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Mobility of capital and external sustainability of the Portuguese economy

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ABSTRACT: *The Feldstein-Horioka thesis was considered one of the greatest puzzles in economics. Proposed to be a measure of international capital mobility, has known a process of immunisation to be conformed to empirical evidence and respect econometric knowledge. We apply to the Portuguese economy the proposed tests not only to know the degree of capital mobility but also to know if this economy is external sustainable. The original ideas in the paper are our interpretation of the theoretical evolution of the F-H thesis, the importance of analysing the random nature of the model of one equation and not only the retention coefficient and the macro view given by an appropriate VAR model with investment and saving. We conclude by the confirmation of important capital mobility in the Portuguese economy and the external unsustainability of this economy.*

Introduction

Feldstein and Horioka (1980) (F-H) proposed a very simple and imaginative measure of the international capital mobility. The results obtained with it originate one of the most important «puzzles» in economics. They have caused innumerable debates, where corrections and extensions were suggested, as well as positions which deny the interest of this thesis. In Andrade (2007) we presented the idea that the studies of this thesis are an example of a scientific practice like Karl Popper described it. In reaction to the problems of refutation, attempts of immunization were built. We can also recognize in this evolution a certain "methodological anarchism" *à la* Feyrabend[1].

Accepting the positive effects of the mobility of capital for the development, a measurement of this mobility is very important. The results of the tests to confirm the thesis were responsible by its evolution, either at the level of the analysis, or at the level of the econometric techniques. A theoretical position has adapted to the econometric methods and allowed an interpretation in terms of external sustainability and capital mobility. We will apply these ideas to the Portuguese economy to the period 1910-2004. Finally we conclude.

F-H and the international capital mobility

The mobility of capital is important, if not even essential, to allow an efficient allocation of capital, from the point of view of the diversity of its industrial uses as well as geographical location. An economy is internationally integrated if its flows of capital can enter and leave the country freely and if the national financial assets are good substitutes of the financial assets of other countries. The real and financial integration of less developed economies has the consequence of worsen the negative external balances[2]. And a country whose growth is faster than that of the others will have, in theory, an imbalance of its external balance more important.

The development of financial practices of protection against the risk will also contribute to

[1] Feyerabend (1993).
[2] Or the avarage level of development. Blanchard and Giavazzi (2002).

the reduction of the national savings[3] and consequently to worsen external imbalance. Economic integration can lead, in the case of certain countries to external unsustainability of the economy. Independently of this last result, economists believe in the growth of the economy[4] as a result of the mobility of capital. As a consequence we are interested in a simple measurement of this mobility.

The idea, behind the thesis of Feldstein and Horioka (1980), (F-H), is quite simple: if an economy is well internationally integrated, then, its accumulation of capital should not be constrained by national savings. That paper, later on, was refined by Feldstein (1983) and Feldstein and Bacchetta (1991). The equation which summarizes their work is the following:

$$\frac{I}{Y} = \alpha + \beta \cdot \frac{S}{Y} \quad [5]$$

Feldstein and Horioka (1980) concluded that 85% to 95% of the national saving was invested locally. Vis-a-vis these results, of absence of international mobility of capital, for developed economies, Obstfeld and Rogoff (2000) regarded this result as a enigma (a "puzzle") and as one of the six larger "puzzle" than one knows in international economy.

The empirical result is difficult to accept. How can one accept that contrary to our convictions, about freedom of capital movements, the national saving can continue to constraint national investment?

The definition of F-H of international capital mobility, that the variations of domestic saving will not have effects on domestic investment, is the most demanding of the definitions[6]. Taking account of the existence of exchange rate risk and his cost (the cost of this risk) and also of real losses anticipations of the currency value, there will be certainly considerable differences, between countries, in the real interest rate. And consequently, one must expect that the coefficient of retention of F-H (β) can have values far away from the unit[7].

From a more formal point of view Lemmen and Eijffinger (1998) showed that the conditions required by F-H to evaluate a perfect integration are really leonine. It is consequently natural that one can arrive at different ideas on actual integration when other methods are used[8]. Methodologically this thesis is extremely powerful, because it is exposed to its refutation. The problem, moreover frequent in economy, it is that it's possible refutation has resulted in the creation of auxiliary conditions to protect it, to immunize it[9].

The adaptation of F-H Thesis to the results

We can summarize in two tendencies the models which worked on the assumption of F-H: the conciliation of their results with the accepted fact of the mobility of capital and the proposal of the new methods more appropriate to the problem in question[10]. In the first case the authors are

[3] Kimball (1990) and Parker, Jonathan and Preston (2002).
[4] See Agenor (2003). For another point of view, Edison, Ricci and Slok (2002).
[5] They have studied the OCDE countries for the period of 1960 to 1976, with cross-section data, to eliminate cyclical and endogenous problems. See also Bayoumi (1990).
[6] See Frankel (1992).
[7] For small economies the coefficient β must be zero. For big economies it must be equal to the contribution of the country to the world stock of capital. A big economy will have a higher retention coefficient, cf. Ho (2003). For Murphy (1986), a scale effect doesn't allow the F-H aproach to measure the capital mobility.
[8] See Bayoumi (1990), Sachs (1981), Obstfeld (1986), Frankel (1991), Levy (1995), Frankel and MacArthur (1988), Popper (1990), Baxter and Crucini (1993), Bayoumi and MacDonald (1995) and Goldberg, James and Okunev (2003).
[9] In the sense of Popper. Popper (2002).
[10] Coakley, Kulasi and Smith (1998).

led to confirm two ideas: the international mobility of the capital was very high for the period of the traditional Gold Standard; it was considerable less for the period of Bretton-Woods agreements, with an increasing tendency after the abandonment of this regime[11]; at the same time, the mobility of the capital for the less developed countries is always higher than that obtained for developed countries[12]. Obviously that there are results which contradict those[13] and Coakley, Hasan and R.Smith (1999) support the assumption that a low value for the coefficient of retention can be, simply, the result of not strong economic policies measures in response to external imbalances. Other authors as Pomfret (1998) defend the idea according to which the test of F-H is a reasonable measurement of the immobility of capital, but not of the mobility of capital. The zero value of β, ($\beta = 0$), is a sufficient condition but not a necessary one for perfect mobility of capital. And the value of β equal to 1, does not imply necessarily the immobility of capital[14]. With regard to the new econometric methods we must take into account the difficulty in comparing the former results, because a good share of them were obtained with stationary methods[15] applied to non-stationary data[16]. We must apply non-stationary approaches, either with time series data, or panel data, for the study of the «puzzle» of F-H[17]. Even if with these techniques of Co-Integration (CI) the contents of information of the thesis can almost be destroyed[18].

