingent on the values of the parameters just chosen, we will also consider another range for the unknown parameters to see whether there are important modifications in our conclusions.

The results from the present value tests for the period 1885 - 2002 are summarized in Table 8. Each column of the Table represents a different specification of the model. The first column shows the benchmark - model which ignores changes in the real interest rate and the exchange rates. Columns two to five show the model augmented with these two variables for different values of the elasticity of substitution. In particular, we first consider the value of γ that makes the predicted current account (calculated using the expression $\overset{\wedge}{CA^*_t} = k'z_t$) have the same variance as the actual current account and then consider the results for the model with γ taking the values of 0.2, 0.5 and 0.9. Finally, columns six to nine are similar to columns two to five but for the model in which the exchange rate is not permitted to vary, but the real interest rate is. This is intended to distinguish the separate effects of the two components of the consumption-based real interest rate and to try to determine, if any, the most important one. The first row in each column reports the estimated χ^2 statistic and its associated $p - value$, respectively. In the third row of each column are the number of degrees of freedom used in the calculation of the $p-values$, which corresponds to the number of restrictions in the system (the number of elements in the vector k).[20] We then present the volatility of the predicted and the actual current account (measured by the standard deviation), their ratio, and the simple correlation between the predicted and the actual current account. To illustrate further how well the restrictions of the model are satisfied, we will present some figures with the model prediction for the current account and the

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[19]The authors calibrate a real business cylce model for Argentina for the period 1951 - 1997.

[20]Note that in the case where the elasticity is calculated to match the variance of the actual current account, we have to reduce the degrees of freedom by one to take into consideration the penalty for using one restriction to identify the elasticity we estimate.

actual data.[21]

The ratio of the standard deviations of the predicted and actual current accounts, their correlation, and their simple graph are presented as a way to informally evaluate the performance of the model. The actual series of the current account should equal this theoretical series whenever the model is correct. If the variance and the correlation both equal one, then both series are the same and the model is satisfied. Deviations of historical values from the theoretical ones consequently provide an informal measure of the "fit" of the model. Large observed differences in the time series movements of the two variables imply (subject to sampling error) economically important deviations from the model. This evaluation may be an important complement to formal statistical tests since formal tests are often too powerful so that the merits of the model frequently became obscured by statistical rejections (Huang and Lin, 1993).

For our case, Figure 5 shows the current account variable computed from the data and the prediction generated by the version of the intertemporal model that excludes interest rates and exchange rates for the period 1885 - 2002 (the benchmark-model). This simple model is a bad predictor of the general direction of the current account fluctuations. Even worse, what is apparent from the picture is that if the Argentinean current account should have behaved as the benchmark - model predicts, one should have observed almost the opposite evolution of the current account. Even if the volatility of both series is not so different, their correlation is very negative. In total accordance with these results, the statistical test presented in column one of Table 8 soundly rejects the model. The intertemporal theory suggests that with two variables and three lags (which was the VAR selected in the last section) the $k-$ vector accompanying the z_t vector should be $\begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \end{bmatrix}$ while the estimated $k-$ vector is in fact $\begin{bmatrix} 0.226 & 0.133 & -0.016 & -0.458 & -0.176 & -0.230 \end{bmatrix}$.[22] The coefficient on the current account at date t is -0.458853 and while it is significantly different from zero it is also different from the value of unity suggested by the theory. Further, the other values are significantly different from their theoretical values of zero. The negative values of the actual and past current account in the vector z_t are at the heart of the negative relation found between the predicted and actual current account. This result is a sharp contrast to the general tests in the area in which a simple graphical analysis suggests that the simple intertemporal model can explain much of the evolution of the actual current account without being validated by the statistical tests.

Next consider an intertemporal model which includes a time varying real interest rate and the appreciation of the exchange rates. We present in Figure 6 the predicted current account using an elasticity of intertemporal substitution of 0.9. By looking at the $p-value$ this is supposed to be the less rejected of the full-models with different elasticities of substitution. From that Figure we can see that the performance of the model is as bad as that of the benchmark - model,

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[21] Note that the figures do not offer a way to control for the number of variables in the model. Therefore, if one is willing to make comparaisons between alternative models, we must rely primarily on the statistical tests.

[22] The $z_t{'}$ vector in this case consists of $\begin{bmatrix} \triangle no_t & \triangle no_{t-1} & \triangle no_{t-2} & CA_t^* & CA_{t-1}^* & CA_{t-2}^* \end{bmatrix}$.

because the volatility is by far greater in the predicted current account and the correlation with the actual current account is almost zero. In column five of Table 8 we see that we can statistically reject the model. In particular, with only one lag and seven variables (remember that we included also the levels of the inverse of the commercial and market real exchange rates in the estimation of the VAR) the theoretical $k-$ vector should be $\begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$ when it is in fact $\begin{bmatrix} -0.252 & -0.223 & 0.275 & 0.034 & 0.042 & -0.335 & 0.458 \end{bmatrix}$. The value for the coefficient of the current account is again negative (-0.223) and the other values seem to be significantly different from zero. Columns two, three and four show that we get similar results with other values for the elasticity of substitution. This is, we are always able to reject the model both formally and informally (the $p-values$ are zero and the correlation of the predicted and actual current account is negative).[23]

The picture does not get better with the model that includes the change in net output and the real interest rate but not the appreciation of the real exchange rates. Even if we cannot reject the model for values of γ equals 0.5 and 0.9, the predicted current account is by far more volatile than the actual (2,418 times for a γ equal 0.5 and 3,836 times for a γ equal 0.9) and the correlation is still negative.[24] So, even if formally we cannot reject the model, we can do so informally. The coefficient for the current account at t in the $k-vector$ remains negative and the other values do not seem to be statistically equal to zero.

From what we have been saying, the intertemporal model in any of the forms (the benchmark the full model and the one with only real interest rate) do not pass the formal nor informal statistical tests for the validity of the model for the Argentine experience in the period 1885 - 2002. The model is not even capable of explaining the turning points of the Argentinean current account. So, the results just obtained show that if the Argentinean current account should have behaved as the model predicted, one should have observed almost the opposite evolution of the actual current account. We derive this result from the negative and higher correlations between the actual and predicted current accounts.

Why is the performance of the model so poor in the case of Argentina? From a statistical point of view, the problem comes from the fact that the estimated coefficients in the VAR models (in terms of signs and magnitudes) contrast with what would be predicted by the theory. For instance, we should have that the lagged values of the current account in the equation of the change in net output are negative, since from the model an increase in the current account today should anticipate a fall in the future net output. This is not what we found since we often find positive signs for that variable in that equation. Changing just the signs of these coefficients makes us get by far more similar results to those suggested by the theory, than those that we get now.[25]

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[23]The positive value for the elasticity of intertemporal substitution that match the variances is 0.468.

[24]Note that as with the full model, the volatility of the predicted current account rises with the intertemporal elasticity of substitution.

