THE EX-ANTE INFLATION CORRECTED GOVERNMENT BALANCE: THEORY AND APPLICATION TO TEN OECD COUNTRIES

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Abstract

The thesis uses a conventional consumption function, annual data for a number of OECD countries and up-to-date precise econometric techniques to assess the extent to which consumers allow for the effects of inflation on conventional measures of income and wealth. More concretely, it uses a life cycle consumption function, which is estimated for both the long run and the short run for 10 OECD countries. For the estimation of the long run function, the Johansen approach is used. This estimation is followed by the estimation of an error correction model. The latter is accompanied by the performance of all the necessary statistical tests regarding the validity of the classical regression assumptions. In the case of a number of countries considered the wealth variable used includes series of housing wealth generated in the thesis using the perpetual inventory method. Regarding the data for the remaining variables, our effort was to use data for as many years as possible. Thus, usually the sample extents from mid-fifties to early nineties. The data sources were the OECD, the IMF, and in some cases national sources. Regarding now the estimates of the degree of income correction, the results show that the long run one exhibits considerable variation from country to country, while the short run one is generally rather low. The estimates of the short and the long run degree of income correction are used to correct the official current account government balance for the effects of inflation. The government balance as it is corrected by our approach is many times considerably different from both the conventional balance and the traditionally corrected one, while substantial are sometimes the differences between the short run and the long run estimates of this balance.

To my Father

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INTRODUCTION

The purpose of this thesis is to present a different approach to the inflation correction of the government balance. The need for adjustment of the official statistics for the effects of inflation didn't appear until mid-seventies, when double digit inflation rates became a painful reality for many industrialised countries. Actually, it was not earlier than 1979 when the first papers about the inflation correction of government and saving statistics appeared[1]. However, a look at those papers, as well as at those that were written later, shows that the inflation correction is carried out in an accounting fashion and the estimates are no more than ex-post ones. Thus, they have very little usefulness as indicators of the economic effects of the fiscal policy. In fact, it is this weakness that attracted the attention of the author of this thesis. Indeed, what this thesis tries to do is to derive what has not yet been derived i.e. an ex-ante inflation corrected measure.

To move from ex-post to ex-ante measures what is needed is an estimate of the degree by which people correct their nominal incomes for the effects of inflation on the real value of their monetary assets. This degree could also be identified as the opposite of the degree of money illusion. If people suffer from complete money illusion they will not understand the effects of inflation on the real value of the government debt that they own and therefore the government balance that should be used for the examination of the effects of the fiscal policy on the economy will not be the inflation corrected one, but the conventional one. If the degree of money illusion is neither full nor zero, then the ex-ante balance will be somewhere between the conventional one and the ex-post inflation correction one. It is therefore necessary, if we want the inflation corrected figures to make

[1]See Taylor C.T. and Threadgold A.D. (1979) and Siegel (1979).

any sense, to estimate the degree of income correction and then to utilise this degree for the derivation of ex-ante estimates.

The first chapter of this thesis starts presenting the reasons that we need inflation correction. Then, the traditional approach to inflation correction is presented and evaluated. Finally, we derive an ex-ante measure of the inflation corrected government balance.

The second chapter starts the effort for the empirical estimation of the ex-ante measure by presenting a review of the various attempts to estimate the degree of income correction. As it will be seen, all the existing studies estimate the degree of income correction through a consumption function. Since the existing studies are very few in number, each of them will be presented separately. After this presentation, the chapter continues with a critical examination of these models and an exposition of their problems.

These problems are faced in the third chapter of the thesis that starts presenting the concepts of unit roots, cointegration and error correction model. Then these concepts are utilised to develop a valid econometric framework for the estimation of the degree of income correction. As it will be seen, the model, that also discriminates between the long run and the short run degree of income correction, manages to solve most, if not all, of the problems of the previous attempts.

Since the estimation of the degree of income correction will be done through a consumption function, the problem of lack of data on total wealth becomes apparent. This problem is faced in chapter 4, where a method based on capital-output ratios is utilised to obtain a benchmark value for the stock of dwellings[2]. This initial value is then utilised to start the Perpetual Inventory Method which in turn gives us estimates of the stock of dwellings. To evaluate the

[2]The assumption is that all the non-financial wealth of the households is in dwellings.

derived estimates, we compare them with the official data, when such data are available.

After the estimation of data on total wealth, in Part B we estimate the degree of income correction (short run and long run) for 10 OECD countries. These estimates are then applied to derive corresponding estimates of the ex-ante inflation corrected government balance. Each country is examined as a separate case study. Finally the thesis closes with a conclusion.

PART A

CHAPTER 1

INFLATION CORRECTION: A THEORETICAL TREATMENT

1. Introduction

In the most part of the last 20 years, many of the western economies suffered from high inflation rates and high ratios of government deficit and debt to Gross Domestic Product (GDP). The traditional explanation for this co-existence of high inflation rates with high percentages of public deficit/debt is based on the assumption that the causality runs from the deficit to inflation. Thus it is supposed that, a high public deficit denotes an expansion of the fiscal policy which results in inflation and this is the reason that high percentages of public deficits/debt co-exist with high inflation rates.

Starting from the innovative work of C. T. Taylor and A. R. Threadgold (1979), a new view has been proposed. According to this view, the national accounts statistics that include, either as payment or as income, interest payments/receipts (as such statistics one could refer the government balance, the private savings, the balance of payments etc.), should be fully corrected for the effects of inflation on the real value of the monetary assets that the respective sector (government, private, external) possesses. The reasons for such corrections as well as the way that they are usually carried out will be examined in sections 2 and 3 respectively. Section 4 will consider the deficiencies of this usual way of computing inflation-corrected statistics and will present a different approach. As it will be seen, both the conventional measures and the corrected with the usual way ones are based on extreme assumptions about economic behaviour. These assumptions will be relaxed under a different approach undertaken here[1].

[1]From here onwards, the following terminology will be applied: the term "conventional measures" will denote the measures that follow the definitions of the national accounts; the term "traditionally corrected measures" or "ex-post" measures will denote the conventional measures as they are corrected by the

2. Why inflation correction ?

The main justification for the inflation correction of the national accounts is that the national accounts statistics do not take into account the fact that the real value of the monetary assets that the various sectors possess is eroded by inflation. In contrast, they treat the whole nominal net interest receipts as income, ignoring that at least part of these payments may not be real income but just a compensation for the erosion of the principal because of inflation. But let's expose the argument regarding the need for inflation correction more analytically.

Let's suppose that the government issues short term, non-indexed internal debt[2] to cover a deficit of £1,000,000 of the budget of year t-1. Also, let's suppose that the expected inflation rate for year t is zero and that the annual nominal interest rate is 5%. Moreover, let's assume that the nominal interest rate is determined by a Fisherian scheme i.e.:

$$n_t = r^e + \pi^e_t \qquad \text{E.1.1}$$

where : n_t is the nominal interest rate at period t

r^e is the ex-ante real interest rate that is assumed constant

π^e_t is the expected rate of inflation for period t

According to E.1.1, a higher expected inflation rate for period t will cause the full and immediate adjustment of the nominal interest rate, thus keeping the ex-ante real interest rate constant. In our case, since the expected inflation rate is zero, the real ex-ante interest rate will be equal to the nominal interest rate.

Finally, let's assume that the government's debt at the end of year t-1 was zero and that the government decides to cover the deficit by issuing and selling

approach that is usually followed by the literature; finally the term "ex-ante measures" will denote the inflation corrected measures suggested in this dissertation.

[2]The cases of long term, indexed and external debt will be considered later.

securities that have one year duration and expire at the last day of year t[3]. Since the nominal interest rate is 5%, the interest payments of the government in period t will be £50,000. Of course, the government will also have to repay £1,000,000 which is the amount that it borrowed in the beginning of year t. However, this amount is just an amortisation payment, a return of capital, and as such it is assumed that it will not be considered by the private sector as income generated in period t. In contrast, the £50,000 is a return on capital for its services in period t, and therefore it is income generated in that year. Thus, the National Accounts will record the £50,000 as an expense of the government and as income of the private sector. As long as the expected (and realised) inflation rate is zero, it is evident that there is no place for any inflation correction since there is no inflation.

Now, let's compare the above case of zero expected inflation with one with positive expected inflation. A comparison of the two cases will help us to see the distortions (if any) that inflation causes. So let's assume that the deficit in period t continues to be equal to £1,000,000 but now the expected inflation rate for year t+1 is positive, say 5%. This increase in the expected inflation rate will press for an equal increase in the nominal interest rate so that the ex-ante real interest rate remain the same (i.e. 5%). In other words, for the government to sell its debt under the same maturity conditions (1 year maturity), it will have to increase the nominal interest rate from 5% to 10%. Assuming that expected and realised inflation rates are again equal, the real interest rate on the government debt is the same as in the previous period (i.e. 5%). Under these conditions, at the end of period t+1 the government will have to make an amortisation payment of £1,000,000 and an interest payment of £100,000. However, part of this interest bill is just a compensation for the loss of the real value of the principal. For, although the

[3]It is implicitly assumed that all the deficit was created on the last day of period t-1 and therefore the need for borrowing was generated at the first day of year t.

initial capital that was invested in the beginning of period t+1 had a **real** value of £1,000,000 , the amount that is taken as a repayment is equal to £1,000,000 only in **nominal** terms. The reason is that the 5% inflation rate has eroded the real value of the invested capital by £50,000. The question here is what is the right treatment of the £100,000 of interest payments that the government pays and the private sector receives? Should only £50,000 be counted as income of the private sector and as an expense of the government, and the remaining £50,000 be counted as an amortisation payment, as the proponents of the traditional view of inflation correction proposes or should all the £100,000 be counted as income (expenditure) of the private sector (of the government), as the conventional treatment of the National Accounts is? On the other hand, why one has to choose only between the exclusion or the inclusion of the **full** amount that corresponds to the monetary erosion of the principal?

Below, we will present the traditional way of correcting the government balance for the effects of inflation. After presenting the traditional view, we will expose a new approach to the inflation correction of the government balance. I believe that the derived by this approach measure is a much better indicator of the effects of the fiscal policy than both the conventional measure and the traditionally corrected one.

3. The traditional way of correcting the government balance for the effects of inflation.

3.1. A review of the literature

The need for inflation correction of the National Accounts was first mentioned in late-70's. Of course, it is not surprising that this happened in a time where the inflation rate had reached some of its highest levels in the post-war period. The first papers written about the subject of inflation correction were those of Taylor-Threadgold (1979) and Siegel (1979). The first of these papers corrected the financial assets statistics of the UK, while the second corrected the government balance and the private savings statistics of the USA. Another important study in the same area was that of Miller (1982) who attempted to correct the government deficit statistics of the UK. In the next year (1983), Cukierman and Mortensen published a study which continues to be one of the most thorough (if not the most thorough) in the area. This study was reprinted in a supplement of the "Studies in Banking and Finance" in 1986. This supplement, with more than twenty articles about the effects of inflation on the national accounts statistics, consists the largest collection of articles written about the traditional approach to the inflation correction.

Reviewing the literature on the traditional approach to the inflation correction, one can see that there are two branches that belong to it and the main difference between them is on whether a distinction is made between anticipated and unanticipated inflation gains/losses. This different view is manifested in the inflation rate that is used to carry out the corrections. So, the one proposes the use of *realised* inflation rates while the other recognises that it would have more economic meaning if one used *expected* inflation rates. Those that support the usage of the expected inflation rate take into account the fact that part of the monetary erosion was expected and for this reason it had been anticipated in increased interest payments. More analytically, according to this view the bond - holders recognise that an amount of the increased interest payments equal to $\pi^e D$ is just a compensation for the loss in the value of the debt that they possess, i.e. an amortisation payment, and therefore they do not treat that amount as income[4].

[4]A full Fisher effect is supposed to be in act in the determination of the nominal interest rates.

To tell it differently, the first view, that proposes the use of the realised inflation rate, does not separate between expected and unexpected inflation losses but it is concerned with the total inflation gains/losses only. On the other hand, the second view considers as inflation correction only the amount that people anticipated as inflation loss of their assets. Thus, although the first view gives the amount that people **really** lose, the second view is nearer to a Hicksian definition of income where: in inflationary times, income "must be defined as the maximum amount of money which the individual can spend this week and still **expect** to be able to spend the same amount in *real terms* in each ensuing week"[5].

Although the second view, by distinguishing between expected and unexpected inflation gains/losses, has ex-ante meanings that the first view lacks, very few have used it for computations of the inflation correction. Really, except for the study of A.Cukierman, K.Lennan and F.Papadia (1985) where a serious attempt to discriminate between expected and unexpected inflation gains/losses is made, all the remaining studies that recognise the role of inflation expectations either use realised inflation rates, justifying this on the assumption of perfect foresight[6], or they make too naive assumptions about inflationary expectations. However, it has to be noted that even the studies that use these naive assumptions about the expected inflation rate are very few while the greatest majority[7] uses the realised inflation rate.

Hence, although some that follow the traditional way of inflation correction recognised that the behavioural and policy implications of anticipated versus unanticipated inflation corrections are different, all of them save very few (from whom only one can be considered as a serious attempt), when it came to the

[5]See Hicks (1946) p.174. The italics are as in the original text, while boldness was added.
[6]This assumption has been rejected by tests based on expectations generated by surveys. See Holden et al. (1985)
[7]See the references in footnote 14.

empirical investigation they got, implicitly or explicitly, the view of those of the other branch of the traditional school whose viewpoint is: "that of national accounting which attempts to measure **actual realised income flows without distinguishing between situations in which individuals had perfect advance knowledge of the flows and situations in which these flows were partially anticipated**"[8]

The presentation of the traditional view of the inflation correction that is done below follows the work of Cukierman-Mortensen i.e. it does not discriminate between expected and unexpected inflation gains/losses. To make a discrimination like this, the only that is needed is to substitute the realised inflation rate for the expected one. If other differences arise they will be exposed in footnotes.

3.2 The traditional approach to the inflation correction of the government balance.

As it was said in the introduction, the period after the first oil shock was a period of high inflation rates and high government deficits[9]. Furthermore, it was a period with really high percentages of government interest payments to GDP. It is exactly this latter item that is distorted by inflation and consequently causes the distortion of the conventionally defined deficit as well. The reason that this happens is because the interest bill of the government, as it is defined in the national accounts, does not give the true debt service because it ignores the fact that part of the government debt has been eroded by inflation. Consequently, in periods of positive inflation rates and positive government debt the conventionally

[8]See Cukierman - Mortensen (1985) p.67. Emphasis added.

[9]Here it should be noted that we subtract from the question "which deficit?". This question is not relevant here, since our analysis is applicable for any measure of government deficit provided that includes the net nominal interest payments as an expense.

defined interest bill and deficit will be exaggerated[10]. To correct this problem, the solution that has been suggested is to include as interest payments only the difference between the nominal interest payments and the inflation erosion of the government debt. More analytically, the government deficit as it is defined in the national accounts is:

$$CCAB = G + n_g L_g - T \qquad \text{E.1.2}$$

where : CCAB is the conventional current account government balance[11]

G is the government expenditure for goods and services

$L_g = B + H$ is the total debt of the general government composed of interest bearing (B) and non-interest bearing (H) debt.

T is the total tax collections net of subsidies.

n_g is the average nominal interest rate on L_g.

Now, let γ be the ratio of the total government debt to GDP and let also f be the ratio of CCAB to GDP i.e. :

$$\gamma = \frac{L_g}{X} \qquad \text{E.1.3}$$

[10]The explanation that the second branch that was referred above gives is different: According to this branch, as the nominal interest rates increase to match the increase in the inflationary expectations the nominal interest payments increase. But since inflation also causes the erosion of the real value of the government debt, part of the increased interest payments could be considered as a compensation for the loss in the real value of the principal . As it can be seen, the difference between the two views of the traditional approach is that the one does not consider part of the increased interest payment as a compensation for the loss of the value of the principal but it is concerned with an accounting correction. On the other hand, the other recognises it and pay attention to the loss that people anticipated that they would lose and for this reason they asked for higher interest payments.

[11]The analysis is equally applicable if instead of the current account balance, we use the net lending of the general government or the general government borrowing requirement. Also, as it is evident by E.1.2 the balance is positive when there is a deficit. In part B this will be reversed and the balance will be positive when there is a surplus.

$$f \equiv \frac{CCAB}{X} \qquad \text{E.1.4}$$

where X is the GDP. According to the followers of the traditional inflation correction view, the ratio of government deficit to GDP, as it is given by E.1.4, is not a reliable measure of the thrust of the fiscal policy even if it is corrected for the effects of the economic cycle. The reason is that E.1.4 does not take into account the implicit amortisation of the government debt caused by inflation. According to this view, for the deficit to be rightly defined, it must exclude from the interest payments an amount equal to the implicit amortisation of the government debt. Now, if π is the inflation rate then the implicit amortisation of the government debt caused by inflation will be equal to πL_g. In turn the inflation corrected deficit will be :

$$\begin{aligned} CCAB' &= G + n_g L_g - T - \pi L_g \\ &= CCAB - \pi L_g \qquad \text{E.1.5} \end{aligned}$$

where : CCAB' is the inflation corrected government balance[12].

Similarly the corrected deficit as a ratio to GDP will be :

$$\begin{aligned} f' &= f - \pi \frac{L_g}{X} \\ &= f - \pi\gamma \qquad \text{E.1.6} \end{aligned}$$

[12]For those that follow the second branch of the traditional approach, the correction must be made using the expected inflation rate and only that part of the government debt that is interest-bearing. In this case, the corrected deficit will be:

$$CCAB' = G + n_a L_g - T - \pi^e B \qquad \text{E.1.5'}$$

As it can be seen from E.1.6, when $\gamma > 0$ the ratio of the conventional deficit to GDP is biased upwards by the amount $\pi\gamma$. Generally, the conventional deficit will be equal to the corrected deficit only in the case where $\pi = 0$ and/or $\gamma = 0$. In any other case, f will be different from $f^{'}$. In the most usual case, where $\gamma > 0$, f will be greater than $f^{'}$. From E.1.6 it can also be seen that the larger the inflation rate and the ratio of the government debt to GDP the larger the bias (as a percentage to GDP). Below we give a numerical example[13] where we compute the percentage of the CCAB to GDP for various values of π and γ, assuming that the inflation corrected deficit is zero. The computations are straightforward using E.1.6:

Table T.1.1: Values of f when $f^{'} = 0$

Inflation rate (π)	**The CCAB as a % to GDP when $\gamma = 0.4$**	**The CCAB as a % to GDP when $\gamma = 0.6$**	**The CCAB as a % to GDP when $\gamma = 1$**
0	0	0	0
0.02	0.8	1.2	2
0.04	1.6	2.4	4
0.06	2.4	3.6	6
0.08	3.2	4.8	8
0.1	4	6	10
0.12	4.8	7.2	12
0.16	6.4	9.6	16
0.20	8	12	20

As it can be seen from the above table, the distortions that inflation causes can be very large. For a country, with a government debt equal to 60 percent of GDP and inflation rate equal to 4 percent, the government deficit, as it is conventionally defined, will be equal to 2.4 percent of GDP, though the inflation corrected one will be zero. If this number does not appear horrible what about

[13]This example is taken from A. Cukierman and J. Mortensen (1985), p.14

economies, like Greece, where $\gamma > 1$ and $\pi \approx 0.1$? In a case like this, the conventional deficit will be as high as 10 percent of GDP, though the traditionally corrected one will be zero!!

As it was said above, responsible for the distortion of the conventional deficit is the distortion of the conventional interest bill that exaggerates the true debt service. The amount of the distortion can be easily computed: If $a' \equiv n_g \frac{Lg}{X}$, then the traditionally corrected ratio of the debt service to GDP will be:

$$a' = n_g \frac{Lg}{X} - \pi \frac{Lg}{X} \Leftrightarrow$$

$$a' = a - \pi \gamma \qquad \text{E.1.7}$$

where a' is the corrected ratio. As it can be seen from E.1.7, the difference between the ratio of the conventionally measured interest payments to GDP and the corrected one is equal to the difference of the ratio of the conventional deficit to GDP from the corrected one. This is not surprising since, as it was said, the cause of the trouble is the distortion of the conventionally defined interest bill. Again, table T.1.1 can be used to give an idea about the size of the distortion.

To conclude this subsection, the proponents of the traditional way of inflation correction of the government deficit support that in periods of high inflation and high government debt the conventionally defined ratios of interest payments and government deficit to GDP, are seriously distorted. The reason is that the interest bill does not include the depreciation of the government debt caused by inflation and consequently exaggerates the true debt service as well as the true deficit. The correction, according to the traditional approach, is equal to the product of the realised inflation rate with the average government debt of the year[14]. In the next subsection another suggested virtue of the inflation corrected deficit will be presented.

3.3 The stock-flow consistency properties of the corrected and the non-corrected government deficit.

Another shortcoming of the conventional government deficit is that it is not stock-flow consistent with the real government debt. A pair of variables x(t) and y(t) is defined as stock-flow consistent if:

$$y(t) = \dot{x}(t)$$

where the variable y is the flow counterpart of the stock variable x. An example of a pair of stock-flow consistent variables is the net investment and the capital stock[15]. In our case the real CCAB and the real government debt are not "stock-flow consistent" variables since, as it will be seen, there may be a decrease in the real government debt and at the same time the real CCAB be positive. In other words, the cumulating of the real CCAB, does not give the real debt. On the other hand, the inflation corrected deficit as it is computed by E.1.5 is stock-flow consistent with the real government debt.

But let's make a more formal examination. So let D be the government deficit net of interest payments and let B_g be the interest-bearing government debt. Then, we will have:

$$D + nB_g = \dot{H} + \dot{B}_g \qquad \text{E.1.8}$$

where : $\dot{H}$ is the change in the non-interest bearing debt

and $\dot{B}_g$ is the change in the interest bearing government debt

[14]See Cukierman-Mortensen (1985) p. 43 and pp. 67-68, Bache (1985) p. 103, B.Connolly (1985) pp. 137-138, Lennan (1985) pp. 188-189, Reati (1985) p. 229, Wittelsberger (1985) pp. 276-277, Eisner-Pieper (1985) p. 130, Salvemini (1985) p.257-269, Ferri (1985) pp. 359-360, Lindberger (1985) p. 370, Eriksen (1985) p.374 , Siegel (1979) , C.T. Taylor and A.R. Threadgold (1979) .

[15]See Siegel (1979), pp. 84-85

What E.1.8 says is that the nominal deficit must be financed by an increase either in the interest bearing government debt or in the non-interest bearing debt or in both. Now, let's divide each part of E.1.8 by the general price level to transform the corresponding nominal magnitudes to real ones. So:

$$\frac{D}{P}+n\frac{Bg}{P}=\frac{\dot{H}}{P}+\frac{\dot{Bg}}{P}\Leftrightarrow\frac{D}{P}+nb=\frac{\dot{Bg}}{P}+\theta h\Leftrightarrow$$

$$\Leftrightarrow\frac{\dot{Bg}}{P}=\frac{D}{P}+nb-\theta h \qquad \text{E.1.9}$$

where $b=\frac{Bg}{P}$, $\theta=\frac{\dot{H}}{H}$, $h=\frac{H}{P}$

Also, by differentiating $b=\frac{Bg}{P}$ logarithmically we will have:

$$\frac{\dot{b}}{b}=\frac{\dot{Bg}}{Bg}-\frac{\dot{P}}{P}\Leftrightarrow\frac{\dot{b}}{b}=\frac{\dot{Bg}}{Bg}-\pi \qquad \text{E.1.10}$$

Rearranging E.1.10 we obtain:

$$\frac{\dot{Bg}}{P}=\dot{b}+\pi b \qquad \text{E.1.11}$$

Combining E.1.9 and E.1.11 we end up with the following equation :

$$\dot{b}+\theta h=\frac{D}{P}+(n-\pi)b=\frac{D}{P}+rb \qquad \text{E.1.12}$$

where r is the ex-post real interest rate.