Mobility, External Soutenabilité and Co-integration

Coakley, Kulasi and Smith (1996), applying non-stationary methods, support the thesis according to which F-H does not measure capital mobility, but external sustainability. A coefficient close to the unit is nothing more but the result of the intertemporal[19] budgetary constraint. A very simple development, starting from the accounting identity of the macro equality between global supply and demand, makes it possible to expose this argument. From the macro definition of product: $Y = C + I + G + (X - M)$ [20], we deduce: $\frac{S-I}{Y} = \frac{(X-M)}{Y}$. The stationnarity of $\frac{(X-M)}{Y}$ [21] is sufficient to prove external solvency[22]. This stationnarity means that the series $\frac{I}{Y}$ and $\frac{S}{Y}$ are integrated of order 1 and co-integrated with the vector of Co-integration (1, -1). In this case, we cannot deduce anything with regard to the international capital mobility from the value of the long term coefficient.

The econometrics of the non-stationary variables involves with it new questions. How "to deduce" the F-H thesis from the obtained coefficients? Corbin (2004) proposes that if Co-integration is not rejected, the adjustment coefficients to correct de disequilibrium in the ECM model represent the intensity of the capital mobility. But in this case we can also put the question

[11] Hogendorn (1998). Aussi Bayoumi (1990) and Blanchard and Giavazzi (2002).
[12] Coakley, Hasan and R.Smith (1999). See also Mamingi (1997), Chakrabarti (2006), Payne and Kumazawa (2006) and Payne and Mohammadi (2006).
[13] See Lemmen and Eijffinger (1998) and Rocha and Zerbini (2000).
[14] See also Jansen and Schulze (1996).
[15] See Ho (2002).
[16] First difference estimates are not efficient if the variables are C-I. As certain authors have done, Feldstein (1983), Feldstein and Bacchetta (1991) and Bayoumi (1990).
[17] Coakley, Kulasi and Smith (1998). Coakley, Fuertes and Spagnolo (2004) and Kim, Oh and Jeong (2005).
[18] Totally in the case of Jansen (1997).
[19] Tesar (1991), Husted (1992), Jansen (1996), Jansen and Schulze (1996), Moreno (1997) and Corbin (2004).
[20] Where C, G, X and M represents Private Consumption, Public Consumption, Exports and Imports.
[21] If wee want to me more precise we must add other variables to obtain de Current Account from the Commercial Account.
[22] Obstfeld (1991), Alyousha and Tsoukis (2003) and Coakley, Kulasi and Smith (1996).

of the policy interventions, in short period, to push the economy towards its balance of long period. And so will the analysis be done compared to the capital mobility or to the effectiveness of the interventions? One will be able to never answer this question in a simple way[23]. Moreover, let us not forget that, with the increase in the number of observations, the probability of the stationnarity of the external balance increases[24] [25].

Taylor (1996) and Banerjee and Zanghieri (2003) propose the equation $\Delta I_t = \alpha + \beta \cdot \Delta S_t + \gamma \cdot (S_t - I_t)$ [26] to test the presence of Co-integration[27]. For these authors, γ represents the degree of capital mobility. Jansen (2000) proposes β to measure short period mobility and γ the long period mobility. Beyond of an abusive simplification, the interpretation of the coefficients is obviously not clear.

Applied analysis to the Portuguese Economy (1910-2004)

We will apply the above ideas to the Portuguese economy for the period 1910 to 2004. After presenting the sources of data (a), we look for this economy in the international context (b). The evolution of investment and saving (c), as well as of the current account (d), will be analysed in order to identify periods of rupture. After this previous analysis we will be in conditions to verify the F-H thesis with respect to capital mobility and external sustainability. We will study the traditional model of a single equation (e), usually authors stop at the interpretation of regression coefficients and the quality of fitting, we will go beyond this and we will insist on the stability of the model. In order to apply non-stationary methods we must be sure about the presence of unit roots in the series (f). We will use traditional ADF method, but also the KPSS, the Perron method for structural rupture, the value of persistence in accordance with Cochrane and a more recent version of the Variance Ratio of Wright (2000). After this study we will be in conditions for the study of a VAR model (g) and for the analysis of co-integration between investment and saving (h). We think that at the end of our analysis we are in conditions to have a supported opinion on the international mobility of capital and on the external sustainability of Portugal.

A. Statistical Sources. From 1910 to 1953 we used indices of Investment, Saving and Gross Domestic Product published by Batista, et al. (1997); with these indices we have calculated the values of our variables taking in account the information about 1953 from Banco~de~Portugal (1998); with this last source we construct our base from 1953 to 1959; and with Commission (2005) we widened the information from 1960 to 2004. For the international comparisons we used the values of Taylor (1996) updated with those from Commission (2005) and for the cases of Greece and Ireland we used the data of Heston, Summers and Aten (October 2002) for the initial period of 1910-14.

B. International Comparison. At the beginning of the 50's and 60's Portugal invests a proportion of its product greater than that of Greece and Ireland, but lower, in general, to that of developed economies (Table 1). After the 70's Portugal invests more than the developed economies, Greece and Ireland. At the beginning of the new millennium, the Portuguese economy continues to invest more than those economies.

The saving at the beginning of the century and at the beginning of the decades of 50 and 60

[23] See also Fattouh (2005).
[24] Taylor (2002) confirms the sustainability for 15 countries since 1870 to 1990.
[25] The ruptures in the series raise also particular problems. See Husted (1992), Ozmen and Parmaksiz (2003a), Ozmen and Parmaksiz (2003b) and Westerlund (2006).
[26] That we adapted here to the time series data.
[27] What poses interrogations concerning the remainder of the C-I model and constraints of nullity of the coefficients.

was less than that of developed countries (Table 2). The Portuguese economic growth has contributed to high levels of saving during the 70's, 80's and 90's. But at the beginning of the millennium it presents lower values than those of the other selected economies. In a process of sustainable economic growth we have an increase in savings to support investment. Its relative reduction can mean the end, or an impediment, of this growth process, unless other sources of investments can be obtained.

