

The current account and the new rule in a two-country world

Iñaki Erauskin-Iurrita
Deusto University, San Sebastián*

21st May 2004

Abstract

This paper studies the impact of transitory income shocks (fluctuations in output, for example) on the current account in a two-country world. According to the standard intertemporal approach (or “the traditional rule”) to the current account, the variation in the current account is equal to the amount of saving generated by a transitory income shock in all countries. In contrast, Kraay and Ventura (2000, p. 1137) brilliantly argue that “the current account response is equal to the saving generated by the shock multiplied by the country’s share of foreign assets in total assets”, which they have termed “the new rule”. Here we propose an extension of the new rule to a two-country world. Then we study the empirical relevance of the extended new rule in contrast to either the traditional rule or the new rule. We find that the extended new rule adds important insights, even though the empirical validation is not completely satisfactory.

JEL classification: F41; F43

*Address: ESTE Facultad de CC. EE. y Empresariales, Departamento de Economía, Mundaiz 50, Apartado 1359, 20080 Donostia-San Sebastián, Spain. Tel: +34-943-326600, Fax: +34-943-273932, e-mail: ineraus@ud-ss.deusto.es. The author thanks Javier Gardeazabal, Cruz Ángel Echevarría, Maite Manterola, Asier Minondo, Jesús Vázquez, and seminar participants at the “brown bag” seminar at the Departamento de Fundamentos del Análisis Económico II (Universidad del País Vasco) for their very helpful suggestions and comments, and Jaume Ventura for very kindly providing me with the data set on which Kraay and Ventura (2000), and subsequently this paper, is based. The remaining errors and omissions are entirely the responsibility of the author.

Keywords: Intertemporal Approach, Current Account, traditional rule, new rule

Contents

1	Introduction	4
2	Theory	5
2.1	Basic structure	5
2.2	The traditional rule	7
2.3	The new rule and the extended new rule	8
3	Data sources	14
4	Empirical evidence	16
4.1	The traditional rule	16
4.2	The new rule	18
4.3	The extended new rule	20
5	Conclusions	23
A	Appendix: Second order conditions	26
B	Appendix: Balanced sample	28
C	Appendix: Figures	33

1 Introduction

Recent studies [Kraay and Ventura (KV hereafter) (2000), for example]¹ propose incorporating new features to the intertemporal approach to the current account, so that the theory fits the empirical evidence on current accounts more satisfactorily. According to the standard version of the intertemporal approach², which KV have termed “the traditional rule”, the impact of transitory income shocks (fluctuations in output, for example) on the current account is equal to the amount of saving generated by transitory income shocks in all countries. The reason behind the result lies in the fact that, in addition to saving part of the transitory income shock, so that consumption is smoothed, “in existing intertemporal models of the current account, countries invest the marginal unit of wealth in foreign assets” (KV, 2000, p. 1138). However, the empirical evidence seems to be at odds with the theory. In fact, according to Ventura (2003, p. 510), “there are some patterns in the current accounts of industrial countries that are inconsistent with the basic theory that international economists have been using for more than two decades”.

KV (2000, p. 1138) have had a remarkable insight challenging the traditional rule by postulating “that the country invests the marginal unit of wealth as the average one”. Then they get that “the current account response is equal to the saving generated by the shock multiplied by the country’s share of foreign assets in total assets” (p. 1137), which they have termed “the new rule”. The new rule implies a response which depends on the net foreign asset (creditor or debtor) position of the country, thus departing in a superbly simple way from the traditional rule. In addition, the empirical evidence seems to support the new rule. Therefore, KV provide a new framework that coherently relates the theory on the intertemporal approach to the current account and the evidence on current accounts. However, the characterization of the new rule is based on a small open economy model and therefore it does not focus on important channels through which the foreign economy influences on the domestic economy.

This paper analyzes the impact of transitory income shocks on the current

¹Other references include Ventura (2001), Kraay and Ventura (2002), and Ventura (2003).

²See Obstfeld and Rogoff (1995, 1996), Razin (1995), and Frenkel, Razin and Yuen (1996), for example, for excellent surveys on the intertemporal approach to the current account.

account by extending the new rule to a two-country stochastic AK growth model. We begin by reviewing the traditional rule and the new rule. Then an extension of the new rule to a two-country world is characterized. We briefly discuss the sample data on which the testing of the model is based, since we use the same data as KV: thirteen OECD countries for the 1973-1995 period. Next, the empirical relevance of the extended new rule in contrast to the other rules, either the traditional rule or the new rule, is studied. Finally, we conclude indicating possible avenues for future research.

2 Theory

2.1 Basic structure

The world economy is composed of two countries, each of them producing only one homogeneous good. In each country there exists a representative agent with an infinite time horizon. The homogeneous good produced by both countries can be either consumed or invested in capital without having to incur in any kind of adjustment costs. There are three assets: domestic capital, foreign capital and bonds. Unstarred variables refer to the domestic economy, whereas the starred variables refer to the foreign economy. Both domestic capital, K , and foreign capital, K^* , can be owned by the domestic representative agent or the foreign representative agent. The subscript d denotes the holdings of assets of the domestic representative agent and the subscript f denotes the holdings of assets of the foreign representative agent. So it must be satisfied that

$$\begin{aligned} K &= K_d + K_f \\ K^* &= K_d^* + K_f^*. \end{aligned}$$

Domestic production is obtained using only domestic capital, K , through an AK function, and it is expressed through a first order stochastic differential equation, so that production flow dY is subject to a stochastic disturbance

$$dY = \alpha K dt + \alpha K dy,$$

where $\alpha > 0$ is the (constant) marginal physical product of capital and dy represents a proportional domestic productivity shock. More precisely, dy

is the increment of a stochastic process y . Those increments are temporally independent and are normally distributed. They satisfy that $E(dy) = 0$ and $E(dy^2) = \sigma_y^2 dt$.³ We omit, for convenience, formal references to time, although those variables depend on time. We must note that dY indicates the flow of production, instead of Y , as is ordinarily done in stochastic calculus. We should note that here the marginal product of physical capital is constant for simplicity, whereas in KV it is not.

The foreign economy is structured symmetrically to the domestic economy. Thus, foreign production is carried out using capital domiciled abroad, K^* , with a production function very similar to the one in the domestic economy

$$dY^* = \alpha^* K^* dt + \alpha^* K^* dy^*,$$

where $\alpha^* > 0$ is the marginal physical product of capital and dy^* represents a proportional foreign productivity shock. The term dy^* is the increment of a stochastic process y^* . Those increments are temporally independent and are distributed normally, satisfying that $E(dy^*) = 0$ and that $E(dy^{*2}) = \sigma_{y^*}^2 dt$.

In addition, bonds pay an exogenous instantaneous risk-free rate of interest η . The domestic economy can be lending to (and thus $B > 0$) or borrowing from (and thus $B < 0$) the foreign economy.⁴ Thus B denotes the net position of risk-free loans. The wealth of the domestic representative agent, W , and the wealth of the foreign representative agent, W^* , therefore will be

$$W = K_d + K_d^* + B \tag{1}$$

$$W^* = K_f + K_f^* - B. \tag{2}$$

The net foreign asset position for the domestic economy, P , is defined as

$$P = K_d^* - K_f + B, \tag{3}$$

³That is, the production flow follows a Brownian motion with drift αK and with variance $\alpha^2 K^2 \sigma_y^2$.

⁴Since the world economy is composed of the domestic and foreign economies, the assumption of an exogenous risk-free rate of interest is “heroic” indeed. However, since the purpose of this chapter is not to analyze the world macroeconomic equilibrium as such, but to focus on the impact of shocks on the current account, we believe that assumption is not so heroic. Similar assumption is made in Obstfeld (1994) in a different context.

where changes in any of those variables lead to changes in the net foreign asset position.

The current account of the domestic economy, CA , is defined as the variation in its net foreign asset position given by (3), dP . Thus we have that

$$CA = dP = dK_d^* - dK_f + dB. \quad (4)$$

This means that, for example, the current account is positive if the variation in K_d^* and B is higher than the variation in K_f .