The middle statement in equation E.1.12 corresponds to the inflation corrected deficit in real terms. What E.1.12 says is that the real deficit net of interest payments ($\frac{D}{P}$) plus the inflation-corrected real interest payments is equal to the change in the real value of the interest bearing government debt ($\dot{b}$) plus the change in the real value of the non-interest bearing debt (θ)

The corresponding formula for the conventional deficit can also be derived from E.1.12. The only that is needed is to move the inflation correction term to the left hand side. To facilitate comparisons we present below both the real inflation corrected deficit and the real, conventional deficit. So:

Real conventional deficit : $\frac{D}{P} + nb = \dot{b} + \theta h + \pi b$ E.1.13

Real inflation corrected deficit : $\frac{D}{P} + rb = \dot{b} + \theta h$ E.1.14

As it can be seen from E.1.13, the real conventional deficit is not stock-flow consistent. Indeed, if the change in the real total debt is zero ($\dot{b} + \theta h = 0$) the real conventional deficit may be different from zero by a size equal to πb i.e. equal to the real inflation correction. On the other hand, the inflation correction moves this size to the left of E.1.13 and gives by this way a stock-flow consistent definition of the deficit.

3.4 Extension of the analysis to other types of government debt.

The analysis that has been made by now is based on the assumption that the government debt is consisted of short term, non-indexed, domestically denominated securities. In the next, this assumption will be relaxed and the examination will be expanded to the cases of debt denominated in foreign currencies (sub-section I), as well as to the cases of indexed (sub-section II) and long term debt (sub-section III).

I. The case of debt denominated in foreign currencies

One of the assumptions of the above analysis was that the government debt is exclusively denominated in domestic currency. Now, let's relax this assumption and let's assume that all the government debt is denominated in one foreign currency and let's denote this part, converted to local currency, by B_f[16]. Also let E and e be the corresponding exchange rate[17] and the proportionate rate of change in E respectively. In this case, the real value of the government debt is affected not only by the inflation rate, but also by changes in the exchange rate. To make this clear let's assume that in all countries of the world the inflation rate is zero except for the country that has issued the debt where it is positive, say 10%. Then, assuming that the exchange rate is determined by purchasing power parities (PPP), it will rise by 10%. This, will leave unaffected the real value of the government debt since the depreciation caused by inflation will be compensated by the rise of the exchange rates. Of course, in most of the cases the exchange rates are not determined, at least only, by PPP and very often the inflation rate and the rate of change in the exchange rates are different. In this case there is ground for inflation correction and its size will be equal to the product of the difference of π from e with the foreign debt B_f. More formally, in the case that part of the government debt is denominated in a foreign currency, the ratio of the corrected for inflation deficit to GDP will be:

[16]In the case that the government debt is denominated in more than one foreign currencies, to get B_f one has to multiply the amount of the government debt that is denominated in each currency with the corresponding exchange rate. Also in this case e will be a suitable index of the changes in the corresponding exchange rates.

[17]In other words, E is the number of domestic currency units that are needed to buy one unit of foreign currency.

$$\frac{CCAB'}{X} = f' = \frac{(G - T + n_d B_d + n_f B_f)}{X} - \frac{\pi B_d}{X} - \frac{(\pi - e)B_f}{X} \qquad E.1.15$$

where n_d and n_f are the average interest rates on the domestic (B_d) and the foreign (B_f) debt respectively.

What E.1.15 says is that the ratio of the inflation corrected deficit to GDP is equal to the conventional ratio minus the ratio of the inflation correction of the domestic debt to GDP and also minus the ratio of the inflation correction of the foreign debt to GDP. If all debt was foreign and if the exchange rates were determined by strict PPP ($\pi = e$)[18] then the inflation would not distort the ratio of conventional deficit to GDP.

From E.1.15, it can also be seen that in the case that part of the government debt is foreign, the distortion that inflation causes to the ratio of the conventional deficit to GDP is not dependant only on the size of the domestic debt relative to GDP and on the inflation rate as in the case where all the debt is domestic. It also depends on the adjustment of the exchange rates to inflation as well as on the portion of the debt that is denominated in foreign currency. So, the fuller and the quicker the adjustment of the exchange rates to the domestic inflation and the larger the portion of the foreign debt the smaller the distortion of the conventional ratio. From the above it is probably clear that the separate treatment of foreign debt will be significant for the inflation correction of the deficit in developing countries, since in most of them a large proportion of their government debt is denominated in foreign currencies.

[18]It is again assumed that the inflation in the country or countries that possess the foreign debt of the government is zero.

II. The case of indexed bonds

The case of indexed bonds is almost the same with the case of foreign debt. The reason is that, as in the case of the foreign debt, the real value in domestic currency remains unaffected from inflation, so in the case of the indexed debt, the real value of the debt remains unaffected since its nominal value is linked with the inflation. Also since the constant interest rate[19] of these bonds is applied to an increasing (by the rate of inflation) principal, the interest payments will increase at the same rate as the inflation which in turn means that the real interest payments will remain constant. This implies that the ratio of the conventional deficit to GDP will remain the same[20]. Thus, if all the debt was indexed then there would be no need for inflation correction. Although we do not have specific data, it seems that indexed bonds are more popular in countries with very high inflation rates. In the countries of our sample, it does not seem that indexed bonds are a significant part of the government debt.

III. The case of long term bonds.

Another assumption that was made in the analysis of the traditional view was that the government debt is in short term securities. Now it is time to relax this assumption also. So, let's consider the case of a long term bond that is traded in the market and let's assume that at the end of period t there are still k yearly cash-flows to be made and that the first of these payments will be made at the end of period t+1[21]. Also let's denote these cash-flows by C_1, C_2, C_3, ..., C_k . Thus, at the end of period t+1 the bond holder will receive a return of and on his capital equal to C_1. Now, if the inflation rate in year t is $\pi_{t,}$ the cash flow C_1 will suffer an

[19]That the interest rate is constant is an assumption that is made for simplicity.
[20]It is assumed that the index that is applied to the indexed bonds does not diverge from the rate of inflation as it is counted by the GDP deflator. It is also assumed that the real GDP is constant.
[21]See Cukierman - Mortensen (1986) pp. 37-39 whose analysis is closely followed.

inflation loss equal to $\pi_t C_1$. But since C_1 will be received at the end of period t+1, i.e. one year ahead, the present value of the inflation loss at the end of period t will be:

$$\frac{\pi_t C_1}{1+n_t} \qquad \text{E.1.16}$$

where the discounting factor n_t is the market yield to maturity of the bond at the end of period t. More generally, the present value at the end of period t of the loss in the value of each of the remaining payments will be:

$$\frac{\pi_t C_i}{(1+n_t)^i} \quad i = 1,2,\ldots\ldots,k \qquad \text{E.1.17}$$

Consequently, the present value at period t of the losses caused by the inflation of period t will be:

$$\pi_t \left[\frac{C_1}{1+nt}+\ldots..+\frac{C_k}{(1+nt)^k}\right] \qquad \text{E.1.18}$$

Now, if P_t is the market price of the bond it is, by definition of the yield to maturity, equal to the statement enclosed by brackets in E.1.18. Consequently, the loss in the value of C_i because of the inflation in period t will be equal to the product of the inflation rate in period t with the market value of the bond in that period. The difference with the case of the short term bonds is that now market values have to be used instead of face values. Market values will be equal to face values only when the nominal interest rate of the bonds under consideration is equal to the market interest rate. But if, as it is usually the case, the nominal interest rate of the long term bonds is constant and the market rate is volatile then it is almost certain that there will be a difference between the market value and the face value of the long term bonds. This difference will be smaller the more flexible the nominal interest rate of the bond is. Really, if it was permitted to the nominal interest rate of the bonds to be flexible then it could incorporate the changes in the inflationary expectations that cause the changes in the market interest rates.

Despite the fact that the right treatment of the long term bonds requires the usage of market values, the unavailability of data does not permit such treatment. In fact, the estimation of the market value of the government debt is by itself a topic of research and except Siegel (1979) and Eisner (1986) for the USA and Miller (1982) for the UK, I'm not aware of someone else that tried to apply the correction on market values. In contrast, the usage of face value seems to be the rule. Except for data problems, another reason that was put forward by Taylor and Threadgold (1979) to justify the usage of face values, is the fact that it is usually very difficult to discriminate which portion of the change in the market interest rates is due to inflation and which portion is due to changes in the real interest rates. Of course we are interested only in those changes that are caused by inflation[22]. For the above reasons face values will be used in this study as well. As Cukierman and Mortensen say : "Under normal circumstances the redistribution figures may not be seriously affected by this procedure"[23].

[22]See Taylor and Threadgold (1979) p. 37.
[23]See Cukierman and Mortensen (1986), p. 36.

4. The traditional approach to inflation correction: Is it just an accounting exercise?

4.1. Ex-post versus ex-ante inflation correction.

As it was said previously, Cukierman and Mortensen recognised that anticipated and unanticipated flows of income have very different policy and behavioural implications[24]. Nevertheless, the most of the empirical studies that have been done by now utilised the realised inflation rate. Thus, what they actually estimated is corrected *ex-post* (realised) income flows instead of income flows as they are actually perceived by people *(ex-ante)*. Consequently, the corresponding corrected magnitude is rather inappropriate for usage in policy and behavioural analysis. It is indeed correct with an accounting sense and this indeed is the income that the people **really** have. But what about if people, either because of money illusion or because of mistakes in inflationary expectations, do not base their decisions on the income that they really have? Surely, the agents will base their decisions on the income that they ***think*** that they really have. This is the income that has to be used in the consumption functions since it is upon this income that the agents will make decisions about consumption and savings.

On the other hand the branch of the traditional school that suggests the usage of expected inflation rates seems to recognise the need for measures with more behavioural meanings. However, again it has a serious weakness. It assumes that people have no money illusion at all and therefore they fully perceive the effects of inflation on their monetary assets and they ask for a corresponding increase in the interest rates (full Fisher effect) to compensate the loss in the real value of the principal. The weak point is the assumption of no money illusion. It would be better, instead of assuming no money illusion, to construct a more

[24]See the quotation in p. I-7.

general model. This is what will be done below. Furthermore, many that theoretically justify the need for inflation correction upon a logic as the one that was exposed above (full Fisher effect, no money illusion) have ended up using realised inflation rates and thus detracting any ex-ante meaning from the computed magnitudes. In any case, the difference between ex-post and ex-ante magnitudes will be very small in the case of no money illusion since the only difference in that case will be due to differences between expected and realised inflation rates[25].

4.2 Ex-ante inflation corrected measures.

In contrast to the traditional approach, the approach that will be presented here takes explicitly into account the fact that people may suffer from some degree of money illusion. Thus, they may not perceive fully the effects of inflation on the government debt that they possess.

More analytically, let that people correct their nominal income for the effects that inflation has on the real value of their net monetary assets by a degree δ. Let's call this degree "degree of income correction". In other words the income that people believe that it is available for them to spend or save is:

$$PDI'' = PDI - \delta \pi^e L_g \qquad \text{E.1.19}$$

where PDI'' is the income that people think that is available to them or the ex-ante inflation corrected income. $\pi^e L_g$ is the amount that the people would expect to lose if they perceived fully the effects of inflation. However, because it is not sure whether they perceive these effects fully we add a coefficient δ that measures the degree by which people actually correct their incomes and which for this reason is

25Because of the way that the expected inflation rate is usually estimated, such differences will be very small.

called "degree of income correction". If people do not perceive the effects that inflation has on their monetary assets they will not make any adjustment on their nominal incomes. Thus δ will be zero. If they fully perceive the effects that inflation has on their monetary assets they will adjust their income fully which means that δ will be equal to 1. Now, moving one step further: if people fully perceive the effects that inflation has on their income they will ask for an increase in the nominal interest rate high enough to compensate them for the loss in the real value of the principal. Thus the nominal interest rate will be:

$$n_t = r^e + \pi^e_t \qquad \text{E.1.20}$$

while in the previous period it was: $n_{t-1} = r^e + \pi^e_{t-1}$

In other words, the interest rate will increase exactly by the amount of the increase in the inflationary expectations. However, if people, because they do not perceive the effects of inflation on the real value of their monetary assets, do no ask for an increase in the nominal interest rate, then the nominal interest rate will be entirely independent from the inflation expectations. Thus, the nominal interest rate will not change at all. To express these two cases within the context of an equation that determine the nominal interest rates as equation E.1.20, we can use the coefficient δ. More analytically: since the amount for which people ask for compensation, is the amount that they understand as inflation erosion, the change in the nominal interest rates will be directly dependant on the coefficient δ. Indeed, if L_g is the net monetary assets of the private sector, the loss that the people will think that incur and for which they will ask for a compensation will be: $\delta\pi^e L_g$. In other words, they will ask for a nominal interest rate equal to the real ex-ante interest rate plus the term $\delta\pi^e$ i.e.: $n_t = r^e + \delta\pi^e_t$. Hence, if the degree of income correction is zero the addition to the ex-ante real interest rate that they will ask for will be zero, independently of the situation about inflation. The fact that in this case they will not ask for an increase in the nominal interest rate is absolutely natural under the present conditions: the people because they do not understand the effects of inflation on their monetary assets, they believe that the real interest rate is the same while this is not true: the inflation has eroded part of the real value of their monetary assets and therefore the real ex-post interest rate that they receive may be much smaller than the ex-ante one. On the other hand, if people understand only partially the effects of inflation on their monetary assets they will ask for an increase in the nominal interest rates equal to the amount that they believe that they lose. Thus the addition in the ex-ante real interest rate that they will ask for will be: $\delta\pi^e$. Moving now to the government sector this means that if the degree of income correction is zero the deficit as it is perceived by people will be equal to the non-corrected conventional deficit. On the other hand, if the degree of income correction is full this means that the perceived deficit is equal to the one suggested by the second branch of the traditional school. If furthermore the expected and the realised inflation rates are equal, the perceived deficit will be equal to the ex-post one. If we want to show all this by an equation we will have:

$$CCAB'' = G - T + nL_g - \delta\pi^e L_g \qquad \text{E.1.21}$$

In E.1.21, $CCAB''$ is the government deficit as it is perceived by people, L_g is the total debt of the general government[26], and δ is the degree of income correction

[26]The definition of the government excludes the central bank. Therefore L_g does not include the monetary base or any other debt of the central bank. Also it does not include any other non-interest bearing debt. Another thing that has to be mentioned is that if part of the debt is foreign then this would have to be excluded from L_g for the reason that the corresponding interest payments are made abroad and they are not expected to affect the domestic economy. Of course, in this case the interest payments made to foreigners should be excluded from the DEF as well. In the empirical part of this thesis because of unavailability of reliable data about the net foreign liabilities of the general government all the computations will be made using the total government debt. However, this is not expected to affect

that takes values between 0 and 1. For the sake of comparison let's list all the measures of the government deficit that have been introduced by now:

Conventional deficit : $CCAB = G - T + nL_g$ E.1.22

Deficit corrected by the traditional way: $CCAB' = G - T + nL_g - \pi L_g$ or E.1.23

$CCAB' = G - T + nL_g - \pi^e L_g$ E.1.23'

(E.1.23' represents those in the traditional approach that propose the use of expected inflation)

Deficit as it is perceived by people: $CCAB'' = G - T + nL_g - \delta\pi^e L_g$ E.1.21
or ex-ante inflation corrected deficit

As it can be seen, the ex-ante inflation corrected deficit encompasses all the other measures. Indeed E.1.21 can be written as :

$$CCAB'' = CCAB - \delta\pi^e L_g \quad \text{E.1.24}$$

or as[27] :

$$CCAB'' = CCAB' + (1-\delta)\pi^e L_g \quad \text{E.1.25}$$

As it can be seen, the ex-ante inflation corrected deficit will be equal with the conventional deficit only if the expected inflation rate is equal to zero or if the degree of income correction is zero ($\delta = 0$). This suggests that in the case that people do not perceive the effects of inflation on their monetary assets there is no need for correction of the deficit for the reason that people do not make such corrections. Also, as it can be seen by E.1.25 the bias of the conventional deficit will be larger the larger the expected inflation, the larger the debt of the general government and the larger the degree of income correction.

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seriously our results since for the countries of our sample the foreign debt is in most cases a small percentage of the total debt.

[27]For the case of E.1.23 we must additionally assume that expected and realised inflation are equal.

Furthermore, it can also be seen that the ex-ante inflation corrected deficit encompasses the traditionally corrected deficit as well, and they will give equal corrections if there is complete absence of money illusion. The bias of the traditionally corrected deficit relative to the ex-ante one will be larger the larger the presence of money illusion.

As it is obvious from the above, E.1.21 is a much better indicator than the alternative ones since it avoids the extreme assumptions regarding money illusion. that the other measures need in order to have behavioural meanings.

5. Conclusion

In this chapter we examined the traditional approach to inflation correction of the government deficit. The critical weakness of the existing inflation corrected measures is that they lack ex-ante meaning and therefore they are not appropriate for policy analysis. To face this problem new measures were developed that take into account the degree by which people correct their incomes i.e. they take into account the fact that because of money illusion people may not fully correct their incomes. In the next chapters the aim will be to develop a framework through which we could estimate the degree of income correction and consequently the ex-ante inflation corrected deficit.

CHAPTER 2

ESTIMATION OF THE DEGREE OF INCOME CORRECTION: REVIEW AND EVALUATION OF THE EXISTING RESEARCH.

1. Introduction

The first chapter of this thesis introduced a new concept of government balance whose main characteristic is that it takes into account the actual degree by which people correct their income. Furthermore, the new measure has the ability to encompass both the conventional measure and the traditionally corrected one. Except for the new measure of the government balance, we also derived a measure of the private disposable income. For ease of reference we rewrite this:

$$PDI'' = PDI - \delta\pi^e L_g \qquad \text{E.1.19}$$

where PDI is private disposable income

Since in the next we will work with the households' disposable income let's rewrite E.1.19 as follows:

$$YCOR = YD - \delta\pi^e MA \qquad \text{E.2.1}$$

where: YCOR is the households' disposable income corrected for the effects of inflation,

YD is the households' disposable income as it is given by the National Accounts,

π^e is the expected inflation rate and

MA is the net monetary assets of the households

If people do not correct their incomes for the effects of inflation then $\delta = 0$, which means that the conventional income is also the income that the people use in their computations. If on the other hand, people perceive fully the effects of inflation on the real value of their monetary assets then $\delta=1$ which means that people use in their computations the inflation corrected income as it is computed by the second branch of the traditional view. The innovation of what was said in the first chapter of this thesis was the introduction of this coefficient δ and the construction of a more general measure that can accommodate both of these two extreme situations as well as other more probable situations where the degree of income correction is somewhere between 0 and 1 i.e. it is partial.

The aim of the remaining of the first part of this thesis is to construct the necessary background for the estimation of the degree of income correction. This chapter will start this effort by reviewing and evaluating the various approaches that have been undertaken for the estimation of the degree of income correction. The common characteristic of all approaches is that they try to estimate the degree of income correction through a consumption function. As it will be seen, almost all the efforts that have been made by now, have problems with the econometric methodology that they use. Although such problems were rather badly treated in the past, today new methods and concepts have been developed that are able to solve them. These methods and concepts will be combined in the next chapter into a new approach to the estimation of the degree of income correction.

The structure of this chapter is as follows: section 2 presents analytically the main works in the field. After an introduction to this section, each work is examined separately. Section 3 continues with the presentation of the main results that have been obtained while section 4 presents the methodological shortcomings of the existed attempts. Finally the chapter concludes with section 5.

2. A review of the techniques for the estimation of the degree of income correction.

Although in many theoretical economic models it is usually assumed that the degree of money illusion is zero (at least in the long run), until recently consumption functions (a part of the economic system with a great role and significance) were formulated using the conventional definitions of income which implicitly assume complete money illusion. Of course this practise in not right since what has to be used in the consumption function is not the nominal income that the persons receive, but the income that they think that they actually receive i.e. the "perceived income". As Hicks puts it[1]:

"the purpose of income calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea it would seem that we ought to define a man's income as the maximum value which he can consume during a week and still expects[2] to be as well off at the end of the week as he was at the beginning".

An income definition along the lines of the above quotation was given previously in E.2.1. As it can be seen from this definition, as long as people have non-zero inflationary expectations the perceived income may be different from the conventional (National Accounts) income and the difference will be positively dependant on the degree of income correction, i.e. on δ.

The first person who pointed out the need for the consumption functions to be specified using perceived income was Poole in 1972. After his article, the next consumption study that defined income as in E.2.1. was that of D. Hendry and T.

[1]See Hicks (1946), p. 172.
[2]Emphasis was added.

Von Ungern-Sterberg (HUS henceforth) in an influential paper published in 1981. Apart from the introduction of the income correction, this paper was also particularly influential for the fact that it introduced liquid assets in the especially successful consumption function of J. E. H. Davidson, D. F. Hendry, S. Srba and S. Yeo: (DHSY henceforth). Actually, it is mostly this latter reason that made HUS paper widely known. The issue regarding the degree of income correction was examined more closely and extensively one year latter by T. von Ungern-Sternberg (U-S henceforth) one of the authors of the HUS paper. In my opinion, this study is the most serious work that has been done on this topic.

Considerable also is the contribution made by Italian economists. So, Rossi N. and Schiantarely F. (1982) and Rossi N., Tarantelli E. and Tresoldi C. (1983) used income defined as in E.2.1. to estimate the Italian consumption function. On the other hand, Modigliani F., Japelli T. and Pagano M. (1985) as well as Nicolleti G. (1988) deviated from the usual practice and examined the degree of income correction together with the tax discounting hypothesis (Ricardian Equivalence Proposition) . Finally, another attempt to estimate the degree of income correction was made by Davidson and MacKinnon in 1983.

As it can be confirmed by a simple counting of the works referred above, they are very few relative to the voluminous literature on the consumption function. This means that this topic is rather under-researched, and we hope that this thesis will fill part of this gap.

Below we will examine each of the above mentioned works separately, starting from the first work that used income defined as in E.2.1 i.e. from the work of William Poole (1972).

2.1 William Poole (1972)

To estimate the degree of income correction in America, Poole utilised the consumption function of the SSCR - MIT - Penn (SMP) model which was based on a modified version of the life cycle model of Ando and Modigliani (1963). In his model[3] the dependant variable was economic consumption (EC) (i.e. consumption of non-durables and services plus the net yield on and the depreciation of the stock of consumer durable goods[4]). As independent variables, he used the disposable income (YD), the households' net worth (W) and the inflation erosion of the monetary assets (MNER). The first two variables were introduced with distributed lags of twelve and four quarters respectively. Regarding the inflation erosion variable, for its construction it is needed to have estimates of the expected inflation rate and a monetary assets variable. The expected inflation rate was calculated as a seven quarter distributed lag of the rate of change of the private consumption deflator (PCD) with the weights exponentially declined. From this estimate, Poole deducted 1.5 percent under the assumption that PCD is biased by 1.5 percent per annum[5]. Regarding the monetary assets variable[6], he computed it indirectly, as the ratio of the net interest income to a corporate bond rate.