Table 1 – I/Y (%) in Portugal and other countries

	PRT	GRC	IRL	DNK	FRA	ITA	SWE	GBR	USA
1910-14	3			21	14	14	13	10	22
1950-54	17	16	11	26	25	20	21	14	16
1960-64	24	22	18	25	24	29	25	18	19
1970-74	32	28	24	25	27	27	23	20	20
1980-84	34	25	25	17	21	24	18	16	20
1990-94	27	21	17	17	20	19	17	16	16
2000-04	25	24	24	20	20	20	17	17	19

Table 2 – S/Y (%) in Portugal and other countries

	PRT	GRC	IRL	DNK	FRA	ITA	SWE	GBR	USA
1910-14	15			18	16	17	9	12	23
1950-54	16	16	2	25	25	20	21	14	16
1960-64	22	19	16	24	25	28	25	18	19
1970-74	32	33	19	24	27	26	24	19	20
1980-84	27	25	15	18	21	23	19	18	19
1990-94	24	21	17	21	21	20	18	15	16
2000-04	17	17	23	23	21	20	23	15	14

C. The evolution of investment and saving. In the analysis of investment and saving series, I/Y and S/Y, we have applied the methodology of Bai and Perron (1998) and Bai and Perron (2003)28 for the identification of points of rupture.

Let us start with the analysis of investment. On Table 3 we have the average and also the coefficient of variation29. The values on this Table illustrate a change of behaviour in 1983. We can identify a previous 1983 behaviour and another one that starts in 1984. The year of 1983 was a year of strong instability that closed the political cycle after the Democratic Revolution of 1974. In 1983 the President of the Republic decides to dismiss the Government at the beginning of the year, in 23rd January, against the opinion of the State Council. The legislative elections in 25th April will lead to the formation of IXth Constitutional Government of the Central Block, with Mário Soares as First-Minister and Mota Pinto as Vice-First-Minister. The Portuguese currency keeps the system of Crawling Pegg, at the rhythm of 1% the year, being devaluated in 21st June in 12%. The social conflicts were present throughout the year, over all in the naval transports, shipyards, social communication and still with the glass workers of Marinha Grande. More than 100000 workers[30] had not received their wages in due time. In this year the terrorist acts of the FP25 are initiated. The inflation rate reached the highest value after the beginning of XX century, 26.5% in terms of implicit prices of GDP. This value was more than 8,2 points above the value of the previous year. The situation of external disequilibrium was also serious. As a result of an agreement with the FMI, Portu-

[28] We have used as deterministic variables a constant and a trend.
[29] The average divided by the standard deviation.
[30] Of a total of 2 979 900 workers in Portugal (including Madeira and Açores).

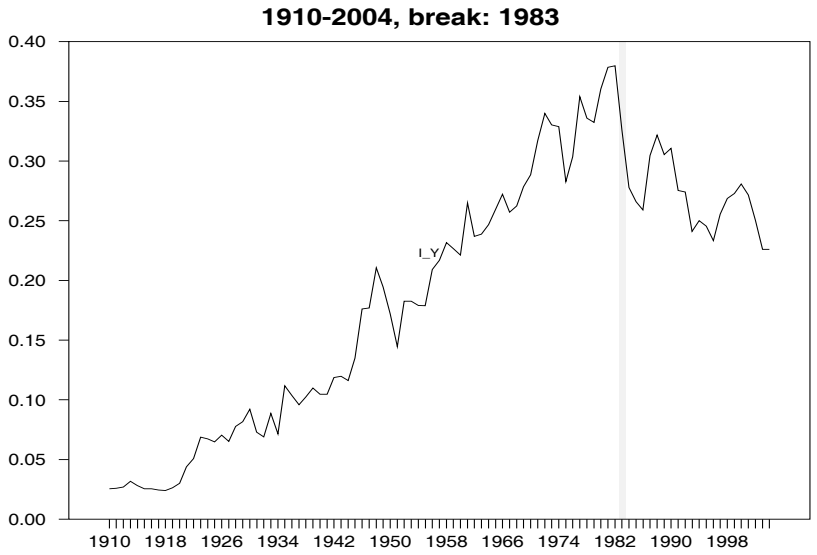
gal receives the first advance of 350 million USD of the total of 750 million. In the second half of the year the monetary and the budgetary policies become strong restrictive[31].

The behaviour of investment proves the importance that the restrictive policies had on the permanent behaviour of this series. In case of unit root the shocks tend to be permanent and so those politics had very high costs for the economy.

Table 3 – Investment

I/Y	Average	CV
1910-1982	0,165	0,658
1984-2004	0,267	0,101

Figure 1 – Investment evolution



The evolution of savings presents different phases as if it can see in Figure 2. Applying the methodology of Bai-Perron we arrive at the identification of three ruptures, 1925, 1946 and 1973, whose sub-periods are characterized in Table 4. This ruptures correspond to years of important political events. The year of 1925 corresponds to the final period of political instability associated with the First Republic; in 1946 the Portuguese economy, after the WWII[32], had important financial problems including problems associated with international reserves; in 1973 we have the end of the dictatorship, the crises of payments with the colonies and the first oil shock; and finally in 1983 we had liquidity problems in international payments that resulted on a new agreement for stabilization with the IMF.

We think that the facts most relevant with savings are its instability of the beginning of XX's century until the WWII, the very low values in the period that follows the war (from 1947 to 1950), the growth of savings up to 1973 and its subsequently decrease on the 90's. The instability of the values of saving is relatively low from 1974 to now. The negative evolution of savings since the 90's has been responsible for an increasing necessity of external financing of the Portuguese economy, as we can see in Table 5[33].

[31] See Banco~de~Portugal (1984) and Moreira and Pedrosa (2004).
[32] Second World War.
[33] Data from Banco~de~Portugal (1997), Banco~de~Portugal (2004) and I.N.E. (2005).