We can convert equation (4), after a bit of algebra, into

$$CA = dW - dK = dW - dW \frac{dK_d}{dW} - dW^* \frac{dK_f}{dW^*}. \quad (5)$$

Thus equation (5) is the national account identity, where the current account balance is equal to the variation in domestic wealth minus the variation in domestic capital. Please note that the variation in domestic wealth, dW , is equal to the national savings for the period, S , that is, national income minus (private and public) consumption. Additionally, the variation in domestic capital, dK , is equal to the domestic investment for the period.

2.2 The traditional rule

Since “in existing intertemporal models of the current account countries invest the marginal unit of wealth in foreign assets” (KV, p. 1138), then $dK_d/dW = 0$. Additionally, the small open economy assumption implies that $dK_f = 0$.⁵ Therefore, the current account, via equation (5), becomes

$$CA = dW.$$

Thus “[...] these models predict that favorable transitory income shocks generate current account responses that are equal to the saving generated by the shock. [...] it implies that all countries respond to transitory income shocks with surpluses in the current account” (KV, p. 1138). KV term this idea the traditional rule.

⁵“In keeping with the small country assumption, we have implicitly assumed that foreign holdings of domestic capital are constant” in KV (p. 1145, footnote 7).

2.3 The new rule and the extended new rule

KV depart from the standard approach following other assumption on how countries save and invest a transitory income shock. The preferences of the domestic representative agent are represented by an isoelastic intertemporal utility function where she obtains utility from consumption, C

$$E_0 \int_0^{\infty} \frac{1}{\gamma} C^\gamma e^{-\beta t} dt \quad (6)$$

$$-\infty < \gamma < 1.$$

The welfare of the domestic representative agent in period 0 is the expected value of the discounted sum of instantaneous utilities, conditioned on the set of disposable information in period 0. The parameter β is a positive subjective discount rate (or rate of time preference). The restrictions on the utility function are necessary to ensure concavity with respect to consumption.

The domestic representative agent consumes at a deterministic rate $C(t)dt$ in the instant dt and thus the dynamic budget restriction can be expressed in the following way

$$dW = [\alpha K_d + \alpha^* K_d^* + \eta B] dt + [\alpha K_d dy + \alpha^* K_d^* dy^*] - C dt. \quad (7)$$

If we define the following variables for the domestic representative agent

$$n_d \equiv \frac{K_d}{W} = \text{share of the domestic portfolio materialized in domestic capital}$$

$$n_d^* \equiv \frac{K_d^*}{W} = \text{share of the domestic portfolio materialized in foreign capital,}$$

$$n_b \equiv \frac{B}{W} = \text{share of the domestic portfolio materialized in bonds,}$$

equation (1) can be expressed more conveniently as

$$1 = n_d + n_d^* + n_b, \quad (8)$$

and plugging (8) into the budget constraint (7) we obtain the following dynamic restriction for the resources of the domestic economy

$$\frac{dW}{W} = \psi dt + dw, \quad (9)$$

where the deterministic and stochastic parts of the rate of growth of assets, dW/W , can be expressed in the following way

$$\psi \equiv (\alpha - \eta) n_d + (\alpha^* - \eta) n_d^* + \eta - \frac{C}{W} \equiv \rho - \frac{C}{W} \quad (10)$$

$$dw \equiv \alpha n_d dy + \alpha^* n_d^* dy^*, \quad (11)$$

where $\rho \equiv \alpha n_d + \alpha^* n_d^* + \eta n_b \equiv (\alpha - \eta) n_d + (\alpha^* - \eta) n_d^* + \eta$ denotes the gross rate of return of the asset portfolio.

The objective of the domestic representative agent is to choose the path of consumption and portfolio shares that maximizes the expected value of the intertemporal utility function (6), subject to $W(0) = W_0$, (9), (10), and (11). This optimization is a stochastic optimum control problem.⁶ It is important to bear in mind that the domestic agent takes as given the rates of return of different assets, as well as the corresponding variances and covariances. However, these parameters will endogenously be determined in the macroeconomic equilibrium we shall obtain. We look for values of the endogenous variables that are not stochastic in equilibrium and then we show that the results validate the initial assumption that equilibrium values are not stochastic.

We introduce a value function, $V(W)$, which is defined as

$$V(W) = \underset{\{C, n_d, n_d^*\}}{Max} E_0 \int_0^\infty \frac{1}{\gamma} C^\gamma e^{-\beta t} dt, \quad (12)$$

subject to the restrictions (9), (10), and (11) and given initial wealth. The value function in period 0 is the expected value of the discounted sum of instantaneous utilities, evaluated along the optimal path, starting in period 0 in the state $W(0) = W_0$.

⁶To solve problems of stochastic optimum control see, for example, Kamien and Schwartz (1991, section 22), Malliaris and Brock (1982, ch. 2), Obstfeld (1992), or Turnovsky (1997, ch. 9; 2000, ch. 15).

Starting from equation (12) the value function must satisfy the following equation, known as the Hamilton-Jacobi-Bellman equation of stochastic control theory or, for short, the Bellman equation

$$\beta V(W) = \underset{\{C, n_d, n_d^*\}}{Max} \left[\frac{1}{\gamma} C^\gamma + V'(W)W\psi + 0.5V''(W)W^2\sigma_w^2 \right]. \quad (13)$$

The right hand side of equation (13) is partially differentiated with respect to C , n_d and n_d^* in order to get the first order optimality conditions of this problem

$$C^{\gamma-1} - V'(W) = 0 \quad (14)$$

$$V'(W)W(\alpha - \eta) dt + V''(W)W^2 cov(dw, \alpha dy) = 0 \quad (15)$$

$$V'(W)W(\alpha^* - \eta) dt + V''(W)W^2 cov(dw, \alpha^* dy^*) = 0. \quad (16)$$

The solution to this problem is obtained through trial and error. We seek to find a value function $V(W)$ that satisfies, on the one hand, the first order optimality conditions and, on the other, the Bellman equation. In the case of isoelastic utility functions the value function has the same form of the utility function [Merton (1969), then generalized in Merton (1971)]. Thus, we guess that the value function is of the form

$$V(W) = AW^\gamma,$$

where the coefficient A has to be determined. This guess implies that

$$V'(W) = A\gamma W^{\gamma-1}$$

$$V''(W) = A\gamma(\gamma - 1)W^{\gamma-2}.$$

Substituting these expressions in the first order optimality conditions (14), (15) and (16) we get that

$$C^{\gamma-1} = A\gamma W^{\gamma-1} \quad (17)$$

$$(\alpha - \eta) dt = (1 - \gamma) cov(dw, \alpha dy) \quad (18)$$

$$(\alpha^* - \eta) dt = (1 - \gamma) cov(dw, \alpha^* dy^*). \quad (19)$$

These are typical equations in stochastic models in continuous time. Equation (17) indicates that at the optimum, the marginal utility derived from consumption must be equal to the marginal change in the value function or the marginal utility of wealth. Equations (18) and (19) show that the optimal choice of portfolio shares of the domestic representative agent must be such that the risk-adjusted rates of return of assets are equalized.

Combining (17), (18), and (19) and inserting them in the equation (13), we can calculate, after some algebra, the equilibrium portfolio shares (implicitly) and the consumption-wealth ratio in the domestic open economy

$$\begin{aligned}
\alpha - \eta &= (1 - \gamma) [n_d \alpha^2 \sigma_y^2 + n_d^* \alpha \alpha^* \sigma_{yy^*}] \\
\alpha^* - \eta &= (1 - \gamma) [n_d^* \alpha^{*2} \sigma_{y^*}^2 + n_d \alpha \alpha^* \sigma_{yy^*}] \\
n_b &= 1 - n_d - n_d^* \\
\frac{C}{W} &= \frac{1}{1 - \gamma} [\beta - \gamma \rho + 0.5 \gamma (1 - \gamma) \sigma_w^2], \tag{20}
\end{aligned}$$

where

$$\sigma_w^2 = n_d^2 \alpha^2 \sigma_y^2 + 2n_d n_d^* \alpha \alpha^* \sigma_{yy^*} + n_d^{*2} \alpha^{*2} \sigma_{y^*}^2.$$