The final estimated equation of Poole is as follows:

$$EC_t = 0.703*YD + 0.046*W - 0.539*MNER_t \qquad \text{E.2.2}$$

$$(16.9) \qquad (5.3) \qquad (-4.0)$$

$R^2 = 0.997 \quad \sigma = 8.7 \quad DW = 0.77$

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[3]The discussion here refers to what Poole calls "alternative equation" in his paper (see Table 1, Poole (1972), p. 216)

[4]See Poole (1972), p. 212

[5]See Poole, (1972), p. 218.

[6]Poole uses the term "fixed income assets variable".

where the numbers in parenthesis represent the value of the t-statistic. In E.2.2, the coefficients of YD and W are the sum of the corresponding lag coefficients. The coefficient of the MNER is negative and statistically significant as one would expect. The estimate of the degree of income correction δ implied by this coefficient can be computed indirectly as the negative of the ratio of the coefficient of the monetary erosion variable to the coefficient of the disposable income variable[7]. In our case this is equal to: 0.539/0.702 = 0.77 which means that the degree of income correction is partial. Of course, this conclusion depends on the reliability of the estimate. As it will be seen latter, there are serious reasons to doubt this reliability. Commenting on the size of this coefficient, Poole[8] said that it is "somewhat below" the value that would have been expected if people discounted fully their interest income for the effects of inflation. Moreover, even though the coefficient is below what one would have expected if there was no money illusion, Rossi and Schiantarelli consider it as overestimated "due to the procedure used by Poole in calculating expected inflation[9]". Generally, the results of this rather innovative study suggest that one must not a priori assume that the degree of income correction is zero[10], nor that it is one[11] (full income correction).

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[7]Indeed, if C represents real consumption per capita, YCOR real corrected income per capita and Z the vector of other relevant independent variables including the constant term, we will have: $C = b_1*YCOR + c'Z + u = b_1*(YD - \delta*MNER) + c'Z + u = b_1*YD - b_2*MNER + c'Z + u$ where c' is the transpose of the vector of the coefficients that correspond to the variables of Z, u is the disturbance term and $b_2=b_1*\delta$. Estimation of this consumption function by OLS will give us estimates of b_1 and b_2. Then, the degree of income correction can be easily recovered from the definition of b_2. Thus:

$$b_2 = b_1*\delta \Leftrightarrow \delta = \frac{b_2}{b_1} \Rightarrow \hat{\delta} = \frac{\hat{b}_2}{\hat{b}_1}$$

where the hat denotes estimated values.

[8]See Poole (1972), p. 218

[9]See Rossi and Schiantarelli (1982) p. 379

[10]This is done by most consumption function studies.

[11]Although this is not done frequently one can meet such cases in the literature. For example see Lester (1994).

Instead, it is necessary to model it as one more coefficient, permitting it to take the value that the data will give.

2.2 R. Davidson and J. MacKinnon (1983)

These authors tried to estimate the degree of income correction for the USA and Canada. For this purpose, they used quarterly data for the period 1954:1 to 1979:4. Their point of departure was the Permanent Income Hypothesis (PIH) of Friedman (1957). This hypothesis was utilised to determine the long run equilibrium of consumption. To model the way that this long run equilibrium is achieved, the authors adopted a partial adjustment process. Their final model, written in terms of a saving ratio function[12] is as follows:

$$\frac{S_t}{Y_t} = b_0 + b_1 \frac{S_{t-1} - Y_{t-1}}{Y_t} + e_t \qquad \text{E.2.3}$$

where S_t is personal savings at the end of period t and e_t is a normally and independently distributed error term. As the authors say: "if this model is expressed in terms of the flow of consumption, C_t, we obtain the familiar consumption model, associated with Duesenberry (1949) and Brown (1962):

$$C_t = (1 - b_0)Y_t + b_1 C_{t-1} + u_t \qquad \text{E.2.4}$$

where u_t is an error term with a standard deviation proportional to Y_t"

Although model E.2.4 does not incorporate the effects that inflation has on the real value of monetary assets, it is not difficult to introduce them. Indeed, if

[12]Since savings are determined residually as the part of income that has not been consumed, one can write any consumption function as a saving function and conversely.

SCOR and YCOR are respectively savings and income corrected for the effects of inflation i.e. if:

$$SCOR_t = S_t - \delta\pi_t^e MNAS_t \qquad \text{E.2.5}$$

and YCOR as in E.2.1, substitution of these definitions into equation E.2.3 will give us the following equation:

$$\frac{S_t}{Y_t} = b_0 + (1-b_0)\delta\frac{MNER_t}{Y_t} + b_1\frac{S_{t-1}-Y_{t-1}}{Y_t} + [\frac{Y_t - \delta MNER_t}{Y_t}]e_t \qquad \text{E.2.6}$$

Although in E.2.6 the error term is heteroscedastic, the authors ignored this problem as quantitatively unimportant and estimated E.2.6. as it stands.

The consumption variable was defined as consumption expenditure while the income variable as personal disposable income. For the computation of the monetary erosion variable, the expected inflation rate was proxied by a weighted average of the inflation in the current and in the past three quarters. Regarding the monetary assets variable, the authors preferred to use financial assets instead of monetary assets[13]. However, the latter seems to be more appropriate for the computation of the monetary erosion[14]. For Canada, financial assets were computed indirectly in a similar fashion as in Poole (1972) i.e. they were defined as the ratio of "interest, dividends and miscellaneous investment income" to the nominal rate of interest of a certain type of bonds. On the other hand, for the USA the authors preferred to use balance sheet data.

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[13]The main difference between financial and monetary assets is that the former, in addition to what is included in the latter, it also includes the value of the shares.

[14]The reason is because a monetary assets variable includes only those assets that have a fixed nominal value and therefore their real value is eroded by inflation. On the other hand, the real value of such assets as shares is determined mostly by relative prices effects and consequently it is difficult to say that inflation has the same effects for such assets as for the fixed income assets.

Now, regarding the results about the parameter of our interest (i.e. the coefficient δ), it was found equal to 0.3935 for USA and 0.5339 for Canada[15]. In both case the estimated degree of income correction was significally different from zero. Yet, in both cases it was far from the value expected when there is no money illusion (i.e. 1). This fact again indicates a partial degree of income correction.

2.3 Rossi N., Tarantelli E. and Tresoldi C. (1983)

This paper is the second[16] in a sequence of papers written by Italian economists, where effort is made to estimate the degree of income correction through a consumption function. The consumption function that was utilised in this particular paper was based on the life cycle theory of consumption and except for the estimation of the degree of income correction, the authors also tried to examine whether consumers react to the *unexpected inflation*[17] losses by introducing a relevant variable into the consumption function. The consumption function that they estimated is as follows:

$$C_t = a\,(Y_t - \delta\pi_t^e NFA_t) + b\,[\delta(\pi_t - \pi_t^e)NFA_t] + c\,W_t + u_t \qquad \text{E.2.7}$$

where Y is National Accounts income, NFA is Net Financial Assets and W is wealth.

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[15]See model IIa for USA and model Ia for Canada in table 3 of Davidson - MacKinnon (1983), p. 732.
[16]The first is that of N. Rossi and F. Schiantarelli (1982) and it will be examined later.
[17]The main theoretical base for the introduction of the unexpected inflation losses in the consumption function is the theory of involuntary saving suggested by Deaton (1977). According to this theory unexpected inflation may lead to involuntary savings, which introduces a wealth effect on the consumption. Also since we speak about Deaton's theory, it is useful to say that both the income correction approach (i.e. redefinition of income according to E.2.1) and the involuntary savings approach try to give to the inflation a role in the consumption function. As U-S (1981 p. 967) says: "While the "Negative Income" approach (the negative income approach is the term that U-S used to denote the approach based on the redefinition of income according to E.2.1) is totally different from Deaton's theory of "Involuntary Saving through unanticipated inflation" it is nevertheless true that all the empirical evidence presented here (i.e. the empirical evidence based on the redefinition of income approach that U-S followed in his paper) can equally well be interpreted as lending support to Deaton's theory. **There seems to be no simple way to differentiate between these two approaches on purely empirical grounds**". (emphasis was added).

In estimating E.2.7, non-linearities were unavoidable since OLS is not able to identify the coefficient δ. For this reason, the authors searched, using a grid search, across values of δ in the unit interval and chose the value that minimised the Residual Sum of Squares (RSS). The value that they found was only 0.1. This estimate indicates substantial money illusion.

2.4 Modigliani F., Japelli T. and Pagano M. (1985)

This study, as the previous one, considered the effects of inflation within the context of the Italian consumption function. An innovation of this study is that the effects of inflation were examined together with the validity of the Ricardian Equivalence Proposition (REP). The theoretical model that was employed was based on the life-cycle theory of consumption[18]. In their enquiry, the authors assumed that the economy has only two sectors: the private sector and the government sector. This approach has some problems which will be discussed after the presentation of the model. To examine the degree of income correction, the authors discriminated between two group of people. The one group, that is proportionally equal to[19] 1-v of the households, it is assumed that has no money illusion at all. On the other hand, the other group that is composed of the remaining of the households (i.e. it is proportionately equal to v), it is assumed that suffers from complete money illusion in the sense that their consumption is controlled by nominal rather than real interest payments[20]. Assuming that for the latter group the propensity to consume out of nominal interest payments is a fraction g" and that all the other propensities are equal between the two groups, the aggregate consumption function with which Modigliani et al. ended up is as follows:

[18]See Ando and Modigliani (1963)
[19]The most of the notation follows the original paper.
[20]See Modigliani et al. (1985), pp. 99-100

$C_p = a(YD - rD) + bW + [c + (1-v)(g-g')r^*]D + f(DEF - rD) + [(1-v)g' + vg'']RD - (1-v)g'pD$ E.2.8

Regarding the notation of E.2.8: r is the real interest rate, D is the beginning of the period government debt, net of the holdings of the central bank and of the foreign sector, r* is the permanent real interest rate, RD is the nominal interest payments, pD is the inflation erosion of the government debt and DEF is the inflation adjusted government deficit. Equation E.2.8 in addition to the term regarding the degree of income correction issue it also includes some terms that refer to the REP issue.

Regarding the role of g, g' and g" the picture that is given by E.2.8. is rather obscure. The difficulty probably arises from the fact that E.2.8. is the result of collecting terms and for this reason the intuition behind it may be unclear. In fact, model E.2.8 is derived from the following equation by collecting terms:

$C_p = a(YD - rD) + bW + cD + [(1-v)g] (r^*D) - [(1-v)g'][r-r^*]D + vg''(RD) + f(DEF-rD)$ E.2.9

In E.2.9, g is the propensity of the 1-v fraction of the population to consume out of the permanent real interest income (r*D), g' is the propensity of the same proportion of the population to consume out of the temporary interest payments ((r-r*)D), and g" is the propensity of the v proportion of the population , that suffers from complete money illusion, to consume out of the nominal interest payments.

The estimable form of model E.2.8 is as follows:

$C_p = b_1YD + b_2W + b_3D + b_4DEF + b_5RD + b_6(pD)$ E.2.10

In equation E.2.10, if $b_6 = -b_5$ then $v = 0$ which means the absence of any money illusion. "On the other hand if b_6 were to fall in the range ($-b_5$, 0), one could infer that v is positive and hence that there is at least some inflation illusion[21]". For the extreme case of complete money illusion, b_6 will be equal to 0.

Equation E.2.10. was estimated by autoregressive least squares and the estimates of b_5 and b_6 were 0.386 and 0.139. The value of the t-statistic was 1.83 and 0.72 respectively.

Commenting on these results, F. Modigliani et al. said: "While the point estimates of our coefficients tend to be consistent with the hypothesis of some inflation illusion, their standard errors are so large that we must regard the issue as wide open of further investigation[22]"

To this comment we may add some points regarding the assumption that the economy is composed of only two sectors : the general government and the private sector. This assumption has the effect that all the debts that the various subsectors of the private sector owe to each other cancel out[23] and what remains is the government debt possessed by the private sector. The problem with this assumption is that while the private consumption is a variable that has almost exclusively to do with the personal sector, instead of using data regarding this sector we use data that refer to the whole private sector. For example, this means that for the determination of the consumption the assets of the personal sector are weighted the same with the debts of the business sector while this may no be true. Probably the best would be to introduce more detailed data (if they are available) about the personal sector.

21 F.Modigliani et al. (1985), p. 100
22 See F.Modigliani et al. (1985), p. 111
23 One example is the deposits of the personal sector to the financial sector.

2.5 G. Nicoletti (1988)

The third and most recent Italian contribution that will be examined is the one of G. Nicoletti. Again as in Modigliani et al. (1985), the income correction issue was examined together with the REP issue. To derive his consumption function the author used the Theil's differential approach to demand analysis[24]. Using this approach the author ended up with the following rather complicated form[25]:

$$\hat{C} = a_0 + a_1\, {}_{t-1}r_t + a_2 \log\left(\frac{W^*_{t-2}}{C^E_{t-1}}\right) + a_3 \log\left(\frac{Y^{*d}_{t-1}}{W^*_{t-2}}\right) + a_4\ {}_{t-1}\hat{Y}_t^* + a_5(\hat{Y}_t^* - {}_{t-1}\hat{Y}_t^*) + a_6\, {}_{t-1}\hat{g}_t \qquad \text{E.2.11}$$

where:

$$W^*_{t-2} = W_{t-2} + (1-a_8)b_{t-2}$$

$$Y^{*d}_{t-1} = Y^d_{t-1} + a_8 s_{t-1} - a_7(1-a_8)_{t-2}q_{t-1}b_{t-2}$$

E.2.12

$${}_{t-1}Y^*_t = {}_{t-1}Y_t - {}_{t-1}\tau_t + a_8\, {}_{t-1}\sigma_t$$

where: $\hat{X}_t = \Delta(\ln X)$

C_t = generic real consumption expenditure

C^E = real economic consumption

g = real public consumption of goods and services

r_t = real rate of return on assets held from period t-1 to t

w_t = real end of period non human wealth net of real end of period stock of government debt b.

[24]Or what is called the Rotterdam model. See G. Nicolleti (1988), p. 45

[25]For the derivation of this form the reader is referred to the original paper. The presentation here is limited to what we are interested.

${}_{t-1}X_t$ = expectation of X_t based on information available at time t-1. He assumes that the expectations are myopic which means that ${}_{t-1}X_{t+1} = {}_{t-1}X_t$

W_t^* = initial non-human wealth

Y^{*d} = current disposable income

Y^{*} = future net labour incomes

τ_t = discounted value of the real resources absorbed by the public sector

s = government deficit gross of interest payments

σ = government deficit net of interest payments

q_t = expected rate of inflation from t-1 to t.

To derive the final estimable form of the model one has to substitute the relationships given in E.2.12 to E.2.11. As it can be seen from E.2.12 and E.2.11 the present model is more complicated than any of the previous ones.

In the system of E.2.11 and E.2.12 the degree of income correction is given by the coefficient a_7, in the second equation of E.2.12 and it takes values in the unit interval. So if $a_7 = 0$, there is no income correction while if $a_7 = 1$ there is full income correction. If on the other hand, a_7 is between 0 and 1 the income correction is only partial.

The equation that results from the substitution of E.2.12 to E.2.11 was estimated for eight OECD countries - USA, Japan, France, Italy, Belgium, Canada, Germany and UK - using annual data for the period 1961-1985. Also a dummy variable approach was utilised to mix all the data into one sample. Moreover, additional equations were estimated using alternative definitions of consumption[26]. In the analysis below, we will consider only the consumption expenditure equations, since it is this definition of consumption that will be employed in the empirical part of this thesis. Apart from the real interest rate and the expected

[26]The three definitions that the author employed were: economic consumption, consumption of non-durables and services and consumer expenditure.

inflation rate that were measured in percentages, all the other variables were in real per capita terms. Regarding the parameter of our interest a_7, as well as the parameter a_8, because of the non-linearities that their estimation implies, they were estimated simultaneously using a grid search. This method has some quite strong weaknesses among which is a disability to estimate the standard errors of the coefficients and consequently a disability to compute the value of the t-statistic. Moreover, the derived estimates are not accurate, and the inaccuracy is larger the greater the space between the various values that are tried in the grid search. This problem seems to be especially relevant to this article since a checking of the results shows that the values that the grid search considered were in a relatively large distance from each other[27]. As the author himself says: "Given the use of scanning procedures, the quantitative magnitudes of the estimates of a_7 and a_8 have a limited meaning per se. The individual statistical significance cannot be assessed and at times the likelihood surface associated with the regressions is too flat for the results of the scanning to have any statistical reliability."[28] Nevertheless, the author tried to extract information by testing the basic model (i.e. no income correction at all) against the model that corresponds to the case of full income correction or the Hicksian model as the author calls it. The test that was used was the Davidson and MacKinnon (1981) J test for non-nested models. The null hypothesis was specified first for the basic model (no income correction) against the alternative of the Hicksian model. Then, this null hypothesis was reversed. Table T.2.1 below presents a summary of the results.

From a look at these results, it is obvious that the degree of income correction differs from country to country. So while it is full in Canada, Italy and Belgium, it is negligible in UK and Germany. However, as it will be seen these are

[27]In the article it seems that the author tried only 5 values for a_7: 0, 0.25, 0.5, 0.75, 1. These means considerable inaccuracy of the estimates.
[28]See G. Nicoletti (1988), p. 66.

not results at which all studies arrive. Also, it can be seen from the table that it is difficult to discriminate between the Hicksian and the basic model on the base of the J statistic, since in six out of nine cases the test was unable to say which model is the best. To conclude, the point estimates of Nicolleti indicate that the degree of income correction shows considerable variability from country to country. Actually, it takes all the five possible values that the author has permitted it to take. This means that:

i) Regarding the consumption function, the degree of income correction must be taken into account.

ii) Regarding the definition of inflation corrected government balance that we proposed at the first chapter of this thesis, the results justify our reservations about the full inflation correction of the government balance.

Table T.2.1

Country	a_7	**H_0: Basic model** **H_1: Hicksian model**	**H_0: Hicksian model** **H_1: Basic model**
Japan	0.5	do not reject the null	do not reject the null
France	0.75	do not reject the null	do not reject the null
UK	0	do not reject the null	do not reject the null
Germany	0	do not reject the null	do not reject the null
USA	0.25	do not reject the null	do not reject the null
Canada	1	do not reject the null	do not reject the null
Italy	1	reject the null	do not reject the null
Belgium	1	reject the null	do not reject the null
Pooled sample	1	reject the null	do not reject the null

2.6 D. Hendry and T. von Ungern-Sternberg (HUS), (1980)

Although the inflation erosion issue was one of the things that this study examined, it is best known for the reason that introduced integral control mechanisms to the successful error correction model of DHSY. Ignoring the technicalities, the final form of the model, derived as a solution to the minimisation of a quadratic loss function[29], is as follows:

$$\Delta c_t = a_0 + a_1\Delta\Delta y_t + a_2(y_{t-1} - c_{t-1}) + a_3(l_{t-1} - y_{t-1}) + u_t \qquad \text{E.2.18}$$

where c, y, l are respectively the logarithm of consumption, personal disposable income, and wealth

By substitution of the definition of the inflation corrected income, E.2.18 can be written as follows:

$$\Delta c_t = a_0 + a_1\Delta\Delta \ln(Y_t - \delta\pi^e_t MNAS_{t-1}) + a_2[\ln(Y_{t-1} - \delta\pi^e_{t-1}MNAS_{t-2}) - c_{t-1}] + a_3[w_{t-1} - \ln(Y_{t-1} - \delta\pi^e_{t-1}MNAS_{t-2})] + u_t \qquad \text{E.2.19}$$

In the HUS paper the wealth variable was defined as net liquid assets of the personal sector. The same variable was also used to compute the monetary erosion i.e. it was used in the place of MNAS in E.2.19. The expected inflation was proxied as a two years moving average of the quarterly inflation rate. As it is evident from E.2.19 the model is non-linear. The solution that the authors followed was to estimate the coefficient δ by using a grid search over the unit interval with steps of 0.1. We have already mentioned the problems of this procedure, especially regarding the accuracy of the estimate of the degree of income correction and the statistical inference. The estimate that HUS obtained for the UK was 0.5 which again implies a moderate degree of income correction.

[29]For a very good analysis of the HUS model and the way that it is derived the reader is referred to G. Hadjimatheou (1987), pp. 73-75 and 83-84.

Generally, HUS paper didn't put much attention to the income correction issue[30]. As it was said, HUS model is better known for the introduction of the deviation of the wealth/income ratio from a long run target rather than for the examination of the inflation effects. The estimation of the income correction parameter attracted more attention in a paper written by one of the authors of the HUS paper, namely T. von Ungern - Sternberg (U-S) one year after the publication of the HUS paper. The U-S paper is reviewed below.

2.7 T. von Ungern-Sternberg (1981)

The starting point of U-S is that the traditional consumption functions do not account explicitly for the inflation erosion of the monetary assets. As U-S says[31] this erosion "has always been incorporated into the real balance effect and while sometimes statistically significant the coefficient of this term is never large enough to account for falls in the average propensity to consume (a.p.c) of the magnitude observed in the 1970's. Given the misspecification involved it is easy to see why this should be the case." To illustrate this point, the author gives an example using the model developed by Zellner et al. (1965) which consists of the following consumption function:

$$C_t = k Y_t^e + a(L_{t-1} - L_t^d) + u_t \qquad \text{E.2.20}$$

where Y_t^e is expected permanent income defined as:

$$Y_t^e = (1-\gamma) \sum_{j=0}^{\infty} \gamma^j Y_{t-j}$$

L_t^d is a demand function for liquid assets defined as:

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[30]In fact, they interpreted the coefficient δ as simply a parameter that "has been introduced to account for any scale effects due to wrongly choosing measures" for the expected inflation and liquidity assets. (HUS, (1980), p. 245)

[31]See U-S (1981), p. 963

$L_t^d = \eta Y_t^e$

C_t is current consumption, Y_t is current income, and L_t is current liquid asset holdings.

Suppose now that inflation sets in, and reduces the real value of liquid asset holdings by a given percentage in each subsequent period. The consumer realises this, and keep his real wealth intact[32]. The measured a.p.c. shows a permanent fall, but liquid asset holdings remain constant. The coefficient of the $(L_{t-1} - L_t^d)$ term will be insignificant and yet the whole fall in the measured a.p.c is due to the negative income incurred on liquid asset holdings.