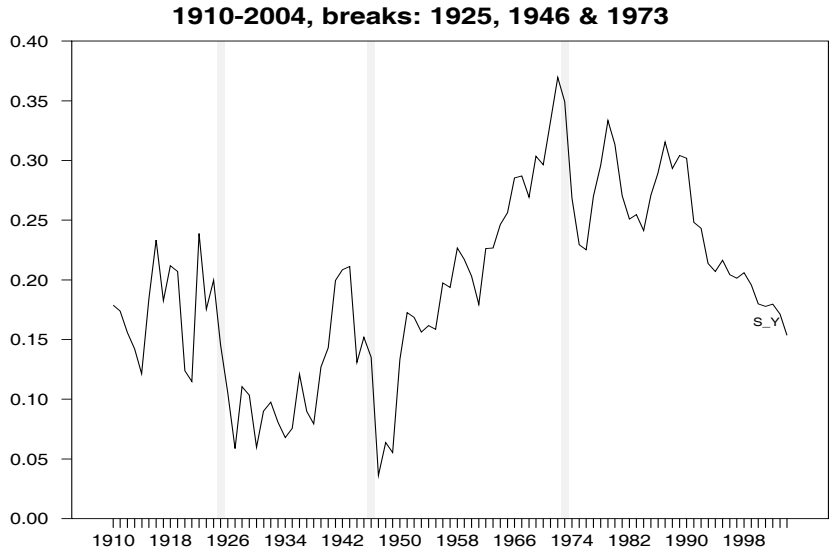
Table 4 – Savinsg

S/Y	Average	CV
1910-1924	0,176	0,221
1926-1945	0,116	0,407
1947-1972	0,209	0,395
1974-2004	0,243	0,201

Table 5 – Net liquid necessity of external financing

	1995	1996	1997	1998	1999	2000	2001	2002	2003
NLFE	0	1,3	3,0	4,5	6,1	8,8	7,9	4,9	3,1
Tx_C_PIB	2,3	3,5	4	4,6	3,8	3,4	1,7	0,4	-1,1

Figure 2 – Saving evolution



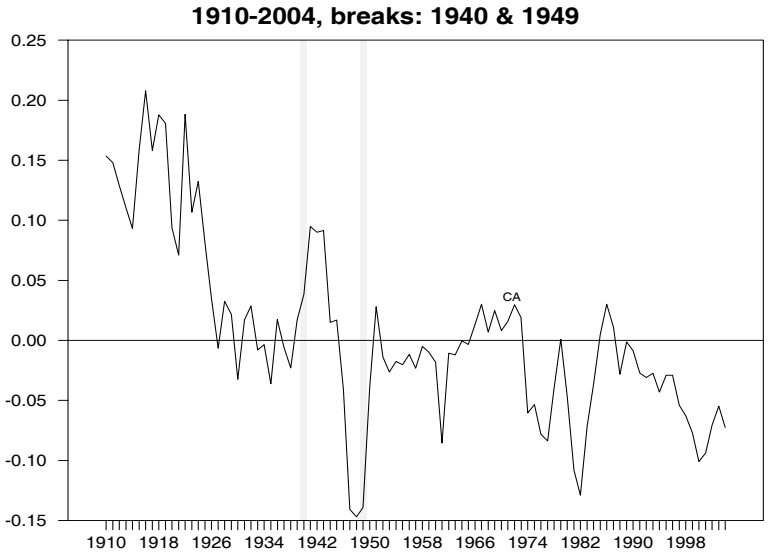
The reduction of the external financial dependence in recent years was caused by the slow-down of economic growth of the economy. Two dates were important in the evolution of saving: 1974 and 1991. The first one corresponds to the Revolution (1974) and its implications on agents behaviour, where we must include a radical change of customs and the changes in terms of institutions. The State started to call itself responsibilities that until then were of individual or family nature. We must remember at the level of social security, the principle of universal pensions, the health national service and the unemployment benefit. The second date corresponds to the practice of financial liberalization[34]. From 1977 to 1990 the monetary policy was based on the direct control of bank credit volume on a context of an inexistent market for funds out of banks. The financial liberalization followed by innovation and increasing competition was a key factor in the reduction, if not elimination, of liquidity constraints of families.

Summarizing, in the evolution of investment and saving we must distinguish long and short term behaviour. In the long term both variables are characterised by values above those of similar economies. In the short term the evolution of investment and saving is a really problem. The first one after 1983[35] and the second since 1989[36], doesn't stop to fall.

[34] See Bação (1997).
[35] In 1982 its value was 0.38.

D. Evolution of the Current Account. We will define current account on a simplified form, as $\frac{CA}{Y} = \frac{S}{Y} - \frac{I}{Y}$. The years of rupture, in accordance with the methodology of Bai-Perron, are 1940 and 1949. In Figure 3 we have its representation.

Figure 3 – Current account evolution



As a general impression the values of this variable has been decreasing, but not on a regular way. The average value becomes negative in the last decades and the instability is considerably in the first period (Table 6). For the total period the average is practically null (0,0057).

Table 6 - Current account

CA/Y	Average	CV
1910-1939	0,075	13,460
1950-2004	-0,029,	-1,337

We also verify that for this variable we must distinguish a long period where the value is null from a short term where after 1986 its value does not stop to fall.

E. Traditional results of F-H equation. In order to take in account the periods of rupture of investment and saving we created the following dummy variables, which take the value 1 for the indicated periods:

mi (1910-1981)	ms_0 (1910-1925)
ms_1 (1926-1946)	ms_2 (1947-1973)

To estimate the model $\left(\frac{I}{Y}\right)_t = \alpha + \beta \cdot \left(\frac{S}{Y}\right)_t + \gamma \cdot D_t + \varepsilon_t$ we looked for the elimination of auto-correlation problems, ARCH process and non normality of the errors. The symbol D represents a vector of deterministic variables beyond the Constant. The three better estimations that we got with the values of the information criteria are reproduced in Table 7. In any one of them we have included one lag of the dependent variable (I/Y) to reject the null hypothesis of the γ coefficient.

[36] With the value of 0.30 this year.

Table 7. Values of the information criteria of the simple model

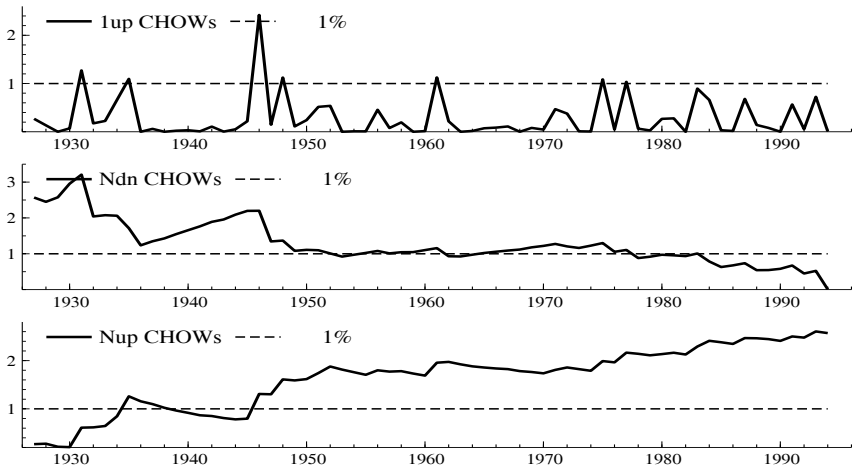
D	◎	AIC	HQ	SC
mi, ms_0, ms_1 and ms_2	0,018	-7,912	-7,830	-7,709
mi, ms_0, ms_1 and T	0,018	-7,958	-7,888	-7,785
mi and T	0,018	-8,025	-7,967	-7,881

AIC represents the criterion of Akaike, HQ of Hannan-Quinn, SC of Schwarz and ◎ the standard error of the estimate.