[25]Consider, for example, the model with only the real interest rate and the change in net output for an elasticity of intertemporal substitution of value 0.2. The estimated coefficient

In principle, we can think of three possible explanations for the very poor performance of the model. One is the possibility that the quality of the data is not good enough for some periods, so that it is not measuring what the agents are supposed to take into account when making their economic decisions. The second possible explanation has to do with the assumptions of the model. We have already said that the hypothesis of perfect capital mobility should in principle be very important since in the model it is assumed that agents can go to the international financial system to finance any current account deficit. Finally, the third possible explanation has to do with two mixed factors which are the occurrence of balance of payments crises and of balance of payments policy experiments that took place during an important part of Argentinean economic history.

Concerning the first possible explanation, one might be concerned that it is the low quality of the data for some periods, in particular the beginning, that is behind such frustrating results. This may be the case since we had to mix lots of sources of information to construct the long run series needed to test the theory. From what has been said at the moment of presenting how the data set was constructed, we can deduct that for the population of working age the quality rised significantly since 1915 when we started to count with quinquennial data over the composition of the population by ages.[26] As for the real exchange rates we have homogenous data for the period 1900 - 1993 to which we added data from the Ministry of Foreign Relationships for the period 1994 - 2002. Therefore, we might be a bit concerned over the quality only for the period 1885 - 1900 (remember that we did not have enough information about France and Belgium, countries with which Argentina had important economic relationships). The same comment is valid for the series on the nominal interest rate since 1900 as it was constructed as an average of a passive and active rate while before that year we counted with only one series (the one on the implicit yield on an internal government bond). But perhaps the most important series are the national accounts used to compute the consumption, the net output and the current account. For these series we are more confident about for the period 1914 - 2002 than from those from before, because, as already mentioned, we had to construct the series for the national accounts for the period 1885 - 1913 making some assumptions concerning the evolution of the aggregate government spending.[27]

So, if one is concerned about the possibility that there are some periods for which the data may not have the necessary quality, one could deal in part

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for the current account in the $k - vector$ is -0.704. When we only change the signs of the coefficients of the VAR to make them suit the theory (which involve changing the sign of the current account in the equation for the change in net output) we get a coefficient for the current account in the $k - vector$ equal to 0.904, which is perfectly in line with the validity of the theory.

[26]Remember that before that year we had to rely on data on the first, second and third National Census of 1869, 1895 and 1914, respectively to make the interpolations necessary to get the annual data that we needed.

[27]Remember that we assumed the evolution of the federal spending as representative of total government spending.

with this problem by restricting the estimation sample to the period 1914 - 2002. For this sample, all of the sources involved in the analysis are relatively homogeneous or involve sources on which we can be very confident (notably, the Central Bank and the National Institute of Statistics). Table 9 at the end shows the results for this new sample period and has the same structure as Table 8.[28] As is the case for the model that includes the change in net output and the real interest rate for the period 1885 - 2002, even if there are some cases where we cannot reject the model, the informal tests show that its performance is awful. We always find strong and negative correlations between the predicted and the actual current accounts that comes from the fact that the coefficient of the current account in t in the $k - vector$ is always negative. From the results for the sub-sample 1914 - 2002 we can conclude that in principle, the possible low quality of the data should not be responsible for the very poor results of the model.

Let us then analyze together the second and third possibilities, that a main assumption of the model is violated for some period of time and that many balance of payments policy experiments and crises took place during an important part of the Argentinean economic history. From what has been said at the introduction, the Argentinean economy had important access to the international financial system untill the 1930s that allowed it to finance important current account deficits of approximately 6% of the GDP. Since the 1930s the international environment changed drastically, first with the occurrence of the big crises and then with the Second World War. The country could not maintain the huge current account imbalances of the past and we observed an almost equilibrated current account until the beginning of the 90s. Since 1990, Argentina was able to continue running current account imbalances but never of the order of those observed during the 1885 - 1930 period. From this observation we can conclude that the hypothesis of the model concerning the existence of an integrated international financial market is supposed to be more valid for the period 1885 - 1930 than from the entire period.

Also, in the 1940s started a period where the balance of payments crises were the order of the day and where the government tried to control the current account applying lots types of policies. During this time, the country suffered from many balance of payments policy experiments, ranging from the general or selective use of quantitative exchange regulations, various forms of price rationing of imports by means of surcharges, prior import deposits and huge devaluations, etc. The goal was to prevent the occurrence of balance of payments crises, which were ineffective most of the time. This type of crisis may be at the root of our negative results. The reasoning goes as follows. In the Argentinean economy of that time, an acceleration of the growth process immediately resulted in a current account deficit. Through time, the accumulation of these deficits became unsustainable and a balance of payments crises resulted in a reversion of the current account, a fall in the GDP, a rise in the interest rate and the devaluation

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[28]We used the same procedure as before to select the number of lags to include in every VAR. For the benchmark and full model we chose a VAR with only 1 lag while for the model with only the real interest rate we selected a VAR with 2 lags.

of the exchange rate.[29] This type of economic growth is known as *stop and go* process, since after a period of raise in output and deficit in the current account, comes a recession. As such, deficits in the current account do anticipate a *fall* in output and a *raise* in the interest rates and not a *raise* in output and *fall* in the interest rate as would be expected from the theory.

We will then reestimate the model for the period 1885 - 1930 with the hope of considering a period of relatively free capital mobility, excluding the episodes of balance of payments crises and policy experiments.[30] In this period, the average real interest rate is such that the discount factor equals 0.98. This is one of the reasons why we chose this as the value for which we expose the results of the models. For this new sub period, we present in Figure 7, the current account variable computed from the data and the prediction generated by the benchmark - model (the version that excludes interest rates and exchange rates). What we can see is that the model can at least track the general directions of the actual current account, even if it does so underpredicting their magnitudes. The correlation between both variables become positive but the variance of the predicted series is by far lower than the actual current account. The formal statistical χ^2 test presented in column one of Table 10 is on the border between the rejection and the non rejection of the model, since the $p - value$ equals 0.05.

If we consider next the predicted current account that appears in Figure 8, calculated from the model which includes a time varying real interest rate and the appreciation of the exchange rates (with a value of γ equals to 0.9), we can see that again, the predicted current account can track the general directions of the actual current account for some periods. As with the benchmark - model, the full - model underpredicts the magnitudes of the variations of the actual current account, having as a result, a lower variance than the actual current account. Note that even if we increased the volatility of the predicted current account with the inclusion of both the real interest rate and the appreciation of the real exchange rates, we also reduced the correlation. So, the informal fit of the full - model is still modest. From columns three to five we see that we can still formally reject the model.[31] When we estimate the model with only the real interest rate and not the appreciation rates of the commercial and market exchange rates we see that we find again a negative correlation between the predicted and actual current accounts, even if for some cases we can not reject the model. So, we can conclude that the predicted current account of the full model can maintain a positive correlation with the actual current account thanks to the appreciation of the commercial and market exchange rates.

To see whether the results presented in this section depend upon the values of the parameters chosen, we also conducted a sensitivity analysis for other

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[29]It is recongnized that in the short run, exports and imports are unresponsive to relative prices so that the only way to produce a reversion in the current account is by means of a recession. See Mallon and Sourruillle (1975) for the Argentine experience.