Then the author proceeds to redefine income according to E.2.1. His model is based on HUS and it was estimated for Germany and UK[33]. Regarding the data: for the UK they were quarterly and covered the period from 1964 III to 1977 III, while for Germany they were semiannual and covered the period from 1963 II to 1977 II. The expected inflation rate was computed as a two year moving-average of the realised inflation rate, while the monetary assets variable was computed at the beginning of the period and net of currency holdings. The equations that were estimated were:

Germany: $\Delta_2 c_t = k^* + b_1\Delta_2 y_t^* + b_2\Delta_2 y^*_{t-1} + \gamma\,(c_{t-2} - y^*_{t-2}) + \mu SD + u_t$ E.2.21

UK : $\Delta_4 c_t = k^* + 3b_1\Delta_4 y_t^* + 2b_1\Delta_4 y^*_{t-1} + b_1\Delta_4 y^*_{t-2} + b_2\Delta_2 y^*_{t-1} +$
$+ \gamma\,(c_{t-4} - y^*_{t-4}) + \lambda(l - y^*)_{t-1} + \sum_{i=1}^{3} \eta_i SD_i + u_t$ E.2.22

where: $\Delta_2 x_t = x_t - x_{t-2}$

$\Delta_4 x_t = x_t - x_{t-4}$

SD = seasonal dummies

[32]This means that he doesn't suffer from any money illusion.

[33]He also tried to estimate a model for the USA, but he was not successful (see U-S (1981), p. 962).

$$(l-y^{*})_t = \log(\sum_{i=0}^{3} L_{t-i}) - \log(\sum_{i=0}^{3} Y^{*}_{t-i})$$

$$y^{*}_t = \log(Y_t - \delta\pi_t^e MNAS_{t-1})$$

All variables were introduced in logarithmic form.

Regarding the results obtained by U-S, it seems that in both countries the degree of income correction is full[34]. Indeed, the point estimate of the degree of income correction was 1.16 for Germany with a standard error of 0.18 while for the UK it was 0.85 with a standard error of 0.19. Both values were significally different from zero and very close to one as one would expect in the absence of money illusion. On the other hand, these results seems to be at odds with those obtained by G. Nicoletti (1988) where for Germany he found that the degree of income correction is zero while for the UK only 0.25[35]. This indicates that more work is needed.

2.8 N. Rossi and F. Schiantarelli (1982)

In this paper, the authors considered the modelling of the consumption expenditure in Italy using quarterly data from 1965 to 1977. Their model was based on HUS model. An innovation of their model was that the expected inflation rate didn't enter the formula for the computation of the monetary erosion variable linearly. Instead, Rossi and Schiantarelli employed the following modified form of E.2.1:

$$YCOR = YD - \delta(\frac{\pi_e}{1+\pi_e})FA \qquad E.2.23$$

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[34]Since the model was again non-linear a non-linear method had to be used. However, this time the estimates were obtained by the Maximum Likelihood (ML) method and not by a grid search, Thus, this study was free from all the problems that we referred previously.

[35]This number corresponds to the consumption function where consumption is defined as the consumption of non-durables, since this is the definition of consumption that was employed by U-S for the UK.

where FA is households' real net financial wealth. The degree of income correction was found equal to 0.2 and not significally different from zero. This estimate indicates the presence of significant money illusion in Italy.

3. Summary of the results

In the previous section we examined the literature about the estimation of the degree of income correction. Table T.2.2 below , presents the main results:

Table 2.2
Results for the degree of money illusion

Country	δ	Study
Belgium	1	Nicolleti (1988)
Canada	0.5339 1	Davidson and MacKinnon (1983) Nicolleti (1988)
France	0.75	Nicolleti (1988)
Germany	0 1.16	Nicolleti (1988) U-S (1981)
Japan	0.5	Nicolleti (1988)
Italy	1 0.1 0.2	Nicolleti (1988) Rossi et al. (1983) Rossi and Schiantarelli (1982)
UK	0 0.5 0.85	Nicoletti (1988) HUS (1980) U-S (1981)
USA	0.77 0.3933 0.25	Poole (1972) Davidson and MacKinnon (1983) G. Nicolleti (1988)

As it can be seen from this table the results are mixed. Really, there are cases where the degree of income correction is full and cases where it is negligible. But, apart from this, what is really strange is that for the countries that we have more than one studies the results are completely different from study to study. Indeed, for Germany the study of Nicolleti found full money illusion, while the study of U-S found that there is no money illusion at all. Such huge differences in the estimates seems also to be the case for UK, USA, Canada and Italy. This is really disappointing and it shows serious problems in methodology. For, the degree of income correction cannot be both full and negligible for the same country. In the next section, a critical appraisal of the various studies is given along with an identification of the reasons that caused these strange results.

4. A critical examination of the various approaches for the estimation of the degree of income correction.

As it was said in the previous section it is really disturbing to have such large differences in the estimates of the degree of income correction for the same country, as those observed in table T.2.2. The purpose of this section is to expose the weaknesses of the above studies, that may be the cause of these strange results. In doing so, we will separate the papers to two groups. In the first group we will examine the weaknesses of those models that were formulated in levels, while in the second group we will examine the weaknesses of the models that were formulated in differences. The reason for a separation like this is because the formulation in levels has very different implications from the formulation in differences.

4.1 Models in levels

The models that belong to this category are those of Poole (1972), Davidson and MacKinnon (1973), Rossi et al. (1983) and Modigliani et al. (1985). The main problem with those models is the very fact that they are formulated in levels. Although, formulation in levels was a very usual practice in the past, it is now widely accepted that the properties of most of the macroeconomic time series in levels are not the ones that are required for valid estimation and inference with the OLS. The problem has to do with the fact that valid statistical inference and estimation requires that all the variables employed in the model are stationary. This essentially means that they must[36]:

i) Exhibit mean reversion in that they fluctuate around a constant long - run mean.

ii) Have a finite variance that is time invariant.

iii) Have a theoretical correlogram that diminishes as lag length increases.

A simple look at the plots of many macroeconomic variables in levels shows that most of them do not satisfy the assumption of stationarity[37]. In fact, as it will be seen latter, such variables as consumption, income, wealth, and monetary erosion were always non-stationary in the countries of our sample. Actually, even from a theoretical point of view, it is expected that as time passes such variables as real consumption, income and wealth, will tend to grow without any tend to return to a supposed constant long run mean as stationarity requires. Therefore, nonstationarity for those variable has to be expected even theoretically.

The violation of the assumption of stationarity has heavy effects on the classical way of inference and estimation. Indeed, if the variables in a regression are non-stationary, the OLS estimators have sampling distributions with properties very different from the ones that would be expected if the variables were stationary. Also the regression coefficients appear to be spuriously significant[38]. This means, that the violation of the stationarity assumption breaks down the whole classical inference framework. Apart from this very serious effect, nonstationarity also affects such measures of goodness of fit as the R^2 coefficient. Actually, it is possible for a model with non-stationary regressors to have an R^2 coefficient as high as 0.99 and yet a large proportion of this goodness of fit be

[36]See: W. Enders (1995), p. 212
[37]See C. R. Nelson and C. I. Plosser (1982)
[38]See R. L. Thomas (1993) p. 151

entirely spurious[39]. Finally, another very serious effect of non-stationarity is that it results in inconsistency of the parameter estimates[40] except if there is cointegration with one cointegrating vector.

Regarding the seriousness of the problem of the spurious regression, Stewart (1991) says that an important warning sign is "an apparently acceptable R^2 value coupled with a low Durbin Watson (D.W.) statistic[41]".

Turning now to the models examined in this chapter the fact that the results of these models may be seriously affected by the spurious regression problem is shown by the fact that:

i) In Poole's model (1972) although R^2 is as high as 0.997 the D.W statistic is as low as 0.77. This according to the above quotation of Stewart is an indication that the spurious regression problem, with all the effects that were exposed above, may indeed be a serious problem in this model.

ii) In the models of Davidson and MacKinnon (1983) and Modigliani et al. (1985) although the D.W statistic is not reported, both models have been corrected for first order autocorrelation. This means that the authors had indications of first order serial correlation and proceeded to correct for it. After the above analysis, there are serious reasons to make us to believe that the autocorrelation in these models was actually an indication of the seriousness of the spurious regression problem.

Finally, in the paper of Rossi et al. the reported results are very poor and the presented regression output omits even very basic statistics. However, since this model is also formulated in levels it is expected that the spurious regression problem will be serious in this model as well.

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[39]See R. L. Thomas (1993) p. 151

[40]See W.Enders (1995) p. 216

[41]See J.Stewart (1991) p. 203. Also see W. Charemza and D. Deadman (1992) p. 124 for an example of an entirely spurious regression.

Finishing this section, it must be said that although the spurious regression problem will continue to be a problem, invalidating classical inference, in a model where the variables are non-stationary and it will also continue to make measures of goodness of fit spurious, nevertheless the parameter estimates of a static equation like equation E.2.10 of the Modigliani et al. model may continue to have the consistency property if the variables in the model constitute **one cointegrating vector**. Yet, the property of cointegration has to be checked and in any case since in most of the models examined in this sub-section more than two variable were employed it would be possible to have more than one cointegrating vector in which case the estimates produced by a simple OLS regression will again be misleading and wrong. The concept of cointegration will be treated more extensively in the next chapter.

4.2. Models in differences.

In the previous sub-section we examined the main problem that models in levels have and which is the spurious regression problem caused by violation of the stationarity assumption. The way to remove the non-stationarity of the variables is to differentiate them until they become stationary. The models of G.Nicoletti (1988), HUS (1980), U-S (1981), and Rossi and Schiantarelli (1982) try to avoid the problem of spurious regression by differentiating most of the variables. However, they have their own inefficiencies that have to do with the validity of what is implicitly assumed by the way that these models are formulated. To show the problems that these four models have, we will use the following model which resembles more or less most of the models in differences that have been examined in this chapter:

$$\Delta c_t = k^* + b_1 \Delta y_t^* + \gamma\,(c_{t-1} - y^*_{t-1}) + z'\mathbb{X} + u_t \qquad \text{E.2.24}$$

where: c, is the logarithm of consumption, **X** is the vector of other variables of the model and **z'** is the transpose of the vector of the corresponding coefficients of these variables (i.e. $z'X = z_1x_1 + z_2x_2 + ...$), and y^{*} is the inflation corrected income defined as follows:

$$y^{*}_t = \log(Y_t - \delta\pi^e_t MNAS_t) \qquad \text{E.2.25}$$

Introducing E.2.25 into E.2.24 we have the following model:

$$\Delta c_t = k^* + b_1 \Delta\log(Y_t - \delta\pi^e_t MNAS_t) + \gamma\, [c_{t-1} - \log(Y_{t-1} - \delta\pi^e_{t-1} MNAS_{t-1})\,]$$
$$+ z'X + u_t \qquad \text{E.2.26}$$

As it can be seen from E.2.26, this is a non-linear model and therefore non-linear methods have to be used for its estimation. Indeed, three of the models that are formulated in differences utilised a grid search to estimate the value of δ, while U-S (1981) applied the maximum likelihood method. The problems connected with the grid search procedures have already been discussed above. Here, we will just remind that the grid search estimates of the coefficient of our interest, will tend to be inaccurate and the inaccuracy will depend on the length of the steps of the grid search. Moreover, grid search makes very difficult the performance of statistical tests about the value of coefficient that is estimated by it, since it does not produce an estimate of the standard error of this coefficient. These problems are avoided if all the parameters are estimated simultaneously, using a suitable non-linear method as in the case of U-S (1981). However even in this case there are the usual problems connected with non-linear methods of estimation.[42]

In addition to the problems caused by non-linearities there are two more problems connected with model E.2.26. The first of these has to do with the

[42]See J. A. Doornik and D. F. Hendry (1994), pp. 170-171 for nine potential problems

meaning of the lagged term in levels i.e. with the meaning of the term: $[c_{t-1}$- $\log(Y_{t-1} - \delta\pi^e{}_t MNAS_{t-1})]$ while the other with a restriction implicitly imposed on E.2.26. But let's examine these problems more analytically starting from the first one.

As it was said in the beginning of this subsection, models formulated in differences avoid the problems that non-stationarity causes. But this is not without a price. The price in this case is that by using differentiated variables we lose all the information about the long run that may exist in the levels of the variables. For example[43], in the DHSY seminal paper three competing hypotheses about the relation of consumption and income in the UK were examined. From these three hypotheses the model that was chosen, according to statistical criteria , was that of Wall et al. (1975) which has the following form:

$$\Delta C_t = a_0 + a_1\Delta Y_t + a_2\Delta Y_{t-1} \qquad a_0 > 0 \qquad \text{E.2.27}$$

In this model all the variables are in differences and therefore the problem of spurious regression is nonexistent[44]. Thus, for model E.2.27 the classical measures of goodness of fit as well as the classical inference procedures are valid[45]. Unfortunately, model E.2.27 has some rather strange economic properties. Thus, it implies that even if the level of income were to remain constant indefinitely, in which case:

$$\Delta Y_t = \Delta Y_{t-1} = 0$$

[43]See R. L. Thomas (1993) , p. 270
[44]It is assumed that consumption and income are integrated of first order.
[45]Provided of course that all the other assumptions of the classical regression model hold.

consumption would continue to rise without limit since under such conditions $\Delta C_t = a_0 > 0$. In other words, equation E.2.27 has no static equilibrium. Also, the equation is apparently independent of any disequilibrium in the previous levels of the variables C_t and Y_t. Normally, when consumption is, for example, "above" its equilibrium level relative to income, the increase in C_t that accompanies an increase in Y_t will be much smaller than what would have been the case if C_t and Y_t had previously been well adjusted to each other.

To solve this problem and assuming the existence of a long run relationship, one could enter the deviation from this long run relationship in the past period into a short run model like model E.2.27. Exactly this is the role that the term $[c_{t-1} - \log(Y_{t-1} - \delta\pi^e_t MNAS_{t-1})]$ in equation E.2.26 is called to play. By this term it is assumed that there is a long run relationship between consumption and inflation corrected income. This long run relationship is assumed to be as follows:

$$c_t = \log(Y_t - \delta\pi_t^e MNAS_t) \qquad \text{E.2.28}$$

In other words, it is assumed that the long run elasticity of consumption with respect to corrected income is one. Despite the fact that equation E.2.26 is assumed that takes into account the information about the long run, with the knowledge that we have today, and which was not available at the time that those authors (especially HUS, U-S, and Rossi - Schiantarelli) made their contributions, there are several problems with equation E.2.26, if E.2.28 is adopted as a long run equation. The first problem is that we have to check if equation E.2.28 is actually a long run relationship instead of assuming it as such from the outset. Here is where the concept of cointegration comes into the discussion. Cointegration is the property where two or more non-stationary variables are moving together through time tied by a stable linear relationship. For example, let's suppose that we have two nonstationary variables x and y that need to be differentiated once to become stationary (i.e. they are integrated of first order). One would normally expect that there is no linear relationship between these variables that would be stable through time. In other words, in the relationship : $y_t = bx_t$ one would normally expect that there is no b for which the difference $y_t - bx_t$ is stationary. However, if there is an equilibrium linear relationship between y_t and x_t one can find a b for which the difference $y_t - bx_t$ is stationary despite the fact that x and y are non-stationary. If there is such a long run relationship then we say that the variables y and x are cointegrated.

Returning now to equation E.2.26, what is actually assumed by the term $[c_{t-1}\text{-}\log(Y_{t-1} - \delta\pi^e{}_t MNAS_{t-1})]$ is that there is a long run relationship of the type given in E.2.28. Nevertheless, we have the following difficulties to accept this supposition. The first difficulty has to do with the fact that the supposed long run relationship described by E.2.28 is non-linear while the whole concept of cointegration is based on the assumption of a **linear** long run relationship. Indeed, non-linear long run relationships, methods to estimate them, and properties of the estimators are topics almost unreaserced yet[46]. Thus, it would be difficult to say what the properties of the coefficient δ would be, if we estimated E.2.28. separately as it is usually done for long run relationships.

In addition to this problem, we have another one that has to do with the fact that we must not **assume** the existence of a long run relationship but instead we must check whether this assumption is true or not. In other words, we cannot assume that equation E.2.28 is a long run relationship and enter the residuals of this relationship in the short run model, without checking that equation E.2.28 is indeed a long run relationship. Nevertheless, one could say that the significance of the coefficient of the disequilibrium term could be used as a test for the existence

[46]For some insights on this see Granger and Terasvirta (1993), pp. 48-61.

of a long-run relationship, since according to the Engle - Granger representation theorem cointegration implies the existence of an error correction model and conversely.

In addition to the problems connected with the presence of the term $[c_{t-1}-\log(Y_{t-1} - \delta\pi^e_t MNAS_{t-1})]$in equation E.2.26 there is another problem that model E.2.26. has. This problem has to do with the fact that model E.2.26 implicitly imposes the restriction that the long run degree of income correction is equal to the short run one. In equation E.2.26 the long run degree of income correction is given by the corresponding coefficient δ in the disequilibrium term, while the short run degree of income correction is given by the corresponding coefficient in $\Delta\log(Y_t - \delta\pi^e_t MNAS_t)$. As it can be seen from E.2.26, these two coefficients are restricted to be equal (they are both expressed by the same letter δ). Yet this may not be true. Actually, one would expect, especially in countries with high inflation, the money illusion to be a short run phenomenon. Actually money illusion is greater when the inflation rate is low or when it changes quickly or when it is a new phenomenon[47]. Under such conditions one would expect that the short run degree of income correction will be lower than the long run one. In fact, restricting the short run degree of income correction to be equal with the long run one gives it the highest value that it could possibly take. In any case, why do we have to impose a restriction that, in my opinion, has more probabilities to be wrong than right, instead of leaving the data to tell us what actually happens? In the next chapter we will develop a different framework to solve all the problems discussed above.

[47]See Tanzi et. al. (1987), p. 723

5. Conclusion

In this chapter the aim was to review and evaluate the methods that have been used to estimate the degree of income correction. Thus in section 2, we examined the various models that have been formulated. They are only eight, which is a very small number relative to the massive research that has been done in the field of the consumption function. In section 3, we presented a brief summary of the results of these attempts. The main conclusion of that summary was that the existing estimates contradict each other. Indeed, there were many cases where the degree of income correction was full according to the one study, and zero according to another. These rather disturbing differences show methodological weaknesses. Those weaknesses were exposed in section 4. There, we saw that the biggest problem with the models in levels is the violation of the assumption of stationarity. On the other hand, for the models formulated in differences we saw that the problems have to do with the meaning of the disequilibrium term as well as with the imposed restriction that the short run degree of income correction is equal to the long run one.

In the next chapter we will develop a different framework for the estimation of the degree of income correction that will solve all the shortcomings of the above studies. Within the last 8 years that separate us from the last study on this topic (the study of Nicolleti (1988) new and very powerful methods have been developed and it is only in the last 2-3 years that they have been started to be utilised extensively in the empirical research.

CHAPTER 3

UNIT ROOTS, COINTEGRATION AND THE DEGREE OF INCOME CORRECTION

1. Introduction

In the previous chapter, we reviewed the research that has been done regarding the estimation of the degree of income correction. As it was said, the existing models suffer from some serious methodological problems that decrease the reliability of their results. These problems are not only problems of the specific models that we examined. In fact, they are problems that affected seriously, most of the applied econometric studies until mid-80's since most of these studies constantly ignored the problem of non-stationarity and the need for explicit discrimination between short run and long run.

Actually, despite the fact that some earlier attempts[1] were made to account for non-stationarity and for the incorporation of the long run disequilibrium into the short run models formulated in differences, it was only after the seminal paper of R.Engle and C.Granger (1987) that the concepts of cointegration and error correction model were formally defined and related. After the publication of this paper, the associated concepts of unit roots, cointegration and error correction model started to be utilised extensively in applied economic research. Today, it is recognised that if a time series econometric study wants to claim reliable results , it has to be based on these concepts.

The good thing with these new concepts and methods is that they compose a complete way of econometric modelling that handles the non-stationarity problem and at the same time it provides for the estimation of a long run model (cointegration) and for a connection between this long run or equilibrium model

[1]See for example DHSY (1978)

with a corresponding short run model (error correction model). Thus, one can estimate both long run and short run parameters and the results will have nothing to fear from the spurious regression problem.

This chapter will start presenting the concepts of unit roots, cointegration and error correction model more formally. Then, we will utilise these new concepts to construct a more robust model for the estimation of the degree of income correction. As it will be seen, our model gives solution to all of the problems referred to the previous chapter. Finally, the chapter will close with a conclusion.

2. Stationarity and non-stationarity: Definitions and tests

As it was said in the previous chapter, one of the problems of the models formulated in levels is the violation of the assumption of stationarity. This violation has very serious effects since it invalidates all the classical inference procedures. Also, it results in inconsistency of the estimated coefficients, except if there is cointegration with one cointegrating vector. This section will consider the definition and the effects of non-stationarity more formally. Moreover it will also consider ways to test the validity of the stationarity assumption.

2.1 Stationarity and non stationarity : Definitions[2]

Let's assume that x_t ($t = 1, 2, ...$) is a time series. Then, we will say that x_t is weakly stationary if:

$$\text{(i) } E(x_t) = \mu$$

$$\text{(ii) } Var(x_t) = \sigma^2 < \infty \qquad \text{E.3.1}$$

[2]A large part of the analysis of this section is based on notes kept by the author of this thesis when he was a student at the University of Essex. Nevertheless, there are various modern textbooks that offer an equally good analysis of the topics under discussion. (see for example the very good book of W. Charemza and D. Deadman (1992)).

(iii) $Cov(x_t, x_s) = \sigma_{|t-s|}$

According to these conditions, for a series to be weakly stationary the mean and the variance must be constant and finite and the covariances must depend only on $|t-s|$ and not on t or s alone. If any of the above conditions is violated, the series x_t is non-stationary. To make things clearer let's consider the following first order autoregressive model (AR(1)):

$$x_t = \alpha x_{t-1} + u_t \qquad \text{E.3.2}$$

where u_t is white noise i.e.: $Eu_t = 0$, $Var(u_t) = \sigma^2_u$, $Cov(u_t, u_s) = 0$ for $t \neq s$

Depending on the value of the coefficient α, we can discriminate three cases.

The first case is $|a| < 1$ i.e. $-1 < \alpha < 1$. Then, if L is the lag operator (i.e. $Lx_t = x_{t-1}$) we can write E.3.2 as follows:

$$x_t = \alpha L x_t + u_t \Leftrightarrow x_t(1-\alpha L) = u_t \Leftrightarrow x_t = \frac{1}{1-aL}u_t \qquad \text{E.3.3}$$

Now since $|a| < 1$, we can exploit the fact that $\frac{1}{1-a} = 1 + \alpha + \alpha^2 + \alpha^3 + \ldots\ldots\ldots\ldots$ and write E.3.3 as follows:

$$\text{E.3.3} \Leftrightarrow x_t = \sum_{j=0}^{\infty} a^j L^j u_t \Leftrightarrow$$

$$\Leftrightarrow x_t = u_t + \alpha u_{t-1} + \alpha^2 u_{t-2} + \ldots\ldots\ldots\ldots \Leftrightarrow$$

$$\Leftrightarrow x_t = \sum_{j=0}^{\infty} a^j u_{t-j} \qquad \text{E.3.4}$$

Now:

$$E(x_t) = \sum_{j=0}^{\infty} a^j E(u_{t-j}) = 0$$

$$Var(x_t) = \sum_{j=0}^{\infty} Var(a^j u_{t-j}) = \sum_{j=0}^{\infty} a^{2j} Var(u_{t-j}) = \sigma^2_u \sum_{j=0}^{\infty} a^{2j} = \sigma^2_u \frac{1}{1-a^2}$$

Therefore, when $|a| < 1$ the time series process is stationary since its mean and variance are constant and finite[3].

