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# THE INTERTEMPORAL APPROACH TO THE CURRENT ACCOUNT: EVIDENCE FOR ARGENTINA

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The Argentinean current account has exhibited large fluctuations over time. Sizable deficits over the last part of the 19th century and beginning of the 20th were followed by an almost equilibrated balance for most of the 20th century. Moderate deficits were again recorded between 1990 and 2002. Can factors highlighted by the intertemporal approach to the current account explain the dynamics of the Argentinean external sector for the 1885-2002 period? To answer this question we make use of a model featuring two main external shocks for small economies: real interest rates and exchange rates. In contrast to its application to other Latin American countries, the intertemporal model does not track well the actual current account from 1885 to 2002 in Argentina. This is due to the country's lack of access to the international financial system (a main assumption in the model), the occurrence of balance of payments crises, and the *stop and go* process. There is, however, some evidence in favor of the theory for the period 1885-1930, when capital mobility was relatively high and free of currency crises and stop and go cycles.

*JEL classification codes*: C32, F32
*Key words*: intertemporal approach to the current account, VAR models, Argentina

## I. Introduction

The field of international macroeconomics has devoted great attention to concerns that arise when the current account is in persistent disequilibrium and has focused on the existence and effectiveness of automatic adjustment mechanisms. While previous theories of the current account emphasized the study of the specific determinants of trade and financial flows, the modern view (the intertemporal

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approach to the current account) highlights the role of saving-investment decisions made by a forward-looking representative agent. In the first generation of intertemporal models, a country's current account surplus equaled the present value of expected future declines in output, minus investment and government purchases (called the net output). Second generation intertemporal current account models were expanded to make room for the roles played by real interest rates and the real exchange rate.

Can factors highlighted by the intertemporal approach to the current account explain the long-run dynamics of the Argentinean external sector? To answer this question an intertemporal model of the current account is estimated for the 1885-2002 period. It is known that the Argentinean current account has exhibited large fluctuations since the end of the 19th century. At the end of the 19th and beginning of the 20th century (*Belle Epoque*), the country had access to international financial markets that allowed the financing of sizable current account deficits (approximately 6% of GDP from 1885 to 1931). Subsequent changes in the international environment, with the Great Depression of the 1930s and the Second World War, caused a slump in international trade and lead to protectionary policies worldwide. Argentina could not maintain the huge current account imbalances of the past and an almost equilibrated current account was observed until the beginning of the 1990s (-0.1% of GDP on average). From 1992-2001, the rise in external funds available to developing countries allowed Argentina to run sizable imbalances of the order of 3.4% of GDP.

According to the intertemporal model, in the periods 1885-1930 and 1991-2002 individuals should have anticipated a rise in net output, while individuals in 1931-1990 should have expected a decline in net income. Given that the end of the 19th and beginning of the 20th century was an affluent time, juxtaposed with 1931-1991, it seems that in principle the theory should track well the long-run evolution of the Argentinean current account.

The paper first briefly exposes the theory of present value models, which underlies most of the empirical work conducted via the intertemporal approach. This section also reviews the applied literature, noting that most of the papers employed a simple version of the current account model in which only the future evolution of net output matters. Next, we present a relevant extension of these models in which variable interest rates and the real exchange rate are included as main variables. The econometric method used to test the theory is presented in Section IV, which is an application of the concepts and methods developed in Section II to the current account. We proceed in Section V to combine various sources of data, constructing the long time series needed to test the theory for Argentina. We present the empirical results in Section VI, first checking for the stationarity of the series and estimating the econometric models. The outputs of the econometric models are then combined with some key parameters of the theory to compute a predicted current account and to extensively evaluate the model performance for the Argentinean case. Section VII concludes.

## II. Testing the intertemporal theory

Present value models, by which one variable is written as a linear function of the present discounted value of other variables, are used to test this theory. One of the main advantages of present value models is that they fully exploit their structure when deriving testable hypotheses. Articles applying this technique to current account data appeared in the early 1990s. In these simpler versions, the objective was to apply to an open economy Campbell's (1987) idea that consumers save for a rainy day: a country's current account surplus equals the present value of anticipated declines in output, minus investment and government purchases (i.e., net output). The analogy to household behaviour is instructive: representative agents save when they expect (labor) income to decline. The key element introduced by present value models involves the way the agent's expectations are estimated. As long as the information set used by the econometrician does not contain all the information available to the representative agent, the current account reveals useful information on the expected evolution of the net output. In these earlier versions, the international real interest rate remains constant and there is no room for non-tradable goods.

Sheffrin and Woo (1990a) presented a pioneering paper studying the case of Belgium, Canada, Denmark and the UK for the period 1955-1985. They found evidence in favor of the theory in the case of Belgium only. Subsequent case studies, e.g., Otto (1992), considered the case of the US and Canada, using quarterly data for the period 1950:1-1988:4. For both countries, the formal restrictions implied by the present value relationship for the current account were strongly rejected, with only some informal evidence in favor for the US case. Ghosh (1995) analyzed the case of Japan, Germany, US, Canada and the UK using quarterly data for the period 1960:1-1988:4. He concluded that the model performs well for all the countries studied in characterizing the direction and turning points of the current accounts, but for the US case alone the model can not be rejected. More recently, McDermott et al. (1999) studied the case of France using quarterly data for the period 1970:1-1996:4. The results showed that the model explains the fluctuations of the current account balance fairly well, even during a period of large external shocks and restrictions on overseas capital transactions.

Studies for developing economies are far less common. To our knowledge, there are only two studies which apply the simple version of the model to Latin America. Suarez Parra (1988) tested this simpler intertemporal model for Colombia using annual data over the period 1950-1996. Arena and Tuesta (1999) used annual data for the period 1960-1996 for Peru. For both countries, the intertemporal model seems to track well the movements in actual current accounts.