[30]We estimated a VAR with only 1 lag for the benchmark and full model and a VAR with 2 lags for the model with only real interest rate.

[31]The column concerning the value of γ that matches the variance is not fulfilled since the value of γ is not real for this case.

values of the discount factor, the share of tradables of total consumption and the parameter of the appreciation of the commercial and market real exchange rates. In particular, we reestimated and evaluated the models for every sub sample for a β equals 0.94, the smallest of the values present in the literature that we evaluated, a participation of tradables of 2/3 instead of 1/2 (as also suggested by Bergin and Sheffrin, 2000), and a coefficient of the appreciation of the commercial real exchange rate equal to 1/3 and 2/3. The main results do not change when we consider these values and not the ones presented at the beginning of this section.

8   Conclusion

In this paper we have presented an intertemporal model of the current account that was expected to take into account important sources of possible external shocks for small economies such as Argentina. A main element in testing this theory was the estimation of the VAR system used to compute the forecasts of the agents. After verifying that the variables to be included in the VAR were stationary, we proceeded to chose the number of lags for the VAR system. The criteria that we used consisted of choosing the most parsimonious VAR which has multivariate white noise errors. For the full model (the one which includes the five variables) the best representation of the data generating process was, in our view, a VAR(1) system. This model is stationary and its residuals are multivariate white noise. Since we were willing to compare how the full model performed over the alternative of a simple intertemporal model, we also estimated a VAR system that only included the current account and the change in net output, choosing a VAR with three lags in this case. On the basis of other experiences it was expected that the full model would perform better than the simple model. To know where the improvement came from, it was useful to estimate a model with only the real interest rate but not the appreciation of the real exchange rates. So, we estimated VAR systems with three variables, that is, the change in net output, the current account and the real exchange rate (but not the appreciation of the real exchange rates). In this case, we chose a VAR with 3 lags as our preferred model. In all of the cases the residuals were multivariate white noise processes and the VARs themselves were stationary.

The next step consisted of combining the results just presented with appropriate values for the discount factor (β), the elasticity of intertemporal substitution (γ), the share of tradables in total consumption (a) and the weight of the appreciation of the commercial real exchange rate (b). We based our choice of these parameters upon the literature (for β and γ) and upon our own computations (for a). Using these parameters and the coefficients of the VAR systems already estimated we computed the k vector and then the χ^2 statistics to test for the validity of the model. We also estimated the variance of the predicted current account and the correlation with the actual current account in order to conduct an informal evaluation of the performance of the models. The results show that the intertemporal model do not pass the formal nor the informal

statistical tests for the validity of the model for the Argentine experience in the period 1885 - 2002. So, the results show that if the Argentinean current account should have behaved as the model predicts, we would have observed almost the opposite evolution of the actual current account. These results are a bit shocking since even for other small developing countries in Latin America such as Peru, Chile and Colombia the intertemporal model seems to work relatively well.

Our main conjecture about the poor performance of the model has to do with the fact that one of its most important assumptions is violated for an important part of the period under consideration, and that the occurrence of the balance of payments crisis may in fact produce the opposite relation between the variables as that suggested by the model. We tried to cope with these problems by estimating a model for the period 1885 - 1930, a period of relatively high capital mobility that excludes episodes of balance of payments crises and policy experiments. We found some evidence in favor of this result since for this period we get a positive correlation between the actual and predicted current account for the benchmark and full models. The conclusion to be drawn from this paper is that, in contrast to other Latin American developing countries, an intertemporal current account model may not account for the dynamics in the current account of Argentina since the last part of the XIXth century, even though there seems to be only little evidence in favor of the model for the period 1885 - 1930.

Before finishing we would like to make two comments concerning the structure of the model that could be useful for future research on the subject. Firstly, even if the paper by Sheffrin and Bergin (2000) constitutes an important improvement to the theory, since it takes into account two other sources of possible external shocks, which may be very important for small developing economies, an alternative that was not explored much but that would merit attention, is the inclusion of the terms of trade (the relative price of exports and imports) in intertemporal models. This would be a substantial contribution since the terms of trade seem to be an important factor in determining the current account in developing countries (see Kent and Cashin, 2003). By doing that, a real convergence between intertemporal models and the elasticities approach would take place, because now not only the intertemporal substitution but the substitution between imports and exports would be taken into account. Secondly, intertemporal models developed until now rely almost exclusively on variations in consumption (and then in savings) to explain movements in the current account. As such, they neglect the importance of endogenous movements in investment as a source of explanation (remember that the investment is part of the net output, which is considered to be the random source of uncertainty in the model). Evidence seems to suggest that movements in investment have typically dominated movements in savings when explaining current account patterns (see Sachs, 1981a). If that is the case, a fruitful extension of these models would be to take into account the endogenous behavior of investors in the determination of the current account balance.

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9 Appendix A: Deriving the Optimal Consumption Profile

For the derivation of equation (2) we must first solve the intratemporal optimization problem of the agent, which involves choosing optimally the consumption of tradables and nontradables. In order to do that, we first define an index of total consumption as $C_t^* = C_{Tt}^a C_{Nt}^{1-a}$ and remind that the total consumption expenditure in terms of traded goods is $C_t = C_{Tt} + P_t C_{Nt}$. We can interpret the index of total consumption as an intratemporal utility function so that we can minimize the total cost in terms of traded goods of attaining a certain level of utility (normalized here to 1). The problem is therefore:

$$\underset{C_{Tt}, C_{Nt}}{Min} \ C_t = C_{Tt} + P_t C_{Nt}$$

$$\text{s.t. } C_t^* = C_{Tt}^a C_{Nt}^{1-a} = 1$$

Using the FOC from this problem and the total consumption expenditure in terms of traded goods we can easily find the optimal consumption of traded and nontraded goods:

$$C_{Tt} = aC_t$$

$$C_{Nt} = \frac{C_t}{P_t}(1-a)$$

We next define a consumption-based price index P_t^*, as the minimum amount of consumption expenditure $C_t = C_{Tt} + P_t C_{Nt}$ such that $C_t^* = 1$, given P_t. Then, by definition of P_t^* we have that $P_t^* C_t^* = C_t$ and since $C_t^* = 1$ it follows that $P_t^* = C_t$. To obtain the P_t^* we substitute the optimal consumption of traded and nontraded goods into the definition of C_t^*:

$$C_t^* = (aC_t)^a \left[(1-a)\frac{C_t}{P_t} \right]^{1-a}$$

and use the definition of P_t^* and the fact that $P_t^* = C_t$ to write:

$$(aP_t^*)^a \left[(1-a)\frac{P_t^*}{P_t} \right]^{1-a} = 1$$

Solve this for the consumption-based price index:

$$P_t^* = P_t^{1-a} \left[a^{-a}(1-a)^{-(1-a)} \right]$$

Using this last expression and generalizing to any C_t^* allows us to rewrite the budget constraint (1) as:

$$Y_t - P_t^* C_t^* - I_t - G_t + r_t B_{t-1} = B_t - B_{t-1} \tag{1.A}$$

We are now able to derive an intertemporal Euler equation for the total consumption C_t^*. To do that we make use of the Bellman Equation:

$$V\left(B_{t-1}, \zeta_{t-1}\right) = \underset{C_t^*}{Max} \left\{ U\left(C_t^*\right) + \beta E_t V\left(B_t, \zeta_t\right) \right\}$$