The second case that will be examined is the case where $|a| = 1$. In this case we will have:

$$x_t = \alpha\, x_{t-1} + u_t \Leftrightarrow x_t = x_{t-1} + u_t \Leftrightarrow x_t(1-L) = u_t \qquad \text{E.3.5}$$

Assuming that the first value of the x_t series is zero (i.e. $x_0 = 0$), we will have:

$x_0 = 0$

$x_1 = u_1$

$x_2 = u_1 + u_2$

$x_3 = u_1 + u_2 + u_3$

....

....

....

$$x_t = \sum_{j=1}^{t} u_j \qquad \text{E.3.6}$$

[3]It can be proven that the requirement regarding the covariances is also met.

As it can be seen from E.3.6, x_t is just a sum of the past values of the random term u_t and although it has zero mean ($E(x_t) = \sum_{j=1}^{T} Eu_j = 0$) its variance is not constant and it is dependant on the sample size. Indeed:

$$Var(x_t) = \sum_{j=1}^{T} Var(u_j) = \sum_{j=1}^{T} \sigma^2_u = t\sigma^2_u \qquad \text{E.3.7}$$

As it can be seen from E.3.7, as the sample size becomes bigger the variance of x_t increases and at the end, as $t \rightarrow \infty$ the variance of x_t becomes infinite. This violates the second requirement for weak stationarity and thus the process is non-stationary. A process like E.3.5 is known as a random walk. Also, since in E.3.5 the expression 1-L has a root for L = 1, this process is also called a process with a *unit root*[4].

Finally, the third case is the case where $|a| > 1$. In this case the series x_t is clearly explosive.

From the above three cases, the most interesting one is when $|a| = 1$. Note that when $|a| = 1$, then, although x_t is non-stationary, its first differences is stationary since $\Delta x_t = x_t - x_{t-1} = u_t$ and u_t is a stationary process by assumption. Because in this case the process x_t should be differentiated once to become stationary, we say that it is integrated of order one[5] or $x_t \sim I(1)$.

[4]Note that in the previous case, where $|a| < 1$, the expression $(1-\alpha L)$ has a root greater than one in absolute value.

[5]The order of integration denotes the number of times that a series must be differentiated to become stationary.

2.2 Testing for a unit root

Having examined the definition of stationarity and the cases where non-stationarity arises, the next step is to see how we can possibly test the stationarity of a series. This seems to be rather straightforward, if we remember that in the model:

$$x_t = \alpha x_{t-1} + u_t \qquad \text{E.3.2}$$

the case of non-stationarity corresponds to the case where the coefficient α is equal to one in absolute terms, while the case of stationarity requires it to be less than one.

Therefore, we can estimate E.3.2. by OLS and test the following hypothesis:

$$H_0: |\alpha| = 1 \text{ (} x_t \text{ has a unit root)} \qquad \text{E.3.8}$$
$$H_1: |\alpha| < 1 \text{ (} x_t \text{ is stationary)}$$

An even easier way to implement a test like this, is to reformulate E.3.2 subtracting from each side the term x_{t-1}. By doing this, we will have:

$$x_t - x_{t-1} = \alpha x_{t-1} - x_{t-1} + u_t \Leftrightarrow \Delta x_t = (\alpha - 1)x_{t-1} + u_t \Leftrightarrow \Delta x_t = bx_{t-1} + u_t \qquad \text{E.3.9}$$

Formulating E.3.2 like this, the test for a unit root becomes a simple test of the significance of b in a regression of the type shown in E.3.9. Thus, in this case to test for a unit root we don't have but to test the following hypothesis:

H_0: $|b| = 0$ (it implies that $|\alpha| = 1$ i.e. x_t has a unit root) E.3.10

H_1: $|b| < 0$ (it implies that $|\alpha| < 1$ i.e. x_t is stationary)

This test can be performed much easier than the previous one, since most of the modern econometric packages routinely compute the value of the required t-statistic. The problem is that under the null hypothesis of non-stationarity, the usual distribution theory is not valid and the critical values that have to be used are not the ones that the statistical tables give for the t-student distribution. Instead, one should use the critical values reported by Dickey-Fuller[6] (1979).

Regression E.3.9 can be augmented by adding a constant and/or a time trend and thus estimating the following model:

$$\Delta x_t = c + gt + bx_{t-1} + u_t \qquad \text{E.3.11}$$

Again, the null hypothesis of a unit root corresponds to $|b|$ equal to zero. However, this time different critical values have to be used.

The above test is known as Dickey-Fuller test or simply DF from the first letter of the surnames of the authors that discovered it[7].

One problem with tests based on equations E.3.9 or E.3.11 is that they do not take account of the possible autocorrelation of the error process u_t[8]. If this error process is autocorrelated then this would result in inefficient OLS estimates of equations E.3.9 or E.3.11. To solve this problem, Dickey and Fuller (1981) suggested the addition of lags of the dependant variables to approximate the

[6]These critical values may differ from author to author. Apart from Dickey- Fuller (1979), critical values have also been produced by MacKinnon (1991) and W. Charemza and D. Deadman (1992)
[7]See Dickey-Fuller (1979)
[8]See W.Charemza and D.Deadman (1992), p. 135

autocorrelation. In other words, they suggested the estimation of the following "augmented" regression:

$$\Delta x_t = bx_{t-1} + \sum_{i=1}^{m} \gamma_i \Delta x_{t-i} + u_t \qquad \text{E.3.12}$$

instead of the simple regression E.3.9. Of course, a time trend and a constant may also be added to E.3.12. The test of the null hypothesis of a unit root is exactly the same as in E.3.10. The problem with equation E.3.12 is that the test loses its power to reject the null hypothesis of a unit root, since the addition of more regressors necessitates the estimation of additional parameters, thus leading to a loss of degrees of freedom. Actually, the reduction of the degrees of freedom is caused not only because of the increased number of the parameters that need to be estimated but also because of the additional lags that decrease the number of the observations that are available for the estimation. On the other hand, if one uses too few lags in E.3.12 there is a danger that the small lag-length will not be enough to capture the actual error process and consequently b and its standard error will not be well estimated. A possible good strategy that could be followed for the choice of the lag length would be to start from a model with many lags and then by using t/F tests to arrive at the appropriate number of lags, checking at the same time if the error process of the final model is white noise[9]. The unit root test that is based on E.3.12 is called augmented Dickey - Fuller test (ADF).

Finally, closing this section, we must not forget to mention that in many cases a look at the plot of a series is a quick way to draw conclusions about its stationarity that will not be too far from reality. This happens because a stationary series is rather volatile, while a non-stationary series grows through time with rare

[9]See W.Enders (1995), pp. 226-227

changes in its trend. Also, it must be said that this section considered only the Dickey-Fuller family of unit root tests. This was done because these tests are the most popular ones today and they will also be used in the empirical work later in this thesis. However, we must say that there are also other tests that we didn't consider here[10].

3. Cointegration: Definition, estimation, and tests

3.1 Definition

In the previous section, we examined the definition of stationarity / nonstationarity as well as some ways to test for nonstationarity. The problem with non-stationarity is that it makes the classical inference procedures meaningless. More formally let x_t and y_t are two independent processes integrated of order one i.e.:

$$x_t = x_{t-1} + u_t$$
$$y_t = y_{t-1} + v_t$$

where x_t and y_t are independent and u_t and v_t are independent standard normal random variables[11]. Suppose now that we run the following regression:

$$y_t = a + bx_t + e_t \qquad \text{E.3.13}$$

[10]For a good review of the unit root tests the reader is referred to W. Enders (1995), pp. 211-267
[11]See W. W. Charemza and D. F. Deadman (1992), pp. 124-126

Since x_t and y_t are independent, we would expect that the t-statistic will not be large enough to reject the null hypothesis that b is equal to zero and also that the R^2 will be low. However, because the series are non-stationary we find that:

i) $t = \frac{b}{s.e(b)} \rightarrow \infty$ as $T \rightarrow \infty$ (where s.e(b) is the estimated standard error of b)

and

ii) R^2 is "acceptable".

Thus, although regression E.3.13 is an entirely spurious regression, based on the t-statistic and on the R^2 coefficient, we may accept it as true.

In a case like this the interest is concentrated on the behaviour of the error term. Typically e_t will also be I(1). The interesting case is when e_t is stationary. In this case, we say that the variables x_t and y_t are **cointegrated** and that there is a long run or equilibrium relationship between them. The reason that the stationarity of the residuals implies a long run relationship is because if such relation was non-existent the variables would move independently from each other. This means that there would be no b[12] to make the difference $e_t = y_t - bx_t$ stationary. However, if there is a linear long run relationship between x_t and y_t, these two series will move together and therefore although they are non-stationary, there will be a b that will make the difference $e_t = y_t - bx_t$ stationary. In other words, since a long run equilibrium relationship entails a systematic co-movement among economic variables, the fact that there is a b for which e_t is stationary shows that such a co-movement and therefore a long run relation is present between the series under examination[13].

[12]We ignore a possible constant term

[13]See A. Banerjee et al. (1993), pp. 2-3

Although the above analysis is rather intuitive, we feel that a more formal and general definition must also be given. Thus[14]: Two time series are said to be cointegrated of order d, b, denoted CI(d, b) if (i) they are both integrated of order d; and (ii) there exists some linear combination of them that is integrated of order b < d. This definition can be easily extended to more than two variables[15].

The discovery of the concept of cointegration had and has revolutionary effects on econometric modelling, since it permits the estimation of long run economic relationships and, as it will be seen, it is directly connected with the concept of the error correction model. As it is well known, most of economic theory is about the long run, and the concept of cointegration was exactly the theoretical framework that was needed to estimate long run economic relationships.

Having defined the concept of cointegration the next step is to examine ways to estimate supposed long run relationships as well as ways to test whether these relationships are really long run. This is what will be done in the next sections.

3.2 Cointegration: Estimation and tests

Although there are quite a few methods to estimate supposed cointegrating relationships and to test whether these relationships are really cointegrating[16], in this sub-section only two of them will be examined. The first **used to be** the most popular way to estimate cointegrating relationships, while the second **is** the most popular and probably the most powerful way that is available today. But, let's begin with the first method.

[14]See R. L. Thomas (1993), p. 164
[15]See Engle and Granger (1987), p. 84
[16]See C. Hargreaves (1994), pp. 87-131 for a recent review.

3.2.1 OLS and the estimation and testing of cointegrating relationships

OLS was the first method that was utilised to estimate cointegrating relationships and it was suggested in the seminal paper of Engle and Granger (1987) as the first step of a two-stage procedure for modelling short run dynamics. To examine the way that this method can be applied, let's assume that we have two I(1) series, x_t and y_t, and we want to test if there is a long run relationship between them, like the one below:

$$y_t = \beta x_t \qquad \text{E.3.14}$$

The method that was suggested by Engle and Granger was to estimate E.3.14 by OLS. Then, if e_t are the residuals of a regression like this, we can test for cointegration by simply testing the stationarity of e_t. If there is cointegration the residuals will be stationary. Thus, a DF/ADF test can be performed to see whether this happens[17]. If the null hypothesis of nonstationarity is not rejected, then we can conclude that there is no cointegration between y_t and x_t and therefore estimation of E.3.14 by OLS will give results that will suffer from the spurious regression problem. On the other hand, if the residuals are stationary then we can conclude that the variables x_t and y_t are cointegrated and thus there is a long run relationship between them. In this case, although the classical inference procedures continue to be invalid, estimation of E.3.14 by OLS produces consistent parameter estimates. Actually, the OLS estimate of the long run parameter β is not just consistent but it is "more than" consistent: it is superconsistent. This means that when there is cointegration between x_t and y_t, the OLS estimate of β collapses

[17]However, the critical values that should be used, should be adjusted for the number of regressors in the right hand side of E.3.14. Such critical values can be found in W. Charemza and D.Deadman (1992), pp. 319-330 as well as in J. G. MacKinnon (1991).

more rapidly to the true value than even when all the classical assumptions of the regression model hold[18].

From the above, one could say that the estimation of cointegrating relationships is really very simple since what is needed is just to run a static regression and then to test the stationarity of the residuals. If the residuals are stationary then the parameter estimates are not only consistent but superconsistent. This simplicity made this method very popular in late 80's and in the first 2-3 years of 90's.

However, this method has serious shortcomings. The most serious of them is connected with the fact that with more than two variables there may be more than one cointegrating vectors. In fact, if we have N non-stationary variables then there may be up to N-1 distinct cointegrating vectors. In this case OLS becomes very problematic since the OLS estimates of the parameters will just be a linear combination of the parameters of the distinct cointegrating vectors. This means that in a case like this the OLS estimates are meaningless and wrong. Actually, the only case where we can be sure that the OLS estimates are consistent (superconsistent) estimates of the true long run parameters is only when we have a model with only two variables. This of course is a very restrictive case. Since in the empirical analysis of this thesis we will use four variables we must look for a way to face this serious problem.

Apart from the above mentioned very serious problem, OLS suffers from some other problems as well. More analytically, although OLS claims superconsistent long run estimates, Banarjee et al. (1986) have found that they may be seriously biased in small samples. Also, although when there is cointegration the OLS parameter estimates are superconsistent, classical statistical tests on these parameters are still invalid because of the spurious regression

[18]See R.L Thomas (1993), p. 167

problem (the variables in the static regression E.3.14. are non-stationary). Therefore, there is no way to contact statistical tests. To correct this small bias problem as well as the problem of statistical inference Engle and Yoo (1991) suggested an alternative path composed of three steps. However, as Cuthbertson et al. say "it has no claim to priority over the maximum likelihood procedure[19]". Finally, a last problem of the OLS method is that although cointegration is a concept that refers to a group of variables, without pre-specifying which variable is endogenous and which is exogenous, the OLS, by defining a specified variable as endogenous and the remaining as exogenous, makes an arbitrary normalisation.

All the above problems may make us seek some other way to estimate and test a long run relationship. With the research that has been done so far, the best way is the Johansen procedure which today is considered as the most powerful and complete way to estimate a long run equilibrium relationship. The next section is devoted to the presentation of this procedure.

3.2.2 The Johansen procedure for the estimation and inference of cointegrating relationships[20]

The starting point of the Johansen procedure is an unrestricted Vector Autoregression Model (VAR). Assuming that we have n variables, the corresponding VAR in matrix form will be[21]:

$$\mathbb{Z}_t = \sum_{i=1}^{k} \mathbb{A}_i \mathbb{Z}_{t-i} + \mathbb{U}_t \qquad \text{E.3.15}$$

[19]See Cuthbertson et al. (1992), p. 140. By "maximum likelihood procedure" is meant the Jochansen method that will be discussed in the next section.
[20]A large part of the analysis of this section is based on W.Charemza and D.Deadman (1992) pp. 195-202.
[21]The bold letters in this sub-section denote vectors or matrices

where: $\mathbf{Z}$ is the vector of the n variables of the model, $\mathbf{A}_i$ is the matrix of the coefficients and $\mathbf{U}$ is the vector of the random errors corresponding to the n equation of our system. This VAR model is in levels and if we add $\mathbf{Z}_{t-1}$, $\mathbf{Z}_{t-2}$, $\mathbf{Z}_{t-3}$,..............., $\mathbf{Z}_{t-k}$ and $\mathbf{A}_1\mathbf{Z}_{t-2}$, ..., $\mathbf{A}_{k-1}\mathbf{Z}_{t-k}$ to both sides of E.3.15 and rearrange, we will end up with the following equivalent model in differences:

$$\Delta\mathbf{Z}_t = \sum_{i=1}^{k-1} \Gamma_i \Delta\mathbf{Z}_{t-i} + \Pi\mathbf{Z}_{t-k} + \mathbf{U}_t \qquad \text{E.3.16}$$

where:

$\Gamma_i = -\mathbf{I} + \mathbf{A}_1 + \ldots + \mathbf{A}_i$ ($\mathbf{I}$ is a unit matrix)

$\Pi = -(\mathbf{I} - \mathbf{A}_1 - \ldots - \mathbf{A}_k)$

In E.3.16, our interest is concentrated on the rank of matrix Π. Since there are n variables in the vector $\mathbf{Z}_t$ the dimension of Π is $n \times n$ and its rank can be at most equal to n. Now according to Granger representation theorem[22] under some general conditions:

(i) If the rank of matrix Π is equal to n, i.e. equal to the total number of the variables explained by the VAR model, all these variables are stationary and therefore there is no point to speak for cointegration.

(ii) If the rank of matrix Π is equal to $r < n$, a representation of Π can be found such that: $\Pi = \alpha \cdot \beta'$ where α and β are both $n \times r$ matrices.

It is this latter case where cointegration makes sense, since matrix β has the property that although $\mathbf{Z}_t$ is I(1), $\beta'\mathbf{Z}_t$ is I(0). Recalling the definition of cointegration, we can say that in this case the variables that compose the vector $\mathbf{Z}_t$ are cointegrated and the cointegrating vectors β_1, β_2, ..., β_r are particular columns of the matrix β which for this reason is called cointegrating matrix.

[22]See Engle and Granger (1987) or Johansen (1989)

Therefore, in a model explaining n variables there can be at most $r = n - 1$ cointegrating vectors.

In the case that cointegration holds, and therefore we can write the Π matrix as $\Pi = \alpha \cdot \beta'$, the system E.3.16 can be interpreted as an error correction system where $\beta' \mathbf{Z}_t$ (~ I(0)) corresponds to the disequilibrium in the long run and matrix α gives the speed of adjustment of the particular variables with respect to a disequilibrium in the long run relation[23].

Now one can ask, how is it possible to identify the rank of matrix Π and moreover, how is it possible to estimate the cointegrating matrix β? The analysis below is based on W.Charemza and D.Deadman[24] which in turn is a simplified version of the analysis given in the original papers of Johansen (1988, 1989).

Thus:

STEP 1: Regress $\Delta\mathbf{Z}_t$ on $\Delta\mathbf{Z}_{t-1}$, $\Delta\mathbf{Z}_{t-2}$, ..., $\Delta\mathbf{Z}_{t-k+1}$. Since there are n variables in the VAR model this implies that n separate regressions are needed. Now let $\mathbf{R}_{0t}$ be the $n \times 1$ vector of the residuals from each of these regressions at time t. Also regress $\mathbf{Z}_{t-k}$ on $\Delta\mathbf{Z}_{t-1}$, $\Delta\mathbf{Z}_{t-2}$, ..., $\Delta\mathbf{Z}_{t-k+1}$ and let $\mathbf{R}_{kt}$ be the $n \times 1$ vector of the residuals from each of these regressions at time t.

STEP 2: Compute the four $n \times n$ matrices S_{00}, S_{0k}, S_{k0}, and S_{kk} from the second moments and cross products of R_{0t} and R_{kt} as follows:

$$S_{ij} = T^{-1}\sum_{t=1}^{T} R_{it}R'_{jt} \quad , i,j = 0,k \text{ (T = sample size)}$$

STEP 3 : Solve the equation:

$$\left| \mu S_{kk} - S_{k0} S_{00}^{-1} S_{0k} \right| = 0$$

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[23]See Johansen (1989), p. 16

[24]See W.Charemza and D.Deadman (1992), pp. 198-199

That is, find the roots or eigenvalues of the polynomial equation in μ. This is a non-standard form of the eigenvalue problem. The solution gives the eigenvalues $\mu_1 > \mu_2 > \mu_3 > .... > \mu_n$ and the associated eigenvectors v_i which can be arranged into the matrix $V = [v_1, v_2, ..., v_n]$. The eigenvectors are normalised such that $V' S_{kk} V = I$. If now the cointegrating matrix β is of rank $r < n$, then the first r eigenvectors $v_1, v_2, ..., v_r$ are the cointegrating vectors, that is they are the columns of matrix β.

STEP 4 : For each μ_i compute the LR statistic:

$$LR = -T \cdot \sum_{i=r+1}^{n} \ln(1-\mu_i) \qquad \text{E.3.17}$$

which under the null hypothesis that there are at most r cointegrating vectors, has an asymptotic distribution whose percentiles are tabulated by Johansen and Osterwald-Lenum (1990). The testing procedure normally starts by testing the hypothesis that $r = 0$ with the alternative that there is one or more than one cointegrating vectors. If this hypothesis is rejected then we check if $r \leq 1$. If this hypothesis is also rejected then we test $r \leq 2$ etc. If the null hypothesis cannot be rejected for, say $r \leq r_0$ but it has been rejected for $r \leq r_0 - 1$ the straightforward conclusion is that the number of cointegrating vectors is r_0. This test is known as the trace test. Except for this test, a similar test is the maximum eigenvalue test that is computed as follows:

$$\mu_{max}(r, r+1) = -T\ln(1-\mu_{r+1}) \qquad \text{E.3.18}$$

This statistic tests the null hypothesis that there are r or less than r cointegrating vectors against the alternative of r+1 cointegrating vectors while the statistic given in E.3.17 tests the same hypothesis against a more general alternative[25]. Therefore, by using tests E.3.17 and E.3.18 one can find the number of the statistically significant cointegrating vectors.

Another question that may be asked is how is it possible to estimate the system E.3.16? Since the separation of the Π matrix to two separate matrices requires the imposition of cross equation restrictions, the use of OLS is impossible. Instead, the method that has to be used is the Maximum Likelihood (ML) method. Using this method, one can estimate all the cointegrating vectors.

The advantages of the Johansen method over the OLS are really many. The first is that the Johansen procedure tests the number of cointegrating vectors instead of assuming only one cointegrating vector as the OLS method does. As it was said, when the number of the variables is more than two there are very good probabilities for multiple cointegrating vectors. In this case, OLS would give meaningless and wrong estimates of the coefficients. Not only does the Johansen procedure provide us with **tests about the number** of cointegrating vectors but also it provides us with estimates of **all** the distinct cointegrating vectors. A third advantage of the Johansen procedure over the OLS is that although in the latter, because of the spurious regression problem, the classical inference procedures are invalid, using the Johansen procedure we can test restrictions imposed on the cointegrating matrix β. The way that these tests may be implemented is by comparison of the eigenvalues without the restrictions with the eigenvalues with the restrictions. If the restriction(s) fits the data well the corresponding eigenvalues, μ^*_i, must not be significally different from those derived without the restrictions, μ_i. To decide whether this happens the following statistic is ussually applied:

[25]See W.Enders (1995), p. 391

$$T\sum_{i=1}^{r} [\ln(1-\mu^*_i) - \ln(1-\mu_i)] \qquad E.3.19$$

Asymptotically , this statistic has an χ^2 distribution with degrees of freedom equal to the number of the restrictions imposed on β . The restriction that forms the null hypothesis is rejected, when the calculated value of the test statistic is higher than the corresponding value of the table of the χ^2 distribution. At that point, it must be mentioned that if the number of the restrictions are less than the number of the cointegrating vectors then the restrictions must be imposed on all the cointegrating vectors and not just on the one that probably attracts our interest. The reason is because if in the case of two, let's say, cointegrating vectors, we imposed only one restriction in only one of the two cointegrating vectors this restriction would always be satisfied by a linear combination of the two cointegrating vectors[26]

Finally, another advantage of the Johansen procedure over the OLS method is that the Johansen procedure avoids arbitrary normalisations since it is based on a **VAR system** and therefore does not discriminate between exogenous and endogenous variables. In contrast the OLS method makes such arbitrary normalisations.

Since the Johansen procedure has all these advantages, it will be adopted for the estimation of the long run consumption function and consequently of the long run degree of income correction in the empirical part of this thesis.

