UNIVERISTAT JAUME I

A LONG-RUN RELATIONSHIP BETWEEN INVESTMENT AND SAVING:

REVISTING THE FELDSTEIN-HORIOKA PUZZLE

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ABSTRACT

The aim of this paper is to analyse the Feldstein-Horioka puzzle using cointegration tests with breaks. The puzzle consisting of finding a high correlation between investment and saving in countries where trade barriers had been eliminated. During the second half of the 20th century, the countries of our sample started a commercial and financial integration process. Despite this fact, these two variables have been found to be highly correlated. Using annual time series data, we first test for the existence of unit roots. Secondly, in order to find if there is relationship between investment and savings, we test for cointegration having into account the potential presence of instabilities in the relationships. In addition, including structural breaks in our regressions will help us to relate the unexpected increases/decreases in saving retention coefficient to the most relevant economic facts that may explain it.

Keywords: Investment, saving retention coefficient, persistence, unit root, cointegration, structural breaks.

JEL Codes: F15, F21, F45.

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To my supervisor. For helping me to extend my knowledge in economics and valuating my efforts during the writing of this project.

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A LONG-RUN RELATIONSHIP BETWEEN INVESTMENT AND SAVING:

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1. INTRODUCTION

Most authors have already tried to explain the Feldstein-Horioka puzzle since its publication in 1980. The origin of this paradox was found by Martin Feldstein and Charles Horioka, who pretended to explain this high persistence between investment and saving of a country. As world economies were initiating a complete and wide global integration in trade and finance during the sixties and seventies, economists expected a decrease in the parameter linking the two variables or even finding no relation whatsoever. Nevertheless, this never occurred, and they justified their findings in the existence of market failures such us uncertainty, risk or institutional rigidities as a reason.

However, this original paper produced an extension in future econometric investigations in order to find additional causes that could explain this persistence among variables. As it will be described afterwards, multiple causes had been attributed to this problem. The size of a country, investors' behaviour or transaction costs have been added as a variable to several economic models, although any of these aspects have been enough to decrease saving retention coefficient associated with economic integration.

This paper has used a sample of seven countries (nowadays, five of them are members of European Union, and others are two of the most powerful economies in the whole word). They are France, Germany, Great Britain, Italy, Japan, Spain and United States of America. At this point, it has to be mentioned that data frame has based on annual time series. Therefore, this paper will try to revisit the Feldstein-Horioka puzzle. Specifically, we are going to study the relationship between saving and investment during the period 1970-2016.

Cointegration and structural break regressions have been two important aspects in order to summarize all presented results. Tested the stationarity of main variables, cointegration techniques have been included in this paper. In addition, including structural changes in each country. Therefore, it has been possible to link these results to current facts, which have happened during years of the sample.

As main results of this paper, we have found evidence of the existence of unit roots in investment and saving data for each country of the sample. Taking into account its long-run relationship among the two variables, in other words, investment and saving

are cointegrated series. Moreover, the use of Dynamic OLS with structural breaks has allowed us to obtain consistent estimations, in contrast to the OLS method. The main result is that the saving retention coefficients decrease, as economic integration advances among the countries of the sample

In Section 1, it is presented a brief introduction of which are the main points of this paper. In Section 2, it will explain theoretical aspects and the first steps which have been taken in order to start this investigation. In Section 3, a review of most specific papers in which this investigation has been based on. In Section 4, the methodology of the project. In Section 5, we present and discuss the empirical results. Finally, the conclusion of the paper is summarized in Section 6. In addition, Section 7 and 8 include the references and an appendix, respectively.

2. THEORETICAL ASPECTS

In order to understand the relationship between saving and investment, it must be explained the simple distinction between a closed and an open economy. Firstly, a closed economy is characterized by the circular movement of income, since revenues and expenditures move within the borders of the corresponding country. As a result, it is possible to obtain this equivalence[1], which represents a closed economy[2]:

$$GNE = GDP = GNI = GNE \tag{2.1}$$

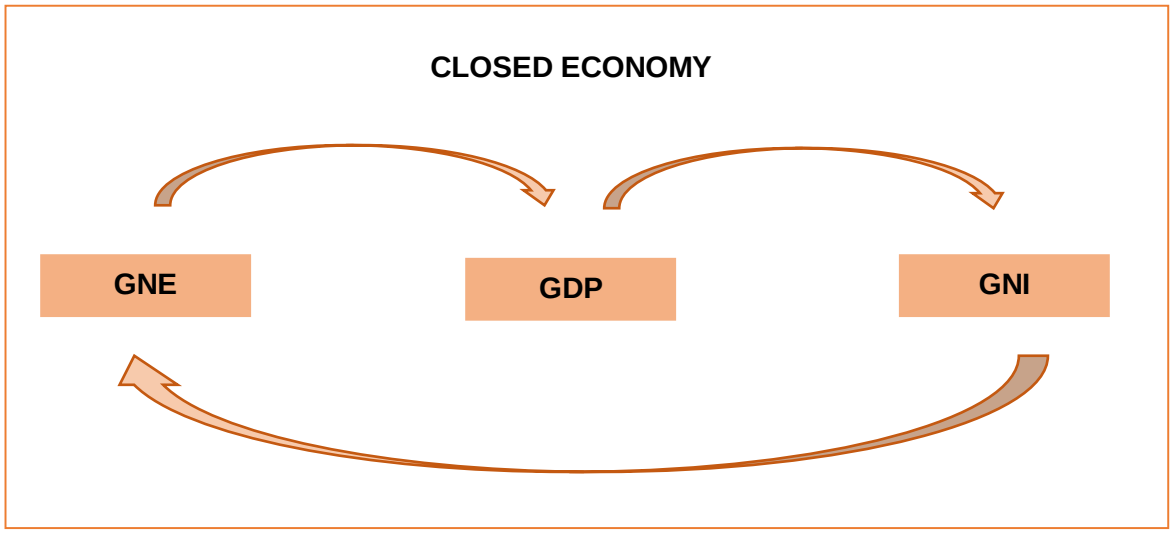


Figure 1: *General system of a closed economy. Source based on Feenestra and Taylor (2012)*

[1] See Appendix A for the explanation of this equivalence

[2] Henceforth, all the equations until equation 2.7, are based on Feenestra and Taylor (2012)

However, this is not how reality works. It must incorporate the effects of the abolition of borders, introducing the economic and commercial openness of the corresponding country (open economy). In this way, capital inflows and outflows will be generated, and all these movements must be accounted in the Balance of Payments (BP). In order to obtain a similar equivalence to equation 2.1, but including the effects that are caused by economic openness, it should take into account three elements:

- Trade Balance (TB) which is the difference between the exports and imports of goods and services.
- Net Foreign Factors Income (NFFI) which is the difference between the exports and imports of productive resources.
- Net Unilateral Transfers (NUT), which is the difference between monetary assistance that comes from foreign economies and economic transfers made by domestic economy to abroad.

Therefore, while a closed economy (based on the circular flow of income), satisfies the GNE = GNI equivalence, opening the country to abroad modifies this condition clearly. The Balance of Payments (BP), an element that summarizes all transactions that the domestic economy accomplishes with the foreign countries, must be joined. BP is the aggregation of the Current Account (CA) = CB + NFFI + NUT, the Financial Account (FA) and the Capital Account (KA), although these last two elements are not significant for this project. Therefore, the system of an open economy[3] would be:

[3] Take into account that the red arrows represent imports (expenses), and the green arrows, exports (income). For example, in the first case, the red arrow indicates the goods and services imports, and the green one, its exports. The justified difference is the Trade Balance (TC).

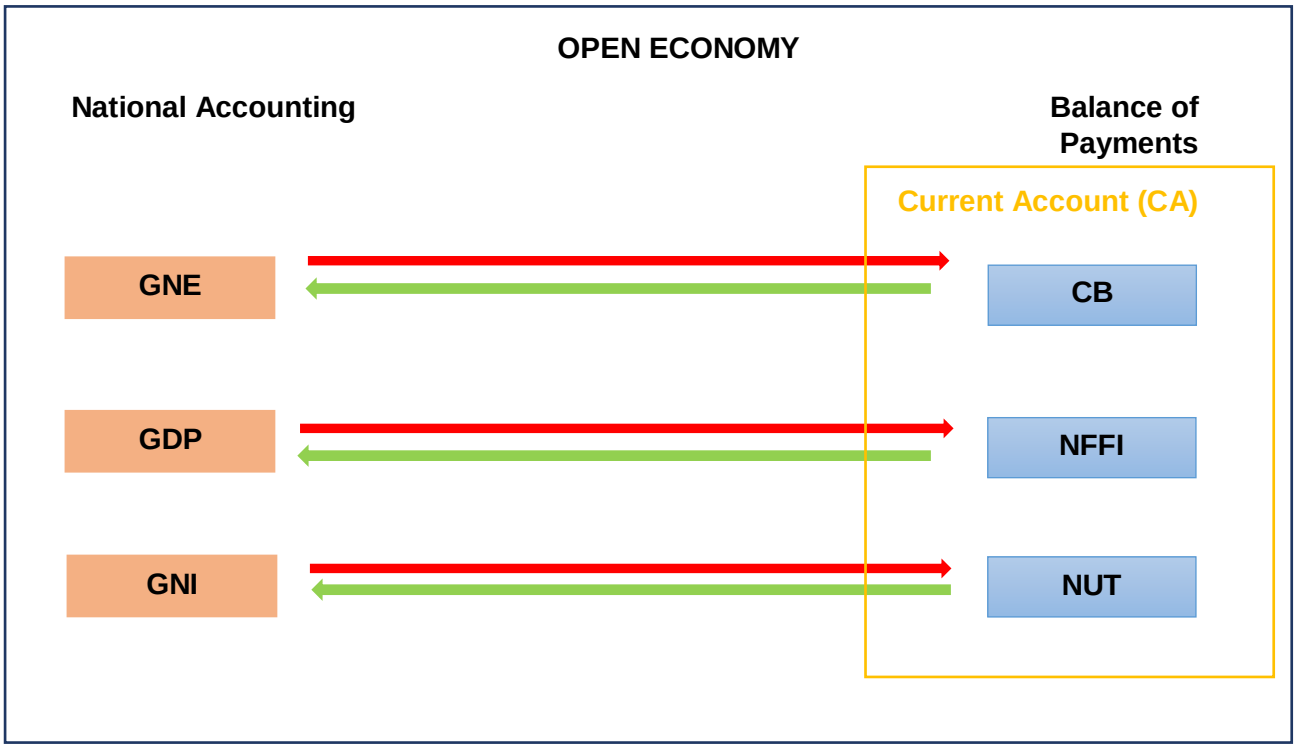


Figure 2: *General system of an open economy. Source based on Feenestra and Taylor (2012)*