Where ζ_{t-1} is the information set available to the agent until moment $t-1$. The problem consist of finding a solution to this equation subject to the budget restriction (1.A). Using (1.A) and the utility function $U\left(C_t^*\right) = [1/(1-\sigma)]\left(C_t^*\right)^{1-\sigma}$ we have:

$$V\left(B_{t-1}, \zeta_{t-1}\right) = \underset{C_t^*}{Max} \left\{ \frac{1}{1-\sigma} C_t^{*(1-\sigma)} + \beta E_t V\left(Y_t - P_t^* C_t^* - I_t - G_t + \beta_{t-1}\left(1+r_t\right), \zeta_t\right) \right\}$$

The FOC is given by:

$$C_t^{*-\sigma} - \beta E_t \left[V'\left(B_t, \zeta_t\right) P_t^*\right] = 0$$

Where $V'\left(B_t, \zeta_t\right)$ is the derivative of V with respect to the first argument. Applying the envelope theorem to the Bellman equation gives:

$$V'\left(B_{t-1}, \zeta_{t-1}\right) = \beta E_t \left[V'\left(B_t, \zeta_t\right)\left(1+r_t\right)\right] = \left(1+r_t\right) \beta E_t \left[V'\left(B_t, \zeta_t\right)\right]$$

Making use of the last two equations we have an intertemporal Euler equation for C_t^*:

$$1 = E_t \left[\beta\left(1+r_{t+1}\right)\left(\frac{P_t^*}{P_{t+1}^*}\right)\left(\frac{C_t^*}{C_{t+1}^*}\right)^\sigma\right]$$

To facilitate empirical implementation, we rewrite this condition in terms of consumption expenditure (C_t) and the relative price of nontraded goods (P_t). We then use the fact that $P_t^* C_t^* = C_t$ and that $P_t^* = P_t^{1-a}\left[a^{-a}\left(1-a\right)^{-(1-a)}\right]$ to get equation (2) in text:

$$1 = E_t \left[\beta\left(1+r_{t+1}\right)\left(\frac{C_t}{C_{t+1}}\right)^\sigma \left(\frac{P_t}{P_{t+1}}\right)^{(1-\sigma)(1-a)}\right] \qquad (2.A)$$

10 Appendix B: Log-linearizing the Euler Equation

We assume that $(1 + r_{t+1})$, $\left(\frac{C_t}{C_{t+1}}\right)^{\sigma}$ and $\left(\frac{P_t}{P_{t+1}}\right)^{(1-\sigma)(1-a)}$ follow a joint log-normal distribution such that $(1 + r_{t+1}) \left(\frac{C_t}{C_{t+1}}\right)^{\sigma} \left(\frac{P_t}{P_{t+1}}\right)^{(1-\sigma)(1-a)}$ also follows a log-normal distribution. Assume also that the variances and covariances between these variables are not time-varying. Call this last expression y_t so that the $\ln y_t$ follows a normal distribution. It's expectation is given by $E(\ln y_t) = E\left[r_{t+1} - \sigma \Delta c_{t+1} - (1 - \sigma)(1 - a)\Delta p_{t+1}\right]$ and it's variance $V(\ln y_t) = \sigma_r^2 + \sigma^2\sigma_c^2 + (1 - \sigma)^2(1 - a)^2\sigma_p^2 - 2\sigma\sigma_{r,c} -$
$-2(1 - \sigma)(1 - a)\sigma_{r,p} + 2\sigma(1 - \sigma)(1 - a)\sigma_{c,p}$. Where $\sigma_r^2 = V(r_{t+1})$, $\sigma_c^2 = V(\Delta c_{t+1})$, $\sigma_p^2 = V(\Delta p_{t+1})$, $\sigma_{r,c} = cov(r_{t+1}, \Delta c_{t+1})$, $\sigma_{r,p} = cov(r_{t+1}, \Delta p_{t+1})$ and $\sigma_{c,p} = cov(\Delta c_{t+1}, \Delta p_{t+1})$. We then make use of the property of Gaussian distributions that says that if $\ln y_t$ follows a normal distribution, then $E(\exp(\ln y_t)) = E(y_t) = \exp\left[E(\ln y_t) + \frac{1}{2}V(\ln y_t)\right]$. Applying logs to (2.A) and using the property just mentioned we have:

$$0 = \ln \beta + E_t\left[r_{t+1} - \sigma \Delta c_{t+1} - (1 - \sigma)(1 - a)\Delta p_{t+1}\right] +$$

$$+\frac{1}{2}\left[\sigma_r^2 + \sigma^2\sigma_c^2 + (1 - \sigma)^2(1 - a)^2\sigma_p^2 - 2\sigma\sigma_{r,c} - 2(1 - \sigma)(1 - a)\sigma_{r,p} + 2\sigma(1 - \sigma)(1 - a)\sigma_{c,p}\right]$$

Which may be rewritten as:

$$\sigma E_t \Delta c_{t+1} = E_t\left[r_{t+1} - (1 - \sigma)(1 - a)\Delta p_{t+1}\right] + \text{ constant term}$$

Then, using the definition of the intertemporal elasticity of substitution $\gamma = 1/\sigma$ we have:

$$E_t \Delta c_{t+1} = \gamma \left\{ E_t\left[r_{t+1} + \frac{(1 - \gamma)}{\gamma}(1 - a)\Delta p_{t+1}\right] + \text{constant term} \right\}$$

Calling $r_{t+1}^* = r_{t+1} + \frac{(1-\gamma)}{\gamma}(1 - a)\Delta p_{t+1} +$ constant term, the consumption based real interest rate, we get to the log-linearized form of the Euler equation that appears in the text:

$$E_t \Delta c_{t+1} = \gamma E_t r_{t+1}^*$$

11 Appendix C: The Intertemporal Budget Constraint and its log-linearization

Using the time t budget constraint $B_t = NO_t - C_t + (1 + r_t) B_{t-1}$ we can write for any period T (with $T > t$): $B_T = NO_T - C_T + (1 + r_T) B_{T-1}$. Summing and discounting we have that:

$$R_{t,T} B_T = \sum_{s=0}^{T} (NO_{t+s} - C_{t+s}) R_{t,t+s} + (1 + r_t) B_{t-1}$$

Applying the limit when $T \to +\infty$, noting $B'_t = (1 + r_t) B_{t-1}$ and using the transversality condition we have the intertemporal budget constraint (4) that appears in the text:

$$\sum_{s=0}^{+\infty} R_{t,t+s} C_{t+s} = \sum_{s=0}^{+\infty} R_{t,t+s} NO_{t+s} + B'_t$$