4. The Error Correction Model

In the previous section we examined, the concept of cointegration. As it was said there, if two or more variables are cointegrated this indicates the existence of a long run relationship among them. Therefore, cointegration is a very

[26]See Johansen and Juselius, (1990), p. 195.

useful concept regarding the long run connections of a group of variables. However, this is not the end of the story since according to the Granger representation theorem, cointegration implies the existence of an error correction model and conversely. But what is an "error correction model"?

An error correction model is a model that models the short run behaviour of a variable, taking into account the fact that changes in the dependant variable may be affected not only by changes in other contemporaneous or lagged variables but also by the disequilibrium in the long run relationship of a previous period. To understand this argument better, let's assume that we have two I(1) variables x and y and that there is a long run linear relationship between them that has the following form:

$$y_t = bx_t \qquad \text{E.3.20}$$

In other words, it is assumed that y and x are cointegrated. In a case like this, where there are only two variables, the coefficient b can be obtained either by the OLS or by using the Johansen procedure.

Since E.3.20 is the long run relationship, one could form the corresponding short run relationship in differences as follows:

$$\Delta y_t = a\Delta x_t \qquad \text{E.3.21}$$

The problem with equation E.3.21 is that it ignores the fact that changes in y_t may be affected, not only by changes in x_t, but also by the disequilibrium in the long run relationship. For, indeed the actual level of y_t may be different from the desired level given by bx_t, thus resulting in disequilibrium in the long run relationship. In fact, what E.3.21 implies is that there is no case for such disequilibrium. Yet this clearly cannot always be the case. For this reason, one has to include in E.3.21, in addition to the other variables, the disequilibrium in the long run relationship as well. If we do this to E.3.21 we will arrive at the following equation:

$$\Delta y_t = a\Delta x_t + \theta(y_{t-1} - bx_{t-1}) \qquad \text{E.3.22}$$

This model is called error correction model because it takes into account the fact that the present behaviour of people may be affected by past errors regarding the desired and the actual level of the variable under consideration[27]. The coefficient θ measures exactly this response giving the speed by which people respond to the disequilibrium of the past period. The sign of θ is expected to be always negative. This is clear since if:

$y_{t-1} < bx_{t-1}$ this means that the actual level of y in the past period was lower than the desired one. For this reason people will increase y_t in the present period which means that $\Delta y_t > 0$. Therefore: $y_{t-1} - bx_{t-1} < 0 \Rightarrow \Delta y_t > 0$

Similarly: if $y_{t-1} > bx_{t-1}$ the actual level of y in the previous period was greater than the desired level which means that people in this period have to adjust y downwards i.e. $\Delta y_t < 0$. Therefore: $y_{t-1} - bx_{t-1} > 0 \Rightarrow \Delta y_t < 0$.

From the above it is clear that since: $\theta = \frac{\partial \Delta y_t}{\partial (y_{t-1} - bx_{t-1})}$ then $\theta < 0$.

Actually, apart from the variables that appear in the long run relationship one could also include other variables in E.3.22, provided that these variables are stationary. In fact, the modelling strategy that appears to be the best, is to start

[27]E.3.22 assumes that the disequilibrium in a period can affect the changes in the dependant variable in the next period only.

from a very unrestricted model and then, through t and F tests to narrow it down. This methodology is known as **general to specific method**.

Now regarding the validity of the statistical tests and the other equation diagnostics, since in E.3.22 all variables are stationary[28] all these tests and diagnostics are valid.

All the above characteristics has made the error correction model very popular in the last eight to ten years.

5. Cointegration, the error correction model and the short run and long run degree of income correction.

Having examined in the previous chapter the attempts for the estimation of the degree of income correction and the problems that they have, and having exposed the recently developed terms of unit roots, cointegration and error correction model, we are now in a position to develop a different framework for the estimation of the degree of income correction. I believe that this approach that is again based on the estimation of a consumption function, constitutes a significant improvement over all the studies examined in the previous chapter since it solves all their problems. More analytically:

i) We perform tests for nonstationarity of the variables of the model.

As it was said, many of the models exposed in the previous chapter suffer from the problem of spurious regression which is the result of the violation of the stationarity assumption. Therefore, before any further analysis, one has to test the validity of the stationarity assumption.

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[28]Note that $y_{t-1} - bx_{t-1}$ is stationary by definition since it constitutes a cointegration relationship.

ii) Estimation, through the Johansen procedure, of a long run consumption function where income is defined as in E.2.1

For this purpose, we will utilise the concept of cointegration. The estimation of a long run consumption function will permit us to estimate the long run degree of income correction. As it was said in the previous chapter, models like those of HUS and U-S impose the restriction that the long run degree of income correction is equal to the short run one. However, this may not be the case since although it is fair and logical that people may not suffer from money illusion in the long run, in the short run this may not happen. Another problem is that in the models of the previous section the long run model is in non-linear form which implies that if there is a long run relationship this is non-linear. Nevertheless, the whole theory of cointegration is developed for linear models and very little (if any) is known about non-linear "cointegrating" relationships. In our model an approximation will be used to avoid all the problems caused by non-linearities.

iii) Estimation of an error correction model

This is the step that one would follow naturally, after the estimation of a long run model. In this step we will derive the short run degree of income correction. As it was said previously, it will be the first time that separate estimates of the long run and short run degree of income correction will be derived. But let's examine some of these points more analytically.

5.1 The long run consumption function

As even one that had just an introductory course in macroeconomics knows, two are the major consumption theories today. The one is based on the Permanent

Income Hypothesis (PIH), while the other on the Life Cycle Hypothesis (LCH). From these two theories the LCH was chosen to be used in our model. As Deaton says[29] the life cycle hypothesis "is the basis for essentially all modern research on consumption and saving" and it is actually the most popular model of consumption. Here, we will only state the final linear form of the model which is[30]:

$$C_t = b_1Y_t + b_2W_t \qquad \text{E.3.23}$$

where all variables are specified in levels. Although in E.3.23 the variables are in levels, in practice, especially in the last years, equation E.3.23 is usually estimated using a logarithmic transformation of the variables[31]. A probable reason for this is that the specification in logarithms has been found better on empirical grounds[32]. In this thesis E.3.23 will also be specified in logarithms since this would help to make our model comparable with the main body of research that specifies E.3.23 in logarithms. Therefore the long run model will be :

$$c_t = a_1y_t + a_2w_t \qquad \text{E.3.24}$$

where small letters denote the logarithm of the corresponding variable in levels.

In the long run relationship given by E.3.24 income is not inflation corrected. To introduce a correction like this, the definition of corrected income should be used. This definition is:

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[29]This quotation was taken from Church et al. (1994)
[30]See Ando-Modigliani (1963) , DHSY (1978) , Modigliani (1975).
[31]See DHSY (1978), Church et al. (1994) where they report a number of the most popular consumption functions for the UK , all of which use the LCH with the variables transformed in logarithms. Also see D. Weiserbs and P. Simmons (1986) etc.
[32]See D. Weiserbs and P. Simmons (1986) as well as DHSY (1978).

$$Y^{*}_t = Y_t - \delta\pi^e_t MNAS_t \qquad \text{E.3.25}$$

where Y^{*}_t is inflation corrected income

Substituting this definition of income into the long run relationship E.3.24 we will have:

$$\log(C_t) = c_t = a_1\log(Y_t - \delta\pi^e_t MNAS_t) + a_2\log W_t \qquad \text{E.3.26}$$

The problem with E.3.26 is that it is non-linear while the concept of cointegration is about linear relationships. Fortunately there is an approximation that can be used to solve this problem. This approximation is as follows:

$$\log(Y_t - \delta\pi^e_t MNAS_t) = \log\{Y_t(1-\delta[\frac{\pi^e{}_t MNAS_t}{Y_t}])\} \approx \log Y_t - \delta[\frac{\pi^e{}_t MNAS_t}{Y_t}] \qquad \text{E.3.27}$$

This approximation was used by Phillips (1992) and it was also referred in the HUS paper. The approximation given by E.3.27 will work better the smaller the rate of inflation. Since in the countries of our sample the rate of inflation was rather low the above approximation is expected to work fairly well. Now taking equations E.3.26 and E.3.27 together we will have:

$$c_t = a_1\{y_t - \delta[\frac{\pi^e{}_t MNAS_t}{Y_t}]\} + a_2 w_t \Leftrightarrow$$

$$\Leftrightarrow c_t = a_1 y_t - a_1\delta[\frac{\pi^e{}_t MNAS_t}{Y_t}] + a_2 w_t \Leftrightarrow$$

$$\Leftrightarrow c_t = a_1 y_t + b[\frac{\pi^e{}_t MNAS_t}{Y_t}] + a_2 w_t \qquad \text{E.3.28}$$

where $b = -a_1\delta$. The coefficient δ is the long run degree of income correction and it can be easily recovered from the estimated version of E.3.28 since $\delta = -\frac{b}{a_1}$. In the case of full income correction, $\delta = 1$ which in turn means that $a_1 = -b$. On the other hand, in the case of zero degree of income correction $\delta = 0$ which in turn means that $b = 0$. Therefore, it is easy to test statistically the null hypotheses of full or zero degree of income correction[33] since each of these hypotheses can be transformed to a hypothesis concerning the coefficients a_1 and b.

Now, regarding the question whether equation E.3.28 represents really a long run consumption function the answer can be given through tests of cointegration. Equation E.3.28 will represent a long run relationship only if cointegration holds. However, before one tests for cointegration, he must first define the order of integration of the variables of the analysis. The order of integration that one expects for our variables is one. Since the variables of our model are more than two (they are actually four) estimation of the supposed cointegrating relationship by OLS is not indicated. In contrast, the Johansen procedure is a much more efficient way to estimate E.3.28 and it is this method that will be used in this work.

5.2 The short run consumption function

Having estimated the long run consumption function, the next natural step is to formulate an error correction model. The fact that there is a long run relationship (i.e. there is cointegration) guarantees, according to the Granger representation theorem, that there is an error correction model. To formulate the error correction term we will use the residuals from the already estimated long run

[33]Of course, apart from these two hypotheses, we can also formulate and test other hypotheses about the value of δ.

relationship E.3.28. If we denote this term as ECT, the general form of our error correction model will be:

$$\Delta c_t = d_0 + d_1 \Delta y^*_t + d'Z + \theta ECT_{t-1} \qquad E.3.29$$

In E.3.29, y^*_t is the logarithm of the corrected income and $\mathbf{d'Z}$ is a vector of other variables (contemporaneous or lagged) that may appear in the model. To avoid non-linearities the approximation E.3.27 will be used. Using this approximation, E.3.29 can be written as follows:

$$\Delta c_t = d_0 + d_1 \Delta\{y_t - \delta_s[\frac{\pi^e{}_t MNAS_t}{Y_t}]\} + d'Z + \theta ECT_{t-1} \Leftrightarrow$$

$$\Leftrightarrow \Delta c_t = d_0 + d_1 \Delta y_t - d_1 \delta_s \Delta[\frac{\pi^e{}_t MNAS_t}{Y_t}] + d'Z + \theta ECT_{t-1} \Leftrightarrow \qquad E.3.30$$

$$\Leftrightarrow \Delta c_t = d_0 + d_1 \Delta y_t + r\Delta[\frac{\pi^e{}_t MNAS_t}{Y_t}] + d'Z + \theta ECT_{t-1} \qquad E.3.31$$

where δ_s is the short run degree of income correction. Although, according to E.3.30 the estimation of this degree seems to need non-linear methods of estimation this is not true, since this coefficient can be estimated indirectly through estimation of E.3.31 by OLS. Indeed, the indirect estimate of δ_s can be derived from E.3.31 as follows:

$$r = -d_1 \delta_s \Leftrightarrow \hat{\delta_s} = -\frac{r}{d_1} \qquad E.3.32$$

Therefore, there is no need to use non-linear methods, although for the short run model there would be no problem if we did so. The problem with non-linearities is in the long run relationships. Nevertheless, even though non-linearities are not a problem for the estimation of the error correction model, it is better to avoid them since they may have other problems[34]. Non-linear methods will become completely unavoidable only in the case that the first difference of corrected income enters into equation E.3.30 with lags. The reason is because in this case, the coefficient δ_s will be over-identified and we will have to impose restrictions for its identification. More concretely, assuming that the corrected income enters the error correction model with one lag[35] we will have:

$$\Delta c_t = d_0 + d_1\Delta\{y_t - \delta_s[\frac{\pi^e{}_t MNAS_t}{Y_t}]\} + d_2\Delta\{y_{t-1} - \delta_s[\frac{\pi^e{}_{t-1} MNAS_{t-1}}{Y_{t-1}}]\} + d'\mathbb{Z} + + \theta ECT_{t-1} \Leftrightarrow \quad \text{E.3.33}$$

$$\Leftrightarrow \Delta c_t = d_0 + d_1\Delta y_t - d_1\delta_s[\frac{\pi^e{}_t MNAS_t}{Y_t}] + d_2\Delta y_{t-1} - d_2\delta_s[\frac{\pi^e{}_{t-1} MNAS_{t-1}}{Y_{t-1}}] + d'\mathbb{Z} + + \theta ECT_{t-1} \Leftrightarrow \quad \text{E.3.34}$$

$$\Leftrightarrow \Delta c_t = d_0 + d_1\Delta y_t + r_1[\frac{\pi^e{}_t MNAS_t}{Y_t}] + d_2\Delta y_{t-1} + r_2[\frac{\pi^e{}_{t-1} MNAS_{t-1}}{Y_{t-1}}] + d'\mathbb{Z} + + \theta ECT_{t-1} \quad \text{E.3.35}$$

From E.3.34 and E.3.35 it can be seen that in a case like the above, we have two estimates of δ_s. The one is $\delta_s = -\frac{r_1}{d_1}$ while the other is $\delta_s = -\frac{r_2}{d_2}$. These two indirect estimates have to be restricted to be equal to each other. Imposition of a restriction like this necessitates the application of non-linear methods.

Although from the above it may seem impossible to avoid non-linear methods yet this is not always so. The reason is that the first difference of corrected income will enter the error correction model with one or more lags only

[34]See J. A. Doornik and D. F. Hendry (1994), pp. 170-171 for nine potential problems.
[35]The argument is exactly the same even if we have more lags.

in the case that such lags are significantly different from zero. Looking at model E.3.33, this requires that d_2 or r_2 be statistically significant. Thus we could estimate model E.3.35 or an even more unrestricted model by OLS and then test the significance of these two coefficients. As it will be seen in the empirical part of this thesis in most of the cases equation E.3.31 is fine.

One problem with using OLS to derive the indirect estimate of δ_S is that this indirect estimate will not have a standard error and therefore statistical tests on the value of δ_S cannot be performed. Nevertheless, this problem can be easily overcome. One way to do this, is to perform such tests indirectly in a similar fashion as in the case of the long run function. However, there is an even better way to follow. Thus we can as a first step estimate E.3.31 by OLS and derive the indirect estimate of δ_S. Then we can introduce the estimates obtained by OLS into the corresponding non-linear model and use a non-linear method. This is expected to converge immediately and also it is expected that the estimates will be the same with the ones derived by OLS. The only difference is that now the estimate of δ_S will have an asymptotic standard error attached to it and therefore we can perform statistical tests. However, this does not mean that the indirect way is not good, since as it will be seen in all cases both ways gave the same results.

6. A modelling strategy for the estimation of the degree of income correction.

The purpose of this section is to summarise, in a step by step fashion, the strategy that will be followed for the estimation of the degree of income correction in the empirical part of this thesis.

1. Test for unit roots

This test is needed before any further analysis starts. If, as it is expected, c_t is integrated of first order, then all the variables in the long run model E.3.28, which is also given for ease of reference below, must be integrated of first order as well.

$$c_t = a_1 y_t + b[\frac{\pi^e{}_t MNAS_t}{Y_t}] + a_2 w_t \qquad \text{E.3.28}$$

If some variables in the long run relationship are integrated of different order and the order of integration of the dependent variable is lower than the highest order of integration of these explanatory variables, there must be at least two explanatory variables integrated of this higher order if the necessary condition for stationarity of the error term is to be met[36].

2. Commence the Johansen procedure by determining the lag length of the VAR model

As it was said previously, the Johansen procedure is based on a VAR approach to cointegration and therefore, it requires a VAR model formed of the variables employed in the analysis. The problem is what is the right lag length for this VAR model? If we had infinite number of observations then this should not have bothered us: we would choose a large lag-length and that's all. However, since the number of observations is not infinite, a careful analysis is needed in order to choose the appropriate lag length of the VAR. Criterion for this decision is the requirement of the Johansen method that the residuals of the VAR must be white noise.

[36]See W. W. Charemza and D. F. Deadman (1992), p. 148.

3. Test about the number of the valid cointegrating vectors and estimate them.

Due to the computer techniques available today, this is rather straightforward. The software package that will be used for this purpose is Microfit 3.0 of M.Pesaran and B.Pesaran (1992). This package performs tests about the number of the statistically significant cointegrating vectors and estimates them. Moreover, it performs tests about the validity of restrictions imposed on them. In the case that there are more than one cointegrating vectors the decision rule that must be followed is to choose the cointegrating vector that comes closer, in terms of the sign and the magnitude of its coefficients, to what is expected from a long run consumption function. From the chosen cointegrating vector we can derive the long run degree of income correction.

4. Impose and test restrictions about the value of the long run parameters.

5. Estimate a general unrestricted error correction model

This is the first step for the estimation of a parsimonious short run equation. The modelling strategy that will be used in this step is to employ all the variables for which there is a suspicion that may affect consumption, even though some of these variables may not appear in the long run model. Requirement for the entrance of any variable in the short run model is to be stationary. Also these variables must be introduced with a long enough lag length if we want to have a real general model. The error correction term is formed of the residuals of the long run relationship and enters the short run model with one lag.

6. Use the general to specific method to arrive at the final equation.

In this step we perform t and F tests to arrive at the final parsimonious equation. After this is done we can get the estimate of the short run degree of income correction.

7. Perform a complete series of statistical tests.

In this step, a variety of statistical tests will be performed that will test the validity of the classical regression assumptions for our model.

7. Conclusion

In this chapter the definitions and the meaning of such new terms as unit roots, cointegration and error correction were developed. Our aim was not to give a complete account of the issues involved. We rather sought to give the intuition behind these terms and to present how these concepts will be applied in the empirical part of this thesis. After the examination of the meaning of these terms we continued with the presentation of the model that will be used in this study. This model is an improvement over all the previous work that has been done in this field. This improvement is consistent of a better specification of the long run model, a discrimination between the short run and the long run degree of income correction and the utilisation of a number of powerful concepts and statistical tests.

Although after the above analysis the next natural step would be to empirically apply what was said in this chapter, we will delay this step for a while. The reason is that data on wealth, which is a very significant variable in a life cycle consumption function, are generally not readily available for many of the countries of our sample. In the next chapter we will develop a new approach for the solution of this problem and we will derive estimates of the stock of dwellings[37] for a large number of OECD countries.

[37]Usually it is inability to find data on this variable that produces the unavailability of data on wealth.

CHAPTER 4

ESTIMATION OF THE STOCK OF DWELLINGS: A CAPITAL - OUTPUT RATIO APPROACH.

1. Introduction

One of the main weaknesses of the empirical studies of the consumption function is the absence of reliable data on wealth. Ignoring human wealth, the wealth of a household is usually composed of financial assets (cash, deposits, shares, bonds etc.) and of a house. It is this later item that is usually ignored in the empirical studies of the consumption function. The reason is lack of data. However, ignorance of this variable essentially means that the corresponding coefficient in the consumption function is assumed as zero, which if it is not true, implies the introduction of a misspecification error[1]. Also, although one would expect that the inclusion of the non-human wealth and the personal income, would solve the potential problem created from the exclusion of the human wealth[2], yet it is rather implausible that the inclusion of the financial only will be enough to account for the effects of the **total** non-human wealth on consumption. The reason is that the relation between the financial and the non-financial wealth of the households is, mostly, that of substitution. Indeed, in periods of a high and volatile inflation rate people move from financial assets to non-financial assets. In such cases, although the amount of financial assets may be decreased, the total value of wealth (financial and non-financial) may not change equally.

In this chapter, a theoretically consistent method, that is first time used in this context, will be utilised to derive a benchmark estimate of the largest item of

[1]For the effects of misspecification see Thomas (1993), pp. 140-141.
[2]The reason is that sooner or later the amount of human wealth will appear either as increased personal income or as increased non-human wealth or as both. Thus, the inclusion of the personal income and the non-human wealth is expected to be enough to account for the effects of the human wealth as well.

the non-financial wealth of the households i.e. the stock of dwellings[3]. Having obtained an initial estimate using this method, we will then apply the Perpetual Inventory Method (PIM henceforth) to derive estimates of the stock of dwellings for 16 OECD countries. The reliability of the estimates will be evaluated by making comparisons with the official data for the countries that such data are available.

Section 2 sets the theoretical foundations of this chapter, while sections 3 and 4 present estimates of the stock of dwellings for 16 OECD countries. In section 4, we compare our estimates with the official estimates for those countries of the sample that such estimates are available. Finally, section 5 concludes this chapter.

2. The Perpetual Inventory Method (PIM).

The PIM is by far, the method that is most extensively used for the derivation of the stock of fixed capital, when the corresponding data requirements are met. The main idea behind the PIM is that a stock is an accumulation of a corresponding flow. Therefore, one would expect that summation of the corresponding past flows will give the stock that has been cumulated up to that time. In our case, since the stock of dwellings is formed by investment in dwellings, we could compute the stock of dwellings at a point of time as the sum of the investment in dwellings that has been taken place up to that point. In other words, if K_T is the stock of dwellings[4] at the end of period T and I_t is the gross

[3]In Church et al. (1994), where a review of the recent UK consumption functions is presented, in all cases (six out of eight) where non-financial wealth is used, it is defined as the stock of dwellings. The significance of this variable is pointed out by the same authors when, regarding the coefficient of the stock of dwellings in the consumption function of the London Business School (LBS), they say: "we find that in the context of the LBS model there is no evidence in favour of excluding housing wealth or, indeed, giving it a smaller weight (they mean relative to the financial wealth) in the consumption decision." p. 73
[4]The analysis is equally applicable to any other type of fixed asset.

investment in dwellings in period t where $t=0,1,2,......,T$. then we could compute K_T as follows:

$$K_T = \sum_{t=0}^{T} I_t \qquad \text{E.4.1}$$

The problem with equation E.4.1 is that it does not allow for the fact that during those T+1 periods, some part of the investment may have reached the end of its useful life and therefore it should not be included in the stock of dwellings. Depending on the way that allowances for the fact that dwellings have a limited useful life are computed, we have two types of stock of dwellings: the gross stock of dwellings and the net stock of dwellings.

From these two, the gross stock of dwellings assumes that dwellings offer equal services from the first day to the last day of their useful life, and that they suddenly stop to offer any service after the last day. Thus, if $L<T$ is the useful life of dwellings then, the gross stock of dwellings at the end of period T, GK_T, will be:

$$GK_T = \sum_{t=0}^{T} I_t - \sum_{l=L}^{T} I_{T-l} = \sum_{t=T-L+1}^{T} I_t \qquad \text{E.4.2}$$

From E.4.2, it is clear that a basic prerequisite for the computation of the gross stock of dwellings is the existence of data on gross investment in dwellings for a period longer than the useful life of dwellings. Otherwise, the accumulation of past investment will give a stock of dwellings that misses those still useful dwellings that were built before the first period for which we have available data.