Applied studies generally find that the actual current account is more volatile than the theoretical current account, except in the case of the US. 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. The result suggests that there were missing variables affecting the current account. Sheffrin and Woo (1990a) propose that small economies may be strongly influenced by external shocks that do not affect the net output. To explain the current account of a small economy it may be important not only to consider shocks to domestic output but also external shocks like international interest rates and the exchange rate. Bergin and Sheffrin (2000) formalized this idea following a proposition by Dornbusch (1983) which suggested that an anticipated rise in the relative price of internationally tradable goods can raise the cost of borrowing from abroad when interest is paid in tradable goods. As a result, real exchange rate changes can induce an intertemporal substitution in consumption, producing similar effects to interest rate changes. In addition, exchange rate changes can have more standard intratemporal effects, by inducing substitution of internationally-tradable goods by non-tradable goods, and vice versa. Bergin and Sheffrin (2000) tested the model for Australia, Canada and the UK and concluded that incorporating these variables improved the current account prediction in the first two cases. Landeau (2002) tested the model for Chile using quarterly data from 1960:1 to 1999:4, reaching the same conclusion. We will now present this model in detail and test it for the Argentinean case.

## III. The theoretical model

In this section, we present the model developed by Bergin and Sheffrin (2000), in which a representative agent chooses a path of consumption for tradable and non-tradable goods to maximize expected lifetime utility under the assumption of full access to the international financial market:

$$\max_{\{C_{Ts},C_{Ns}\}} E_t \sum_{s=t}^{+\infty} \beta^{s-t} U\left(C_{Ts}, C_{Ns}\right) \quad \text{s.t. } Y_t - \left(C_{Tt} + P_t C_{Nt}\right) - I_t - G_t + r_t B_{t-1} = B_t - B_{t-1}, \tag{1}$$

where $U\left(C_{Tt}, C_{Nt}\right)=\frac{1}{1-\sigma}\left(C_{Tt}^{a} C_{Nt}^{1-a}\right)^{1-\sigma}$, with $\sigma>0, \sigma \neq 1, 0<a<1$, $E_t$ denotes conditional expectations on the agent's time $t$ information set. $C_{Tt}$ and $C_{Nt}$ represents consumption of the tradable and non-tradable good, respectively, $Y_t$ denotes current output, It is investment and $G_t$ is government expenditure. $B_t$, the stock of net external assets at the beginning of each period, is endogenously determined once the representative agent has chosen the consumption path. The relative price of non-tradable and tradable goods is denoted $P_t$, so that all of the variables appearing in the budget constraint are measured in terms of the tradable good. Using $P_t$, total consumption in terms of tradable goods can be expressed as $C_t = C_{Tt} + P_t C_{Nt}$. The world real interest rate in terms of tradable goods is $r_t$. Departing from first generation intertemporal current account models, $r_t$ is allowed to change over time and the relative price between tradable and non-tradable goods is included in the analysis.

Solving the program (1) involves, sequentially, finding the solution to an intratemporal and an intertemporal optimization problem. First, the representative agent chooses how to distribute income between consumption of tradable and non-tradable goods. Next, the agent decides on the optimal allocation of consumption over time. From the first-order conditions for this problem, we can derive the following optimal consumption profile:

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

The multiplicative form of equation (2) makes its empirical application difficult. To get an additive form of the equation, joint log-normality is assumed, together with constant variances and covariances among these variables. This allows for the rewriting of equation (2) in log form as:

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

where $\Delta c_{t+1}=\ln C_{t+1}-\ln C_t$ and $\gamma=1/\sigma$ represents the intertemporal elasticity of substitution. $r_{t+1}^{*}$ is a consumption-based real interest rate given by:

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

where $\Delta p_{t+1}=\ln P_{t+1}-\ln P_t$ is the appreciation rate for the real exchange rate.

Equation (3) states that the optimal consumption profile depends on the evolution of the interest rate ($r_t$), and the change in the relative price of non-tradable goods, $p_t$. As mentioned, first generation current account models did not allow for these variables, implying a zero expected change in consumption, with the representative agent always trying to smooth consumption by borrowing and lending with the rest of the world. In this second generation current account model, the agent does not smooth consumption, but instead reacts to changing borrowing conditions.

An increase in the conventional real interest rate ($r_t$) induces substitution for future consumption by raising the cost of current consumption. The relative price of non-tradable goods can also trigger an intertemporal substitution effect, as when an expected increase in the price of tradable goods raises the cost of loan repayment in tradable goods. In this case, $\Delta p_{t+1}$ is negative, and the consumption-based interest rate $r^*_{t+1}$ increases in relation to the conventional interest rate $r_{t+1}$, when the representative agent is willing to substitute consumption over time ($\gamma > 1$). An expected increase in the relative price of tradable goods also pushes the agent to increase the present consumption of the tradable good, thus inducing an intratemporal substitution effect. The intertemporal substitution effect will dominate whenever the elasticity of substitution is greater than one.

As with equation (2), it is also necessary to log-linearize the budget constraint. If we define net output, which is random and the source of uncertainty in the model, as $NO_t = Y_t - I_t - G_t$, the intertemporal budget constraint may be log-linearized as:

$$-\sum_{s=1}^{+\infty} \beta^s \left[ \frac{\Delta no_{t+s}}{\Omega} - \Delta c_{t+s} + \left(1 - \frac{1}{\Omega}\right) r_{t+s} \right] = \frac{1}{\Omega} no_t - c_t + \left(1 - \frac{1}{\Omega}\right) b_t' + \text{ constant term.} \quad (4)$$

Except in the case of the world real interest rate, for which the approximation $\ln(1 + r_t) \approx r_t$ was used, lower case letters represent the logs of upper case counterparts. In equation (4), $\Omega$ is a constant greater than one, $\Omega = 1 + \frac{B}{\Psi}$, where $B$ is the steady state value of net foreign assets and $\Psi$ is the steady state value of the present value of net output.

Taking expectations of this equation, using the log-linearized Euler equation (3) and choosing the steady state around which linearization takes place to be the one in which net foreign assets are zero ($B = 0$ and then $\Omega = 0$), the equation may be written as:

$$CA^*_t = -E_t \sum_{s=1}^{+\infty} \beta^s \left( \Delta no_{t+s} - \gamma r^*_{t+s} \right), \quad (5)$$

where $CA_t^* \equiv no_t - c_t$ and the constant term is left out since in the empirical model we will demean all the variables.[1] Equation (5) expresses the current account as a function of the present discounted value of changes in net output and the consumption-based real interest rate. As highlighted by first generation current account models, if net output is expected to fall, representative agents will save for the rainy day, decreasing consumption and raising the current account balance. A similar result is obtained in this second generation model when the consumption-based real interest rate is expected to increase.