Noting $\phi_t = \sum_{s=0}^{+\infty} R_{t,t+s} C_{t+s}$ and $\Psi_t = \sum_{s=0}^{+\infty} R_{t,t+s} NO_{t+s}$ we will proceed to log-linearize the intertemporal budget constraint in three steps (in order to do that we follow Huang and Lin, 1993). The first step involves log-linearizing the present value of the net output Ψ_t. We start by recognizing that Ψ_t implies a law of motion of the form: $\Psi_{t+1} = (1 + r_{t+1}) (\Psi_t - NO_t)$ where $\Psi_{t+1} = \sum_{s=0}^{+\infty} (R_{t+1,t+1+s}) NO_{t+1+s}$. We can use the fact that $(R_{t,t+s}) (1 + r_{t+1}) = R_{t+1,t+s}$, for $s \geqslant 1$ to easily verify that is the case. Dividing the law of motion by Ψ_t and taking natural logarithms on both sides we have:

$$\ln \Psi_{t+1} - \ln \Psi_t = \ln (1 + r_{t+1}) + \ln \left(1 - \frac{NO_t}{\Psi_t}\right)$$

$$\simeq r_{t+1} + \ln [1 - \exp (no_t - \ln \Psi_t)]$$

Where $no_t = \ln NO_t$. Next, we take a first-order Taylor expansion of $\ln [1 - \exp (no_t - \ln \Psi_t)]$ around $no - \ln \Psi$ to yield:

$$\ln [1 - \exp (no_t - \ln \Psi_t)] \approx \ln [1 - \exp (no - \ln \Psi)] -$$

$$- \frac{\exp (no - \ln \Psi)}{[1 - \exp (no - \ln \Psi)]} [no_t - \ln \Psi_t - (no - \ln \Psi)]$$

$$= k + \left(1 - \frac{1}{\rho}\right) (no_t - \ln \Psi_t)$$

Where $\rho = 1 - \exp\left(no - \ln \Psi\right) = 1 - \frac{NO}{\Psi}$, a number slightly less than one and $k = \ln\left(\rho\right) - \left(1 - \frac{1}{\rho}\right)\ln\left(1 - \rho\right)$. Then:

$$\ln \Psi_{t+1} - \ln \Psi_t \approx r_{t+1} + k + \left(1 - \frac{1}{\rho}\right)\left(no_t - \ln \Psi_t\right) \qquad (1.C)$$

Note also that:

$$\ln \Psi_{t+1} - \ln \Psi_t = \Delta no_{t+1} + \left(no_t - \ln \Psi_t\right) - \left(no_{t+1} - \ln \Psi_{t+1}\right) \qquad (2.C)$$

Substituting (1.C) into (2.C) we obtain:

$$-\left(no_{t+1} - \ln \Psi_{t+1}\right) + \left(\frac{1}{\rho}\right)\left(no_t - \ln \Psi_t\right) \approx -\Delta no_{t+1} + r_{t+1} + k$$

Solving this difference equation forward and using the hypothesis that $\lim\limits_{T \to +\infty} \rho^T \left(no_{t+T} - \ln \Psi_{t+T}\right) = 0$ we get:

$$no_t - \ln \Psi_t = \sum_{s=1}^{+\infty} \rho^s k - \sum_{s=1}^{+\infty} \rho^s \left[\Delta no_{t+s} - r_{t+s}\right]$$

$$= \sum_{s=1}^{+\infty} \rho^s \left[r_{t+s} - \Delta no_{t+s}\right] + \varphi \qquad (3.C)$$

This is the log-linear version of the present value of the net output Ψ_t. The second step lies in log-linearizing the present value of consumption, ϕ_t. As before, we recognize that ϕ_t follows a law of motion $\phi_{t+1} = \left(1 + r_{t+1}\right)\left(\phi_t - C_t\right)$. Similar computation gives the following relationship:

$$c_t - \ln \phi_t = \sum_{s=1}^{+\infty} \left(\rho'\right)^s \left[r_{t+s} - \Delta c_{t+s}\right] + \varphi'$$

Where $\rho' = 1 - \exp\left(c - \ln \phi\right) = 1 - \frac{C}{\phi}$ and $\varphi' = \sum\limits_{s=1}^{+\infty} \left(\rho'\right)^s k'$, where $k' = \ln\left(\rho'\right) - \left(1 - \frac{1}{\left(\rho'\right)}\right)\ln\left(1 - \rho'\right)$. For the moment assume that $\rho' = \rho$ so that $k' = k$ and $\varphi' = \varphi$ (we will see later that this is the case in the steady state):

$$c_t - \ln \phi_t = \sum_{s=1}^{+\infty} \rho^s \left[r_{t+s} - \Delta c_{t+s}\right] + \varphi \qquad (4.C)$$

In the final step, assume that B'_t is strictly positive so that we can log-linearize the intertemporal budget constraint $\phi_t = \Psi_t + B'_t$. That is the same as $\frac{\phi_t}{\Psi_t} = 1 + \frac{B'_t}{\Psi_t}$. We proceed by noting that in the steady-state: $\phi = \Psi + B$ and then taking logs of the former equation. This leads to:

$$\ln \phi_t - \ln \Psi_t = \ln\left[1 + \exp(\ln B'_t - \ln \Psi_t)\right] \qquad (5.C)$$

We proceed as before and we log linearize the right hand side:

$$\ln\left[1+\exp(\ln B_t^{'}-\ln\Psi_t)\right]\approx\ln\left[1+\exp\left(\ln B-\ln\Psi\right)\right]+$$

$$+\frac{\exp\left(\ln B-\ln\Psi\right)}{\left[1+\exp\left(\ln B-\ln\Psi\right)\right]}\left[\ln B_t^{'}-\ln\Psi_t-\left(\ln B-\ln\Psi\right)\right]$$

$$=\ln\left(\frac{\Psi+B}{\Psi}\right)+\frac{B}{\Psi+B}\left[\ln B_t^{'}-\ln\Psi_t\right]-\frac{B}{\Psi+B}\left[\ln B-\ln\Psi\right]$$

Taking into account that $\phi=\Psi+B$ and replacing the last expression into (5.C) we have:

$$\ln\phi_t-\ln\Psi_t=\ln\left(\frac{\phi}{\Psi}\right)+\frac{B}{\phi}\left[\ln B_t^{'}-\ln\Psi_t\right]-\frac{B}{\phi}\left[\ln B-\ln\Psi\right]$$

Noting $\Omega=1+\frac{B}{\Psi}$ we finally have:

$$\ln\phi_t-\ln\Psi_t=\ln\left(\frac{\phi}{\Psi}\right)+\left(1-\frac{1}{\Omega}\right)\left[\ln B_t^{'}-\ln\Psi_t\right]-\frac{B}{\phi}\left[\ln B-\ln\Psi\right]$$