Therefore, without a long enough series of investment in dwellings, application of equation E.4.2 will give inaccurate results, though less so as time passes.

Having examined the gross stock of dwellings, it is now time to examine the net stock of dwellings. As it was said above, depending on the way that we account for the fact that dwellings have a limited useful life, we arrive at two different definitions of the corresponding stock. So in the gross stock of dwellings all the retirement happens in the last moment of the useful life of the house. However, it is much more probable that the house is retired gradually, instead of suddenly. In this case, as the house becomes older and older the stock in existence becomes less and less. Thus, the initial investment must be adjusted by the corresponding amount of retirement in each period in order to arrive at the amount of investment that is still useful. This amount of retirement, is called depreciation or capital consumption. The formal definition of depreciation is given below[5]: "This flow (i.e. depreciation) is based on the concept of the expected economic lifetime of the individual assets; and is designed to cover the loss in value due to foreseen obsolescence and the normal amount of accidental damage which is not made good by repair, as well as normal wear and tear"

The stock of dwellings adjusted for depreciation (gradual retirement) is called net stock of dwellings. To make sure that it is fully clear that the nature of the difference between gross and net stock of dwellings is in **when and how** the retirements take place and not in **whether** they take place or not the following very clear explanation of Tom Griffin of the Central Statistical Office (CSO) of the UK is given[6]: "The essential difference between gross capital stock .... and net capital stock is that, whereas for gross capital stock the whole of the original value of fixed assets is deemed to remain in stock until the year of retirement, for net

[5]See: United Nation, (1968), p. 122
[6]See: Tom Griffin (1979), p. 102

capital stock the original value of assets is deemed to decline gradually over their service lives."

Having clarified the difference between gross and net stock of dwellings, we can present formulas for the derivation of the net stock of dwellings, using the PIM. Thus, the net stock of dwellings at the end of period T, NK_T, will be:

$$NK_T = (I_0 - D_0) + (I_1 - D_1) + \dots\dots\dots + (I_T - D_T) = \sum_{t=0}^{T}(It - Dt) = \sum_{t=0}^{T} I_t^n \qquad \text{E.4.3}$$

where D_t is the depreciation in period t and I_t^n is the net investment of this period. In other words, the net stock of dwellings is equal to the sum of the past net investment. As in the case of the gross stock, so in the case of the net stock , since dwellings usually have a relatively long life, to derive estimates of their net stock using E.4.3, we need a long series of data on net investment. If such series of data is not available (as it is the case for many countries), the problem could be resolved if we had a benchmark estimate for the net stock of dwellings. Thus, if we knew the net stock of dwellings at the end of period m and the gross investment that took place in period m+1, the net stock of capital at the end of period m+1 could be computed as follows:

$$\begin{aligned} NK_{m+1} &= NK_m + I_{m+1} - D_{m+1} = \\ &= NK_m + I_{m+1} - d \cdot NK_m \end{aligned} \qquad \text{E.4.4}$$

where it is assumed that depreciation is a constant percentage d of the net stock of the previous period.

For the needs of this work, where we are interested in the stock of dwellings as part of the wealth of the households, our attention will be concentrated on the net stock of dwellings since net stock seems more appropriate for this purpose than gross stock.

As equation E.4.4 shows, to estimate the net stock of dwellings what is needed is data on gross investment, a depreciation series or an assumption regarding the depreciation rate, and a benchmark value for the net stock of dwellings. Having these data we can apply E.4.4 recursively, thus finding the net stock of dwellings in each successive period. From these three requirements, the last one i.e. the one that refers to a benchmark value, is the most difficult one. Below, after examination of how one could meet the other two data requirements, we will present a simple and theoretically consistent method that it is first time used for the estimation of a benchmark value of the net stock of dwellings.

2.1 A series of gross investment in dwellings.

It is not difficult to find data on gross investment in dwellings. Really, the System of National Accounts (SNA) that is followed by most countries of the world (i.e. the SNA of the United Nations) classifies total investment into seven categories one of which is "investment in residential buildings". As the relevant manual of the United Nations says[7], investment in residential buildings is the "**value of work put in place on the construction of buildings which consist entirely or primarily of dwellings**[8]". Also, as the same source makes clear[9] "hotels, autocourts and similar buildings operated for purely transient occupancy are considered to be non-residential structures". Thus, provided that elementary disaggregation of gross fixed capital formation is available, we can find data on the gross investment in dwellings. For the countries of our sample, OECD

[7]See United Nations (1968), p. 114
[8]Emphasis is added.
[9]See United Nations (1968), p. 114

publishes regularly (from 1950) data on the investment in residential buildings in current and constant prices[10].

2.2 Depreciation estimates

In contrast to the case of gross investment in dwellings, where the relevant series can be measured without much disputation, the measurement of depreciation requires two kinds of assumptions. The first assumption refers to the useful life of houses, while the second to the depreciation method that should be used.

Regarding the first of these two assumptions, the main sources that are usually utilised to obtain information are tax authorities, company accounts, surveys, expert advice and other countries estimates[11]. In table T.4.1 below, we give estimates of the useful life of dwellings for those countries that such information is available. The estimations presented below, will be used in the empirical analysis of the next section. For those countries that official assumptions are not available, we will make guesses based on information for neighbour countries. Thus, for example, the useful life of dwellings in Canada, will be assumed as equal to the one of the United States. Similarly, the useful life of dwellings in Netherlands will be computed as an average of the one in Germany, Belgium and France.

Table T.4.1: Useful life of dwellings in some OECD countries[12]

Country	Useful life in years	Source
USA	80 (1-4 unit structures) 65 (5+ unit structures)	OECD

[10]Data in constant prices are needed if we want to derive estimates in constant prices.
[11]See OECD (1993) , pp. 10-17
[12]See p.7 of OECD (1993) for the specific sources for each country, and p.11 of the same book for the information that each country uses to arrive at these estimates.

Belgium	80	OECD
Finland	55	OECD
Germany	70	OECD
Norway	90	OECD
Sweden	75	OECD
UK	100	OECD
Italy	120	Ward (p.122)
Greece	100	National Accounts of Greece

Now regarding the depreciation method, it is usually computed using one of the following two methods: i) the straight-line depreciation method and ii) the declining balance depreciation method. The first of these methods defines depreciation as a constant **absolute** amount subtracted from the net value of the house, while the second defines it as a constant **percentage** of this value[13]. It is difficult to say which method is the best since both have been used. For the estimation of the stock of dwellings in countries without official data, we will use the double declining balance method[14]. For the remaining countries and for compatibility reasons, we will use the corresponding implicit depreciation rate of the official series (see pp. 23-24 for a more extensive discussion)

[13]This constant percentage is usually computed either as 1/L (L is the useful life of the dwellings), in which case we speak for the single declining balance method, or as 1.5/L (one and a half declining balance method) or finally as 2/L (double declining balance method). For the significance of the depreciation method in the estimates of the stock of fixed capital see H. Stone Tice (1969).

[14]This method implies that in the earlier years of the life of the house the depreciation is higher than the one derived by the straight line method, while the converse is true for the later years. An advantage of the declining balance method over the straight line method, that has special significance in our case, is that the former, with the adoption of a constant percentage of depreciation, makes the depreciation rate independent of the time. This does not happen with the straight line method whose implicit percentage is dependant on time. In the data published by OECD, Greece and France compute their depreciation using a form of the declining balance method. Also , Christensen and Jorgenson (1969) in their estimates of the US stock of dwellings use the double declining balance method.

2.3 A bencmark estimate of the net stock of dwellings.

This last requirement is the most difficult one. Actually, it is failure to meet this requirement that makes impossible to apply E.4.4.

In this section we will present a method, that is first time used to produce a benchmark estimate of the stock of dwellings. Although two others have applied this method - the one to estimate the total stock of capital in the aggregate economy[15] and the other to estimate the same stock in the various divisions of the manufacturing sector[16] - no one has made clear the mechanics and the assumptions behind this method. Moreover, no one has compared the derived estimates with official ones to examine their reliability. Finally, no one has applied this method to derive initial values for the stock of dwellings and no one has applied it to a multicountry sample. Below, we present the method in the more general context of the stock of fixed capital.

The main idea behind the method comes from the theory of economic growth. In this part of the economic science, much significance is given to the average and marginal ratios of capital to output[17]. More concretely, let's define the average capital-output ratio[18] as $\frac{NK_t}{P_{t+1}}$ where NK_t is the net stock of capital at the end of period t and P_{t+1} is the trend output produced in period t+1[19]. The definition of the marginal capital-output ratio is: $\frac{\Delta NK_t}{\Delta P_{t+1}}$. Now, we know that the change in the net stock of capital during a period of time is equal, by definition, to the net

[15]See Oikonomou (1992)

[16]See Armstrong (1979)

[17]For the role that these ratios play in the celebrated models of Harrod and Domar see Tsekouras (1979), pp. 64-81 and p. 103

[18]This ratio corresponds to the "average capital coefficient" of the Domar's model and to the "average accelerator" of the Harrod's model.

[19]Writing the capital-output ratio as the ratio of the stock of capital to the trend output of the next period assumes that the investment that has taken place at period t+1 does not become productive until the next period. Thus the capital available for production in period t+1 is NK_t. Also, although P_t is net rather than gross output, using the latter does not affect the results presented below, since it can be proven that equality of the average and marginal capital output ratio, expressed in net output terms, implies equality of the corresponding ratios expressed in gross output terms.

investment of this period (see E.4.4.). Thus, the marginal capital-output ratio can be written as follows: $\frac{I_t^n}{\Delta P_{t+1}}$. Now, assuming no technical progress or that the technical progress is neutral according to Harrod[20], the average and the marginal capital coefficients will be equal. Thus, under these assumptions, which may not be true in the long run, yet they may not be too far from reality in the short run, we will have:

$$\frac{NK_t}{P_{t+1}} = \frac{I_t^n}{\Delta P_{t+1}} = \gamma \qquad \text{E.4.5}$$

If in E.4.5 we knew the coefficient γ and the trend output at period t+1 then we would be able to compute the stock of capital at period t since:

$$NK_t = \gamma \cdot P_{t+1} \qquad \text{E.4.6}$$

To compute the coefficient γ we need data on the increase of the trend output at period t+1 and data on the net investment at period t.

Turning to our case where the aim is the estimation of a benchmark value for the stock of dwellings, we need data on the trend output of dwellings and on the net investment in dwellings. Fortunately, national accounts classify product generated in the sector of dwellings as a separate category in the product accounts[21]. Thus having this information, we could estimate trend output in the

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[20]This essentially means that the technical progress improves the productivity of labour only, while it leaves the productivity (average and marginal) of capital unchanged.

[21]For the data on the output of dwellings to be useful for our computations they need to be derived independently from estimates of the stock of dwellings. Indeed this is the case. The manual of the sources and methods of the United Kingdom National Accounts (1985) say: "Ownership of dwellings is shown separately and is defined as the contribution to the gross domestic product arising from the use of the stock of dwellings. It is measured by consumer's expenditure at constant prices on rent, including the imputed rent arising from owner occupation".

sector of dwellings. On the other hand, the investment series regarding residential buildings is in all cases in gross terms. Therefore, we must modify our equation E.4.5 to take this into account. Thus:

$$\frac{NK_t}{P_{t+1}} = \frac{I_t^n}{\Delta P_{t+1}} \Leftrightarrow NK_t = P_{t+1}\frac{I_t^n}{\Delta P_{t+1}} \Leftrightarrow NK_t = (I_t - d \cdot NK_{t-1}) \cdot \frac{P_{t+1}}{\Delta P_{t+1}} \qquad \text{E.4.7}$$

To arrive at E.4.7, we utilised the definition of net investment and the definition of depreciation[22]. Equation E.4.7 still is not in an applicable form since it includes both NK_t and NK_{t-1}. To eliminate this problem we will use the definition of the net capital at period t. This is:

$$NK_t = NK_{t-1} + I_t - d \cdot NK_{t-1} \Leftrightarrow NK_{t-1} = \frac{NK_t - I_t}{1-d} \qquad \text{E.4.8}$$

By substitution of E.4.8 to E.4.7 we will have:

$$NK_t = [I_t - \frac{d}{1-d}(NK_t - I_t)] \cdot \frac{P_{t+1}}{\Delta P_{t+1}} \Leftrightarrow$$

$$\Leftrightarrow NK_t \cdot (1-d) = I_t \cdot (1-d) \cdot \frac{P_{t+1}}{\Delta P_{t+1}} - d \cdot NK_t \frac{P_{t+1}}{\Delta P_{t+1}} + d \cdot I_t \cdot \frac{P_{t+1}}{\Delta P_{t+1}} \Leftrightarrow$$

$$\Leftrightarrow NK_t \cdot (1-d + d \cdot \frac{P_{t+1}}{\Delta P_{t+1}}) = I_t \cdot \frac{P_{t+1}}{\Delta P_{t+1}} - d \cdot I_t \frac{P_{t+1}}{\Delta P_{t+1}} + d \cdot I_t \frac{P_{t+1}}{\Delta P_{t+1}} \Leftrightarrow$$

$$\Leftrightarrow NK_t = \frac{I_t}{\Delta P_{t+1}} \cdot \frac{P_{t+1}}{(1-d+d \cdot \frac{P_{t+1}}{\Delta P_{t+1}})} \qquad \text{E.4.9}$$

[22]In E.4.7 depreciation is defined as a constant percentage of the net capital of the previous period. This corresponds to the declining balance method of depreciation that will be used in the largest part of this work. If we assumed the straight line method of depreciation we would make the depreciation rate dependant on time (instead of d , in E.4.7 we would have d_t). However , this would not affect the derived formulas in any other way.

Equation E.4.9 is a working form of our initial equation E.4.5. Truly, having data on the trend output generated in the dwellings industry at periods t and t+1, a depreciation rate, and the gross investment in dwellings at period t we can compute the net stock of dwellings at the end of this period.

In equation E.4.9, although the second ratio of the right hand side is not volatile, since it is a ratio of a rather smooth variable (trend output), this is not expected to be the case for the first ratio. The reason is that the numerator of this ratio, the investment in dwellings, is a rather volatile variable. Although it has been assumed that changes in this variable, however volatile they are, will be reflected in changes in of the trend output of the respective next period (the denominator of this ratio), this may not always be the case. One reason is that the trend output is a concept that is not easily measured and therefore inaccuracies in its measurement are plausible. Another reason, is that the reaction of the trend output to the investment may not happen after just one period, as it is assumed. For this reasons it would be better to use an average of this ratio over a longer period of time[23].

In this section we presented an easy, quick, and theoretically consistent way to estimate a bencmark value for the stock of dwellings, resolving by that way the most difficult obstacle for the application of the PIM in countries that do not fulfil the data requirements that are needed to avoid the need of an initial estimate. It now remains to use this method to start the PIM, and to see the results that it gives and, if possible, to compare these results with official ones in order to evaluate empirically the performance of the method and the reliability of the corresponding estimates. This will be done in the next two sections, where estimates of the real net stock of dwellings will be derived for 16 OECD countries.

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[23]Both Armstrong (1979) and Oikonomou (1994) used averages in their computations.

3. Estimates of the stock of dwellings in Canada, Denmark, Ireland, Italy, Luxembourg, Netherlands, Spain, Sweden

The specific steps that will be followed, for the empirical implementation of what was said in section 2 are as follows:

1. Estimate the real trend output of dwellings.

To do this, we need data on the output of dwellings. As it was said, these are rather readily available in the National Accounts, since they classify dwellings as a separate industry in the product accounts. Since we are interested in the trend output for a short period of time, the estimation of the trend output was done by running a regression of the realised real output of dwellings on a time trend, for a period of 10-13 years (depending on the observations available). Usually the results were in 1963 prices[24].

2. Estimate the first ratio of the right hand side of equation E.4.9

To estimate this ratio we need data on the real investment in dwellings. These data were taken from the same issue of the OECD as the output in dwellings, and therefore they were estimated in 1963 prices. Having data on real investment, we can compute the first ratio of the right hand side of E.4.9 for a series of years and take, for the reasons mentioned above, an average of this ratio.

3. Estimate the second ratio of the right hand side of equation E.4.9

To estimate this ratio we need data on the trend output and on the depreciation rate. Regarding the first requirement the reader is referred to what we have already said in step 1 while regarding the second requirement he is referred to what was said in pages 8-10 above.

4. Estimate a bencmark value for the real net stock of dwellings using E.4.9

[24] 1963 was the base year in the constant price estimates given in the OECD, National Accounts 1950-1968.

Having completed steps 1-3, step 4 is straightforward. The relevant estimate is (in most cases) in prices of 1963 and it can be transformed to prices of a later year using the implicit deflator of the investment in dwellings.

5. Apply the PIM (equation E.4.4).

Having an initial estimate of the net stock of dwellings and data on the real gross investment in dwellings, application of the PIM is easy and gives estimates of the real net stock of dwellings for a period as long as the period that we have data on investment. Below, we give estimates of the net stock of dwellings for those countries that official data are not available. For the remaining countries and for comparison purposes, the estimates will be presented in the next section, together with the official ones. Except for the estimates of the net stock of dwellings we also present data on the implicit deflator of investment. This permits transformation of the estimates from constant prices to current prices. Finally, we present the regressions that were used for the estimation of the trend output[25] as well as information about the estimated average ratio $I_t/\Delta P_{t+1}$ and the depreciation rate. The presentation is made on a country by country basis and each country is presented alphabetically.

CANADA

(millions of Canadian dollars)

Year	Stock of dwellings (prices 1986)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1986)	Implicit deflator of investment in dwellings
1950	175029	0.1299	1972	287311	0.3115
1951	176594	0.15098	1973	300715	0.36
1952	178199	0.15531	1974	313661	0.43
1953	181132	0.1581	1975	324797	0.488
1954	184328	0.1591	1976	339366	0.546
1955	188212	0.1626	1977	352415	0.605
1956	192566	0.16865	1978	364780	0.651

[25] In all regressions the dependant variable is output of dwellings in 1963 prices.

1957	195898	0.17322	1979	376272	0.701
1958	200951	0.17739	1980	390531	0.738
1959	205387	0.18392	1981	405998	0.818
1960	209396	0.19674	1982	416965	0.836
1961	213224	0.1984	1983	431287	0.866
1962	217308	0.1979	1984	445278	0.902
1963	221593	0.2023	1985	461348	0.928
1964	227397	0.2106	1986	480637	1
1965	233576	0.2227	1987	504468	1.103
1966	238769	0.2373	1988	528747	1.19
1967	244043	0.251	1989	554153	1.273
1968	250808	0.254	1990	575452	1.265
1969	259083	0.2653	1991	591919	1.321
1970	265449	0.2737	1992	609913	1.342
1971	275436	0.2908			

Regression equation that was used for the estimation of the trend output in dwellings

The present sample is: 1961 to 1971

Variable	Coefficient	Std. Error	t-value	t-prob	PartR²
Constant	1102.2	23.272	47.360	0.0000	0.9960
Trend	44.818	1.3459	33.300	0.0000	0.9919

$R^2 = 0.991949$ $F(1, 9) = 1108.9$ [0.0000] $\sigma = 14.1157$

RSS = 1793.272727 for 2 variables and 11 observations

Useful life = 80 years (= useful life of the 1-4 units dwellings in the USA)

Depreciation rate = d = 2/80 = 0.025

Average $I_t/\Delta P_{t+1}$ in period 61-71=51.615212

The benchmark value was for year 1966.

DENMARK

(millions of kroner)

Year	Stock of dwellings (prices 1980)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1980)	Implicit deflator of investment in dwellings
1950	75011	0.1364	1972	270493	0.4236
1951	77322	0.1641	1973	296467	0.4972
1952	79611	0.1706	1974	313520	0.6076
1953	82642	0.1653	1975	326632	0.6676

1954	86116	0.1676	1976	343714	0.7127
1955	88622	0.173	1977	357772	0.7775
1956	90803	0.1805	1978	371641	0.8427
1957	93730	0.186	1979	384924	0.9181
1958	96166	0.1853	1980	394260	1
1959	100018	0.1884	1981	398236	1.12
1960	104093	0.1933	1982	400854	1.2443
1961	109163	0.2086	1983	404944	1.3489
1962	114735	0.2205	1984	411973	1.427
1963	119874	0.2286	1985	418434	1.499
1964	127209	0.2424	1986	428506	1.556
1965	135158	0.2649	1987	437600	1.6287
1966	150915	0.282	1988	444482	1.716
1967	168305	0.3013	1989	449512	1.805
1968	184986	0.3247	1990	452058	1.893
1969	206063	0.347	1991	452787	1.959
1970	225784	0.3764	1992	452963	2.079
1971	244517	0.4011			

The regression equation that was used for the estimation of the trend output of dwellings.