We impose the feasibility condition that the marginal propensity to consume out of wealth must be positive to guarantee that consumption is positive. In addition, second order conditions are satisfied once feasibility condition is imposed. That also implies that the macroeconomic equilibrium satisfies the transversality condition (see Appendix A for more details)

$$\lim_{t \rightarrow \infty} E [V(W) e^{-\beta t}] = \lim_{t \rightarrow \infty} E [AW^\gamma e^{-\beta t}] = 0.$$

In the equilibrium achieved all the assets in the domestic economy grow at the same rate, in addition to the fact that consumption-wealth ratio and portfolio shares are constant⁷. That is the point of departure from the traditional rule. In fact, in contrast to the traditional rule, KV assume that “the

⁷With more general utility functions, portfolio shares and consumption-wealth ratio depend on time. However, in our model they are constants because the utility function has constant relative risk aversion, the production function is linear, and the mean and variances of the underlying stochastic processes are stationary. See Turnovsky (1997, p. 370, footnote 6) for more details.

country invests the marginal unit of wealth as the average one” (p. 1138), which they term “the new rule”. Thus

$$\frac{dK_d}{dW} = \frac{K_d}{W} \quad (21)$$

$$\frac{dK_d^*}{dW} = \frac{K_d^*}{W} \quad (22)$$

$$\frac{dB}{dW} = \frac{B}{W}, \quad (23)$$

which is equivalent to saying that all the assets grow at the same rate

$$\frac{dW}{W} = \frac{dK_d}{K_d} = \frac{dK_d^*}{K_d^*} = \frac{dB}{B}.$$

Analogously, if we assume that all the real assets on the foreign economy grow at another rate,⁸ then the current account, via equations (1), (3), (5), (21), (22), and (23), is given by

$$\begin{aligned} CA &= dW \left(\frac{K_d^* + B}{W} \right) - dW^* \frac{K_f}{W^*} \\ &= dW \frac{P}{W} + K_f \left(\frac{dW}{W} - \frac{dW^*}{W^*} \right), \end{aligned} \quad (24)$$

where equation (24) is equal to that shown in Turnovsky (1997, p. 436), except for the existence of risk-free loans here. Thus the variation in the current account when a transitory income shock occurs is equal to the change in savings generated by the income shock minus the investment in domestic capital made by domestic and foreign agents. Please note that the change in domestic wealth is equal to national savings, $dW = S$, as shown in Section 2.1 above. Under the traditional rule, the investment made by domestic and foreign agents was zero, that is, the domestic agent invests all in foreign assets marginally and it is assumed that the holdings of domestic capital by the foreign agent are constant. We can observe in equation (24) that the

⁸A formal difficulty arises here. The point is that if B grows at the rate of the domestic economy in equilibrium, then the portfolio shares of the foreign economy cannot be constant in equilibrium unless both economies grow at the same rate. If we focus on capital only the difficulty disappears and we obtain basically the same result.

impact of a transitory income shock on the current account is equal to the amount of savings generated by the shock multiplied by the net foreign asset position of the domestic economy over domestic wealth, on the one hand, plus the difference in the rates of growth of wealth between domestic and foreign economies multiplied by foreign holdings of domestic capital, on the other hand.

First, if the rates of growth of assets of both countries are equal or do not differ very much, then we can see in equation (24) that

$$CA = dW \left(\frac{P}{W} \right),$$

where “the current account response is equal to the saving generated by the shock multiplied by the country’s share of foreign assets in total assets” (KV, p. 1137). Therefore, the new rule suggested by KV implies a response which depends on the net foreign asset position of the country, that is, whether the country is creditor or debtor: a positive income shock in a creditor nation improves the current account of the country but less than the traditional rule, whereas in the case of a debtor nation a positive income shock deteriorates the current account, in contrast to the result shown by the traditional rule.

Second, if the growth rates of wealth of the domestic and foreign economies are different, then the impact of transitory income shocks on the current account is different from the new rule: the impact of transitory income shocks on the current account depends, in addition to the new rule, on the holdings of domestic capital by the foreign economy and on the difference between the growth rates of wealth in domestic and foreign economies. Thus, the impact of transitory income shocks on the current account follows a more general pattern than that shown in KV. We have termed the new pattern “the extended new rule”. If both growth rates of wealth are equal then the extended new rule becomes the new rule, that is, the new rule is a particular case of the extended new rule. However, if growth rates are not equal, then we could expect that the impact would be different from the new rule. Now we can test whether the empirical evidence confirms the traditional rule, the new rule or the extended new rule.

3 Data sources

We use the same data set on which KV constructed their paper and thus we refer to their Appendix 2 to get rigorous information on data sources. In this respect they consider that “although data on current accounts and saving are available for many more countries and years, we restrict the sample to those countries for which data on stocks of foreign assets are also available, in order to ensure that our tests of the traditional rule and the new rule are comparable” (KV, p. 1151, footnote 11). The data is based on an unbalanced sample of 13 OECD countries for the period 1973-1995: Australia, Austria, Canada, Germany (1975-1989), Spain (1975-1995), Finland (1975-1995), France (1989-1995), Italy, Japan (1979-1995), Netherlands (1982-1995), Sweden (1982-1995), the United Kingdom, and the United States. We will test the extended new rule with the same sample. However, testing the extended new rule implies some problems. It requires having information on the rate of growth of assets of the foreign economy (that is, from the rest of the world) and thus on her level of wealth and amount of savings. That literally is not possible, but we reinterpret the rest of the world as the rest of the sample. Being the sample in KV unbalanced, including or not some countries in the sample can produce significant changes (positive or negative) in some variables (the amount of wealth and savings will differ significantly from year to year, simply due to a change in the number of countries available for that year) and, therefore, testing the extended new rule can be subject to more variability. That is why, in addition to testing based on their sample, we think it is reasonable to test using a balanced sample as well. We show the results for the balanced sample in Appendix B. We should note that the magnitudes of wealth and savings for the rest of the sample are obviously much smaller than those for the rest of the world, S^*/W^* . However, the savings-wealth ratio for the rest of the sample would be a good proxy for that magnitude for the rest of the world if there exists a more or less constant proportionality between the magnitudes of the rest of the sample and those of the rest of the world.

Two additional important details apply here. First, the net foreign asset position in this paper, P , is defined by equation (3): it is equal to the domestic claims on foreign capital minus foreign claims on domestic capital plus the net position on loans. In contrast, the country’s share of foreign assets in total assets in KV, P_{KV} , refers to the domestic claims on foreign capital plus the net position on loans, that is, they do not include foreign claims on

Table 1: Net foreign asset position (over domestic wealth)

	Measure one	Measure two	Difference
	P_{KV} (a)	P (b)	(a)-(b)
Australia	-0.031	-0.126	0.095
Austria	+0.003	-0.019	0.022
Canada	-0.046	-0.138	0.092
Germany	+0.049	+0.028	0.021
Spain	-0.016	-0.067	0.051
Finland	-0.070	-0.086	0.016
France	+0.059	-0.009	0.068
Italy	+0.009	-0.007	0.016
Japan	+0.044	+0.031	0.013
Netherlands	+0.210	+0.070	0.140
Sweden	-0.050	-0.096	0.046
United Kingdom	+0.123	+0.034	0.089
USA	+0.041	+0.005	0.036
No. of creditor countries	8	5	-3
No. of debtor countries	5	8	+3

domestic capital

$$P_{KV} \equiv K_d^* + B \equiv P + K_f. \quad (25)$$

The difference is the direct result of the small open economy assumption in KV. Table 1 shows the net foreign asset position of the thirteen countries, with respect to the level of the domestic wealth of the country, based on both measures of net foreign asset position, P_{KV} and P , respectively. We can observe that there is a substantial difference between both types of measures. This difference will be relevant when we test the rules empirically, as we will show below.

Second, we should note that the rate of growth of assets of the domestic economy, S/W , and the rate of growth of assets of the foreign economy, S^*/W^* , do tend to be different. We show the key properties of the variables S/W and S^*/W^* in Table 2: we find that we can reject that both variables have the same mean values for Austria, Spain, Japan, Sweden, United Kingdom, and United States. Some comments need to be done. First, we are

aware that the test for mean equality applies for random samples, which is not the case here. Additionally, we should observe that, even in those cases where the null hypothesis is not rejected, both series clearly have very different characteristics for most countries and show significant differences comparing contemporaneous values. We can look at the temporal evolution of the variables S/W and S^*/W^* for the unbalanced sample in Appendix C.