These criteria lead to the selection of the last model37. The null hypothesis of the coefficient associated with saving, the retention coefficient, is rejected at the 10% level. Its value is not high, confirming the presence of capital mobility in the Portuguese economy. The positive value associated with the trend (T) translates the reduction of the retention phenomena of investment by saving throughout time, what confirms the idea of mobility.

We think, however, that more than the rejection of the null hypothesis of the retention coefficient, the thesis of mobility must be confirmed by the stability of the model. In Figure 4 we present three tests of Chow38, standardized by the critical values, which clearly exclude the hypothesis of stability of our best model.

Figure 4. Chow tests to the model of one equation



In face of this result we can admit the inexistence of retention of investment by saving in the Portuguese economy, that is, we admit the perfect mobility of capitals in the sense of Feldstein-Horioka.

F. Unit root analysis. As a result of the presence of ruptures in the series we applied the test of Perron (1997), beyond the Dickey-Fuller[39] and KPSS[40] tests. In the application of the Perron test we considered the cases of rupture with change of intercept (a), with change of intercept and inclination (b) and change in inclination without discontinuity in the evolution. In the case of investment we only have a rupture and therefore we can apply the test of Perron to the totality of the available data. In the case of saving we have three ruptures and so we have divided the total sample in sub-samples where the rupture points are inside each sub-sample. We have retained the

[37] To see the coefficients and other data of the estimation see the Annexe.
[38] That is, "1-step Chow Tests", "Break-point Chow Tests" and "Forecast Chow tests". See p. 254 of Hendry (1996).
[39] Dickey and Fuller (1979), Phillips (1987) and Phillips and Perron (1988).
[40] Kwiatkowski, et al. (1992).

estimations of models (a), (b) and (c) that reject the null hypothesis of relevant coefficients[41]. In Tables 8, 9 and 10 we present the results obtained for investment.

Table 8 – Perron test of structural rupture (I/Y)[42]

Model	Lags	$T_{\omega=1}$
(a)	1	-3,991
(c)	0	-4,579*

Table 9 – ADF test (I/Y)

Var.	Periods	Lags	T	Z	Det.[43]
I/Y	1910-2004	0	-1,541	-2,727	C
I/Y	1910-1982	0	-3,788**	-24,168**	C, T
I/Y	1984-2004	0	-2,086	-6,878	C
∅(I/Y)	1910-2004	0	-9,041***	-87,505***	-
∅(I/Y)	1911-1982	0	-9,713***	-82,010***	C
∅(I/Y)	1984-2004	0	-3,799***	-14,731***	-

Table 10 – KPSS[44] test (I/Y)

Var.	Periods	Lags	η_μ	η_τ
I/Y	1910-2004	0	8,325	1,347
I/Y	1911-1982	0	7,078	0,799
I/Y	1984-2004	0	0,782	0,123
∅(I/Y)	1910-2004	0	0,218***	0,077***
∅(I/Y)	1911-1982	0	0,088***	0,013***
∅(I/Y)	1984-2004	0	0,078***	0,075***

Let us analyse the results for (I/Y) starting with the totality of the period. By the ADF and KPSS tests this variable has a unit root. This variable is integrated of order 1, I (1). Although the Perron test, for model (c), allows the rejection of a unit root along the trend, at the level of 10%. For the period until 1983 we verify that the ADF test reject the presence of a unit root at the 5% level and the KPSS test reject stationnarity at 1%. For the subsequent period, after 1983, all the tests allow us to consider (I/Y) as I(1). These confirm, however with some contradiction, the investment to be (I/Y), integrated of order 1, I (1).

The results obtained for saving are in Tables 11, 12 and 13.

Table 11 – Perron test of structural rupture (S/Y)

Periods[45]	Model	Lags	$T_{\omega=1}$
1910-1945	(c)	0	-3,853
1926-1972	(a)	0	-4,502
1947-2004	(b)	2	-5,399**
1947-2004	(c)	1	-4,609*

[41] With the exception of the Constant where sometimes the null hypothesis can't be rejected.
[42] "Lags" means lags to correct for the auto-correlation. Use use 3 stars to represent rejection at least at the level of 1%, 2 for 5% and 1 for 10%.
[43] C means Constant and T trend.
[44] The stars, 3, 2 and 1, mean no rejection at the 10%, 5% and 1% level, respectively.
[45] These intervals allow us to retain maximum periods with an internal rupture.

Table 12 – ADF test (S/Y)

Var.	Periods	Lags	T	Z	Det
S/Y	1910-2004	0	-2,286	-10,236	C
◎ (S/Y)	1910-1982	0	-10,001***	-97,064***	-

Table 13 – KPSS test (S/Y)

Var.	Periods	Lags	η_μ	η_τ
S/Y	1910-2004	0	4,091	0,756
◎(S/Y)	1910-2004	0	0,0612***	0,054***

For this variable (S/Y) we can reject the presence of a unit root along a trend for the period from 1947 to 2004, at the 5% level, in the case of the model (b). For the remaining sub-periods, as well as for the totality of the data, we cannot reject the hypothesis of the presence of a unit root.

Concluding, we will take the investment and saving as integrated of order 1, I (1). We will now study the behaviour of the current account.

The Perron test applied to the subdivisions suggested by the Bai and Perron results doesn't lead to any interesting result. So we have applied the test to the totality of the period. We arrive at the result of Table 14.