Regarding figure 2, it is possible to affirm that the Current Account (CA) is an instrumental element within an open economy, since it summarizes each movement of goods, services and international income. However, the international transactions of financial elements (Financial Account), and the economic support received or loaned from abroad (Capital Account) have to be accounted.

A way to describe the equation which represents an open economy (using international commercial transactions as a basis) is the following[4]:

$$Y = C + I + PE + \{(X - IMP) + (X_{SF} - IMP_{SF}) + (UT_{IN} - UT_{OUT}\} \quad (2.2)$$

GNE TB NFFI NUT

Current Account (CA)

[4] See Appendix B for the explanation of this equivalence.

$$Y\ (GNDI) = C + I + PE + CA \tag{2.3}$$

Equation 2.3 represents the National Income Identity (NII) of an economy which is completely open to the international markets. If the Current Account is subtracted from the previous equation, this element is equal to the difference between the total income obtained in the domestic economy, after accounting for international and national transactions income (GNDI) and gross national expenditure (GNE)[5].

$$CA = Y - C - I - PE \tag{2.4}$$

Applying the knowledge of international macroeconomics, and subtracting (C + PE)[6], meaning, the private agents consumption (C) and expenditure in public sector (PE), on both sides of the equation which shows the National Income Identity (equation 2.3) , it is important to observe that the Current Account is also defined as the difference between savings (S) and investment (I) flows:

$$Y - C - PE = \cancel{C} + I + \cancel{PE} + CA - \cancel{C} - \cancel{PE} \tag{2.5}$$

Equation 2.11 shows the Current Account Identity (CAI)[7], and helps to identify in which type of economic situation is the analysed country:

$$S = I + CA \tag{2.6}$$

$$CA = S - I \tag{2.7}$$

Once it has been found the Current Account Identity, two aspects should be highlighted:

[5] Regarding equation 2.4, it is easy to know if exists a surplus on the balance of payments current account (when GNDI>GNE; or, conversely, if CA keeps a deficit balance (when GNDI<GNE)

[6] Take into account that Y-C-PE=National Saving (S)

[7] In the same way as equation 2.4. in equation 2.6, using the current account identity, we can distinguish between a CA with a surplus (when S>I) or a deficit (when S<I)

- The Current Account of a closed economy is not included in its national accounting equation, due to the income accumulation follows a completely circular flow, meaning, national income works to pay the expenses incurred in the national country. The corresponding country does not negotiate with foreigners, and therefore, it is self-sustaining. In this way, following the current account identity, if CA = 0, then, S = I.

- An open economy, commercially and financially negotiate with other countries. Its international transactions must be accounted for as they directly affect the national income of citizens. Hence, the Current Account is an essential element for its national accounting. Those countries can apply the abolition of economic barriers, acquire possible external funding, receive investments from private agents from abroad, and in the same way, can finance external operations and invest in foreign countries. In this way, the CA ≠ 0, then, S ≠ I. Similarly, there is perfect capital mobility.

Regarding the explanation of the difference between an open or closed economy, it has had of finding the relationship between these two variables: saving and investment of a country. As a consequence, as Martin Feldstein and Charles Horioka published its original article in 1980, the aim of this research will be to obtain the saving-investment correlation and its evolution until 2016 for the countries of reference (will be presented in following sections). In order to indicate possible reasons for the high correlation (basically, it is due to market failures), econometric tools will be used to apply statistical inference.

The Feldstein-Horioka puzzle has been studied and tested many times, since its publication in June 1980. Many authors have tried to justify the Feldstein and Horioka paradox which was raised four decades ago. Nevertheless, the evidence remains inconclusive. In many cases, the empirical applications have consisted of including different variables that could reduce the high correlation between national saving and investment.

Assuming the withdrawal of economic barriers and perfect capital mobility, investors, who are seeking expanded income opportunities, will invest in those countries where the rates of return are higher. So, these flows are transferred from those countries where profitability (rate of return) is low, to regions where it is higher. This situation will occur until the rates of return are equal in both areas.

Feldstein and Horioka (1980) were the first to verify whether what economic theory predicted in this case was also accomplished in empirical evidence. For this purpose, their original regression was formulated as the relationship between investment and saving in several economies. In order to do this, they used as a dependent variable the national investment, in gross terms, with respect to the gross national product (GDP). Likewise, they used as a main explanatory variable, the ratio of gross national saving in terms of gross national product (GDP):

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta \left(\frac{S}{Y}\right)_i + \mu \tag{3.1}$$

They used a sample of twenty-one developed countries[8] (cross-sectional regressions), which were part of the Organization for Economic Cooperation and Development (OECD). Five of them were eliminated from the analysis because of the existence of considerable discrepancies in the methodology of their national accounts. The original investigators proposed the following hypothesis:

$$\begin{cases} H_0: \beta = 0\ (perfect\ mobility\ of\ capital) \\ H_1: \beta = 1 (financial\ autarchy) \end{cases}$$

Thus, assuming perfect capital mobility, β (which is known as the saving retention coefficient) should be close to zero or zero. As a result, the investment-saving relationship would be almost null. The domestic economy would receive financing from abroad in order to formulate the external agents' investments. On the contrary, if β obtains a value close to unity, it means that the increases in savings by the national agents of the corresponding country have been invested in its own country. In this case, the national economy is self-financing.

Using gross saving and investment flows, Feldstein and Horioka obtained a β value of 0.89, which would be clearly inconsistent with the assumption of perfect mobility of

[8] Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom and USA, were the group of countries that constitute the entire sample. France, Luxembourg, Norway, Spain and Switzerland were eliminated.

capital. This has come to be known as the puzzle or paradox, since a much lower saving retention coefficient was expected for a developed OECD countries group such as those analysed. Additionally, the analysed period (1960-1974) were years of economic prosperity, especially for the European Economic Community countries, that had already taken the first steps towards economic and financial integration.

3. REVIEW OF THE EMPIRICAL EVIDENCE

Since Feldstein and Horioka's original publication, many economists have tried to provide an explanation to the high investment-saving correlation, found even with high capital mobility. Hargberger (1980) emphasized that those countries that had a vast territorial extension, and therefore, with most economic disadvantages, would become better receptors of external funding, especially when facing an economic contraction. Therefore, knowing the heterogeneous sample of countries that Feldstein and Horioka used in their original article, this could be accepted as an explanation of high correlation. Feldstein (1994), justified this relationship due to bias, that investors of the national economy can cause because of their adverse behaviour in front of risk. In other words, this fact could encourage them to invest in their country of origin.

However, other authors such as Dooley et. al (1987) invalidated this argument. It only alluded to the relationship between the Current Account and Gross National Income, and not to the reduction of the saving retention coefficient. On the other hand, it is important to underscore the role of the research carried out by Sinn (1992). He studied the saving and investment relationships in order to analyse capital movements. This showed that the use of long-term saving and investment increases the bias to accept the assumption of financial autarchy. To do so, he implemented a study based on regions of the same country[9] with annual frequency data. As a result, he obtained smaller coefficients, and he concluded that the mobility of capital within a country is much more adaptable than between countries.

Another of the most relevant economic investigations was the analysis of the Six Puzzles in International Macroeconomics, carried out by Obstfeld and Rogoff (2000). They obtained the saving retention coefficient for the OECD countries (24 countries) for the period 1990-1997. They obtained β of 0.60 by OLS (much lower than 0.89, β of the original article). Hence, they found evidence of a reduction in the coefficient (although it

[9] Sinn (1992) used United Stated for his economic investigation.

was still too large) in a financially integrated world and where investments are received directly to those countries where rates of return are higher[10].

In spite of the acceptance by economic researchers of a high saving-investment correlation, or, event, the decrease of the saving retention coefficient of some of the aforementioned investigations, Blanchard and Giavazzi (2002) regressed investment on saving for the period 1975- 2001. But not only for the OECD countries (β = 0.57 for 1991-2001), but also for countries that were part of the euro zone (β = 0.14 for 1991-2001). Their regressions showed that this relationship is increasingly weaker, especially for euro countries, since they had created a group of countries which were increasingly integrated in trade and finance. Authors such as Coakley et al (2004), had already verified that the capital movements between these countries were very high.