Substituting the expressions for $\ln\Psi_t$ and $\ln\phi_t$ in (3.C) and (4.C), respectively, and assuming that $\rho=\beta$ we get to the equation that figures in the text (equation (5)):

$$-\sum_{s=1}^{+\infty}\beta^s\left[\frac{\Delta no_{t+s}}{\Omega}-\Delta c_{t+s}+\left(1-\frac{1}{\Omega}\right)r_{t+s}\right]=\frac{1}{\Omega}no_t-c_t+\left(1-\frac{1}{\Omega}\right)b_t^{'}+\text{ constant term}$$

Assuming that the steady-state net foreign assets are zero, we have that $B=0$ and then $\Omega=1$. In this case we have that $\phi=\Psi$ in the steady-state intertemporal budget and $c=no$ making $\rho^{'}=\rho$, $\varphi^{'}=\varphi$ and $k^{'}=k$. This allowed us to write the equation (4.C) in the way we did it. With these hypotheses, applying expectations to the last equation and using the log-linearized Euler equation we get to the equation (6) in the text.
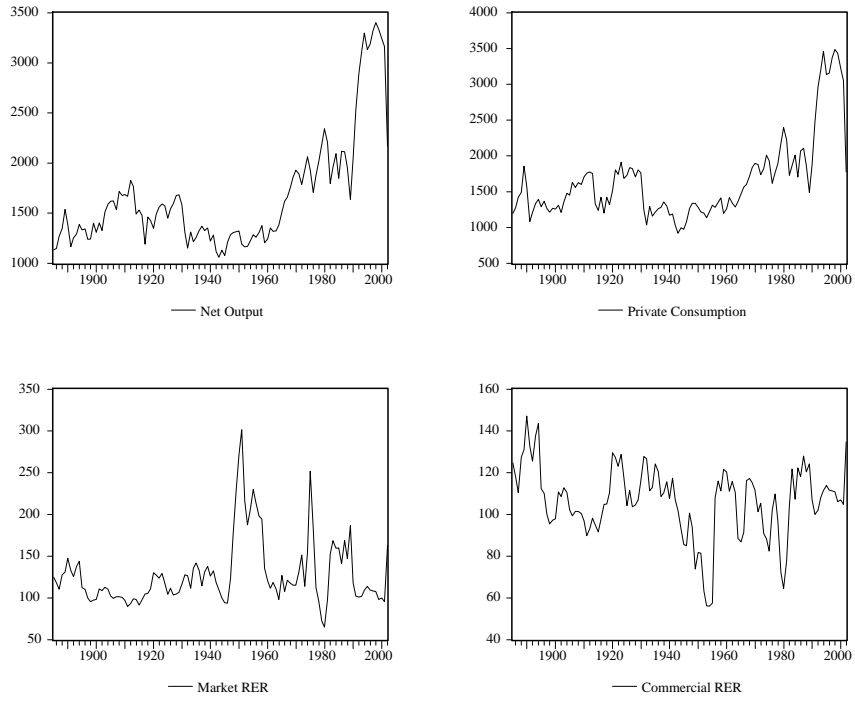
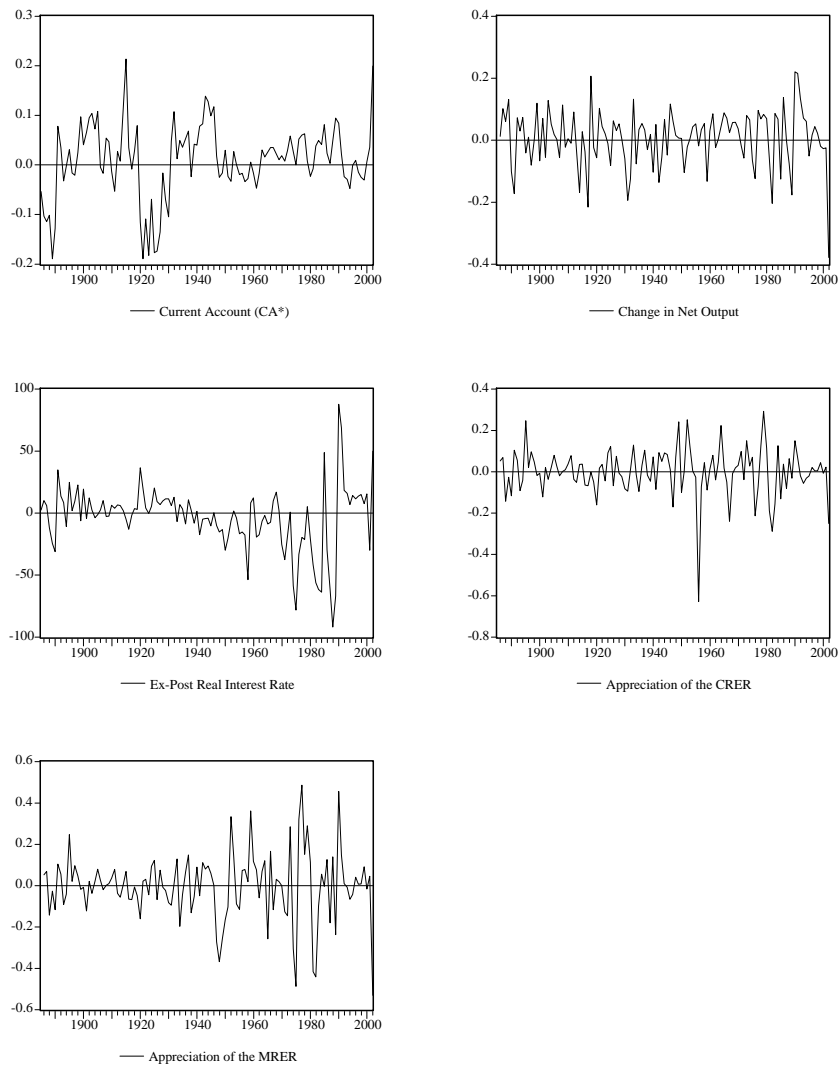Figure 1 : Constructed variables