4 Empirical evidence

Now, the results of the traditional rule and the new rule in KV are shown, and then the extended new rule tested.

4.1 The traditional rule

Following KV we test the traditional rule following via the following regression equation

$$CA_{ct} = \alpha + \beta S_{ct} + u_{ct}, \quad (26)$$

where S_{ct} denotes the amount of savings for country c in period t , and u_{ct} is the error term for country c in period t . Under the null hypothesis that the traditional rule is true then the parameter β should be equal to one: an increase in savings leads to a one-to-one increase in the current account. We should point out two differences between this test and the usual followed in the literature. First, Feldstein and Horioka (1980)⁹ regressed investment

⁹Feldstein and Horioka (1980, p. 317) wanted to “[...] measure the extent to which a higher domestic saving rate in a country is associated with a higher rate of domestic investment.”, so that “with perfect world capital mobility, there should be no relation between domestic saving and domestic investment: saving in each country responds to the worldwide opportunities for investment while investment in that country is financed by the worldwide pool of capital.” They find that the empirical evidence runs in favour of a strong relationship between both variables, thus attributing it to the lack of perfect world capital mobility. According to Frankel (1992, p. 41), “Feldstein and Horioka upset conventional wisdom in 1980 when they concluded that changes in countries’ rate of national saving had very large effects on their rates of investment and interpreted this finding as evidence of low capital mobility”. However, many economists do not share Feldstein and Horioka’s conclusion. The paradox of having perfect capital mobility going along with a strong association between savings and investment has been termed the “Feldstein-Horioka

Table 2: Key properties of the series S/W and S^*/W^*

	Mean value of S/W	Mean value of S^*/W^*	p -value for null hypothesis that both means are equal
Australia	0.074 (0.022)	0.074 (0.008)	0.979
Austria	0.088 (0.022)	0.074 (0.008)	0.005
Canada	0.073 (0.017)	0.074 (0.008)	0.773
Germany	0.076 (0.017)	0.072 (0.008)	0.420
Spain	0.089 (0.022)	0.074 (0.007)	0.005
Finland	0.074 (0.019)	0.074 (0.008)	0.950
France	0.075 (0.007)	0.079 (0.002)	0.264
Italy	0.079 (0.014)	0.074 (0.007)	0.144
Japan	0.110 (0.017)	0.064 (0.007)	0.000
Netherlands	0.074 (0.014)	0.073 (0.008)	0.724
Sweden	0.060 (0.017)	0.073 (0.008)	0.013
UK	0.067 (0.010)	0.075 (0.008)	0.009
USA	0.060 (0.007)	0.087 (0.012)	0.000

Standard errors are in parenthesis.

on savings. Instead, KV regressed the current account on savings, making it easier to compare the new rule with the traditional rule. However, both approaches are equivalent. Second, Feldstein and Horioka (1980) used data related to Gross Domestic Product, whereas KV have used data related to Gross National Product. We follow the approach used by KV in order to carry out similar comparisons.

We show in Table 3 the results of fitting equation (26) by OLS, shown in KV. We reject the null hypothesis that the coefficient β is equal to one, that is, we reject the traditional rule. That is, of course, another evidence in favor of the Feldstein-Horioka puzzle. Additionally, we show the between-group estimates (that is, based on the mean values of the variables of the group) and the within-group estimates (also called fixed-effects estimators, that is, in terms of deviations from the mean values of the variables of the group). In any case the null hypothesis that the traditional rule is true is rejected.

4.2 The new rule

We test the new rule following KV again

$$CA_{ct} = \alpha + \beta \frac{P_{ct}}{W_{ct}} S_{ct} + u_{ct}. \quad (27)$$

Under the null hypothesis that the new rule is true then the parameter β should be equal to one: increases in savings lead to variations in the current account that are equal to the fraction of the net foreign asset position for country c in period t with respect to the level of domestic wealth for country c in period t .

puzzle”. Many studies followed suit and analyzed the reasons to explain the evidence, while assuming perfect world capital mobility. However, “it seems likely that of many potential explanations of the Feldstein-Horioka results, no single one fully explains the behavior of all countries”, according to Obstfeld and Rogoff (1995, p. 1779). We should note that Feldstein and Horioka (1980, p. 319) were aware that a high association “could reflect other common causes of the variation in both saving and investment”, but they argue that a high association “would however be strong evidence against the hypothesis of perfect capital mobility and would place on the defenders of that hypothesis the burden of identifying such common causal factors.” Finally, recent empirical studies suggest that the Feldstein-Horioka finding seems to be losing some support in the euro area; see Blanchard and Giavazzi (2002).

Table 3: The traditional rule
Pooled regression

Gross national saving/GNP	0.236 (0.061)
R^2	0.158
Number of observations	247
p -value for $\beta = 1$	0.000
Between-group regression	
Gross national saving/GNP	0.265 (0.073)
R^2	0.251
Number of observations	13
p -value for $\beta = 1$	0.000
Within-group regression/Fixed effects	
Gross national saving/GNP	0.193 (0.049)
R^2	0.569
Number of observations	247
p -value for $\beta = 1$	0.000

Standard errors are in parenthesis.

First, we show in Table 4 the results of fitting equation (27) by OLS for the sample of thirteen countries, using both the net foreign asset position defined by KV,¹⁰ P_{KV} (first definition, from here onwards), and the net foreign asset position defined by us, P (second definition, from here onwards). We observe that the null hypothesis that the coefficient β is equal to 1, that is, the new rule, cannot be rejected in any of both cases. In general we can see that the estimation using the first definition is closer to 1 compared with the result obtained using the second definition. That is confirmed by a higher p -value as well. However, the goodness-of-fit is slightly better using the second definition than the first. Similar conclusions apply for the between-group and within-group estimations. Additionally, using the first (second) definition most of the variation of the variables is within-(between-)group.

4.3 The extended new rule

Following the discussion in section 2 above we test the extended new rule, given by equation (24), making use of the regression equation

$$CA_{ct} = \alpha + \beta \frac{P_{ct}}{W_{ct}} S_{ct} + \gamma \frac{K_{f,ct}}{W_{ct}^*} S_{ct}^* + \delta \frac{K_{f,ct}}{W_{ct}} S_{ct} + u_{ct}. \quad (28)$$

Under the null hypothesis that the extended new rule is true then β should be equal to one, γ should be equal to minus one, and δ should be equal to one. If the null hypothesis that the new rule were true, then the parameter β should be equal to one, and γ and δ should be equal to zero.

We estimate equation (28) by OLS. In Table 5 we find that the estimates of the coefficients have the expected signs, and that we cannot reject that $\beta = 1$, $\gamma = -1$, or $\delta = 1$ individually. However, the point estimates fall far from the expected magnitudes and the joint hypothesis that $\beta = 1$, $\gamma = -1$, and $\delta = 1$ is rejected. We should note that the standard errors of the estimates γ and δ are quite high indeed. In addition, we should observe that the goodness-of-fit increases somewhat with respect to the test of the new rule. If we focus on the between-groups estimation we see very high standard errors, and even though two of the estimates are quite far from the theoretical values, they are not significantly different. The within-groups estimation generates results that resemble those obtained in the pooled regression.

¹⁰Remind the discussion on the net foreign asset position in Section 3.