Different additional aspects were studied in the Obstfeld and Rogoff (2000) research such as the implication of transaction costs in the investment and saving relationship. In the same way that these authors affirmed that commercial costs could be a cause that motivated the high correlation, Fazio et al. (2008), verified it through a gravity model with multilateral trade, whose econometric technique was maximum likelihood. They used annual frequency observations for the period 1980-2000. Both investigations concluded that trade costs can justify the Feldstein-Horioka puzzle.

On the other hand, Bebczuk and Schmidt-Hebbel (2010) studied a new version of the Feldstein-Horioka puzzle. Instead of focusing on the investment-saving relationship at national level, they focused on a sectoral perspective of the domestic economy and how each market agent manages finances in order to have an effect on the Trade Balance[11]. This result allowed to stand out investigations that determine other reasons that may explain the puzzle. According to Bai and Zhang (2010), frictions in financial markets could be the key. Among them, they studied two: on the one hand, the limited application of contracts and their non-compliance punishment; and on the other, the impossibility of creating capital bonds, so that the room for manoeuvre is limited. The

[10] In addition, they scaled up the sample. The obtained saving retention coefficient was still lower. Nevertheless, the included countries were practically poor, and the data are not entirely reliable because of the economic and administrative conditions of them.

[11] The resulting endogeneity in the intersectoral connection between investment-saving is also treated.

interaction of both limits the capital flows of the country, providing a possible solution to the puzzle.

Studies such as Holmes and Otero (2015), tested the existence of capital mobility, but with two relevant differences. First, they used domestic investment flows as a dependent variable, and foreign saving flows as explanatory variable in order to estimate the innovated regression. Second, they studied country pairs, using a sample which included both OECD countries and developing countries (in total, thirty-eight countries). In addition, they used annual frequency data based on time series tools. Although they found limitations to free capital flows between countries, they highlighted that capital mobility had increased, especially among pairs of countries belonging to euro zone.

At this point, it is important to mention the imbalances in the Japanese Current Account, especially, since 1980. In honour to McKinnon's (1996) paper on Current Account balance, Horioka (2016) (given his contribution to the paradox of the saving-investment correlation), wanted to relate the Japanese surplus with the high saving rates of this country. In the same way, it gives possible explanations to these imbalances for the period 1983-1993 and 1994-2011; and which are the future anticipations ("trends") that could realign the Current Account again.

Ma and Li (2015)-using advanced econometric techniques (cointegration[12]) and unit root tests with a sample of twenty-two countries (including developed and emerging countries) combine information about investment and saving flows. In their study, saving retention coefficients are still large for countries with notable economic growth (due to mainly market failures), while for developing countries the coefficients are lower. They attribute this discrepancy to legal differences in the solvency limits among the two types of countries.

Eaton et. al (2015) analysed this puzzle again using a sample of 19 countries, (18 nations and the rest of the world), with panel data and a dynamic multi-country model (based on the work of Obstfeld and Rogoff (2000)). They use quarterly data from 2000 to 2012, and the retention coefficients are different before the financial collapse of 2008 (a retention coefficient of 0.24, evidence in favour of the assumption of capital mobility)

[12] Econometric technique that is used to test the long-term relationship between two variables, in this case, the saving-investment relationship. It also eliminates possible spurious correlations.

and afterwards, as, the retention coefficient increased to 0.63. This difference can be due to new market and economic barriers imposed after 2008.

In the same way, Morley (2016) analyses the puzzle for 34 OECD countries during the period 1980-2012, and impinge on the saving retention coefficient differences before the bursting of the real estate bubble and afterwards. As a result, as shown by Ford and Horioka (2016), the globalization of financial markets would be a necessary but not sufficient condition for capital mobility. Furthermore, the demise of market failures would be convenient, and however, they still remain currently and inhibit full financial integration. Despite the increase in capital mobility among countries before the Great Recession of 2008, its crash increased uncertainty and protectionism, once again boosting the saving-investment correlation.

Katsimi and Zoega (2016) apply cointegration techniques and unit root tests to study the evolution of financial integration in European countries for the period 1980-2014. They still justified the existence of the puzzle in these countries in some possible causes, such as the quality of institutions, the risks that are assumed in order to ask for a loan and the impairment losses on exchange rates. In addition, structural breaks were found at several moments of the period such as the introduction of the euro on the market in 1999 or the economic breakdown in 2008.

As new approach is going to be applied, Ketenci (2012) developed an investigation based on structural changes related to European Union nations. She analysed the capital fluctuations between these 23 countries during 1995-2009, in order to demonstrate the paradox. Finally, Camarero et al. (2019) developed a new completely integrated state-space framework, that can be applied to panel time series. They test Feldstein-Horioka puzzle for 17 countries[13] during the period 1970-2016. They found a reduction in the original saving retention coefficients, while financial integration was raising among OECD countries.

As a conclusion, this empirical review has tried to follow the evolution of the literature from the origin of the puzzle to the most recent empirical research. The introduction of new variables has permitted to find lower values of the saving retention coefficient, but it is still too high in order to accept the assumption of perfect capital mobility. In the next sections, some applied tests are presented in order to analyse the behaviour of each main variable throughout time. Moreover, the existence of cointegration will be an

[13] Twelve countries are part of Eurozone, while the rest are developed countries, which are non-member of this group.

object of study in each country of the sample, in order to give an answer to why investment and savings are related to each other in long term.

4. METHODOLOGY

In this research exercise, we use annual-frequency time series data frame for seven different countries with an heterogenous economic growth process throughout the twentieth century: France, Germany, Great Britain, Italy, Japan, Spain and United States of America (henceforth, USA). This database consists of gross investment and saving rates as a percentage of GDP, from 1970 until 2016. The empirical results have been obtained using Eviews.

Once the database is described, it is important to introduce the steps which are going to be followed. The main objective of the project is to understand the actual relationship between investment and saving of a country, using as reference, aspects such as past and future effects on them. At this point, this investigation can be divided in two parts. First of all, it is going to be tested the existence of unit root in gross investment and saving rates behaviour.

4.1. Unit root tests

Generally, in order to test whether if main variables follow an autoregressive model or not, it must be regressed gross investment and saving rates to themselves but with the inclusion of one lag. In other words, it has to be known if gross investment rate in period *t* (as dependent variable) is completely explained by gross investment rate of period *t-1*[14]. It is going to proceed by the same way with gross saving rates.

$$I_t = \alpha_0 + \theta_1 I_{t-1} + \mu_t \tag{4.1}$$

$$S_t = \alpha_0 + \gamma_1 S_{t-1} + \varepsilon_t \tag{4.2}$$

being I_t, gross investment rate in period *t,* and I_{t-1}, gross investment rate in the previous period to *t.* And logically, S_t, gross saving rate in period *t*, and S_{t-1}, gross saving rate in the previous period to *t.*

As a result, if it is obtained a θ_1 or γ_1 values of almost one or one, it can be affirmed that these regressions follow a unit root and have high persistence. Nevertheless, most macroeconomic variables commonly have high persistence between two periods

[14] In econometrics, this process is known as random walk.

(t, t-1). In this case, first differences would be necessary, in order to avoid spurious relationship. But, if there is cointegration, a regression in levels would be.

In this part of the investigation, three different econometric tests will be applied. They will allow us to know if the variables in previous regressions (one for each country of the sample) follow unit root, or instead, if they are stationary.

4.1.1. Augmented Dickey Fuller (1979) test

One of them is Augmented Dickey Fuller test (henceforth, ADF), as an improved test based on Dickey and Fuller (1979). They considered the possibility of obtaining autoregressive model I (1), when $\rho = 1$ (as null hypothesis), and by contrast, the existence of a stationary variables I (0), when $\rho \neq 1$ (as alternative hypothesis)[15]. Nevertheless, the possibility to find deterministic trends throughout the time frame, and therefore, the increasing probability to include a white noise into the estimation of coefficients, it may make it possible to create bias in favour of unit root hypothesis. In order to avoid these possible problems, it is going to use ADF, a test that will allow a parametric correction in the autocorrelation of the residuals. This process consists of estimating following regressions[16]:

$$I_t - I_{t-1} = \alpha_0 + \beta_t + \rho I_{t-1} - I_{t-1} + \mu_t$$
$$\Delta I_t = \alpha_0 + \beta_t + (\rho - 1) I_{t-1} + \sum_{i=1}^{\rho} \delta_i \Delta I_{t-\rho} + \mu_t \quad (4.3)$$

$$S_t - S_{t-1} = \alpha_0 + \beta_t + \rho S_{t-1} - S_{t-1} + \varepsilon_t$$
$$\Delta S_t = \alpha_0 + \beta_t + (\rho - 1) S_{t-1} + \sum_{i=1}^{\rho} \delta_i \Delta I_{t-\rho} + \varepsilon_t \quad (4.4)$$

In other words, it must be tested this relationship between $(I_t, I_{t-1}); (S_t, S_{t-1})$. The statistics are the t-tests of the OLS coefficients for:

[15] This test focuses on finding the most negative t-statistic. In other words, as more negative is t-statistic, the possibility to reject null hypothesis is stronger.