In what follows and for the sake of comparison, two simple versions of the intertemporal model will also be tested. One in which the consumption-based interest rate is assumed to be constant, and the other in which only the real interest rate is allowed to vary. In the first case, the objective is to test whether an expanded model improves upon the simple intertemporal versions. In the second, the objective is to try to determine the source of this improvement.

## IV. The econometric method

In order to test the prediction that the current account depends on the expected future path of changes in net output and the consumption-based interest rate, proxies for these variables are needed. The simplest approach would be to project the individual variables over the future using univariate ARMA models. As noted by Ghosh (1995), this is unlikely to suffice since a representative agent will in general posses broader information on which to base expectations. Using vector auto regression (VAR) models allows for full exploitation of the information set, since each variable depends on every other. The VAR framework can then be used to obtain expectations of the net output and the consumption-based real interest rate on the basis of previous values for these variables. 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 form expectations, in which case we would have to estimate just a two variable VAR. Another option is to consider $\Delta no_{t+s}$ and $r_{t+s}^*$ as separate variables and estimate a three variable VAR (Bergin and Sheffrin, 2000). 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. This gives the advantage of judging the relative importance of each variable in explaining the current account.

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

We rewrite equation (5) using the expression for the consumption-based real interest rate as:

$$CA_t^* = -E_t \sum_{s=1}^{+\infty} \beta^s \left[\Delta no_{t+s} - \gamma r_{t+s} - (1-\gamma)(1-a)\Delta p_{t+s}\right]. \quad (6)$$

As Argentina suffered from exchange rate controls, it is convenient to split the appreciation of the real exchange rate ( $\Delta p_{t+s}$) into two components: the appreciation of the commercial exchange rate and the market exchange rate. The former corresponds to a regulated exchange rate used for import and export transactions while the latter consists of the free market exchange rate determined in the free or black market.

Defining $\Delta p_{t+s}^C$ as the appreciation of the commercial real exchange rate and $\Delta p_{t+s}^M$ as the appreciation of the market real exchange rate, equation (6) can be rewritten (where $b$ is a weighting parameter) as:

$$CA_t^* = -E_t \sum_{s=1}^{+\infty} \beta^s \left[\Delta no_{t+s} - \gamma r_{t+s} - (1-\gamma)(1-a)\left[b\Delta p_{t+s}^C + (1-b)\Delta p_{t+s}^M\right]\right]. \quad (7)$$

If the model is not rejected, the current account should then reflect the future change in net output, the real interest rate and the appreciation rate of the real exchange rate. This means that the current account can help predict the evolution of these variables thus justifying the estimation of the following VAR:

$$\begin{bmatrix} \Delta no \\ CA^* \\ r \\ \Delta p^C \\ \Delta p^M \end{bmatrix}_t = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \\ a_{51} & a_{52} & a_{53} & a_{54} \end{bmatrix} \begin{bmatrix} \Delta no \\ CA^* \\ r \\ \Delta p^C \\ \Delta p^M \end{bmatrix}_{t-1} + \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \\ u_5 \end{bmatrix}_t . \quad (8)$$

In the model in which the consumption-based interest rate is assumed to be constant, only the first two variables are included in the VAR. When only the real interest rate is allowed to change, the fourth and fifth equations and variables are omitted from the system.

Expressing the system (8) in compact form and assuming that the VAR is stationary, it is possible to write (7), as:

$$CA_t^* = \left[-\left[g_1' - \gamma g_2' - (1-\gamma)(1-a)g_3'\right]\beta A\left(I - \beta A\right)^{-1}\right]z_t, \tag{9}$$

where $g_1' = [1\,0\,0\,0\,0]$, $g_2' = [0\,0\,1\,0\,0]$ and $g_3' = [0\,0\,0\,b\,1-b]$. With the estimated parameters of the VAR and some values for the parameters $\beta, \gamma, a$ and $b$ it is possible to find the estimated optimal current account $\hat{CA}_t^* = k'z_t$, where $k' = -\left[g_1' - \gamma g_2' - (1-\gamma)(1-a)g_3'\right]\beta\hat{A}\left(I - \beta\hat{A}\right)^{-1}$ and $\hat{A}$ is the matrix of estimated parameters from the VAR. This expression gives a 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).

If the null hypothesis that the actual current account behaves as the model predicts is not rejected, we should observe that $\hat{CA}_t^* = CA_t^*$ except for an innovation, in which case the vector $k'$ should equal $[0\,1\,0\,0\,0]$. This hypothesis can be tested using the delta method. Defining $\pi = vec(\hat{A})$, the estimated variance-covariance matrix of $\pi$ as $V$, and the vector of deviations of the estimated system from the theoretical model as $\tilde{k}$ (the difference between the actual $k$ and the hypothesized value), then $\tilde{k}'\left(\left(\partial k / \partial \pi\right)V\left(\partial k / \partial \pi\right)'\right)^{-1}\tilde{k}$ will be chi-squared distributed with degrees of freedom equal to the number of restrictions in the model (the number of elements of $\tilde{k}$, in this case five). Another way of (informally) evaluating the model consists of comparing the variances and computing the correlation between the actual and predicted current accounts. If the model performs well, the ratio of variances and the correlation should be approximately equal to one.

## V. Data construction

In this section we proceed to construct a number of series to test the theory for Argentina. Since the intertemporal model of the current account determination is more a statement of long-run tendencies between the variables than short-run dynamics, annual data for the period 1885-2002 are used in the estimations (Sheffrin and Woo 1990b).

### A. Population and working-age population

All the models of the intertemporal approach express net output and the current account in per capita terms with the explicit goal of mimicking the theoretical assumption of a representative agent. In our case, the agent represents the population of working age rather than the general population. This factor may affect the dynamic of the variables since the working age and total populations may exhibit differing trends over the long run.

We need data on the total population and the population age structure to compute the working age population. Total population for the period 1885-1913 was obtained from Vázquez-Presedo (1971), while for the years 1914-1979 we chained the previous series with that of Maddison (1995). Data from CEPAL (2002) was used for 1980-2002. A regression method was used to chain the variables. The population age structure was elaborated using data from Vázquez-Presedo (1971) for 1869, 1895 and 1914 (first, second and third National Census), Vázquez-Presedo (1976) for 1915-1940 (quinquennial data), and the National Institute of Statistics and Censuses of Argentina (INDEC) for the period 1950-2005. The share of people aged 15-60 years in the total population is considered the measure of the working age population. Linear interpolation methods were used to generate yearly data for the missing years.