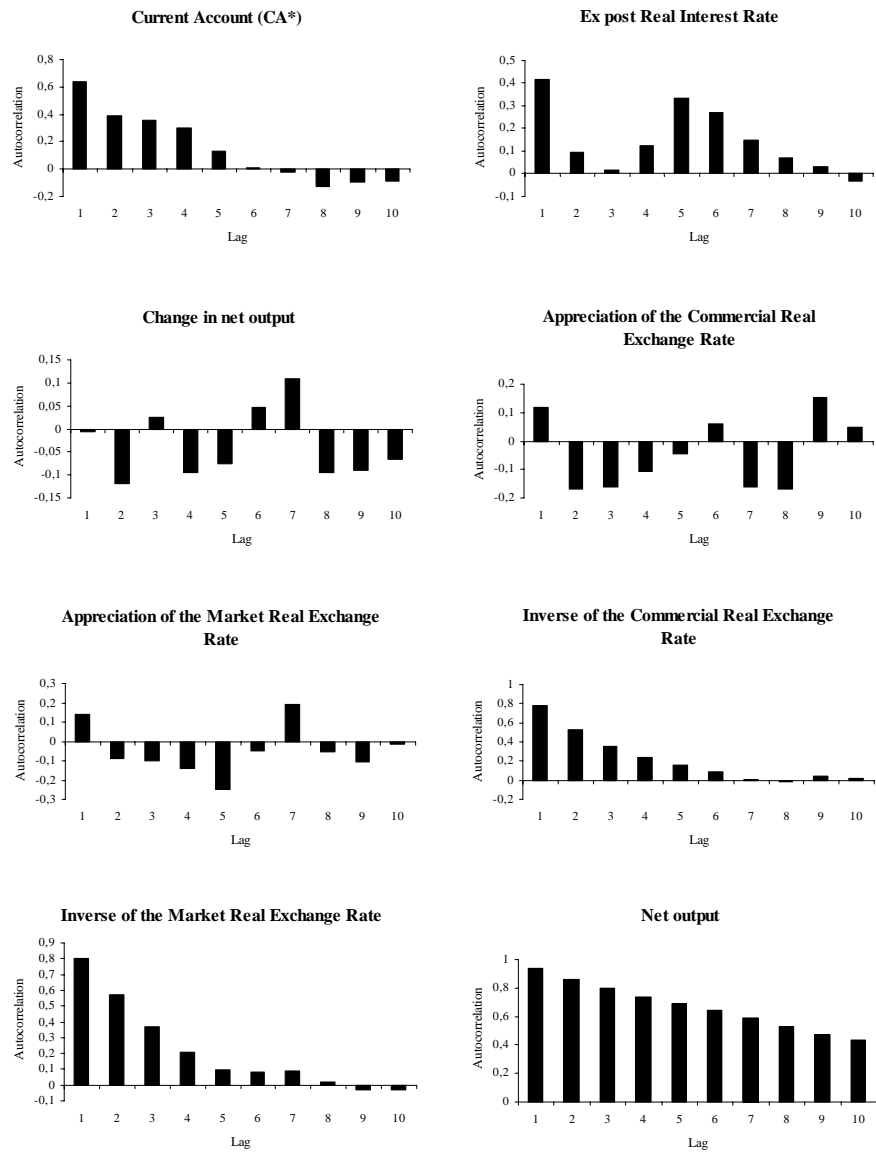41

Figure 2: Constructed variables (cont.)

Figure 3: Direct correlograms

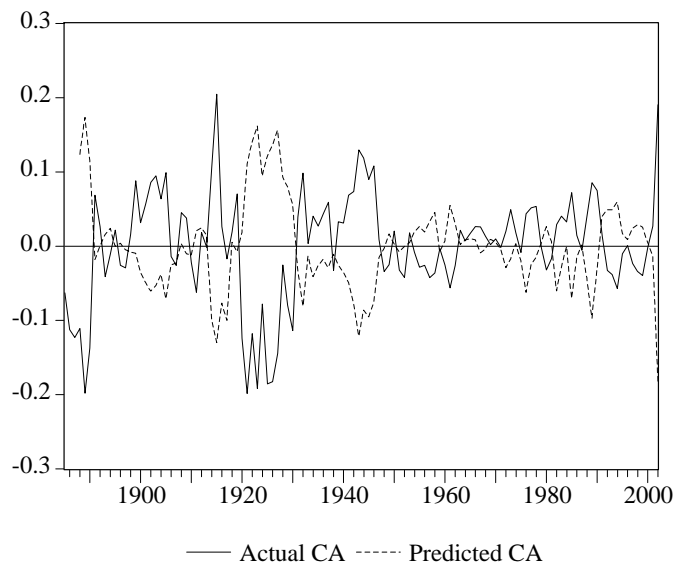Figure 4 : Evolution of the Share of Traded Goods
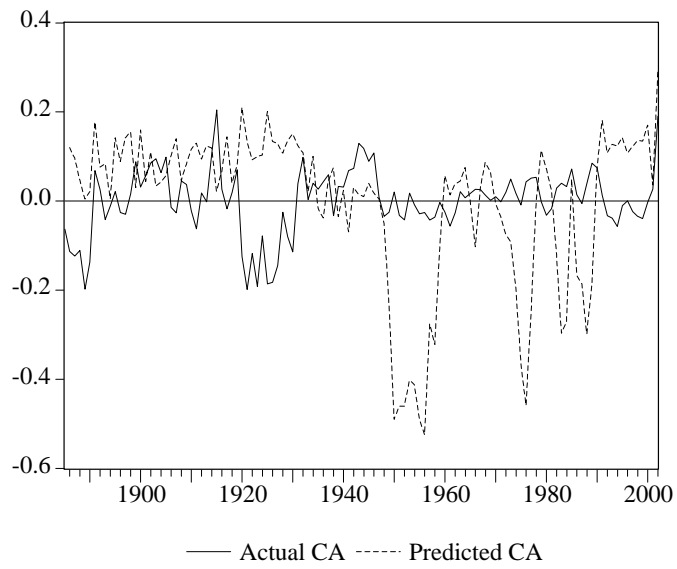

Figure 5 : The Benchmark - Model 1885 - 2002

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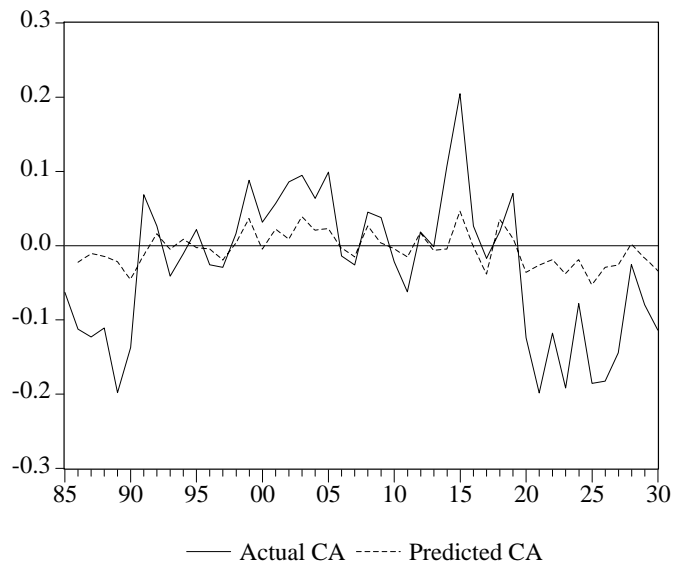Figure 6 : The Full - Model 1885 - 2002
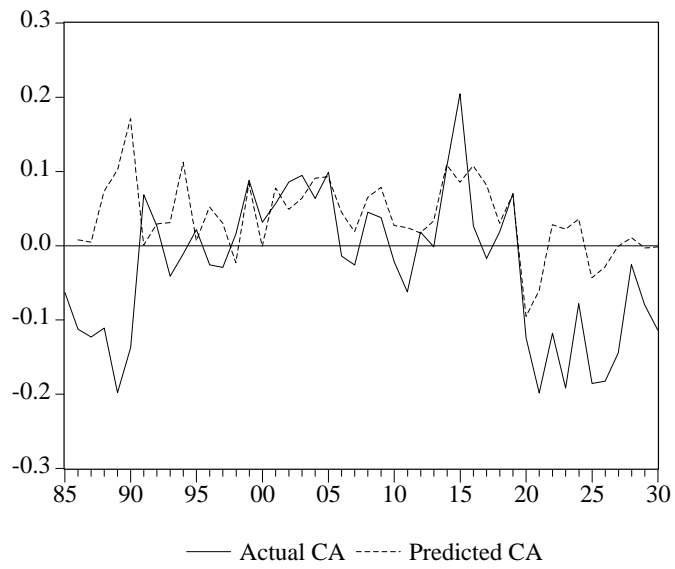