[16] It is important to highlight the use of Modified Akaike Criterion, as a parametric correction tool in order to choose the optimal number of lags into regressions.

$$\begin{cases} H_0: \rho = 1 \longrightarrow \text{AR (1) = I (1)} \\ H_1: \rho \neq 1 \longrightarrow \text{Stationary variable = I (0)} \end{cases}$$

4.1.2. Elliot, Rothenberg and Stock (1996) test

Secondly, we will proceed with ERS test, created by Elliot, Rothenberg and Stock (1996), as an upgrading of the previous ADF test. They proposed an econometric test that allows to detrend the regression. Namely, this test filters gross saving and investment rates from their deterministic components. They tried to increase the power of the previous test and to help filtering time variables to analyse. In order to achieve the removal of the trend, they took into consideration two regressions[17]:

$$I'_t = d_t + \mu_t \tag{4.5}$$

where, d_t is the deterministic trend element. Following this econometric procedure:

$$\begin{aligned} I_t &= \alpha_0 + \beta_t + \mu_t \\ \mu_t &= I_t - \alpha_0 + \beta_t = I_t' \end{aligned} \tag{4.6}$$

And then, testing the stationarity of residuals.

$$\mu_t = a\mu_{t-1} + v_t \tag{4.7}$$

where v_t is included as a stationary error. The hypothesis should be tested is:

$$\begin{cases} H_0: a = 1 \longrightarrow \text{AR (1) = I (1)} \\ H_1: a < 1 \longrightarrow \text{Stationary variable = I (0)} \end{cases}$$

4.1.3. Kwiatkowski et al. (1992) test

As a third econometric test, in this case with the null hypothesis of stationarity or I (0), versus autoregressive model or I (1), it is Kwiatkowski et al. (1992) test (henceforth, KPSS test). As Carrion-i-Silvestre and Sansó (2006) showed: "In contrast to unit root

[17] It is going to be showed Gross Investment Rate case. Gross Saving Rate has to follow same methodology.

tests, this test specifies the null hypothesis of stationarity and the alternative of non-stationarity, so they can be seen as the reversal complement of the unit root tests". Furthermore, KPSS is proposed as a solution because of the problems that may be arisen when the sample is not extensive enough.

The KPSS[18] test consists of breaking the series down in three different elements: a deterministic trend (δ_t), a random walk (β_t) and a stationary error (ε_t)[19]:

$$I_t = \delta_t + \beta_t + \varepsilon_t \quad (4.8)$$

$$\beta_t = \alpha\beta_{t-1} + \mu_t \quad (4.9)$$

In order to test the stationarity of the main variables, it must be accepted or rejected following null hypothesis. The statistics are based on the Lagrange multiplier, and critical values are obtained, in our case, from Eviews:

$H_0: \alpha = 0$ → AR (1) = I (1)

$H_1: \alpha \neq 0$ → Stationary variable = I (0)

4.2. Cointegration

However, the fact based on the large relationship between investment and saving has not been analysed yet. In this part, what is going to be tested is the existence of cointegration. In other words, whether there is long-run relationship between the two variables, savings and investment. In order to find cointegration, there are two requirements:

- The two variables (gross investment and saving rates) have to be non-stationary processes, or I (1).
- It must exist a lineal combination between both and it has to be stationary, or I (0)[20].

[18] KPSS test is based on the variance of residuals. Basically, if it is obtained a small variance, it means that the process follows a stationary method.

[19] This is the case for Gross Investment Rate. Gross Saving Rate has to follow same methodology

[20] See Theoretical Aspects in order to remember the relationship between Investment and Saving.

As a result, it can be said that two time series are cointegrated if they have the simultaneous movements throughout the time and their differences among them are stables or stationary, although each time series had an stochastic tendency and they followed a unit root model in its particular behaviour. In this way, cointegration reflects a long-run equilibrium between the main variables.

First of all, it will be estimated OLS regression and with their residuals, applied ADF test, based on Engel and Granger[21] (1987) test. They were eminences in the eighties due to their work on stationarity and the existence of common trends and volatility. According to the mention made in Hansen (1992)**:** "they suggested that the residuals from OLS estimation of the cointegrating regression be examined for the presence of a unit root in the autoregressive representation". They suggested several tests, but the most popular probably was the augmented Dickey-Fuller (ADF) test.

4.3. Introduction of Structural Breaks

Finally, it has been tested the relationship among investment and saving, including structural breaks (henceforth, SB) in order to account for potential instabilities, to be expected as the variables start in the seventies. Many economists have tested for structural changes for economic indicators, such as Haug et al. (2011) basing their paper on Fisher effect. The purpose of including this method in this project account for structural breaks and to include them in the empirical results. As a result, it will be possible to compare Dynamic OLS, and Dynamic OLS with structural breaks. In this way, we will find evidence of consistency in the final results.

[21] Engle and Granger were awarded with Nobel in Economics 2003 due to their papers based on time series analysis in economic risks and financial markets.

5. EMPIRICAL RESULTS

5.1. Results of unit root tests

Using the econometric programme Eviews, it has been possible to obtain the estimations for the first part of the investigation. In other words, applying unit root test such as ADF, ERS and KPSS, it can be analysed if the two main variables (gross investment and saving rate) have high persistence or are stationary.

As it can be observed in the tables, the results for the variables in differences are quite conclusive, and can be summarized as follows:

- ADF tests in differences for Gross Investment Rate and Gross Saving Rate database: It can be rejected the null hypothesis of two-unit roots at any level of significance.
- ERS tests in differences for the two main variables: Knowing that this technique includes improvements, it can also be rejected the null hypothesis of two-unit roots. However, this conclusion is not as clear as in previous test, in the case of Gross Saving Rate results.
- KPSS tests in levels using the model with a constant, and constant and trend for Investment and Saving, respectively. The null hypothesis is generally rejected, when a constant is included for both variables. However, in the model with a trend, null hypothesis can-not be rejected so clearly. A potential reason for this contradiction is the presence of structural breaks.

Furthermore, we apply the ADF and ERS tests in levels to cover all stages of the econometric investment and saving process. As it can be expected, in contrast to the variables in first differences, the null hypothesis of a unit root existence can-not be rejected in any case of gross saving and investment rates, so that we conclude that the variables are non-stationary. For instance, including a constant and a trend in the regression, it results a t-statistic of -2,67 versus a critical value of -3,18 (α=10%), -3,51 (α=5%), -4,17 (α=1%), in the Spanish ADF case for Gross Investment Rate.

	ADF			ERS	
	τ_μ	τ_τ	τ	τ_μ	τ_τ
France	**-4.32*** **	**-4.40*** **	**-4.32*** **	**-4.20*** **	**-4.40*** **
Germany	**-4.05*** **	**-4.21*** **	**-3.87*** **	**-1.89**	**-3.89*** **
Great Britain	**-4.74*** **	**-4.68*** **	**-4.69*** **	**-4.75*** **	**-4.78*** **
Italy	**-4.84*** **	**-4.80*** **	**-0.86**	**-4.82*** **	**-4.85*** **
Japan	**-4.35*** **	**-4.30*** **	**-4.21*** **	**-0.72**	**-4.25*** **
Spain	**-3.78*** **	**-3.77** **	**-3.83*** **	**-2.89*** **	**-3.19** **
USA	**-3.74*** **	**-3.74** **	**-3.77*** **	**-3.78*** **	**-3.82*** **

Table 1: *Unit root and stationarity tests (ADF and ERS) to the variable Gross Investment Rate in differences. Source: Author's results.*

	ADF			ERS	
	τ_μ	τ_τ	τ	τ_μ	τ_τ
France	**-5.28*** **	**-5.35*** **	**-5.18*** **	**-5.28*** **	**-5.47*** **
Germany	**-5.77*** **	**-6.15*** **	**-5.83*** **	**-0.45**	**-1.15**
Great Britain	**-6.39*** **	**-6.34*** **	**-1.23**	**-6.45*** **	**-6.46*** **
Italy	**-6.91*** **	**-6.82*** **	**-6.91*** **	**-1.03**	**-1.31**
Japan	**-2.83***	**-2.89**	**-2.56** **	**-0.45**	**-1.47**
Spain	**-3.40** **	**-3.52** **	**-3.42*** **	**-3.33*** **	**-3.64** **
USA	**-4.00*** **	**-3.93** **	**-3.81*** **	**-3.86*** **	**-3.83*** **

Table 2: *Unit root and stationarity tests (ADF and ERS) to the variable Gross Saving Rate in differences. Source: Author's results*.

	ADF			ERS		KPSS	
	τ_μ	τ_τ	τ	τ_μ	τ_τ	η_μ	η_τ
France	-1.80	-1.43	-0.80	-1.42	-1.68	0.48**	0.18**
Germany	-2.602	-2.32	-1.49	1.31	-1.90	0.78***	0.06
Great Britain	-0.80	-2.38	-1.00	-1.03	-2.29	0.79***	0.06
Italy	-0.45	-1.90	-1.12	0.11	-1.95	0.73**	0.10
Japan	-0.65	-1.64	-1.41	0.11	-1.63	0.80***	0.08
Spain	-2.64*	-2.67	-0.42	-2.52**	-2.80	0.08	0.08
USA	-1.23	-2.08	-0.63	-1.37	-1.89	0.38*	0.09

Table 3: *Table of ADF, ERS and KPSS in levels – results for Gross Investment Rate.*

Source: Author's results.