### B. The real exchange rate

A multilateral real exchange rate for the period 1885-1900 was computed as a weighted average of the bilateral exchange rates between Argentina and its main commercial partners.[2] The weights consisted of each country's trade share over these countries' total trade (Vázquez-Presedo, 1971). See the Appendix for a detailed description of the series used in these calculations.

The real exchange rate from 1900-1993 corresponds to that of Winograd and Véganzonès (1997) and is measured in australes (the national currency before the peso) of 1985. Two series of real exchange rates are used since Argentina faced exchange rate controls from the 1930s until the 1990s. One series corresponds to a commercial real exchange rate, calculated using the regulated nominal exchange rate for foreign trade. The other corresponds to a free market real exchange rate. These series of course coincide in periods without exchange rate controls.

Data for the period 1994-2002 was obtained by linking the real exchange rate of Winograd and Véganzonès (1997) with that of the Center of International Economics (Ministry of Foreign Relationships, Argentina). The appreciation of the commercial

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[2] Argentina's main partners over the late nineteenth century were Germany, UK, US, France and Belgium. As no exchange rate data were available for France and Belgium, only the first three countries were considered.

and market real exchange rates was then constructed as $\Delta p_{t+1} = \ln P_{t+1} - \ln P_t$, where $P_t$ is the inverse of the real exchange rate.

## C. The wholesale price index

Since in the theoretical model the variables are expressed in terms of tradable goods, a wholesale price index is used as a proxy for the price of tradable goods. In constructing the wholesale price index three data sources were mixed: Della Paolera and Taylor (2003) for 1885-1900, Winograd and Véganzonès (1997) for 1901-1993, and the National Institute of Statistics and Censuses of Argentina (INDEC) for the remaining period. The wholesale price index was then used to deflate consumption and net output and to construct the real interest rate. Surprisingly, the entire literature on the subject uses the GDP deflator to deflate consumption and the net output, and the consumer price index to construct the real interest rate, knowing that both indices have a sizable component of non-tradable goods.

## D. Nominal and real interest rates

As previously mentioned, the simple intertemporal current account model assumes a constant interest rate generally fixed at 2-6% (Sheffrin and Woo 1990a; Ghosh 1995; Suarez Parra 1998, McDermott et al. 1999). In the theoretical model presented here, the real interest rate is no longer constant, raising the issue of how to construct the relevant international real interest rate. The traditional view consists of building an ex ante interest rate for the G-7 economies following the method of Barro and Sala i Martin (1990). Expected inflation is forecast on the basis of country ARMA models and then combined with nominal interest rates to compute an ex ante real interest rate. Time-varying weights based on GDP are then used to compute an average or international real interest rate. This procedure may not be applicable to the Argentinean case over the long run and is not followed here, since when the country has access to the international financial market the cost of borrowing will usually be higher and will display far more volatility than the G-7 rate. Unfortunately, a measure for the international cost of capital for a country like Argentina is not readily available. In such an event, even if it is not entirely satisfactory, the internal interest rate is used as an alternative.[3]

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[3] Nevertheless, an international real interest rate will be used in the calculations when performing a sensitivity analysis in a later section.

The nominal interest rate considered here is an average of a passive and an active rate. For 1885-1899 data comes from Della Paolera and Taylor (2001), which is respectively taken from Cortes Conde (1998). This corresponds to the implicit yield of an internal government bond (*fondos públicos nacionales*). For the years 1900-1993 the rates are from Winograd and Véganzonès (1997), while for 1994-2002 the rates were constructed using data from the Banco Nación, the Central Bank of Argentina and the IMF (2003). The wholesale price index was then used to obtain a real ex-post interest rate, using the formula: $r_t = (1 + i_t)\left(W_t / W_{t+1}\right) - 1$, 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 $W_t$ is the price index for period $t$.

### E. Consumption and net output

To construct the consumption and net output series, we used the nominal National Accounts presented in IEERAL (1986) for the period 1914-1980. Net output was calculated as the gross domestic product minus investment and public expenditures. We then extended this series over the future using data from INDEC (nominal National Accounts, methodologies 1986 and 1993).

The extension over the past (1885-1913) was based on information from Taylor (1997), Vázquez-Presedo (1971) and IEERAL (1986). Nominal GDP, investment and total consumption (private plus public consumption) were obtained from the first author. To split total consumption into private and public consumption, the share of public consumption over total consumption for the year 1914 was first calculated using data from IEERAL (1986). Data from Taylor (1997) and the evolution of expenditures by the federal government provided by Vázquez-Presedo (1971) were then used to reconstruct the evolution of public consumption over the period 1885-1913, with the caveat that the evolution of public expenditure by local governments is neglected. This does not seem to be a problem since at that time, local government represented only 16% of total public expenditure (federal plus provincial governments).[4] Private consumption was then calculated as the difference between total and public consumption.

Nominal net output and consumption were first deflated using the wholesale price index (in australes of 1985) and expressed in terms of the working age population. The modified current account was calculated as $CA_t^* \equiv no_t - c_t$.

[4] See Porto (2003). It was assumed the evolution of the federal spending as representative of total government spending.

## VI. Empirical results

### A. Testing for unit roots

Before estimating the VAR, it is important to check that the variables in (8) do not contain unit roots. The variables in levels are also tested for unit roots, since a cointegrating relation may exist among them. We apply the ADF-GLS test presented in Elliott, Rothenberg and Stock (1996) to test for unit roots, deciding a priori whether a trend is present in the data. In such a case, the variables are de-trended and the remaining demeaned, to remove their deterministic components. Based on a visual inspection of the variables, the only variable that was de-trended was net output. The next step consists of applying ADF tests to the transformed variables, using the specification that excludes the constant and time trend, since the deterministic components were already eliminated. The optimal number of lags included in the ADF regressions was determined on account of the Schwarz Information Criteria (SIC) and starting with a maximum of five lags, which seems to be enough for annual data. Only in the case of net output do we not reject the null hypothesis of a unit root. In the remaining cases it is possible to reject the null hypothesis, either at the 5% significance level (for the current account) or at 1% (for the other variables).