Table 14 – Perron test of structural rupture (CA/Y)

Period	Model	Lags	$T_{◎=1}$
1910-2004	(c)	0	-4,503*

Table 15 – ADF test (CA/Y)

Var.	Periods	Lags	T	Z	Det
CA/Y	1910-1939	0	-3,279*	-17,428*	C,T
CA/Y	1950-2004	0	-4,672***	-24.968**	C,T
CA/Y	1910-2004	0	-3,685**	-23,853**	C,T
◎ (CA/Y)	1911-1939	0	-6,926***	-36,198***	-
◎ (CA/Y)	1951-2004	0	-7,289***	-49,170***	-
◎ (CA/Y)	1911-2004	0	-9,836***	-95,432***	-

Table 16 – KPSS test (CA/Y)

Var.	Periods	Lags	η_μ	η_τ
CA/Y	1910-1939	0	2,301	0,183*
CA/Y	1950-2004	0	1,130	0,154*
CA/Y	1910-2004	0	4,505	0,643
◎ (CA/Y)	1911-1939	0	0,039***	0,038***
◎ (CA/Y)	1951-2004	0	0,040***	0,025***
◎ (CA/Y)	1910-2004	0	0,031***	0,019***

We cannot reject the stationnarity along a trend, with a temporal rupture (Table 14), at the level of 10%. The ADF test reject, in general at the level of 5%, the presence of a unit root for the totality of the period and for its last part, 1950-2004. For the period 1910-1939, the presence of a unit root is rejected at the level of 10%. The KPSS test denies these results. This test only supports

stationnarity of the sub-periods along a trend, at a very weak level of not rejection. In what concerns the first difference of this variable all the results are conclusive about the stationnarity. Concluding, we will take this variable as probably stationary along a trend since 1950.

In face of all these results for the three variables we have opted for studying two more characteristics of the series: the persistence, measured by the A (1) factor of Cochrane (1988)[46], and the ratio of variance in accordance with Campbell, Lo and MacKinlay (1997)[47] and Wright (2000).

In Table 17 we have the values of the first indicator, for different values of the lags.

Table 17 – Cochrane A(1) factor

k	S/Y	I/Y	CA/Y	◎(S/Y)	◎(I/Y)	◎(CA/Y)
5	0,776	0,872	0,785	0,435	0,507	0,450
10	0,749	0,845	0,661	0,387	0,353	0,387
20	0,709	1,019	0,489	0,241	0,294	0,254

The persistence is clear in the case of saving and investment and less clear in the case of the current account. In this case, 50% (0,489) of a shock will be present 20 years later. As is expected the differentiation leads to a substantial reduction of the persistence.

In Table 18 we have the values for different forms of the variance ratio for the study of IID and MDS48 processes. M1 and M2 correspond to the usual tests of the variance ratio; R1 and R2 correspond to those ranking the values of the variables; and S1 from the signal of the values of the series. The second test (M2 and R2) corrects the presence of conditional heterocedasticity.

Table 18 - Values of M, R and S

Var	k	M1	M2	R1	R2	S1
I/Y	20	22,88	20,02	22,79	20,35	29,18
S/Y	20	21,82	19,47	22,48	21,16	29,18
CA/Y	20	5,87	4,71	5,73	5,51	4,40
◎(I/Y)	20	-0,72	-0,64	-0,97	-0,90	-0,90
◎(S/Y)	20	-1,34	-1,23	-0,90	-1,11	-1,10
◎(CA/Y)	20	-1,63	-1,53	-1,43	-1,51	-1,40

All the variables in levels reject those processes. After differentiation they do not reject the hypothesis of IID or MDS processes, at least at the level of 5%[49]. As a consequence of these results, we will take investment and saving as integrated variables of order 1, I (1). We think this hypothesis is the most reasonable. The possible stationnarity of CA along a trend reduces the value of information of tests in Table 18 for this variable.

G. A VAR model. Respecting the F-H hypothesis we propose a VAR model between exclusively investment and saving, to evaluate the importance that assumes the saving for the investment. In the case of a macro model a weak constraint of saving on investment can be the result of important capital mobility or the Keynesian confirmation of investment exogeneity and saving endogeneity. In this case the investment will cause the saving. If the influence of investment on saving is weak we can conclude for a neo-classical regime.

To obtain the order of our model we start from a maximum of 4 lags. The only dummy

[46] See also Campbell and Mankiw (1987).
[47] See point 2.4.3, pp. 48-56.
[48] IID, identically independent distributed values and MDS, martingale difference sequence.
[49] See Table 1 of Wright (2000).

variable that we can't reject is ms_0. In Tables 19 and 20 we present the values of different information indicators and the tests of restriction on the coefficients.

Table 19 – Information indicators

VAR(k)	SC	HQ	AIC
Var(4)	-8,157	-8,486	-8,709
Var(3)	-8,334	-8,597	-8,775
Var(2)	-8,520	-8,718	-8,851
Var(1)	-8,690	-8,821	-8,910

Table 20 – Restriction tests on coefficients

Var(k+1) -> Var(k)	DF of F	F	SL
Var(4) -> Var(3)	4, 160	0,429	0,788
Var(3) -> Var(2)	4, 164	0,247	0,911
Var(2) -> Var(1)	4, 168	0,613	0,654

As we can verify by the information criteria and also by the restriction tests on the coefficients, we must retain a model of order 1. This model rejects the nullity of endogenous variables as well as the dummy variable (ms_0). In Table 21 we summarize these results.

Table 21 – Restriction tests on VAR(1)

Variables	F(2,89)	SL[50]	Variables	F(2,89)	SL
$(I/Y)_{-1}$	228,1	(0,0)	$(S/Y)_{-1}$	40,0	(0,0)
Constant	1,654	(0,197)	ms_0	4,959	(0,009)

Only for the Constant we can't reject the null hypothesis. The eigen values of the accompanying matrix of the VAR have as modules 0,9589 and 0,6356. In Table 22 we have the usual tests to the errors of the model. Either for first order auto-correlation (AR (1)), or for the normality by the Jarque-Bera test (J-B), or for the presence of first order ARCH process (ARCH (1)), the model presents the desirable characteristics at the desirable level of 5%.

Table 22 – Analysis of the errors of the VAR (1)

Equation	Test	Statistics and SL
I/Y	AR(1)	F(1,89) = 0.173 (0.68)
S/Y	AR(1)	F(1,89) = 1.034 (0.31)
I/Y	J-B	Chi^2(2) = 3.569 (0.17)
S/Y	J-B	Chi^2(2) = 4.837 (0.09)
I/Y	ARCH(1)	F(1,88) = 0.026 (0.87)
S/Y	ARCH(1)	F(1,88) = 0.261 (0.61)

The decomposition of the variance (Table 23) confirms the importance of each variable in the explanation of the other[51]. The contribution of investment in the explanation of the saving is greater than the inverse (30.49>21.65) what is a suggestion of a Keynesian behaviour.