	ADF			ERS		KPSS	
	τ_μ	τ_τ	τ	τ_μ	τ_τ	η_μ	η_τ
France	-2.33	-2.07	-1.60	-0.68	-1.67	0.56**	0.141*
Germany	-2.55	-3.32*	-0.46	-0.96	-1.28	0.18	0.15**
Great Britain	-1.14	-0.40	-1.56	-0.41	-2.75	0.84***	0.102
Italy	-1.63	-3.19*	-0.85	-0.45	-3.12*	0.75***	0.073
Japan	-1.94	-2.01	-1.70*	-0.17	-1.76	0.80***	0.099
Spain	-3.03**	-1.85	-0.35	-0.93	-1.08	0.13	0.12*
USA	-0.21	-2.87	-0.95	-0.07	-2.53	0.77***	0.09

Table 4: *Table of ADF, ERS and KPSS in levels – results for Gross Saving Rate.*

Source: Author's results.

5.2. Engle and Granger (1987) test

Once, it has been obtained first conclusions, that is the non-stationarity of the two variables, it is possible to continue with results from next step. Previously, it has been said that second part is going to be based on cointegration and SB, in order to extend and analyse relationship between investment and saving. The study of how these variables may be related to each other in long-term, and the capability to identify economic, political and social facts which can be the key of its high persistence, are going to be the focus of the project.

Firstly, it must be estimated OLS regression for each country. Formally, what is going to be estimated is[22]:

COUNTRY	*ECONOMETRIC REGRESSION*
France	$I_{Ft} = \alpha_0 + \beta_1 S_{Ft} + \varepsilon_t$ $I_{Ft} = 8.994 + 0.587 S_{Ft}$
Germany	$I_{Gt} = \alpha_0 + \beta_1 S_{Gt} + \varepsilon_t$ $I_{Gt} = 16.306 + 0.268 S_{Gt}$
Great Britain	$I_{GBt} = \alpha_0 + \beta_1 S_t + \varepsilon_t$ $I_{GBt} = 5.372 + 0.759 S_{GBt}$
Italy	$I_{It} = \alpha_0 + \beta_1 S_{It} + \varepsilon_t$ $I_{It} = -0.800 + 1.000 S_{It}$
Japan	$I_{Jt} = \alpha_0 + \beta_1 S_{Jt} + \varepsilon_t$ $I_{Jt} = 4.463 + 0.802 S_{Jt}$
Spain	$I_{St} = \alpha_0 + \beta_1 S_{St} + \varepsilon_t$ $I_{St} = -3.361 + 1.188 S_{St}$

[22] Those coefficients which are above 0.5 are written in blue. It has to be understood that these coefficients are general for complete period of the sample. They are not specific. Relationship among investment and saving is large for France, Great Britain, Italy, Japan and Spain.

USA	$I_{USAt} = \alpha_0 + \beta_1 S_t + \varepsilon_t$ $I_{USAt} = 12.957 + 0.431 S_{USAt}$

Table 5: *OLS results for each country[23]. Source: Author's results.*

Secondly, continuing with the econometric methodology and testing the existence of cointegration, we are going to use Engle and Granger (1987)[24] test. Following their two-steps method, it must store OLS estimated residuals from each-country regression and test them under ADF unit root test (in levels and without any constant and trend), in order to test its stationarity. In other words, the purpose of this test has been to test whether the relationship between the two variables is stationary, that is, if the residuals do not contain a unit root. The next estimation is an auxiliary regression in order to test residuals from each-country OLS estimation:

$$I_t = \alpha_0 + \varphi_1 S_t + \mu_t \tag{5.1}$$

$$\Delta\mu_t = (\rho - 1)\,\mu_{t-1} + \varepsilon_t \tag{5.2}$$

The hypothesis that has to be tested is:

$H_0: = 0$ ⟶ Residuals with unit root. No existence of cointegration.

$H_1: \neq 0$ ⟶ Stationarity of residuals. Existence of cointegration.

As a result, using estimated residuals and tested them under ADF unit root test, it must be completely rejected null hypothesis meaning that it must be accepted the existence of cointegration for all the countries in the sample.

[23] It has not been written OLS residuals because of until cointegration were not tested, it is not possible to know if parameters are correct to realise inference.

[24] However, this is not the only test that Engle and Granger (1987) purposed.

Therefore, it is possible to conclude the stationarity of residuals. So, at this point, it possible to say that investment and saving are cointegrated. In this way, the possibility of having spurious relationship between investment and saving is eliminated, and it must be confirmed that long-run relationship among them is strong.

Countries	***Tau-statistic***	***Mackinnon (1992)[25] P-values***
France	-1.638*	0.707
Germany	-2.239**	0.413
Great Britain	-2.696***	0.219
Italy	-1.802*	0.631
Japan	-3.119***	0.103
Spain	-1.724*	0.668
USA	-1.811*	0.627

Table 6: *ADF cointegration test based on OLS residuals. Source: Author's results.*

5.3. Comparative of OLS and DOLS estimations

To improve our estimation and avoid endogeneity and autocorrelation problems, and make the estimators consistent, we estimated each-country regression based on cointegration criteria and using DOLS (Dynamic Ordinary Least Squares method), including one lag and one lead in each one. Generally, the econometric regression model for each country would be:

[25] P-values are obtained from Mackinnon (1992) paper. Accordingly, to him: "This paper provides tables of critical values for some popular tests of cointegration and unit roots". Engle and Granger test stands out between them.

$$I_t = \alpha_0 + \beta_1 S_t + \beta_2 \Delta S_{t-1} + \beta_3 \Delta S_{t+1} + \mu_t \quad (5.3)$$

As it can be seen in Table 8, the dynamic results are more accurate than which are obtained from OLS method. These estimators are now consistent. Theoretically, this kind of method is less strict than OLS group and the existence of the independent variable (Gross Saving Rate) with lags and leads make main statistics unreliable due to multicollinearity problem. Using a dynamic model, it has been possible to use statistical inference and to obtain consistent results for each country, in an asymptotic way.

COUNTRY	***ECONOMETRIC REGRESSIONS***
France	***OLS*** $I_{Ft} = 8.994 + 0.587 S_{Ft}$ ***DOLS*** $I_{Ft} = 9.573 + 0.553 S_{Ft}$
Germany	***OLS*** $I_{Gt} = 16.306 + 0.268 S_{Gt}$ ***DOLS*** $I_{Gt} = 27.092 - 0.190 S_{Gt}$
Great Britain	***OLS*** $I_{GBt} = 5.372 + 0.759 S_{GBt}$ ***DOLS*** $I_{It} = 4.915 + 0.784 S_{It} IT$
Italy	***OLS*** $I_{It} = -0.800 + 1.000 S_{It}$ ***DOLS*** $I_{It} = -3.258 + 1.103 S_{It}$
Japan	***OLS*** $I_{Jt} = 4.463 + 0.802 S_{Jt}$

	DOLS $I_{Jt} = 3.763 + 0.824S_{Jt}$
Spain	***OLS*** $I_{St} = -3.361 + 1.188S_{St}$ ***DOLS*** $I_{St} = -8.537 + 1.418S_{St}$
USA	***OLS*** $I_{USAt} = 12.957 + 0.431S_{USAt}$ ***DOLS*** $I_{USAt} = 12.865 + 0.435S_{USAt}$

Table 7: *OLS and DOLS comparative. Source: Author's results.*

5.4. Hansen (1992) Instability Test

Nevertheless, the existence of structural breaks in this data can predict misleading results, and obtain conclusions which are not comparable to current facts. In front of this econometric problem, it has proposed Hansen (1992) instability test. As he suggested: "trends be excluded in the levels regression for maximal efficiency". In this way, cointegration should be accepted if the lowest value of ADF has been found. Based on Table 9 results, it is not possible to reject the null hypothesis of cointegration for any of the countries of the sample.

$$\begin{cases} H_0 = Series\ are\ coitegrated \\ H_1 = No\ cointegration \end{cases}$$

COUNTRIES	***Lc statistic***	***p-value***
France	0.009	>0.2
Germany	0.022	>0.2
Great Britain	0.014	>0.2
Italy	0.015	>0.2
Japan	0.021	>0.2
Spain	0.016	>0.2
USA	0.013	>0.2

Table 8: *Hansen instability test results. Source: Author's results.*

5.5. Structural Breaks estimations

As last part of the project, it has realised structural changes regression per each country, in order to detect those years in which economic, political or social causes could affect the relationship between savings and investment in the country. In Table 9 we present the estimation by DOLS taking into account the structural breaks and, therefore, obtaining different estimations for each sub-period. For example, three sub-periods have been detected in France: 1970-1992; 1993-2004 and 2005-2016. In another case, such as USA, five sub-periods have been analysed: 1970-1977; 1978-1988; 1989-1998; 1999-2008; 2009-2016. As a result, these sub-periods must be related to economic fact, which are happened throughout years[26]

COUNTRY	***TIME***	***OBSERVATIONS***	***ECONOMETRIC REGRESSION***
FRANCE	***1970-1992***	***23***	$I_{Ft} = 9.423 + 0.587S_{Ft}$
	1993-2004	***12***	$I_{Ft} = 12.241 + 0.370S_{Ft}$
	2005-2016	***12***	$I_{Ft} = 15.772 + 0.306S_{Ft}$

[26] Four countries have been chosen in order to show possible reasons which caused behaviour changes in economic cycle: France, Japan, Spain and USA.