Figure 7 : The Benchmark - Model 1885 - 1930

Figure 8 : The Full - Model 1885 - 1930

	Autocrrelation (a)	ARCH (b)
Current Account (CA*)	No	No (in every lag)
Ex post Real Interest Rate	No	**Yes (in every lag)**
Change in net output	No	No (in every lag)
Appreciation of the Commercial Real Exchange Rate	No	No (in every lag)
Appreciation of the Market Real Exchange Rate	No	**Yes (in every lag)**
Inverse of the Commercial Real Exchange Rate	No	No (in every lag)
Inverse of the Market Real Exchange Rate	No	**Yes (in every lag)**
Net output	No	**Yes (in the first lag)**

(a) Breusch-Godfrey LM test statistic for autocorrelation. Tests performed from 1 to 5 lags at the 5% level.

(b) Auto regresive condition heteroskedasticity. Tests performed from 1 to 5 lags at the 5% level.

Table 1: Testing autocorrelation and heteroskedasticity

To Lag	Chi-Square	DF	Prob > Chi-Sq
2	30.90	25	0.1922
3	53.29	50	0.3488
4	84.83	75	0.2050
5	101.42	100	0.4415
6	120.26	125	0.6030
7	136.33	150	0.7811
8	157.22	175	0.8286
9	190.12	200	0.6804
10	209.58	225	0.7620

Equation	DW(1)	R-square	StdDev	F Value	Prob>F
Change in net output	1.71	0.2214	0.0840	5.12	0.0001
Current Account (CA)*	1.93	0.4957	0.0526	17.70	<.0001
Ex post Real Interest Rate	1.89	0.2199	23.9051	5.07	0.0001
Appreciation of the Commercial Real Exchange Rate	1.95	0.1921	0.1075	4.28	0.0007
Appreciation of the Market Real Exchange Rate	1.92	0.2649	0.1455	6.49	<.0001

Table 3 : Univariate Model Diagnostic Checks for the VAR(1) full model

To Lag	Chi-Square	DF	Prob > Chi-Sq
4	16.89	9	0.0504
5	28.87	18	0.0501
6	39.80	27	0.0535
7	41.24	36	0.2521
8	50.97	45	0.2504
9	65.89	54	0.1287
10	71.79	63	0.2095

Table 4 : Portmanteau Test for Residual Cross Correlations - VAR(3) with three variables

Equation	DW(1)	R-square	StdDev	F Value	Prob>F
Change in net output	1.94	0.3001	0.0806	5.63	<.0001
Current Account (CA*)	1.89	0.5181	0.0517	14.11	<.0001
Ex post Real Interest Rate	1.93	0.2240	24.1704	3.79	0.0006

Table 5 : Univariate Model Diagnostic Checks for the VAR(3) with three variables

To Lag	Chi-Square	DF	Prob > Chi-Sq
4	7.40	4	0.1162
5	9.72	8	0.2851
6	15.58	12	0.2112
7	16.80	16	0.3989
8	22.21	20	0.3290
9	28.80	24	0.2276
10	33.52	28	0.2170

Table 6 : Portmanteau Test for Residual Cross Correlations - VAR(3) with two variables

Equation	DW(1)	R-square	StdDev	F Value	Prob>F
Change in net output	1.85	0.0369	0.0933	0.83	0.5323
Current Account (CA*)	1.88	0.4870	0.0526	20.51	<.0001

Table 7 : Univariate Model Diagnostic Checks for the VAR(3) with two variables

	Benchmark Model	Full Model				Only Real Interest Rate			
		Match variance	0,2	0,5	0,9	Match variance	0,2	0,5	0,9
X2 Statistic	39,9119	26,4516	46,671	24,035	21,857	122,816	37,637	7,967	5,850
p-value	0,000	0,000	0,000	0,001	0,003	0,000	0,000	0,537	0,755
Degrees of freedom	6	6 (a)	7	7	7	8 (a)	9	9	9
SD(predicted CA)	0,060	0,073	0,034	0,078	0,174	0,073	0,104	0,177	0,280
SD(actual CA)	0,073	0,073	0,073	0,073	0,073	0,073	0,073	0,073	0,073
Predicted/Actual	0,820	1,000	0,471	1,074	2,386	1,000	1,429	2,418	3,836
Correlation	-0,895	-0,220	-0,487	-0,212	-0,094	-0,823	-0,837	-0,781	-0,733

(a) Degrees of freedom equal 6 for the full model and 8 for the model with only real interest rate, instead of 7 and 9 respectively, because of extra estimated parameter.

Table 8 : Results from Present Value Tests for the period 1885 - 2002

	Benchmark Model	Full Model				Only Real Interest Rate			
		Match variance	0,2	0,5	0,9	Match variance	0,2	0,5	0,9
X2 Statistic	11,376	8,62645	27,369	8,402	6,528	7,396	26,419	4,608	4,162
p-value	0,003	0,196	0,000	0,298	0,480	0,193	0,000	0,595	0,655
Degrees of freedom	2	6	7	7	7	5	6	6	6
SD(predicted CA)	0,020	0,072	0,035	0,072	0,153	0,072	0,055	0,101	0,174
SD(actual CA)	0,072	0,072	0,072	0,072	0,072	0,072	0,072	0,072	0,072
Predicted/Actual	0,282	1,000	0,491	1,008	2,122	1,000	0,763	-9,869	2,424
Correlation	-1,000	-0,408	-0,670	-0,427	-0,266	-0,708	-0,825	-0,710	-0,613

Table 9 : Results from Present Value Tests for the period 1914 - 2002

	Benchmark Model	Full Model				Only Real Interest Rate			
		Match variance	0,2	0,5	0,9	Match variance	0,2	0,5	0,9
X2 Statistic	5,993	-	40,979	32,755	25,288	4,547	21,443	4,907	2,596
p-value	0,050	-	0,000	0,000	0,001	0,474	0,002	0,556	0,858
Degrees of freedom	2	-	7	7	7	5	6	6	6
SD(predicted CA)	0,023	-	0,050	0,049	0,050	0,095	0,026	0,088	0,203
SD(actual CA)	0,095	-	0,095	0,095	0,095	0,095	0,095	0,095	0,095
Predicted/Actual	0,245	-	0,524	0,515	0,529	1,000	0,273	0,922	2,127
Correlation	0,825	-	0,214	0,312	0,427	-0,619	-0,003	-0,617	-0,623

Table 10 : Results from Present Value Tests for the period 1885 - 1930