Table 4: The new rule

Pooled regression	P_{KV}	P
Gross national saving/GNP		
×Net foreign assets over wealth	0.955	1.164
	(0.078)	(0.105)
R^2	0.369	0.420
Number of observations	247	247
p -value for $\beta = 1$	0.564	0.121
Between-group regression		
Gross national saving/GNP		
×Net foreign assets over wealth	0.996	1.324
	(0.145)	(0.214)
R^2	0.684	0.789
Number of observations	13	13
p -value for $\beta = 1$	0.828	0.158
Within-group regression/Fixed effects		
Gross national saving/GNP		
×Net foreign assets over wealth	0.689	0.655
	(0.187)	(0.284)
R^2	0.563	0.558
Number of observations	247	247
p -value for $\beta = 1$	0.096	0.226

Table 5: The extended new rule (I)

	Pooled regression	Between-group regression	Within-group regression
Estimate of β	1.178 (0.097)	1.248 (0.160)	0.831 (0.276)
Estimate of γ	-1.298 (0.357)	-3.252 (1.625)	-0.647 (0.416)
Estimate of δ	1.608 (0.336)	3.490 (1.594)	1.025 (0.393)
R^2	0.467	0.863	0.573
No of observations	247	13	247
p -value for $\beta = 1$	0.068	0.155	0.540
p -value for $\gamma = -1$	0.404	0.199	0.397
p -value for $\delta = 1$	0.072	0.153	0.948
p -value for $\beta = 1$, $\gamma = -1$, $\delta = 1$	0.012	0.212	0.000

Alternatively, rearranging equation (28) under the hypothesis that $\beta = \delta$, the extended new rule can be tested following equation (24) as

$$CA_{ct} = \alpha + \beta \frac{P_{KV,ct}}{W_{ct}} S_{ct} + \gamma \frac{K_{f,ct}}{W_{ct}^*} S_{ct}^* + u_{ct}. \quad (29)$$

We can observe that under the null hypothesis that the extended new rule is true then β should be equal to one, and γ should be equal to minus one. If the null hypothesis that the new rule (first definition) was true, then β should be equal to one, and γ should be equal to zero. Thus, if $\gamma = 0$, equation (29) becomes the new rule (27).

Table 6 shows the results. The estimates have the expected signs, but we reject the null $\beta = 1$ and the joint hypothesis $\beta = 1$ and $\gamma = -1$. The standard errors of the estimates are much lower than before, and therefore we have improved the precision of the estimates. In addition, the goodness-of-fit increases somewhat with respect to the test of the new rule, whereas we get a similar result compared with equation (28). The between-group estimation provides a much better fit than before, and none of the hypothesis can be rejected. The within-group estimation generates results that differ considerably from the other estimations. Therefore, the extended

Table 6: The extended new rule (II)

	Pooled regression	Between-group regression	Within-group regression
Estimate of β	1.201 (0.094)	1.316 (0.173)	0.880 (0.222)
Estimate of γ	-0.906 (0.143)	-1.111 (0.304)	-0.492 (0.267)
R^2	0.464	0.837	0.572
No of observations	247	13	247
p -value for $\beta = 1$	0.033	0.097	0.589
p -value for $\gamma = -1$	0.511	0.723	0.055
p -value for $\beta = 1, \gamma = -1$	0.008	0.222	0.000

new rule adds interesting features, even though the empirical validation is not completely satisfactory.

5 Conclusions

The intertemporal approach to the current account is the standard model used today to analyze the impact of real factors on the current account. According to the standard version of the intertemporal approach, or the traditional rule, the impact of a transitory income shock on the current account is equal to the savings generated by the shock *one-to-one*, in all countries, regardless of the net creditor or debtor position of the country. However, the traditional rule fails to account for the empirical evidence on current accounts. KV have proposed recently a remarkably insightful departure from the traditional rule, which they termed the new rule. KV have established that, under the new rule, the impact of a transitory income shock on the current account is equal to the savings generated by the shock multiplied by the net foreign asset position of the country, so that the income shock has a different impact on creditor or debtor economies. In addition, the new rule is a consistent model that brings together the theory and the empirical evidence on current accounts. However, the new rule has been derived from a small open economy model and therefore it ignores some channels through which the foreign economy influences the domestic economy. This paper extends

the new rule to a two-country stochastic AK growth model.

First, after reviewing the traditional rule and the new rule, we have shown an extension of the new rule, which we have termed the extended new rule. According to the extended new rule, the impact of a transitory income shock on the current account is equal to the impact suggested by the new rule plus foreign holdings of domestic capital multiplied by the difference between the growth rates of assets in domestic and foreign economies. Thus, only when the domestic and foreign economies grow at the same rate, then the extended new rule becomes the new rule. Therefore, the traditional and the new rule can be understood as particular cases of the extended new rule.

Second, we have tested the traditional rule, the new rule and the extended new rule, based on the unbalanced sample used by KV and a balanced subsample derived from the unbalanced sample. We find that the evidence rejects the traditional rule and thus we have the “Feldstein-Horioka puzzle” again. In order to test the new rule we have used two different measures of net foreign asset position, the one used by KV (first definition) and the another one including foreign claims on domestic capital (second definition). We think that the second definition is more reasonable and compelling. Having tested the new rule using both measures, we found that the results using the first definition are closer to the new rule in the unbalanced sample, whereas the results using the second definition are closer in the balanced sample. However, the goodness-of-fit using the second definition is better in both cases.

Third, we believe that the extended new rule has added important insights to the new rule suggested by KV in order to analyze the impact of transitory income shocks on the current account. Thus the testing based on the data produces estimates that have the expected signs and move around the expected values. That means that the incorporation of the rest of the world cannot be ignored and thus it has to be explicitly modeled. In fact, the rates of growth of the economies do tend to be significantly different. In addition, the goodness of fit of the estimation based on the extended new rule does improve with respect to the new rule. However, it is evident that the data rejects sometimes the null hypothesis that the extended new rule is true. In addition, we should remind that there are important data problems with the estimation of the extended new rule. In a nutshell, we think that the extension of the new rule is a positive step on the road to better understanding the behavior of current accounts. Therefore, even though theoretically we think that the extended new rule provides a good model, the empirical validation

of the extended new rule is far from being definitive.

Finally, we would suggest possible avenues for future research. First, the number of countries included in the sample should be extended, since the sample used in this paper has a clear limitation. Second, interesting features have been recently added to the new rule, such as adjustment costs and differences in short run and long run behavior (See Kraay and Ventura, 2002; Ventura, 2003). They could, in turn, be extended to a two-country world. In addition, the extended new rule suggests a possible relation between the rates of growth and creditor/debtor position, which can be empirically tested. That could complement the work by Lane and Milesi-Ferretti (1999, pp. 24-36), where they review the relation between the net foreign asset position and GDP, size and openness to trade, or the “stages hypothesis” suggested by Eichengreen (1991).

A Appendix: Second order conditions

In this appendix we check the second order condition and the transversality condition.

To guarantee that consumption is positive in the domestic open economy we impose the feasibility condition that the marginal propensity to consume out of wealth must be positive since wealth does not become negative

$$\frac{1}{1-\gamma} [\beta - \gamma\rho + 0.5\gamma(1-\gamma)\sigma_w^2] > 0.$$

For the first order optimality conditions to characterize a maximum, the corresponding second order condition must be satisfied, that is, the Hessian matrix associated to the maximization problem and evaluated at the optimal values of the choice variables

$$\begin{bmatrix} (\gamma - 1) (V'(W))^{\frac{\gamma-2}{\gamma-1}} & 0 \\ 0 & V''(W)W^2\Delta \end{bmatrix}$$

must be negative definite,¹¹ which implies that

$$\begin{aligned} (\gamma - 1) (V'(W))^{\frac{\gamma-2}{\gamma-1}} &< 0 \\ V''(W)W^2\Delta &< 0, \end{aligned}$$

where $\Delta = \alpha^2\sigma_y^2 + 2\alpha\alpha^*\sigma_{yy^*} + \alpha^{*2}\sigma_{y^*}^2 > 0$. To evaluate those conditions first we obtain the value of the coefficient A in equation (17)

$$A = \frac{1}{\gamma} \left(\frac{C}{W} \right)^{\gamma-1}, \quad (30)$$

where C/W is the optimal value pointed out by equation (20). Then substituting expression (30) into the value function (??), we get that the value function is given, after some algebra, by

$$V(W) = \frac{1}{\gamma} \left(\frac{C}{W} \right)^{\gamma-1} W^\gamma, \quad (31)$$

¹¹See Chiang (1984, pp. 320-323), for example.

where we can observe that, given the restrictions on the utility function, $V'(W) > 0$ and $V''(W) < 0$ provided that $C/W > 0$.