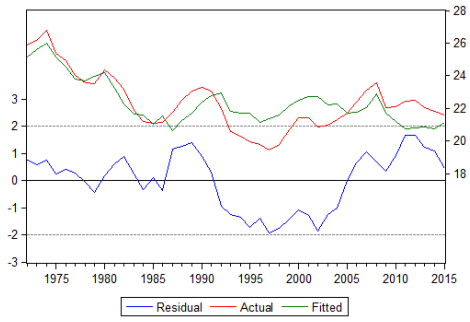
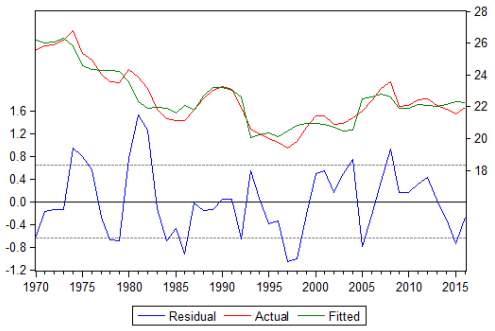
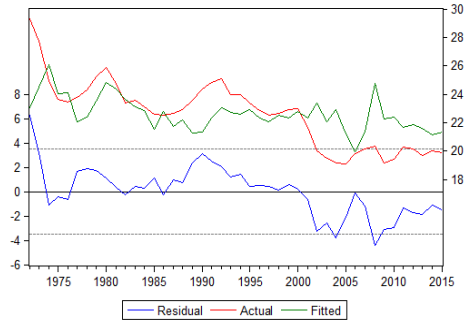
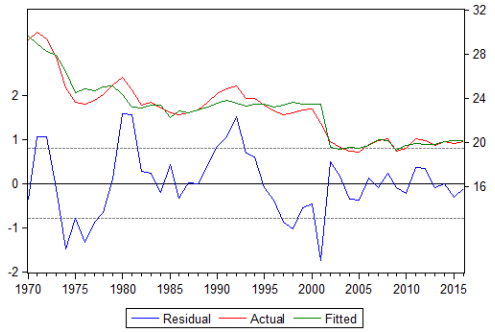
GERMANY	***1970-1984***	***15***	$I_{Gt} = 10.621 + 0.613S_{Gt}$
	1985-2001	***17***	$I_{Gt} = 14.111 + 0.386S_{Gt}$
	2002-2016	***15***	$I_{Gt} = 10.242 + 0.218S_{Gt}$
GREAT BRITAIN	***1970-1979***	***10***	$I_{GBt} = 34.676 - 0.427S_{GBt}$
	1980-2016	***37***	$I_{GBt} = 5.460 + 0.749S_{GBt}$
ITALY	***1970-1982***	***13***	$I_{It} = 24.108 + 0.030S_{It}$
	1983-1992	***10***	$I_{It} = 5.906 + 0.712S_{It}$
	1993-1999	***7***	$I_{It} = 20.341 - 0.058S_{It}$
	2000-2009	***10***	$I_{It} = 15.448 + 0.257S_{It}$
	2010-2016	***7***	$I_{It} = 48.132 - 1.551S_{It}$
JAPAN	***1970-1982***	***13***	$I_{Jt} = 11.529 + 0.625S_{Jt}$
	1983-2002	***20***	$I_{Jt} = 5.454 + 0.760S_{Jt}$
	2003-2016	***14***	$I_{Jt} = 15.254 + 0.342S_{Jt}$
SPAIN	***1970-2003***	***34***	$I_{St} = 4.221 + 0.861S_{St}$
	2004-2016	***13***	$I_{St} = -46.180 + 3.016S_{St}$
USA	***1970-1977***	***8***	$I_{USAt} = 5.761 + 0.710S_{USAt}$
	1978-1988	***11***	$I_{USAt} = 16.301 + 0.314S_{USAt}$
	1989-1998	***10***	$I_{USAt} = -3.536 + 1.209S_{USAt}$
	1999-2008	***10***	$I_{USAt} = 15.621 + 0.363S_{USAt}$
	2009-2016	***8***	$I_{USAt} = 9.886 + 0.565S_{USAt}$

Table 9: *Structural changes results. Source: Author's results.*

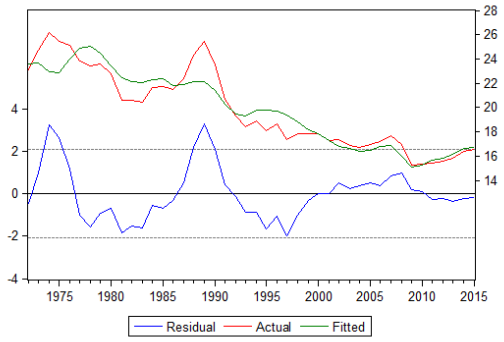
On the other hand, it will be possible to have a comparative among residuals based on Dynamic OLS without breaks, and residuals extracted from structural breaks regression, referring to Table 9. This is another way to test for the existence of cointegration. Basically, it is going to be observed if residuals are stationary, or in contrast, they follow an autoregressive model (main hypothesis of cointegration). It is important to remark two points that are common among countries of sample:

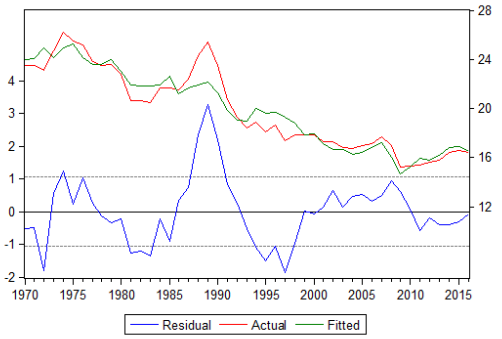
- Residuals based on Dynamic OLS without breaks are less accurate than those resulted with DOLS in SB regressions. The explanation is the presence of economic, political and social changes, captured by the structural breaks.
- In this graph analysis, it has been possible to detect the stationarity of residuals, and therefore, the accomplishment of cointegration condition.

Then, these are graphs of the adjustment and residuals obtained from the estimation of the savings-investment relationships using DOLS and DOLS with structural breaks.:

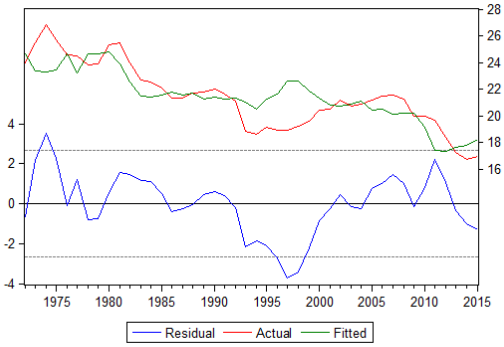
	DYNAMIC OLS	**DOLS WITH SB**
FRANCE		
GERMANY		

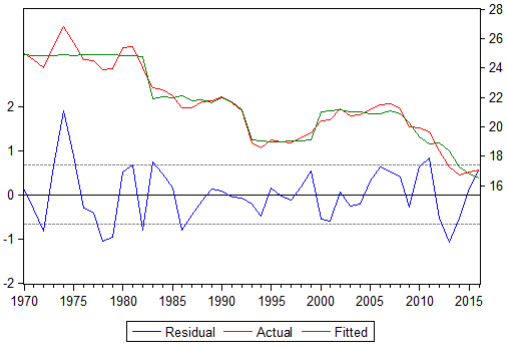
GREAT BRITAIN



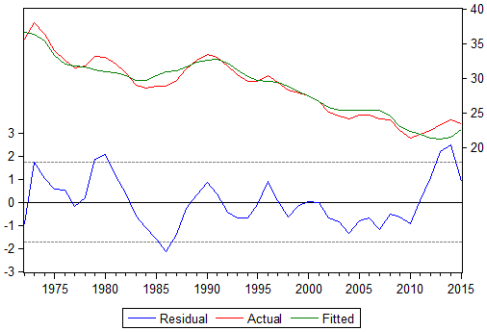


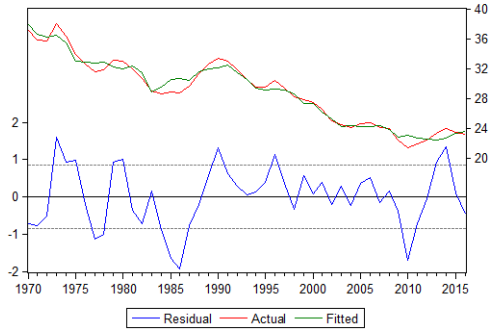
ITALY



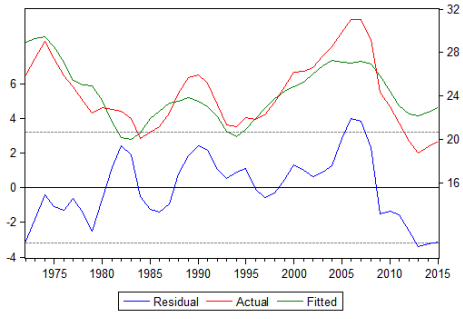


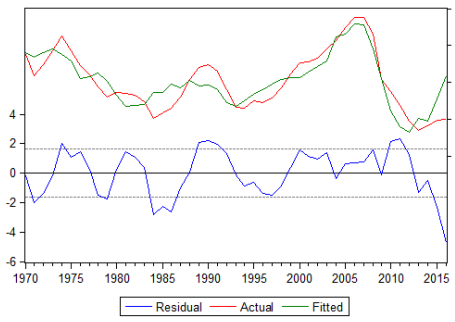
JAPAN





SPAIN





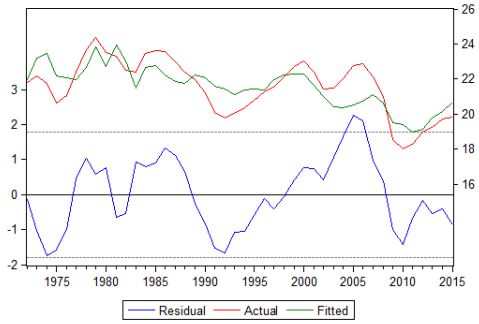
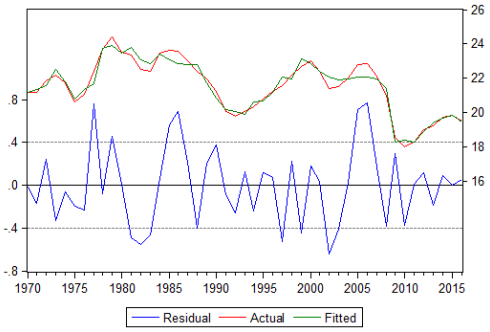
UNITES STATES OF AMERICA		