Before taking these results at face value, it is necessary to determine whether the error terms from the estimated equations satisfy the assumptions of the Dickey-Fuller test. In particular, ADF residuals were tested for autocorrelation and conditional heteroskedasticity.[5] While we found no evidence of autocorrelation in each variable, conditional heteroskedasticity seems to be a problem for the ex post real interest rate, the inverse and the appreciation of the market real exchange rate and net output. Following Trehan and Walsh (1991), the Phillips-Perron (PP) unit root test will be applied for these variables, since it is robust to the presence of conditional heteroskedasticity in the error term. The PP test is performed invoking the Newey-West automatic truncation lag selection (four for every variable).[6] For all series except net output, the results show that it is possible to reject the presence of a unit root at 1% significance.

[5] Autocorrelation is tested by the Breusch-Godfrey LM test statistic, while conditional heteroskedasticity is checked via the ARCH LM test.

[6] 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 : $4\left(\frac{T}{100}\right)^{2/9}$, where $T$ is the sample size.

We can conclude that the variables in the VAR are stationary and that no co-integration relation can exist between net output and the level of the commercial and market real exchange rates, since these are stationary variables. The fact that these variables enter the VAR in differences results in over-differenced system, which will be important when specifying the VAR model.

## B. Estimation of the VAR system and parameter values

All variables were demeaned before estimating the VAR, since the model restricts only the dynamic interrelation between the variables, not their mean values. The (demeaned) inverse of the commercial and market real exchange rates are also included in the system as predetermined variables, since they are already stationary in levels. These variables will be included in the system with a two period lag.

We estimated three VAR systems. The first includes the five variables appearing in (8), labeled the *full model*. The second and the third are simple versions, one that excludes the consumption-based interest rate (called the *benchmark model*), and another that only excludes real exchange rates. The idea in the first case is to see whether the extension of the model improves upon the simple intertemporal model and, if so, the second model is used in order to determine the source of the improvement. The criterion of choosing the most parsimonious model with multivariate white noise errors was followed in the selection of the optimal lag length for the VAR. In particular, VARs of orders five to one were estimated sequentially, and multivariate white noise errors were checked at every step using a Portmanteau test. Based on this methodology, a first order VAR was selected for the full model, while a third order VAR was selected for the remaining cases. Verification that the moduli of all the eigenvalues of the companion matrix were less than one confirmed that each VAR was stationary.

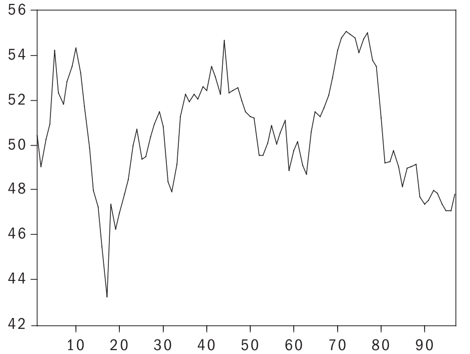
Before testing the validity of equation (7) for Argentina we need values for the discount factor ($\beta$), the intertemporal elasticity of substitution ($\gamma$), the share of tradable goods over total private consumption ($a$) and the coefficient of the appreciation of real exchange rates ($b$). Concerning the discount factor, from equation (2) we can seen that in the steady-state the model implies that $\beta = \frac{1}{1+r}$, where $r$ is the steady-state value of the real interest rate. Since the sample mean for the real interest rate over the period 1885-2002 is negative, the literature will be used as a guideline to choose the value for $\beta$. 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) use a $\beta$ of 0.97 when calibrating their model to explain the procyclicality of public expenditures in developing countries. Uribe (2002) uses a value of 0.98 when calibrating the model to study the relation between private consumption and exchange rate behavior in stabilization plans for Argentina. Since the last author uses data from Argentina, a value of 0.98 is retained for the discount factor.

The share of tradable goods in private final consumption was calculated using data from Martinez (1998) who decomposes the Argentinean GDP into nine sectors for the period 1901-1997. We follow Stockman and Tesar (1995) in considering that the share of tradable goods over total private consumption is the same as tradable output over total output and in categorizing the sectors into tradable and non tradable activities. Figure 1 shows the evolution of the share of tradable goods ($a$) using this decomposition, with the average from 1901-1997 at about 0.5 and no evident trend. This result is also 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 g ranging from 0.022 to 1, depending on the country. Uribe (2002) uses a value of 0.2 for Argentina. Landeau (2002) and Kydland and Zarazaga (2000) use a value of 0.5. In order to reflect the probable uncertainty regarding this parameter, we consider values for the intertemporal elasticity of 0.2, 0.5, 0.9 and the value that makes the predicted current account match the variance of the actual current account. For the value of b, we find no reason to choose any other value than 0.5.

**Figure 1.** Evolution of the share of tradable goods



## C. Evaluating the performance of the model

With the parameters and the VAR coefficients established we can now compute vector $k$ and the $\chi^2$ statistic to test for the validity of the model. Knowing that the test of equation (9) is contingent upon these parameter values, robustness checks will be performed in a later section. Table 1 summarizes the results from the present value tests for the period 1885-2002. Each column represents a different model specification. The second column shows the benchmark model, which ignores changes in the real interest rate and exchange rates, while columns three to six show the model augmented with these two variables for different values of the elasticity of substitution. These include the $\gamma$ that makes the predicted current account (calculated using the expression $C\hat{A}_t^* = k'z_t$) have the same variance as the actual current account, and values of 0.2, 0.5 and 0.9. Columns seven to ten present the results for the model in which the exchange rate is not allowed 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. The second and third rows report the estimated $\chi^2$ statistic and the associated p-values. In the fourth row, the number of degrees of freedom used in the calculation of the p-values are shown, corresponding to the number of restrictions in the system (the elements in vector $k$).[7] Let us next present the volatility of the predicted current account (standard deviation), as well as its ratio to the actual current account volatility and the correlation between the two.