In addition, we impose that the macroeconomic equilibrium must satisfy the transversality condition so as to guarantee the convergence of the value function

$$\lim_{t \rightarrow \infty} E [V(W) e^{-\beta t}] = 0. \quad (32)$$

Now let us show that should the feasibility condition be satisfied then that would be equivalent to satisfy the transversality condition.¹² To evaluate (32), we start expressing the dynamics of the accumulation of wealth

$$dW = \psi W dt + W dw. \quad (33)$$

The solution to equation (33), starting from the initial wealth $W(0)$, is¹³

$$W(t) = W(0) e^{(\psi - 0.5\sigma_w^2)t + w(t) - w(0)}.$$

Since the increments of w are temporally independent and are normally distributed then¹⁴

$$\begin{aligned} E[AW^\gamma e^{-\beta t}] &= E[AW(0)^\gamma e^{\gamma(\psi - 0.5\sigma_w^2)t + \gamma[w(t) - w(0)] - \beta t}] \\ &= AW(0)^\gamma e^{[\gamma(\psi - 0.5\sigma_w^2) + 0.5\gamma^2\sigma_w^2 - \beta]t}. \end{aligned}$$

The transversality condition (32) will be satisfied if and only if

$$\gamma [\psi - 0.5\gamma(1 - \gamma)\sigma_w^2] - \beta < 0.$$

Now substituting equations (10) and (20), it can be shown that this condition is equivalent to

$$\frac{C}{W} > 0, \quad (34)$$

and thus feasibility guarantees convergence as well.

¹²See Merton (1969). Turnovsky (2000) provides, for example, the proof of the transversality condition as well.

¹³See Malliaris and Brock (1982, pp. 135-136), for example.

¹⁴See Malliaris and Brock (1982, pp. 137-138), for example.

B Appendix: Balanced sample

This appendix shows the results corresponding to the balanced sample. We restrict ourselves to 8 countries and the 1975-1995 period. First, five countries must be dropped out from the sample. The reunification of Germany in 1990 makes non-comparable data before and after the event. Additionally, data for France is only available for 1989-1995, Japan for 1979-1995, Netherlands for 1982-1995, and Sweden for 1982-1995. Second, for the remaining countries we have complete data from 1975-1995. Summing up, we have chosen 8 countries for our sample, namely, Australia, Austria, Canada, Spain, Finland, United Kingdom, Italy, and the United States, and the sample period is 1975-1995.

First, we show the net foreign asset position and the key properties of the savings-wealth ratio of the eight countries in Table B.1 and Table B.2, respectively. They resemble very much those of the unbalanced sample.

Table B.1. Net foreign asset position (over domestic wealth)

	Measure one	Measure two	Difference
	P_{KV} (a)	P (b)	(a)-(b)
Australia	-0.034	-0.127	0.093
Austria	+0.001	-0.021	0.022
Canada	-0.051	-0.138	0.087
Spain	-0.016	-0.067	0.051
Finland	-0.070	-0.086	0.016
United Kingdom	+0.126	+0.034	0.092
Italy	+0.009	-0.007	0.016
USA	+0.041	+0.005	0.036
No. of creditor countries	4	2	+2
No. of debtor countries	4	6	-2

Table B.2. Key properties of the series S/W and S^*/W^*

	Mean value of S/W	Mean value of S^*/W^*	p -value for null hypothesis that both means are equal
Australia	0.0696 (0.0151)	0.0637 (0.0063)	0.1055
Austria	0.0838 (0.0162)	0.0636 (0.0064)	0.0000
Canada	0.0697 (0.0121)	0.0635 (0.0064)	0.0464
Spain	0.0887 (0.0219)	0.0630 (0.0061)	0.0000
Finland	0.0741 (0.0189)	0.0638 (0.0064)	0.0219
UK	0.0664 (0.0100)	0.0637 (0.0063)	0.2862
Italy	0.0769 (0.0126)	0.0625 (0.0062)	0.0000
USA	0.0590 (0.0057)	0.0738 (0.0113)	0.0000

Second, testing the traditional rule we find that the Feldstein-Horioka puzzle applies again, more so in the balanced sample than in the unbalanced sample. Table B.3 shows the results. The estimates of β in the balanced sample are generally much lower than those of KV and, additionally, the R-squared falls drastically.

Table B.3. The traditional rule

Pooled regression	
Gross national saving/GNP	0.096 (0.050)
R^2	0.021
Number of observations	168
p -value for $\beta = 1$	0.000
Between-group regression	
Gross national saving/GNP	-0.002 (0.149)
R^2	0.000
Number of observations	8
p -value for $\beta = 1$	0.000
Within-group regression/Fixed effects	
Gross national saving/GNP	0.180 (0.058)
R^2	0.331
Number of observations	168
p -value for $\beta = 1$	0.000

Third, Table B.4 shows the results of fitting the new rule. Again the most visible feature is that the estimates of this sample are significantly lower than those obtained with the unbalanced sample in Table 4.4. That is clearly confirmed by lower p -values than those obtained in the unbalanced sample. While in the unbalanced sample estimation the first definition provided estimates closer to 1, now the second definition generates better results to accept the new rule. In fact, using the first definition we find that the null hypothesis that the coefficient β is equal to 1 can be rejected. As before, the estimation following the second definition provides a much better goodness-of-fit than the first. Similar comments apply to the between-group and within-group estimation. In addition, we have that the goodness-of-fit of the estimation is better following the second definition than the first in all cases.

Table B.4. The new rule

Pooled regression	P_{KV}	P
Gross national saving/GNP		
×Net foreign assets over wealth	0.654	0.844
	(0.168)	(0.130)
R^2	0.117	0.252
Number of observations	168	168
p -value for $\beta = 1$	0.048	0.2341
Between-group regression		
Gross national saving/GNP		
×Net foreign assets over wealth	0.695	0.879
	(0.248)	(0.210)
R^2	0.391	0.759
Number of observations	8	8
p -value for $\beta = 1$	0.265	0.585
Within-group regression/Fixed effects		
Gross national saving/GNP		
×Net foreign assets over wealth	0.406	0.697
	(0.368)	(0.343)
R^2	0.298	0.324
Number of observations	168	168
p -value for $\beta = 1$	0.109	0.379

Finally, we have the results of the extended new rule in Table B.5 and B.6. On the one hand, fitting equation (28), we get similar results to the unbalanced sample (Table 4.5), but the goodness-of-fit falls drastically now again. On the other hand, fitting equation (29), we get less optimistic results compared with those of the unbalanced sample (Table 4.6). The estimates are further away from the theoretical values compared to the results obtained in the unbalanced sample. In addition, the goodness-of-fit is worse in the balanced sample than in the unbalanced one.

Table B.5. The extended new rule (I)

	Pooled regression	Between-group regression	Within-group regression
Estimate of β	0.780 (0.159)	0.743 (0.214)	0.616 (0.413)
Estimate of γ	-1.353 (0.641)	-0.248 (1.831)	-0.421 (0.808)
Estimate of δ	0.852 (0.649)	-0.367 (1.535)	0.212 (0.738)
R^2	0.280	0.824	0.325
No. of observations	168	8	168
p -value for $\beta = 1$	0.169	0.296	0.353
p -value for $\gamma = -1$	0.583	0.702	0.475
p -value for $\delta = 1$	0.820	0.424	0.287
p -value for $\beta = 1$, $\gamma = -1$, $\delta = 1$	0.137	0.435	0.000

Table B.6. The extended new rule (II)

	Pooled regression	Between-group regression	Within-group regression
Estimate of $\beta + \delta$	0.778 (0.158)	0.669 (0.140)	0.567 (0.395)
Estimate of γ	-1.276 (0.191)	-1.439 (0.604)	-0.861 (0.421)
R^2	0.280	0.796	0.324
No of observations	168	8	168
p -value for $\beta + \delta = 1$	0.162	0.065	0.274
p -value for $\gamma = -1$	0.150	0.500	0.741
p -value for $\beta + \delta = 1$, $\gamma = -1$	0.063	0.310	0.000