[50] SL: significance level.

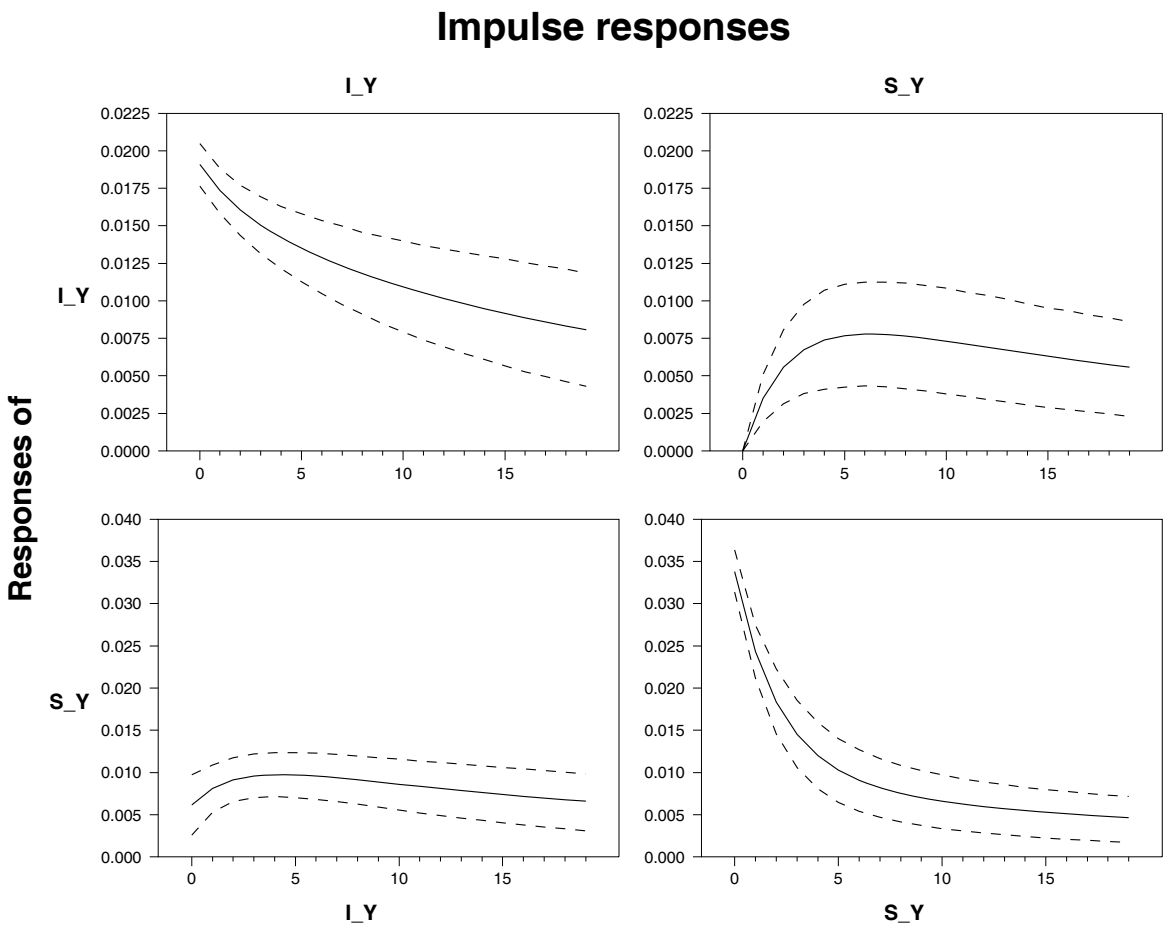
[51] We have tried to obtain a structural representation of this model but the overidentification L-R test rejected this possibility at the 5% level.

Table 23 - Decomposition of the Variance of I/Y and S/Y

T	I/Y	S/Y	T	I/Y	S/Y
1	100,0	0	1	3,06	96,94
2	98,15	1,85	2	5,42	94,58
...	...	...	...	....	...
20	78,35	21,65	20	30,49	69,51

Figure 5 presents the evolution of the two variables and the 95% intervals, during 20 years, after shocks of the magnitude of the standard error of each equation.

Figure 5 - Effect of Shocks



The investment is the variable with the higher degree of inertia to its own shock. Ten years after a shock on this variable 58.13% of it will still be retained. The effects of this shock over the saving are much more reduced but more persistent. In the 5th year the effect is 62% higher, and in the 20th year is of equal value, than in the period of the shock in the investment.

The shocks on the saving have an impact on it that disappear quickly, in the 10th period they are 18% of the initial shock. The effects over the investment are slightly more important, but less than of the investment on the saving, and are relatively persistent, the value of the 10th period being the same of that of the 7th period. A shock of 10% on savings produces an increase in the 7th period of 2.3% on the investment and 1.9% on the saving. This difference of results will last for long time.

We conclude therefore that the shocks on the saving are not important for the investment, what confirms the international financial integration of the Portuguese economy. This conclusion

confirms thus the result obtained with the traditional model, to an equation, of the F-H hypothesis.

H. Co-Integration between the investment and the saving: the problem of external sustainability. As the VAR model was of order 1 we concentrate our attention in co-integration relations, between investment and saving, with 1 lag[52]. We have two possibilities for our dummy variables: its inclusion in the vector of co-integration or its exclusion of this vector, but being part of the VECM[53] model. In the first option we have considered the presence of ms_0. Its exclusion of the co-integration space is rejected by a LR test, $\chi_1^2 = 9,06 \quad (0,00)$ [54]. We identify this model as C-I (A). We arrive also to the conclusion that we can reject the nullity of the presence in the co-integration space for all the dummy variables. We have the following results for the LR tests when we include all de dummies:

$$mi = 0 \quad \chi_1^2 = 4,690 \quad (0,03)$$
$$ms\_0 \quad \chi_1^2 = 16,287 \quad (0,00)$$
$$ms\_1 \quad \chi_1^2 = 9,660 \quad (0,00)$$
$$ms\_2 \quad \chi_1^2 = 7,161 \quad (0,01)$$

And for all the variables $\chi_4^2 = 18,80 \quad (0,00)$. This means that we must consider a model (C-I (B)) with the inclusion of all these variable. In the second possibility we have put all the dummies out of the vector of C-I, but they belong to the VECM (C-I(C)). The tests for the rejection are the following:

$$mi = 0 \quad F_{2,84} = 2,699 \quad (0,07)$$
$$ms\_0 \quad F_{2,84} = 16,291 \quad (0,00)$$
$$ms\_1 \quad F_{2,84} = 12,178 \quad (0,00)$$
$$ms\_2 \quad F_{2,84} = 6,139 \quad (0,00)$$

All these results reject the null hypothesis of the dummy variables. The values of the Johansen test for each one of these models are on Table 24.