As previously mentioned, the ratio of the standard deviations and the correlation between the predicted and actual current accounts informally evaluates the performance of the model. The actual and the predicted current account should coincide 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 consequently provide an informal measure of the model fit. Large differences in the time series of the two variables imply, subject to sampling error, economically important deviations from the theoretical model. This evaluation may be an important complement to formal statistical tests, since they are often so powerful that the merits of the model became obscured by statistical rejections (Huang and Lin 1993).

[7] Note that for the case in which the elasticity is calculated to match the variance of the actual current account, the number of degrees of freedom must be reduced by one in order to consider the penalty for using one restriction to identify the estimated elasticity.

**Table 1.** Results from present value tests (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 |
| $x^2$ Statistic | 39.91 | 26.45 | 46.67 | 24.04 | 21.86 | 122.82 | 37.64 | 7.97 | 5.85 |
| p-value | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.54 | 0.76 |
| Degrees of freedom | 6 | 6 (a) | 7 | 7 | 7 | 8 (a) | 9 | 9 | 9 |
| SD (predicted CA) | 0.06 | 0.07 | 0.03 | 0.08 | 0.17 | 0.07 | 0.1 | 0.18 | 0.28 |
| Predicted/actual | 0.82 | 1 | 0.47 | 1.07 | 2.39 | 1 | 1.43 | 2.42 | 3.84 |
| Correlation | -0.89 | -0.22 | -0.49 | -0.21 | -0.09 | -0.82 | -0.84 | -0.78 | -0.73 |

Note: (a) Degrees of freedom are reduced by one given the extra estimated parameter.

**Figure 2.** The benchmark model (1885-2002)

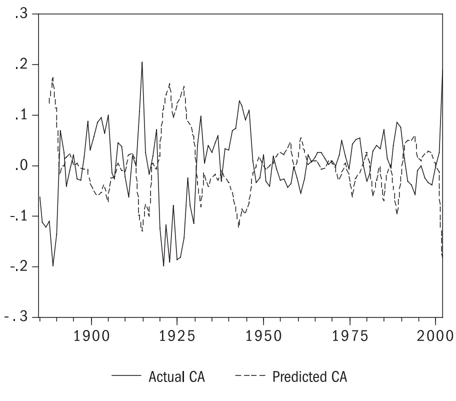



Figure 2 shows the actual current account and the prediction generated by the intertemporal model excluding the consumption-based interest rate for the period 1885-2002 (the benchmark model). This model does not provide a good prediction of current account fluctuations. If the Argentinean current account had behaved as the benchmark model predicts, one would have observed almost the opposite evolution. Even if both volatilities are relatively similar, their correlation is negative. The statistical test for the restrictions of the theory soundly rejects the model. The theory suggests that with two variables and three lags, $k'$ should equal [0 0 0 1 0 0], when the estimated $k$-vector is in fact [0.226 0.133 – 0.016 – 0.458 – 0.176 – 0.230].

The negative values associated with the actual and past current accounts in the vector $z_t$ are at the heart of the negative relation between the predicted and actual current accounts. Similar results are obtained for the other models and performance does not improve vis-a-vis the benchmark model. This is in sharp contrast with evidence for other Latin American countries like Chile, Colombia and Peru (Suarez Parra 1998; Arena and Tuesta 1999; Landeau 2002), for which even a simple graphical analysis suggests that the intertemporal model can explain much of the evolution of the actual current account.

**Why doesn´t the model match the data in the Argentinean case?**

In principle, we can think of three possible explanations for the poor performance of the intertemporal model. One is the potential low quality of the data for some periods, so that the model does not measure what a representative agent supposedly considers when making economic decisions. The second possible explanation has to do with the assumptions of the model; the perfect capital mobility hypothesis is very relevant since it is assumed that the country has perfect access to the international financial system. The third possible explanation involves the occurrence of balance of payments crises and policy experiments during an important part of the Argentinean economic history.

The first possible explanation is particularly of concern for the beginning of the sample; in this case many sources were mixed to construct the long-run series. For example, for the population of working age the quality of data has improved significantly since 1915, when quinquennial data for the composition of the population by ages was first made available. As for real exchange rates, homogenous information covers the period 1900-1993, to which data from the Ministry of Foreign Relationships for the period 1994-2002 was added. Therefore, one might only be concerned about data quality for the period 1885-1900. The same is true for the nominal interest rate, since it was constructed as an average of a passive and active rate while before 1900 it was the implicit yield on an internal government bond. Perhaps the most important series include the national accounts used to compute consumption, net output and the current account; for these series quality may be lower for the period 1885-1913, for which the series for the national accounts were constructed making some assumptions concerning the evolution of aggregate government spending.

To deal with this concern about data quality, we can restrict the sample to the period 1914-2002. For this sample, all the sources are relatively homogeneous and reliable (notably, the Central Bank and the National Institute of Statistics). Table 2

**Table 2.** Results from present value tests (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 |
| $x^2$ Statistic | 11.38 | 8.63 | 27.37 | 8.4 | 6.53 | 7.4 | 26.42 | 4.61 | 4.16 |
| p-value | 0.00 | 0.20 | 0.00 | 0.30 | 0.48 | 0.19 | 0.00 | 0.60 | 0.66 |
| Degrees of freedom | 2 | 6 (a) | 7 | 7 | 7 | 5 (a) | 6 | 6 | 6 |
| SD (predicted CA) | 0.02 | 0.07 | 0.04 | 0.07 | 0.15 | 0.07 | 0.06 | 0.10 | 0.17 |
| Predicted/actual | 0.28 | 1.00 | 0.49 | 1.01 | 2.12 | 1.00 | 0.76 | -9.87 | 2.42 |
| Correlation | -1.00 | -0.41 | -0.67 | -0.43 | -0.27 | -0.71 | -0.83 | -0.71 | -0.61 |

Note: (a) Degrees of freedom are reduced by one given the extra estimated parameter.

shows the results for this new sample period and has the same structure as Table 1.[8] It is apparent that, again, the model does not track the evolution of the actual current account; strong negative correlations are always found between the predicted and actual current accounts.

Regarding the second and third potential reasons for the model's performance, it has been noted that the country had access to the international financial system until the 1930s, allowing Argentina to finance sizable current account deficits. The 1930s' crisis and the Second World War changed the international scenario and an almost equilibrated current account was observed until the beginning of the 1990s. Access to the international financial system was restored in the 1990s, but Argentina never reached current account imbalances of the level observed during the *Belle Epoque*.