Table 10: *Comparative among DOLS residuals and DOLS with Structural Breaks residuals for each country. Source: Author's results.*

5.5.1. Economic facts related to each-country structural breaks

Finally, as it has been indicated previously, and as SB regressions have been estimated, we are going to analyse each structural break detected for countries of the sample[27], and we will relate them to most relevant economic facts. It is focused on a comparative between graphs which shows the tendency followed by gross investment and saving rates[28], and SB regression for each country according to Table 9 above. This is justified in order to give some reasons that can explained economic changes in each one[29].

5.5.1.1. Members of the European Union

For example, first cases that have been analysed are the group of EU members: France, Germany, Great Britain, Italy and Spain. The time frame can be divided in different sub-periods, which are strongly related to economic and political changes. The fact that is important to observe is how saving coefficients are decreasing throughout years, in accordance to gross investment and saving rates linear graph. The explanation of this situation has been based on the elimination of trade barriers and intensification of migration due to the increasing commercial and financial integration in

[27] France, Germany, Great Britain, Italy and Spain are going to be analysed as a unit due to they are members of European Union, and most economic facts were common among them.

[28] See Appendix C to find linear graphs based on investment and saving data.

[29] Most countries of the sample are part of European Economic and Monetary Union. In addition, it has been included two important countries for international trade and financial movements since seventies.

European Union. This situation, has helped to reduce transactions costs and impulse capital investment to other countries, where rates of return can be much higher.

Moreover, the coincidence between years of SB and changes in linear graph can have three possible causes: Firstly, it was signed Maastricht Treaty in 1992, in which were introduced institutional changes in the EU and the start of the process of convergence towards the Monetary Union. Secondly, gross investment rate starts to increase since 1998, probably due to Finland, Sweden and Austria entrance. Thirdly, the discrepancy between investment and saving during nineties until 2016. The main reason is Great Recession on 2008. This global problem induced European agents to save more in its own country, and reduce its investment to other countries.

As it can be observed in graph, the behaviour of Spain has followed such a different patter from French, German, Italian or British case. Since its entry in the EEC in 1986, Spain has been involved in an economic and financial integration process (period 1970-2003). Spain received external investment flows from intra-community countries as well as international global markets. Nevertheless, its saving coefficient has been relatively high in first subperiod 1970-2003 due to its incapability to confront economic shocks such is oil crisis, inflation, imbalances in balance of payments in eighties

Nevertheless, Spain was one of the countries most seriously hit by Great Recession initiated in 2008. In previous years, gross investment rates were much higher than gross saving rates, meaning that Spain exceeded its economic possibilities and challenged them, generating problems in capital markets. These high levels of investment were accompanied by lower rates of return. As a result, a housing bubble was extended through national companies and families. Once, the bursting of sub-prime mortgage bubble occurred, Spanish investment rates crashed.

5.5.1.2. Japan

Japan is one of the most important savers in the world, as it can be observed in linear graph. Its gross saving rates has always been greater than its gross investment rate. This behaviour has helped them to make a stronger country before opening its trade barriers. As Japan has always been a country with an active industrial policy, they decided to invest in capital, technology, infrastructures development, but above all, in education and healthcare, meaning to create strong social classes. Their saving was being used to finance the industrialisation of country, supporting those industries that will be able to demonstrate its competitiveness in global markets.

Nevertheless, it is possible to find two structural changes where saving coefficients are decreasing in each period, due to the introduction of Japan into global economy. Firstly, celebrated Tokyo Round (1974-1979) and created World Trade Organisation in 1995, Japan increased its gross saving rate in order to confront the reduction of global tariffs and strengthen its link between industry and development. On the other hand, they had also decreased its levels of investment and saving at same time, allowing new investment from other countries since 2003.

5.5.1.3. United States of America

Finally, it has been detected five different subperiods for USA. Since II Word War, USA had experienced an economic boom, which concerned to an expansion of industry, stable growth of prices, and high employment rates. Nevertheless, as European countries were recovering their markets, the growth of USA, a country that had been the largest commercial creditor in terms of raw materials and manufactured products, was stagnant. In order to confront this situation, USA began printing massive dollars as a solution.

Consequently, it caused the indebtedness of national accounts, the increase of prices, and therefore, the rise of inflation. This situation was aggravated by oil crisis succeeded in seventies, and produce the rise industrial and transaction costs. As it can be observed in linear graph, gross saving rate was an important funding source in order to soften this economic impact in inside markets. In consequence, Federal Reserve Bank was forced to apply a contractive monetary policy, in order to stall the non-stopped inflation. This fact leaded to bring the employment, and generally, whole American economy down.

Therefore, seventies and eighties were included in a deeply recession, and investment levels logically went down. However, the end of Bretton Woods and the introduction of flexibility in ex-change rates in 1971 were a good conductor to push capital market integration with the rest of the world. During nineties, USA recovered its global position, based on control of prices, political and labour stability. As third SB sub-period, the level of saving increased significantly in its process of recovery and probably, due to the Asian crisis in 1997. However, American integration was accelerated into world economy, and as a result, generated new competitiveness strategies regarding other countries.

Nevertheless, these years of capital liberalization flows (1999-2008) were interrupted by the bankruptcy of Lehman Brothers[30]. This crisis was expanded through global markets and caused a ripple effect. As a solution, the injection of money was crucial in order to enable the banks financing and give an exit to business operations. Despite of being the origin of the problem, USA took action rapidly. In recent years, saving rates has increased among families and companies in order to avoid fear when markets start to speculate, as an effect of the Recession.

[30] This was one of the most important banks in USA. The high valuation of properties and the granting of fast and easy loans, generated uncertainty and mistrust in stock markets. In consequence, fear and risk were transferred to national agents.

6. CONCLUSION

The main objective of this project has been to analyse Feldstein-Horioka puzzle using econometric techniques with breaks. As many economic indicators[31] which have lots of connections among them, these authors found large persistence between investment and saving data during the period 1960-1974 in their original paper. However, this strong relationship was not directly related to the process of trade and financial liberalization which most countries of the world were experienced. Any justification was found, and this economic problem opened new horizons for others future econometric investigations. In this paper, a sample of seven countries has been used in an annual time series data for the period 1970-2016.

In the empirical literature, the inclusion of some instrumental variables achieved a soft reduction in saving retention coefficient, as well as, the justification based on market failures. However, large persistence was remaining and, in this investigation, we have tried to analyse if the large coefficient obtained changed along time as a consequence of world globalization and economic integration in Europe.

The first step of the analysis has been testing for the existence of unit roots in investment and saving respectively. Three tests have been used, in order to confront autoregressive model to the stationarity of variables. At this point, it has been possible to conclude that the main variables are non-stationary.

Secondly, it has been estimated relationship between investment and saving in the long-run. This econometric technique is known as cointegration, and it has been used as an approach of this puzzle. Basing on residuals of OLS regression and applying, Engle and Granger (1987) test, cointegration among investment and saving is clearly accepted. In order to complete this step, it has been taken into consideration a comparative between Ordinary Least Squares (OLS) and Dynamic OLS (DOLS). This last method allows us to work with consistent estimators

Finally, we have allowed for structural breaks in the previous DOLS estimations for each country and we have tested for cointegration. In essence, as trade and financial integration were progressing, it has been found a reduction of saving retention coefficient. Furthermore, we have found structural breaks in investment and saving data using Dynamic OLS that allow the author find adjusted and consistent estimations.

[31] For example, Nelson and Plosser (1987) indicated that some variables such as employment, wages or consumer prices followed an I (1) model. In other words, they remain stochastic trends throughout time.

On the other hand, economic, social and political events such as oil crisis during seventies and eighties or the burst of the housing bubble in 2008 have been linked to SB detected for each country. They had relevant implications in each country of the sample, and forced behaviour's changes in national agents and companies.

In conclusion, the author has tried to extend the studies based on Feldstein-Horioka puzzle. The use of unit root test, the application of more advanced econometric techniques and the possibility of relating the evolution of the economy and the integration process to the structural breaks detected have been our objective. Despite the non-stationarity of the two variables, we find cointegration for all countries of the sample, with a saving retention coefficients that have been decreasing, with economic convergence over time. As a result, we have definitely found less evidence of the Feldstein-Horioka puzzle.