C Appendix: Figures

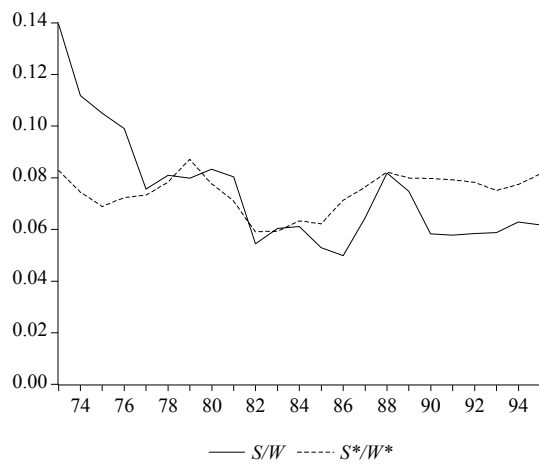


Figure 1: Australia

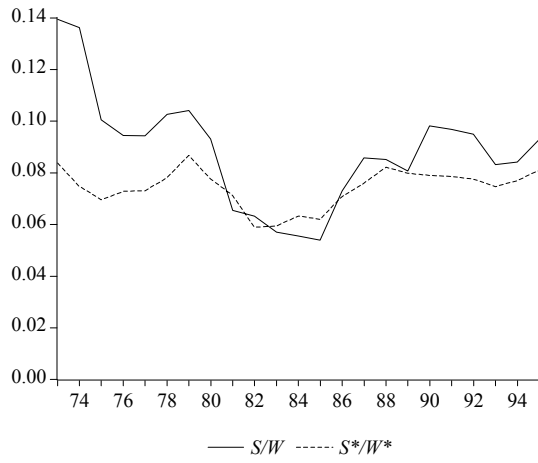


Figure 2: Austria

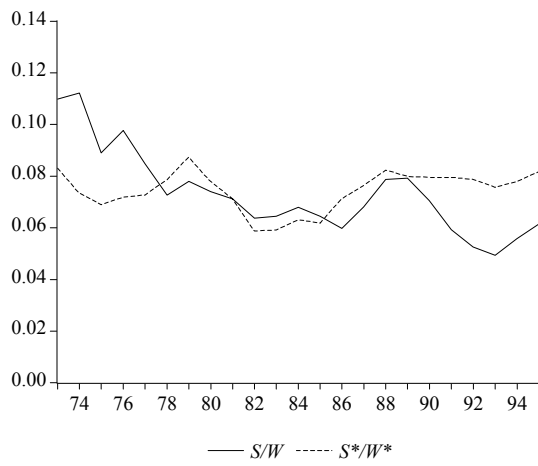


Figure 3: Canada

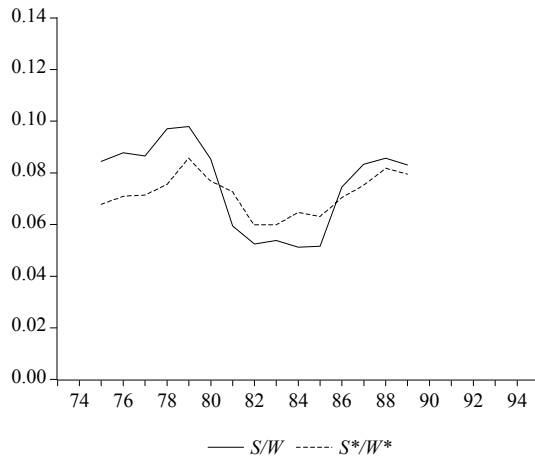


Figure 4: Germany

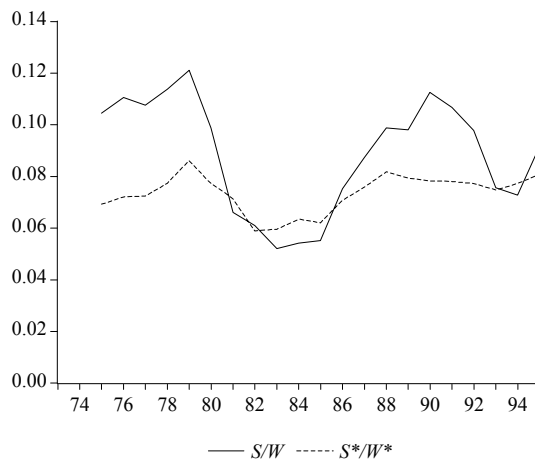


Figure 5: Spain

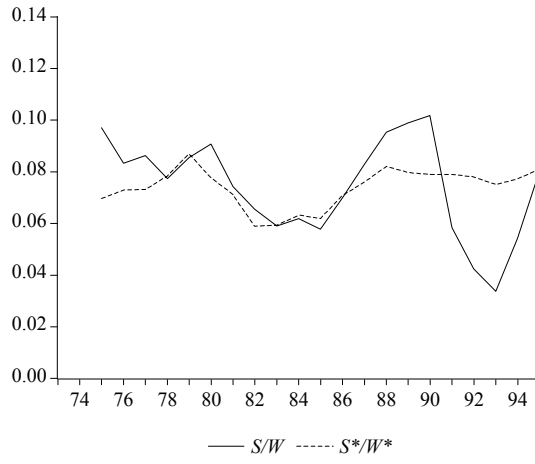


Figure 6: Finland

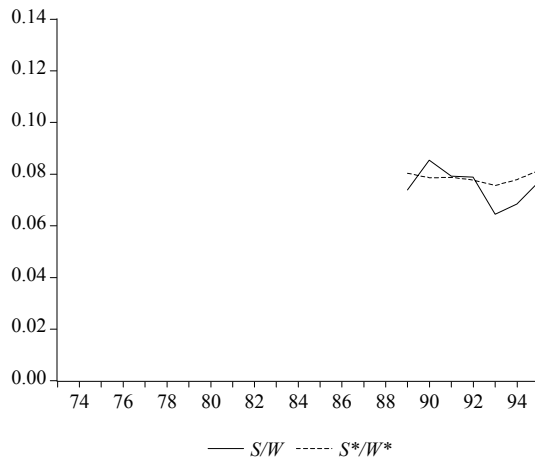


Figure 7: France

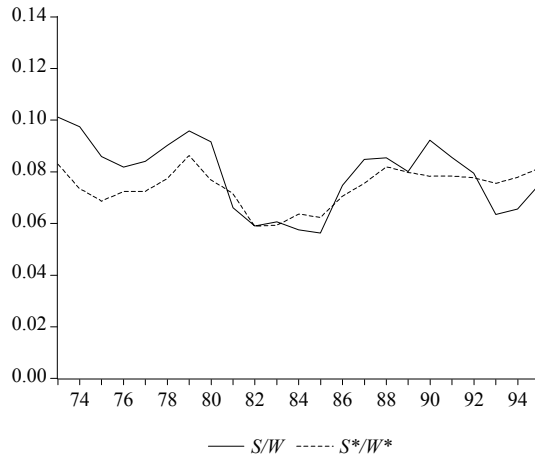


Figure 8: Italy

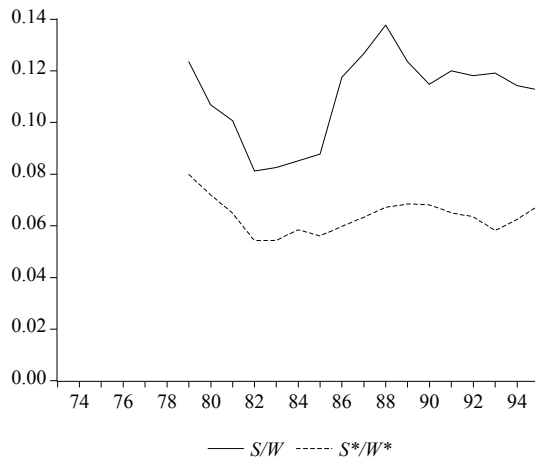


Figure 9: Japan

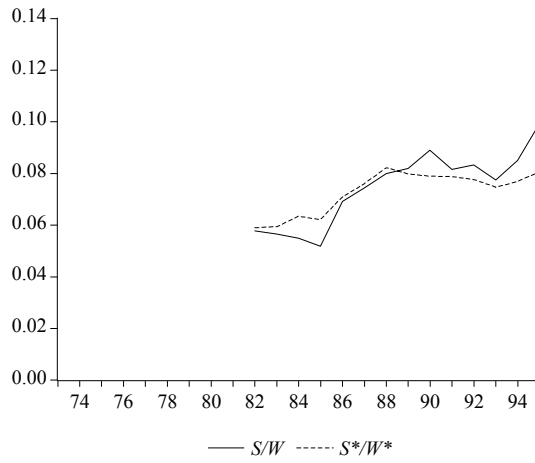


Figure 10: Netherlands

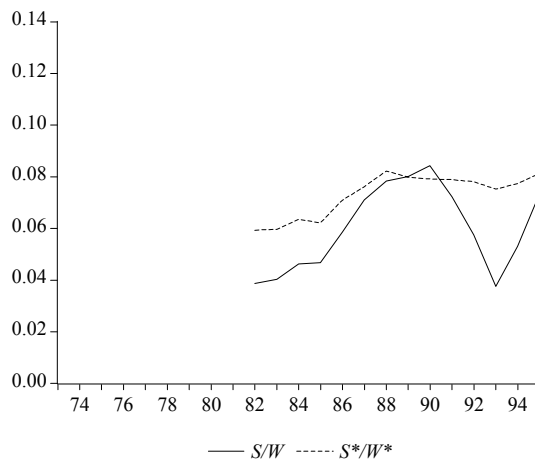


Figure 11: Sweden

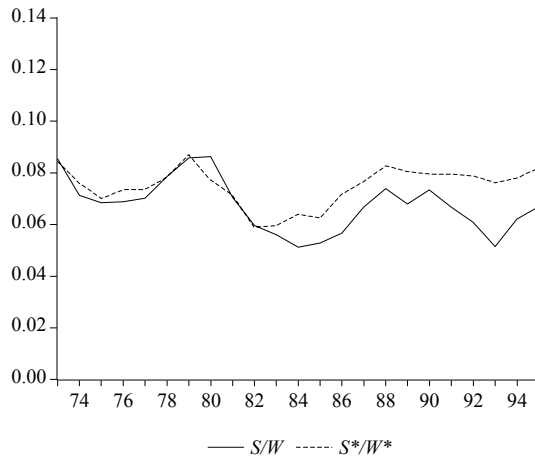


Figure 12: United Kingdom

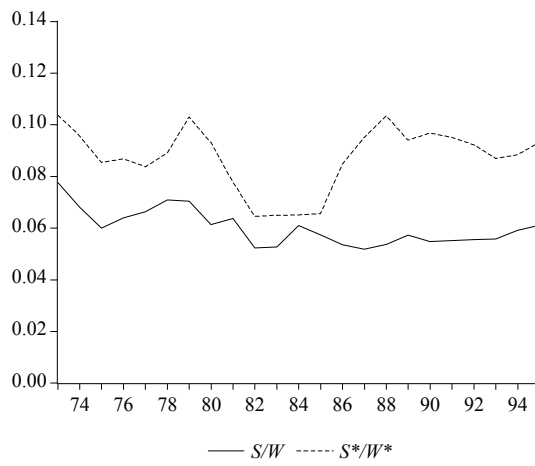


Figure 13: United States

References

- [1] Baltagi, Badi H. (2001). *Econometric analysis of panel data. Second edition*. John Wiley and Sons, Ltd, Chichester, England.
- [2] Blanchard, Olivier J., and Francesco Giavazzi (2002). “Current account deficits in the euro area: the end of the Feldstein-Horioka puzzle?”. *Brookings papers on economic activity*, n°2: 147-209. Brookings Institution, Washington D.C., United States of America.
- [3] Dixit, Avinash K. and Robert S. Pindyck (1994). *Investment under uncertainty*. Princeton University Press, Princeton, New Jersey, United States of America.
- [4] Eichengreen, Barry (1991). “Trends and cycles in foreign lending”. In H. Siebert (Ed.), *Capital flows and the world economy*. Tübingen, Mohr, Germany.
- [5] Feldstein, Martin and Charles Horioka (1980). “Domestic savings and international capital flows”. *Economic Journal*, 90: 314-329.
- [6] Frenkel, Jacob A.; and Assaf Razin, with the collaboration of Chi-Wa Yuen (1996). *Fiscal policies and growth in the world economy. Third edition*. MIT Press, Cambridge, Massachusetts, United States of America.
- [7] Greene, William H. (1997). *Econometric analysis. Third edition*. Prentice-Hall, New Jersey, United States of America.
- [8] Kamien, Morton I., and Nancy L. Schwartz (1991). *Dynamic optimization. Second edition*. North-Holland, United States of America.
- [9] Kraay, Aart and Jaume Ventura (2000). “Current accounts in debtor and creditor countries”, *Quarterly Journal of Economics*, 115:1137-1166.
- [10] Kraay, Aart and Jaume Ventura (2002). “Current accounts in the long and short run”. Working paper, available from website <http://econ-www.mit.edu/faculty/jaume/papers.htm>.
- [11] Kraay, Aart; Norman Loayza; Luis Servén and Jaume Ventura (2000). “Country portfolios”. *NBER Working paper series 7795*, available from website <http://www.nber.org/papers/w7795>.

- [12] Lane, Philip and Gian Maria Milesi-Ferretti (1999). “The external wealth of nations: measures of foreign assets and liabilities for industrial and developing countries”. *Working Paper of the International Monetary Fund, WP/99/115*.
- [13] Malliaris, Anastasios G., and William A. Brock (1982). *Stochastic methods in economics and finance*. North-Holland, Amsterdam, The Netherlands.