Additionally, the 1940s began a period of repeated balance of payments crises in which the government tried to control the current account by applying different policy experiments. These included general and selective use of quantitative exchange regulations, various forms of price and quantity imports rationing, prior import deposits, etc. The goal of preventing the occurrence of balance of payments crises was not achieved on the whole. Balance of payments crises may be at the root of previous results since in the Argentinean economy during the second half of the 20th century, an acceleration of growth immediately resulted in a current account

[8] The same procedure as before was used to select the number of lags included in the VARs. For the benchmark and full models, a VAR with only one lag was chosen, while for the model with real interest rates, a VAR with two lags was selected.

deficit. Through time, these deficits became unsustainable, and a balance of payments crisis resulted in a current account reversion, a drop in GDP, a rise in interest rates and devaluation of the currency.[9] This type of growth is known as the *stop and go* process, since a period of rise in output and current account deficit is followed by a recession. As such, current account deficits lead to a *drop* in output and a *rise* in interest rates, not a *rise* in output and *drop* in interest rates, as the theoretical model would predict. In terms of the estimated VARs, the theory predicts a negative coefficient of the lagged current account in the change in net output equation. However, in the Argentinean case and in accordance with the stop and go growth process, that variable has a positive coefficient. Changing the sign of this coefficient obtains more similar results to those suggested by the theory.[10]

Let us re-estimate the model for the period 1885-1930, a time of relatively high capital mobility, free of balance of payments crises and policy experiments (Table 3).[11] The average real interest rate for this period is such that the discount factor equals 0.98. Figure 3 presents the actual current account and the prediction generated by the benchmark model; the model tracks the general direction of the actual current account, even if it under-predicts their magnitudes. The correlation between both variables becomes positive but the variance of the predicted series is lower than that of the actual current account. With the full model, the predicted current account can track the general direction of the actual current account for at least some periods. The full model also under-predicts the magnitudes of the actual current account variations, having as a result a lower variance. Note that even if the predicted current account volatility is increased with the inclusion of both the real interest rate and the appreciation of real exchange rates, the correlation is reduced. As such, the informal fit is still modest and the full model can still be formally rejected.[12] When

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

[10] Consider, for example, the model with only the real interest rate as an additional variable to the change in net output and an intertemporal elasticity of substitution of 0.2. The estimated coefficient for the current account in the *k-vector* is -0.704. Changing the sign of the VAR coefficients to make them suit the theory, the current account coefficient in the *k-vector* becomes 0.904, which is perfectly in line with the theory.

[11] A first order VAR was estimated for the benchmark and full models, a second order VAR for the model with only real interest rates.

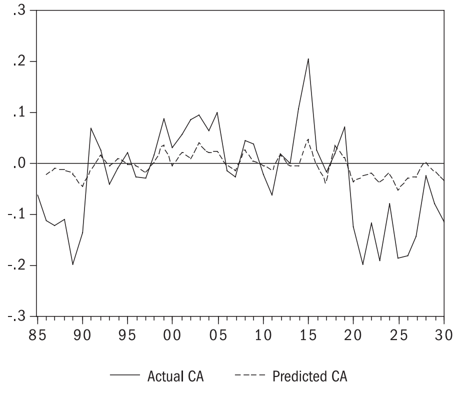
[12] The column concerning the value of $\gamma$ that matches the variance is not fulfilled since $\gamma$ is not real for this case.

Table 3. Results from present value tests (1885-1930)

| | Benchmark model | Full model | | | | Only real interest rate | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Match variance | 0.2 | 0.5 | 0.9 | Match variance | 0.2 | 0.5 | 0.9 |
| $x^2$ Statistic | 5.99 | – | 40.98 | 32.76 | 25.29 | 4.55 | 21.44 | 4.91 | 2.60 |
| p-value | 0.05 | – | 0.00 | 0.00 | 0.00 | 0.47 | 0.00 | 0.56 | 0.86 |
| Degrees of freedom | 2 | – | 7 (a) | 7 | 7 | 5 (a) | 6 | 6 | 6 |
| SD (predicted CA) | 0.02 | – | 0.05 | 0.05 | 0.05 | 0.10 | 0.03 | 0.09 | 0.20 |
| Predicted/actual | 0.25 | – | 0.52 | 0.52 | 0.53 | 1.00 | 0.27 | 0.92 | 2.13 |
| Correlation | 0.83 | – | 0.21 | 0.31 | 0.43 | -0.62 | 0.00 | -0.62 | -0.62 |

Note: (a) Degrees of freedom are reduced by one given the extra estimated parameter.

Figure 3. The benchmark model (1885-1930)




we estimate the model with only the real interest rate (not the appreciation rates of the commercial and market exchange rates), we find a negative correlation between the predicted and actual current accounts, perhaps because the internal real interest rate computed here does not effectively reflect the cost of capital in an open economy.

## D. Sensitivity analysis

To check whether the results depend upon the chosen parameters, we conducted a sensitivity analysis for other values of the discount factor, for the share of tradable goods over total consumption and for the parameter of real exchange rates. We re-estimated and evaluated the three models for every sub-sample for a $\beta$ equal to 0.94 (the smallest of the values in the literature) and a share of tradables of 2/3 instead of 1/2 (suggested by Bergin and Sheffrin 2000). Values of 0, 1/3, 2/3 and 1 for the coefficient of the appreciation of the commercial real exchange rate were considered. When $b$ = 0 the market real exchange rate is the best proxy for the relative price of tradable goods, implying that only this rate would matter for conducting external transactions. The Argentinean economy suffered from periods of exchange rate controls and government-induced distortions from the 1930s and until the late 1980s. In this context, and especially considering the huge departures from the commercial exchange rate, one expects that the market rate would have affected exports by inducing the representative agent to under-declare and liquidate exports in the black market. As it is unlikely that all of the Argentinean international trade was conducted in this manner, the commercial exchange rate may also have been relevant. The other extreme case in which only the regulated commercial exchange rate would have mattered for shaping the Argentinean foreign trade is given by $b$ = 1; the main results do not change when these new parameters are considered.