APPENDIX

APPENDIX A: Closed economy cycle

The totality of the resources allocated to domestic expenditure is based on the sum of three elements, and as a result, we have the Gross National Expenditure (GNE).

$$GNE = Consumption(C) + Investment(I) + PublicExpenditure(PE) \quad \text{(A.1)}$$

Once this equivalence is obtained, it must be included the payment of all those goods and services that have been manufactured in the domestic economy. In this way, it must subtract from the income generated by goods manufactured by companies, the payment of those resources which companies have used to manufacture goods and offer services. They are known as factors of production. By doing this operation, it will obtain the Gross Domestic Product (GDP). Since it is a nation that is not open to the outside, GNE will be equal to GDP.

$$GNE = GDP \quad \text{(A.2)}$$

All income that has been generated in the companies due to the production of the goods, and, once the factors of production have been paid, the companies send the positive balance created, the incomes, to those in charge of providing the work and the capital to the companies in order to produce. The agents of the domestic economy are who lends the factors of production in a country with a closed economy. Therefore, the earnings are directed to the agents constituting the total flow of income, which subsequently will be used to pay the expenses. This is the Gross National Income (GNI), and as a result:

$$GNE = GDP = GNI = GNE \quad \text{(A.3)}$$

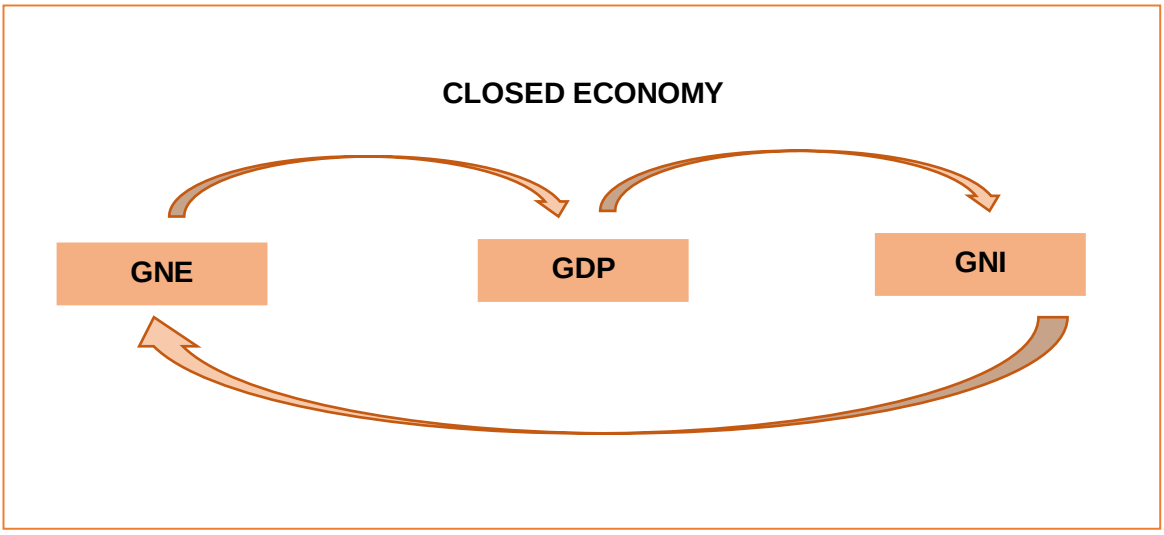


Figure 1: *General system of a closed economy. Source based on Feenestra and Taylor (2012).*

APPENDIX B: Open economy cycle

Firstly, it must be subtracted (from the GNE) the imported goods and services payment from abroad, as well as, we will add to GDP, those revenues of the national companies that have been generated due to the exports undertaken. Consequently, it must be included the Commercial Balance (BC), which is the difference between the exports and imports made, to the GNE, and it will be obtained:

$$GNE + CB = GDP \tag{B.1}$$

On the other hand, it will be payed external income received by agents who provide their production factors, in other words, the provision of foreign labour and capital. Likewise, the income generated (by lending these factors of production abroad) will be included in the value of GDP. This is known as Net Foreign Factors Income (NFFI), which is the difference between exports and imports of productive resources. Adding this element, to the value of GDP, it would be the new Gross National Income (GNI), meaning, the total income that would obtain the national agents, including those from abroad.

$$GDP + NFFI = GNI \tag{B.2}$$

Finally, it is necessary to include net unilateral transfers (NUT). That is to say, the economic transfers (such as financial support, donations from abroad or wages that immigrants send their families in their country of origin) will be subtracted from the GNI. On the contrary, the GNI will be increased by the monetary assistance that come from foreign economies. As a result, it will obtain the Gross National Disposable Income (GNDI), which is the total income that domestic country sustains, adding the GNI and the NUT.

$$GNI + NUT = GNDI \tag{B.3}$$

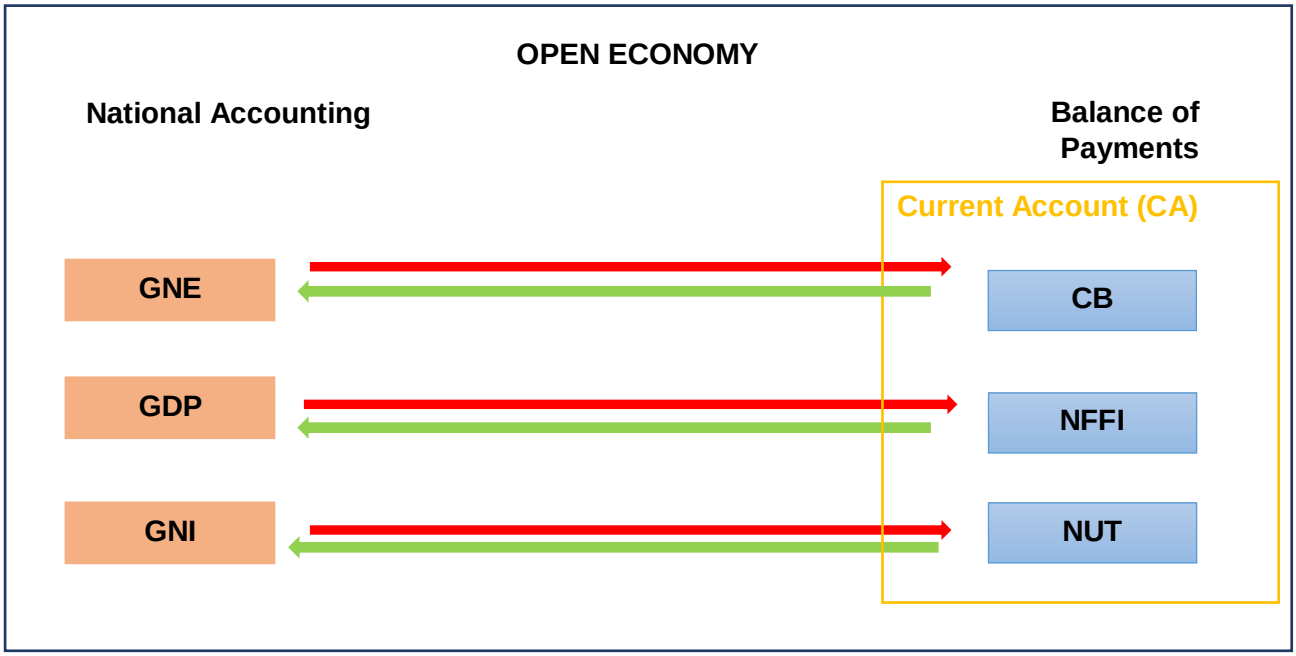
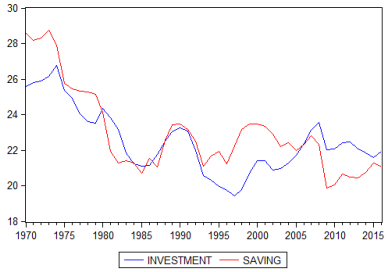


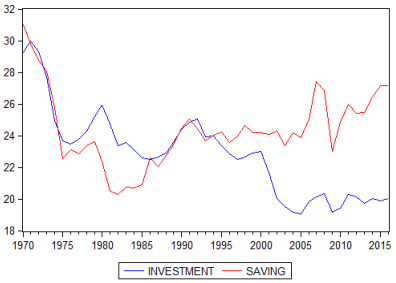
Figure 2: *General system of an open economy. Source based on Feenestra and Taylor (2012).*

APPENDIX C: Description of the variables. Graphs by country.

FRANCE



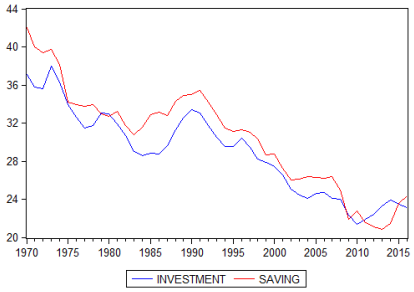
GERMANY



GREAT BRITAIN

ITALY

JAPAN



SPAIN

UNITED STATES OF AMERICA

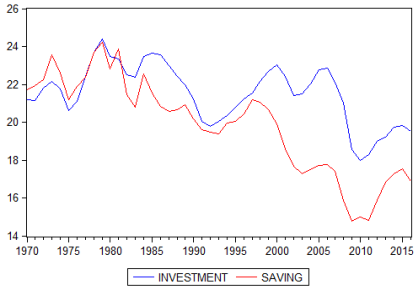


Table 11: *Description of the variables. Graphs by country. Source: Author's results.*

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