Table 24 - Johansen tests of Co-integration

	Lambda	H0: r<=	Trace	SL
C-I(A)				
	0,199	0	23,802	0,002
	0,031	1	2,847	0,086
C-I(B)				
	0,278	0	39,054	0,000
	0,086	1	8,460	0,004
C-I(C)				
	0,257	0	30,030	0,000
	0,022	1	2,137	0,140

The joint hypothesis of stationnarity for investment and saving in the case of the first two models is not rejected. This means that the correct representation will be by a VAR, like we have done below. As for the last model we couldn't reject the existence of a relation of co-integration between investment and saving. We have tried the hypothesis of a vector (1,-1). The LR test give

[52] The rule of *k-1* could not be applied because *k=1*. See Lütkepohl (2004).
[53] Also known as VAR model accompanying the C-I. VECM: vector error correction mechanism.
[54] The SL (significance level) is on parenthesis.

the result ⊚²₁=4,167 (0,041), and so we must reject such restriction. The values of the equilibrium relation are in Table 25.

Table 25 - Coefficients of the space of co-integration

Var.	⊚	⊚	⊚⊚	⊚⊚
I/Y	1	-0,209	---	0,064
S/Y	-0,677	0,434	0,094	0,119

The study of co-integration between investment and saving leads to two alternative ways: the analysis in terms of VAR or the acceptance of a co-integration model, C-I (C). We have already considered the first way. The second produces a long run retention coefficient equal to 0.68 and the rejection of a unitary value for this coefficient. From this relation of long term we obtain the value of CA/Y as $CA_t = \frac{S_t - I_t}{Y_t} = \varepsilon_t + 0,32 \cdot \frac{S_t}{Y_t}$, where ⊚t represents a stationary variable and, remember, S/Y is a variable with a unit root, I(1). The current balance presents a situation of not sustainability in the Portuguese economy.

Conclusion

The original ideas in the paper are our interpretation of the theoretical evolution of the F-H thesis, the importance of analysing the random nature of the model of one equation and not only the retention coefficient and the macro view given by an appropriate VAR model with investment and saving. The F-H thesis is presented as a simple measure of the international capital mobility. We have presented its importance and the problems that were raised. The application of the thesis was immunized to economists' beliefs and its evolution reflects also the advances in econometric practice. Nowadays the thesis allows not only measuring the level of financial integration of the economies but also to test its external sustainability. After a short theoretical presentation of the thesis we applied it to the Portuguese economy.

We begin the empirical part of this paper by the analysis of the evolution of investment and saving in Portugal. Those values must be considered favourable to growth and give a better picture than other developed economies. A deep regarding gives us a different picture for the short term. Since 1983 and 1989, investment and saving, respectively, have a decreasing behaviour and since 1986 the disequilibrium between the two is worsening every year. The rupture years given by Bai and Perron method coincide with abnormal years from the point of view of the economic environment and political events for those variables in the Portuguese economy.

With the study of the F-H relation in its traditional form, of one equation, we have estimated a retention coefficient for the long term equal to 0.212. A value of this magnitude confirms a situation of great capital mobility. We think, however, that more than analysing the average value of a coefficient, it will be more interesting to study the random nature of the model if we want to know the level of restriction on investment from saving. When following this strategy we discover that the chosen model is not stable. And so we can conclude for the presence of international capital mobility in the case of the Portuguese economy.

In the study of the stationnarity characteristics we had in account the rupture periods previously identified. The ordinary used tests don't give a unanimous and clear answer. We have used other tests and we think that we can conclude that investment and saving could be taken as integrated of order 1, I(1).

We think that the level of integration of these variables is very interesting from the macro point of view. A shock on investment or saving will produce very long term consequences. We begin our macro interdependence research by the study of a VAR model of order 1 and we have verified that the importance of the saving in the explanation of investment was inferior to the inverse one. In terms of analyses of the shocks we conclude that the effect of a shock on saving were not important on investment. We have obtained with the VAR information that confirms the idea of the international capital mobility in the Portuguese economy.

The analysis of co-integration between investment and saving was conducted with three possible VECM models. By the multivariate test of Johansen we can't reject the joint stationnarity of investment and saving in the case of the first two models. The Johansen test confirms the presence of 1 vector of co-integration in the last model. The study of this model rejects the hypothesis of a vector (1, - 1), what means that the BC is not sustainable. In terms of short period we can confirm the idea of capital mobility, the ◎ is 0.21, and in terms of long period the retention coefficient of 0.68 puts some doubts on the level of integration.

we can conclude by the idea of a high level of capital mobility and a strong propensity to external unsustainability of the Portuguese economy.

***Annexe**: Linear equation model, OLS*

EQ(13) Modelling I_Y by OLS, The estimation sample is: 1911 to 1994

	Coefficient	Std.Error	t-prob
I_Y_1	0.701435	0.06922	0.000
S_Y	0.0634468	0.03421	0.067
mi	0.0361159	0.007945	0.000
Trend	0.00139731	0.0003385	0.000
Constant	-0.0469948	0.01156	0.000
sigma	0.0175698		
R^2	0.975116		
ARCH 1-1 test:	F(1,77) = 0.086785 [0.7691]		
Normality test:	Chi^2(2) = 3.3048 [0.1916]		
RESET test:	F(1,78) = 0.58714 [0.4458]		

Solved static long-run equation for I_Y

	Coefficient	Std.Error	t-prob
S_Y	0.212506	0.1114	0.060
mi	0.120965	0.02712	0.000
Trend	0.00468008	0.0004356	0.000
Constant	-0.157402	0.03576	0.000
Long-run sigma = 0.0588473			
WALD test: Chi^2(3) = 265.211 [0.0000] **			

Testing for error autocorrelation from lags 1 to 1
Chi^2(1) =0.0087593 [0.9254] and F-form F(1,78) =0.0081344 [0.9284]

Testing for error ARCH from lags 1 to 1
ARCH 1-1 test: F(1,77) = 0.086785 [0.7691]

Normality test for Residuals
Normality test: Chi^2(2) = 3.3048 [0.1916]

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