- [14] Malliaris, Anastasios G. (1987). “Stochastic optimal control”. In Eatwell, John; Murray Milgate, and Peter Newman (Eds.). *The New Palgrave. A dictionary of economics*. Volume 4. First published in paperback, 1998. Macmillan, London, United Kingdom.
- [15] Merton, Robert C. (1969). “Lifetime portfolio selection under uncertainty: the continuous-time case”, *Review of Economics and Statistics*, 51: 247-257. Reimpressed in Merton, Robert C. (1992). *Continuous-time finance*, Blackwell, Massachusetts, United States of America.
- [16] Merton, Robert C. (1971). “Optimum consumption and portfolio rules in a continuous-time model”, *Journal of Economic Theory*, 3: 373-413. Reimpressed in Merton, Robert C. (1992). *Continuous-time finance*, Blackwell, Massachusetts, United States of America.
- [17] Merton, Robert C. (1987). “Continuous-time stochastic models”. In Eatwell, John; Murray Milgate, and Peter Newman (Eds.). *The New Palgrave. A dictionary of economics*. Volume 1. First published in paperback, 1998. Macmillan, London, United Kingdom.
- [18] Obstfeld, Maurice (1992). “Dynamic optimization in continuous-time economic models (a guide for the perplexed)”. Working paper (University of California at Berkeley, United States of America), available from website <http://emlab.berkeley.edu/users/obstfeld/index.html>.
- [19] Obstfeld, Maurice (1994). “Risk-taking, global diversification, and growth”. *American Economic Review*, 84(5): 1310-1329.
- [20] Obstfeld, Maurice and Kenneth Rogoff (1995). “The intertemporal approach to the current account”. In Grossman, Gene M., and

Kenneth Rogoff (Eds.). *Handbook of international economics. Volume III*. Elsevier Science B.V., Amsterdam, Netherlands.

- [21] Obstfeld, Maurice and Kenneth Rogoff (1996). *Foundations of international macroeconomics*. MIT Press, Cambridge, Massachusetts, United States of America.
- [22] Obstfeld, Maurice and Kenneth Rogoff (2000). “The six major puzzles in international macroeconomics”. *NBER macroeconomics annual*, n° 15. MIT Press, Cambridge, Massachusetts, United States of America.
- [23] Razin, Assaf (1995). “The dynamic-optimizing approach to the current account: theory and evidence”. In Kenen, Peter B. (Ed.). *Understanding interdependence. The macroeconomics of the open economy*. Princeton University Press, Princeton, New Jersey, United States of America.
- [24] Sachs, Jeffrey (1981). “The current account and macroeconomic adjustment in the 1970s”. *Brookings papers on economic activity*, I. Brookings Institution. United States of America.
- [25] Turnovsky, Stephen J. (1997). *International macroeconomic dynamics*. MIT Press, Cambridge, Massachusetts, United States of America.
- [26] Turnovsky, Stephen J. (2000). *Methods of macroeconomic dynamics*. Second edition. MIT Press, Cambridge, Massachusetts, United States of America.
- [27] Ventura, Jaume (2003). “Towards a theory of current accounts”. *The world economy*, 26(4): 483-512.