We also conducted estimations, swapping the internal real interest rate for an international real interest rate, as proxied by the US rate.[13] Results were unchanged for the periods 1914-2002 and 1931-2002, with negative correlations between the predicted and actual current account across the board. However, results do improve for the 1885-1930 period, with positive correlations even in the model that includes only the interest rate. Table 4 reports these results, with the graphs showing the evolution of the predicted and actual current account being very similar to Figure 3. Three elements may help explain this improvement. First, using the international real interest rate avoids the potential double-counting implicit when including in the estimations both the local interest rate and the real exchange rate. Second, the local real interest rate may not induce a traditional intertemporal substitution effect when it reflects in part the expected access to the international financial system. In such a case, restricted access would result in an equilibrated current account balance at the moment the market dries up, but previously issued debt would continue to

[13] This was computed by chaining three interest rates: the US Call Money Rates (1885 - 1934), the New York City Commercial Paper Rates (1935-1971), and a three-year Government Bond Yield (1972-2002). The nominal interest rate was deflated by the US wholesale price index and annual values were then computed using monthly averages. The series were chosen based on data availability and are taken from the NBER Macrohistory Data Base.

**Table 4.** Results from present value tests using the international interest rate (1885-1930)

| | Full model | | | | Only real interest rate | | | |
|---|---|---|---|---|---|---|---|---|
| | Match variance | 0.2 | 0.5 | 0.9 | Match variance | 0.2 | 0.5 | 0.9 |
| $x^2$ Statistic | 20.49 | 73.06 | 35.69 | 15.15 | 2.95 | 9.85 | 9.80 | 9.41 |
| p-value | 0.00 | 0.00 | 0.00 | 0.03 | 0.71 | 0.13 | 0.13 | 0.15 |
| Degrees of freedom | 6 (a) | 7 | 7 | 7 | 5 (a) | 6 | 6 | 6 |
| SD (predicted CA) | 0.10 | 0.04 | 0.06 | 0.11 | 0.10 | 0.02 | 0.02 | 0.02 |
| Predicted/actual | 1.00 | 0.42 | 0.64 | 1.14 | 1.00 | 0.18 | 0.21 | 0.20 |
| Correlation | 0.20 | 0.00 | 0.23 | 0.30 | -0.19 | 0.51 | 0.68 | 0.63 |

Note: (a) Degrees of freedom are reduced by one given the extra estimated parameter.

pay the international rate.[14] Finally, the local interest rate may not be a good proxy for the international cost of capital in a highly internationally integrated economy with a small capital domestic market.[15]

## VII. Conclusion

In this paper we presented an intertemporal model of the current account including likely sources of external shocks for a small economy, like the real interest rate and the real exchange rate. The goal was to test if the factors highlighted by the intertemporal approach can explain the long-run dynamics of the Argentinean external sector. Extensive testing of the model shows that, in contrast to other Latin American countries such as Peru, Chile and Colombia, the intertemporal model does not pass the formal or the informal statistical tests for the 1885-2002 period. If the Argentinean current account behaved as the model predicts, we would have observed almost the opposite evolution of the actual current account.

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

[14] For the period under analysis, this could have been the case when access to the international system was temporary disrupted, as with the Baring Crises of 1890 and the First World War of 1914. We are very thankful to an anonymous referee for having pointed out the first two of the three elements.

[15] To have an idea of the level of Argentina's integration in the world economy, it is estimated that by 1914 half of the total stock of capital was foreign owned (Taylor 2003). The same author states that in tranquil times, Argentine bond yields in the London market were just above those of core countries.

of the period under consideration, and that the occurrence of balance of payments crises may produce the opposite relation between the variables than that suggested by the model. An acceleration of the growth process results in a current account deficit that becomes unsustainable, leading to a current account reversion, a drop in GDP, a rise in interest rates and devaluation of the currency (stop and go process). In such a case, current account deficits anticipate *drops* in output and *rises* in interest rates and not *rises* in output and *drops* in interest rates, as stated by the intertemporal theory.[16]

To cope with these problems, the model was re-estimated for a period of relatively high capital mobility, relatively free of balance of payments crises and policy experiments (1885-1930). Some evidence in favor of the model was found, resulting in a positive correlation between the actual and predicted current accounts for the benchmark and full models. The same is true for the model including the interest rate when the internal and international real interest rates are swapped; perhaps because this is a better proxy for the international cost of funds in a highly integrated economy with a small domestic capital market. The conclusion drawn from this paper is that, unlike in other Latin American countries, an intertemporal current account model may not account for the dynamics in the Argentinean current account since the last part of the 19th century, even though there seems to be small evidence in favor of the model for the period 1885-1930.

## Appendix: Constructing the real exchange rate

In computing the multilateral exchange rate, the following information was used:

- Price index of Argentina and nominal exchange rate (per US dollar): the wholesale price index (base 1885=100) and the nominal exchange rate (pesos per US dollar) presented in Della Paolera and Taylor (2003) were used.
- Price index of US: the annual wholesale price index (base 1885=100) was constructed as an average of monthly values. The source was the NBER Macrohistory Data Base.
- Price index of Germany and nominal exchange rate between the peso and the Deutsch mark: the price index is an annual wholesale price index (base 1885=100)

[16] In essence, a current account deficit is only a predictor of a future increase in net output if the budget constraint is absolutely binding. As with unsustainable deficits reflecting overborrowing on the part of Argentina, the connection between the current account and the net output is broken and the present value model does not hold. Again we thank a referee for pointing this out.

obtained form the NBER Macrohistory Data Base. For the period 1885-1888 the monthly Deutsch mark to the French franc nominal exchange rate and the French franc to the US dollar exchange rate were used to construct the Deutsch mark to the US dollar exchange rate. The annual exchange rate was calculated by averaging the monthly values. For the period 1888-1900 a monthly Deutsch mark to the US dollar was used to construct the annual exchange rate. In all of the cases the source was the NBER Macrohistory Data Base.

- Price index of UK and nominal exchange rate between the peso and the sterling pound: the annual wholesale price index (base 1885=100) was constructed as an average of the monthly values. The source was the NBER Macrohistory Data Base. For the nominal exchange rate, a monthly sterling pound to the US dollar exchange rate was used. As before, the annual exchange rate was calculated by averaging the monthly values.

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