The present sample is: 1950 to 1961

Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
Constant	1663.2	10.030	165.819	0.0000	0.9996
Trend	70.451	1.3628	51.696	0.0000	0.9963

$R^2 = 0.996272$ $F(1, 10) = 2672.5$ [0.0000] $\sigma = 16.2967$

RSS = 2655.824009 for 2 variables and 12 observations

Useful life = 73.33 years (= the average of the three other Nordic countries)

Depreciation rate: 2/73.33 = 0.027272729

Average $I_t/\Delta P_{t+1}$ in period 50-60 = 16.98019753

Year for which the bencmark value was computed: 1955

IRELAND (millions of Irish pounds)

Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings
1957	5862	0.0755	1975	10488	0.296
1958	5895	0.0771	1976	10996	0.35
1959	5936	0.0802	1977	11549	0.393
1960	5995	0.082	1978	12214	0.448
1961	6060	0.087	1979	12998	0.543
1962	6150	0.0902	1980	13665	0.668
1963	6265	0.0983	1981	14329	0.811
1964	6437	0.1061	1982	14967	0.881
1965	6664	0.114	1983	15569	0.935
1966	6862	0.114	1984	16197	0.978
1967	7132	0.116	1985	16780	1
1968	7398	0.1225	1986	17326	1.043
1969	7676	0.134	1987	17812	1.094
1970	7947	0.145	1988	18180	1.121
1971	8297	0.1611	1989	18644	1.165
1972	8784	0.1844	1990	19134	1.257
1973	9348	0.2027	1991	19608	1.306
1974	9980	0.2485	1992	20164	1.354

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1958 to 1967

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	19.725	0.63160	31.231	0.0000	0.9919
Trend	0.52848	0.045761	11.549	0.0000	0.9434

$R^2 = 0.943414$ $F(1, 8) = 133.38$ [0.0000] $\sigma = 0.415641$

RSS = 1.382060606 for 2 variables and 10 observations

Useful life : 100 years (= useful life in the UK)

Depreciation rate = d = 2/100 = 0.02

Average $I_t/\Delta P_{t+1}$ in period 58-66= 45.139526

Year for which the bencmark value was computed: 1963

ITALY[26]

(billions of lire)

Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings
1951	328498	0.0466	1972	933737	0.11
1952	336229	0.04771	1973	971362	0.137
1953	346379	0.4773	1974	1009052	0.176
1954	359451	0.0496	1975	1043908	0.209
1955	376232	0.051	1976	1074046	0.252
1956	395199	0.052	1977	1103698	0.299
1957	417087	0.054	1978	1132718	0.347
1958	439527	0.054	1979	1162647	0.409
1959	463828	0.054	1980	1194348	0.508
1960	488035	0.056	1981	1225457	0.627
1961	514783	0.057	1982	1253807	0.735
1962	546475	0.062	1983	1283839	0.84
1963	582505	0.067	1984	1313110	0.921
1964	620648	0.075	1985	1340458	1
1965	655165	0.075	1986	1366327	1.039
1966	688542	0.076	1987	1390620	1.082
1967	723852	0.078	1988	1415018	1.166
1968	764144	0.081	1989	1440312	1.228
1969	811659	0.088	1990	1465920	1.358
1970	853908	0.102	1990	1465920	1.358
1971	894866	0.106			

The regression equation that was used for the estimation of the trend output of dwellings

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	952.93	13.723	69.439	0.0000	0.9979
Trend	35.843	1.6621	21.564	0.0000	0.9789

The present sample is: 1951 to 1962

$R^2 = 0.978948$ $F(1, 10) = 465.01$ [0.0000] $\sigma = 19.8764$

RSS = 3950.70979 for 2 variables and 12 observations

Useful life : 120 years (Ward , 1976 , p.122)

Depreciation rate = d = 2/120 = 0.01666

Average $I_t/\Delta P_{t+1}$ in period 51-61= 33.58648

Year for which the bencmark value was computed: 1956

[26]For Italy the main source of data was the work of P. Pagliano and N. Rossi (1992)

LUXEMBOURG

(millions of francs)

Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings
1960	96235	0.162	1976	209379	0.591
1961	101566	0.176	1977	213647	0.625
1962	106689	0.185	1978	217238	0.647
1963	111543	0.199	1979	221049	0.688
1964	119424	0.221	1980	225091	0.732
1965	129882	0.229	1981	228350	0.791
1966	141710	0.231	1982	230235	0.858
1967	152652	0.231	1983	230677	0.911
1968	160616	0.249	1984	231002	0.963
1969	165780	0.275	1985	231397	1
1970	169294	0.308	1986	232416	1.039
1971	173226	0.348	1987	234396	1.083
1972	179099	0.387	1988	238044	1.113
1973	187819	0.402	1989	243510	1.176
1974	196292	0.475	1990	250033	1.238
1975	203787	0.547	1991	256777	1.297

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1960 to 1967

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	257.02	770.02	0.334	0.7499	0.0182
Trend	388.57	52.454	7.408	0.0003	0.9014

$R^2 = 0.901441$ $F(1, 6) = 54.877$ [0.0003] $\sigma = 339.94$

RSS = 693354.5984 for 2 variables and 8 observations

Useful life: 75 years (= average of the useful lives in Belgium , France and Germany)

Depreciation rate = d = 2/75 = 0.026666667

Average $I_t/\Delta P_{t+1}$ in period 60-66= 25.4951

Year for which the bencmark value was computed: 1963

NETHERLANDS

(millions of guilders)

Year	Stock of dwellings (prices 1990)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1990)	Implicit deflator of investment in dwellings
1950	97043	0.099	1972	294034	0.375
1951	101200	0.115	1973	311745	0.416
1952	105403	0.126	1974	325793	0.467
1953	111273	0.121	1975	337786	0.514
1954	117037	0.125	1976	349990	0.563
1955	122231	0.135	1977	365236	0.616
1956	129116	0.149	1978	380737	0.669
1957	136760	0.165	1979	394501	0.728
1958	143519	0.17	1980	410470	0.831
1959	150724	0.165	1981	423472	0.887
1960	157477	0.168	1982	434791	0.912
1961	163944	0.173	1983	445720	0.913
1962	169925	0.181	1984	457360	0.915
1963	175923	0.191	1985	468533	0.918
1964	185087	0.209	1986	480399	0.917
1965	195640	0.222	1987	492347	0.935
1966	207004	0.237	1988	506768	0.961
1967	220069	0.246	1989	520984	0.974
1968	234537	0.255	1990	534131	1
1969	248016	0.276	1991	544547	1.026
1970	261496	0.3	1992	555745	1.056
1971	276358	0.339			

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1961

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	726.83	65.146	11.157	0.0000	0.9256
Trend	54.504	8.8516	6.157	0.0001	0.7913

$R^2 = 0.791296$ $F(1, 10) = 37.915$ [0.0001] $\sigma = 105.85$

RSS = 112041.9986 for 2 variables and 12 observations

Useful life: 75 years (= average of the useful lives in Belgium, France and Germany)

Depreciation rate = d = 2/75 = 0.026666667
Average $I_t/\Delta P_{t+1}$ in period 50-60= 31.958
Year for which the bencmark value was computed: 1955

SPAIN

(billions of pesetas)

Year	Stock of dwellings (prices 1986)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1986)	Implicit deflator of investment in dwellings
1958	5196	0.0526	1976	22814	0.271
1959	5755	0.0553	1977	23920	0.342
1960	6267	0.0527	1978	24910	0.424
1961	6891	0.0502	1979	25768	0.5291
1962	7522	0.0569	1980	26751	0.6204
1963	8174	0.0643	1981	27702	0.695
1964	8948	0.0692	1982	28604	0.7828
1965	9802	0.0742	1983	29406	0.844
1966	10683	0.0787	1984	30118	0.9071
1967	11786	0.085	1985	30889	0.8891
1968	13156	0.0893	1986	31695	1
1969	14419	0.0937	1987	32564	1.082
1970	15542	0.1015	1988	33589	1.181
1971	16581	0.1115	1989	34648	1.2662
1972	17754	0.119	1990	35801	1.365
1973	19089	0.1441	1991	36870	1.4483
1974	20448	0.1825	1992	37810	1.499
1975	21651	0.2278			

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1958 to 1968

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	-4.6218	2.5080	-1.843	0.0985	0.2740
Trend	2.4782	0.17474	14.182	0.0000	0.9572

$R^2 = 0.957169$ $F(1, 9) = 201.13$ [0.0000] $\sigma = 1.83271$
RSS = 30.22945455 for 2 variables and 11 observations

Useful life: 98.3 years (= average of the useful lives in Mediterranean countries (France , Italy , and Greece))
Depreciation rate = d = 2/98.3 = 0.020339673
Average $I_t/\Delta P_{t+1}$ in period 58-67 = 20.1438
Year for which the bencmark value was computed: 1963

SWEDEN (millions of kronor)

Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings	Year	Stock of dwellings (prices 1985)	Implicit deflator of investment in dwellings
1950	248120	0.097	1972	610386	0.262
1951	254431	0.123	1973	634397	0.278
1952	260911	0.131	1974	654050	0.299
1953	269911	0.128	1975	672723	0.334
1954	281622	0.124	1976	687843	0.395
1955	293318	0.128	1977	701730	0.458
1956	305637	0.134	1978	719784	0.523
1957	318206	0.139	1979	738016	0.599
1958	332104	0.14	1980	756535	0.696
1959	347364	0.141	1981	772597	0.768
1960	359679	0.15	1982	787380	0.817
1961	373300	0.155	1983	801593	0.886
1962	388514	0.163	1984	819359	0.944
1963	405383	0.169	1985	835654	1
1964	424777	0.176	1986	850672	1.049
1965	444602	0.188	1987	868560	1.119
1966	463365	0.197	1988	889290	1.264
1967	486072	0.203	1989	911649	1.449
1968	508653	0.208	1990	936734	1.634
1969	531855	0.219	1991	959978	1.939
1970	558581	0.235	1992	979522	1.882
1971	584409	0.245			

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1961					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
Constant	1944.3	54.766	35.501	0.0000	0.9921
Trend	101.33	7.441	13.618	0.0000	0.9488
$R^2 = 0.948834$ $F(1, 10) = 185.44$ [0.0000] $\sigma = 88.9838$					

Useful life: 75 years (source : OECD , 1994)
Depreciation rate = d = 2/75 = 0.02666667
Average $I_t/\Delta P_{t+1}$ in period 50-60 = 31.22942
Year for which the bencmark value was computed: 1955

4. The stock of dwellings in Belgium, Finland, France, Germany, Greece, Norway, UK and USA: Estimates and comparisons with official data.

In the previous section we presented the specific steps that have to be followed in order to estimate a bencmark value that will enable us to start the PIM. and then we presented estimates of the stock of dwellings for 8 OECD countries. In this section this presentation will be completed with estimates for eight more country-members of the same organisation. However, this time we will take advantage of the fact that for these countries OECD publishes data on the stock of dwellings, to make comparisons of our estimates with the official ones. This would be particularly useful for the drawing of conclusions regarding the reliability of our estimates. However, if we want these comparisons to be sensible, our estimates must be compatible with the official ones. This requirement seems to be fulfilled partially since all the estimates presented by OECD are derived using the perpetual inventory method. Nevertheless, there three more requirements that must also be fulfilled for full compatibility. Thus both estimates must use the same deflator for the deflation of the current prices data and they must also use the same method of depreciation. Finally they must employ the same investment series. Regarding the first requirement, it was met by deflating the official **current** prices data with the implicit deflator of the investment in dwellings that we used in our estimates. Regarding the second requirement, although in the estimates of the previous section we used the double declining balance method, here we must find a solution to the fact that six out of the eight countries for which we have official data use the straight line depreciation method that implies a variable depreciation rate. The solution that was found was to simulate the depreciation rate of the official data and to apply it to our estimates. Finally, regarding the last requirement though it should have been satisfied automatically this frequently does not happen since sometimes there are slight differences between the OECD National Accounts data of gross investment and the corresponding data of the OECD estimations of the stock of dwellings. To avoid the effects of such differences we used the latter data for our computations.

After this brief discussion about the compatibility of the two sets of estimates, it is now time to move to the comparisons.

The case of Belgium

For the case of Belgium we have:

(millions francs)

Year	**Stock of dwellings (our estimates) (prices 1985)**[27]	**Stock of dwellings (Official estimates) (prices 1985)**	**Implicit deflator of the investment in dwellings**	**Difference of our estimates from the official estimates (as ratio to the official estimates)**
1953	3541821		0.163	
1954	3581027		0.164	
1955	3606234		0.17	

[27]Data for years earlier to 1964 were computed using the PIM backwards. The depreciation rate that was applied for those years was 2.5%, which is the average rate for recent to 1964 years.

1956	3638770		0.176	
1957	3675516		0.191	
1958	3696693		0.199	
1959	3726553		0.202	
1960	3776597		0.204	
1961	3835437		0.210	
1962	3884676		0.222	
1963	3929677		0.234	
1964	4037878	2185000	0.252	0.848
1965	4199878	2347000	0.266	0.789
1966	4343878	2491000	0.277	0.744
1967	4608878	2756000	0.294	0.672
1968	4740878	2888000	0.300	0.641
1969	4874878	3022000	0.312	0.613
1970	5026878	3174000	0.331	0.583
1971	5132878	3280000	0.361	0.564
1972	5241878	3389000	0.382	0.546
1973	5389878	3537000	0.420	0.523
1974	5568878	3716000	0.509	0.498
1975	5738878	3886000	0.584	0.476
1976	5939878	4087000	0.643	0.453
1977	6139878	4287000	0.694	0.432
1978	6353878	4501000	0.736	0.411
1979	6522878	4670000	0.777	0.396
1980	6689878	4837000	0.843	0.383
1981	6747878	4895000	0.893	0.378
1982	6796878	4944000	0.886	0.374
1983	6842878	4990000	0.908	0.371
1984	6883878	5031000	0.950	0.368
1985	6929878	5077000	1	0.364
1986	6977878	5125000	1.035	0.361
1987	7029878	5177000	1.089	0.357
1988	7115878	5263000	1.116	0.352
1989	7231878	5379000	1.174	0.344
1990	7367878	5515000	1.208	0.335
1991	7499878	5647000	1.227	0.328

Source of primary data: Bureau du Plan : Investissements , stocks de capital et amortissements par secteur et par produit.

The regression equation that was used for the estimation of the trend output of dwellings is:

The present sample is: 1956 to 1968

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	36695.	511.50	71.739	0.0000	0.9979
Trend	402.20	37.811	10.637	0.0000	0.9114

$R^2 = 0.911396$ $F(1, 11) = 113.15$ [0.0000] $\sigma = 510.098$

RSS = 2862197.802 for 2 variables and 13 observations

The estimates given above are also presented in the diagram below:

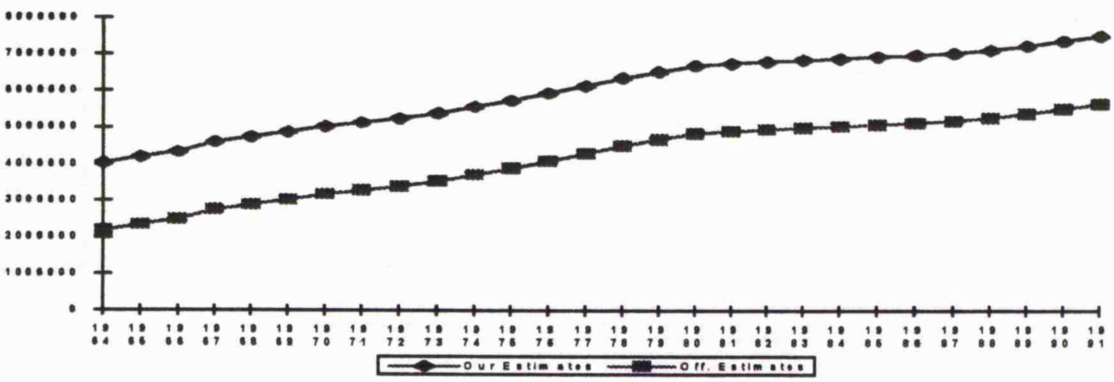


Diagram 4.1

The average discrepancy of our estimates from the official ones is 48.3% of the later. This is the biggest discrepancy among all the cases that are examined in this section. The discrepancy is larger for the first ten years where its average is 66.7%. Excluding this period the average discrepancy comes down to 38.8%. The reason that this decline occurs is because the discrepancy in the initial value (year 1964) loses its effect with the years (because of depreciation) and consequently, since both the official and the estimated series have all the other data the same, it is reasonable for them to come closer and closer as time passes.

The case of Finland

For Finland we have :

(millions of markkaa)

Year	Stock of dwellings (our estimates) (prices 1975)[28]	Stock of dwellings (Official estimates) (prices 1975)	Implicit deflator of the investment in dwellings	Difference of our estimates from the official estimates (as ratio to the official estimates)
1950	27833		0.161	
1951	29173		0.222	
1952	30726		0.238	
1953	32371		0.231	
1954	34031		0.229	
1955	35831		0.231	
1956	37402		0.245	
1957	39149		0.261	
1958	40576		0.256	
1959	42067		0.262	
1960	43997	44916	0.269	-0.020
1961	46694	47613	0.280	-0.019
1962	49730	50649	0.291	-0.018
1963	52807	53726	0.309	-0.017
1964	56012	56931	0.328	-0.016
1965	58419	59338	0.347	-0.015
1966	61539	62458	0.360	-0.015
1967	65283	66202	0.380	-0.014
1968	68433	69353	0.416	-0.013
1969	71968	72887	0.441	-0.013
1970	76675	77595	0.483	-0.012
1971	81159	82079	0.534	-0.011
1972	86485	87405	0.588	-0.011
1973	92321	93240	0.699	-0.010
1974	98424	99344	0.904	-0.009
1975	104423	105342	1.000	-0.009
1976	109457	110377	1.093	-0.008
1977	114817	115736	1.215	-0.008
1978	119573	120492	1.287	-0.008
1979	124154	125074	1.429	-0.007

[28]Data for years earlier to 1960 were computed using the PIM backwards. The depreciation rate that was applied for those years was 2.65% which correspond to the implicit average depreciation rate of recent to 1960 years.

1980	129149	130069	1.657	-0.007
1981	132961	133880	1.842	-0.007
1982	137703	138623	1.989	-0.007
1983	142527	143446	2.202	-0.006
1984	147643	148562	2.372	-0.006
1985	151761	152681	2.539	-0.006
1986	155184	156103	2.672	-0.006
1987	158933	159853	2.880	-0.006
1988	163456	164376	3.237	-0.006

Source of primary data: Kansantalouder tilinpito , Central Statistical Office

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1962

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	644.69	10.296	62.615	0.0000	0.9972
Trend	42.956	1.2972	33.115	0.0000	0.9901

$R^2 = 0.990069$ $F(1, 11) = 1096.6$ [0.0000] $\sigma = 17.4999$

RSS = 3368.725275 for 2 variables and 13 observations

Below we give a diagrammatic picture of the estimates:

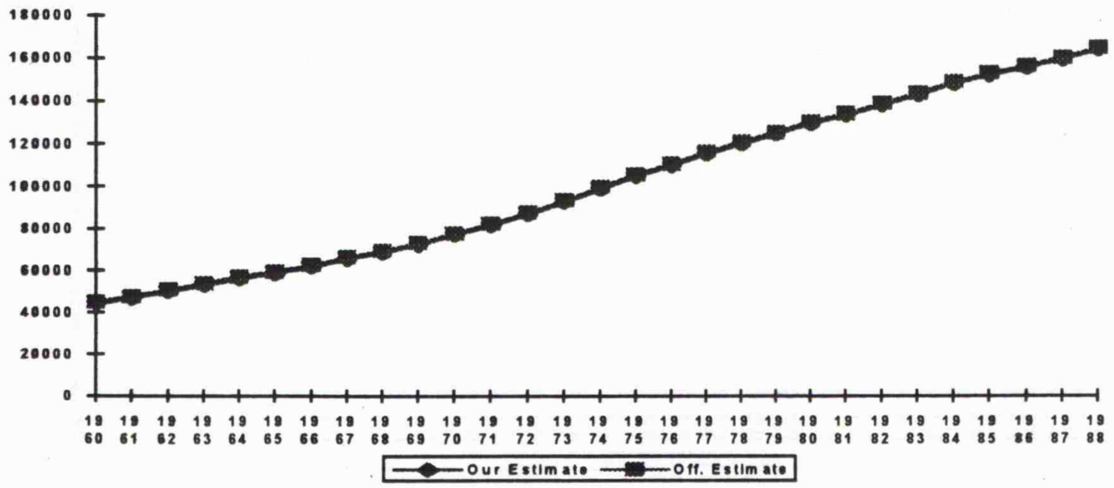


Diagram 4.2

As it can be seen from the table and the diagram, the two set of estimates are almost identical to each other. The average absolute difference for the whole period is only 1.1% of the official estimates which, by itself, shows the similarity of the estimates. In fact, excluding the first ten years this difference comes down to only 0.8%

The case of France

For France we have:

(millions of francs)

Year	Stock of dwellings (our estimates) (prices 1980)[29]	Stock of dwellings (Official estimates) (prices 1980)	Implicit deflator of the invest-ment in dwellings	Difference of our estimates from the official estimates (as ratio to official estimates)
1950	503956		0.141	
1951	525749		0.127	
1952	550851		0.159	
1953	577401		0.157	
1954	610749		0.157	
1955	649149		0.161	
1956	687860		0.172	
1957	729620		0.195	
1958	773311		0.219	
1959	830258		0.220	
1960	888859		0.222	
1961	950907		0.229	
1962	1016202		0.238	
1963	1088603		0.259	
1964	1181766		0.276	
1965	1286153		0.289	
1966	1394319		0.298	
1967	1503898		0.305	
1968	1615103		0.321	
1969	1738409		0.343	
1970	1892930	1806158	0.360	0.048
1971	2089150	2002378	0.376	0.043
1972	2303397	2216625	0.399	0.039
1973	2549101	2462329	0.441	0.035

[29]Data for years earlier to 1960 were computed using the PIM backwards. The depreciation method that is followed by the official data is the declining balance method with a depreciation rate equal to 1.3%. This rate was applied to our estimates as well.

1974	2706834	2620062	0.517	0.033
1975	2960452	2873680	0.572	0.030
1976	3090048	3003277	0.646	0.029
1977	3260151	3173380	0.709	0.027
1978	3448906	3362134	0.777	0.026
1979	3647170	3560399	0.869	0.024
1980	3711232	3624461	1.000	0.024
1981	3922778	3836007	1.096	0.023
1982	3989944	3903173	1.231	0.022
1983	4102637	4015865	1.326	0.022
1984	4182768	4095997	1.410	0.021
1985	4305380	4218609	1.460	0.021
1986	4431390	4344619	1.512	0.020
1987	4533706	4446934	1.564	0.020
1988	4666297	4579526	1.611	0.019
1989	4787528	4700757	1.641	0.018
1990	4959811	4873039	1.688	0.018
1991	5094650	5007878	1.754	0.017
1992	5154744	5067972	1.788	0.017

Source of the primary data: Rapport sur les comptes de la Nation , Institut National de la statistique et des etudes Economiques.

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1961

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Constant	6717.1	351.84	19.091	0.0000	0.9733
Trend	447.62	47.806	9.363	0.0000	0.8976

$R^2 = 0.897616$ $F(1, 10) = 87.671$ [0.0000] $\sigma = 571.678$

RSS = 3268158.275 for 2 variables and 12 observations

The estimates are also presented diagrammatically, in diagram 4.3 below. Again, as in the case of Finland, the discrepancy is very small and it is really difficult to discriminate the two estimates. The average absolute difference for the whole period is only 2.6%. This is analysed to 3.4% for the ten first years, and 2% for the remaining years[30].

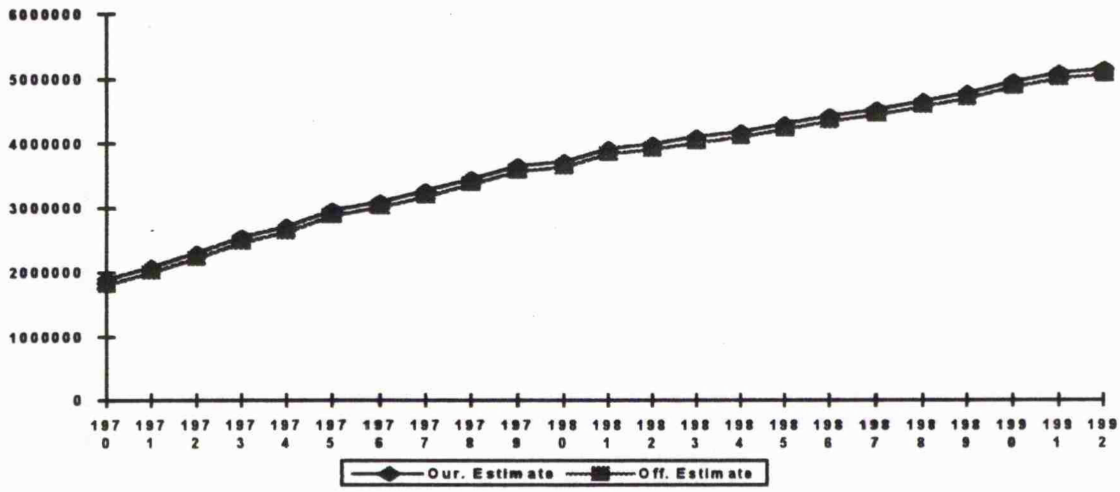


Diagram 4.3

The case of Germany

For Germany we have:

(millions of DM)

Year	Stock of dwellings (our estimates) (prices 1991)[31]	Stock of dwellings (Official estimates) (prices 1991)	Implicit deflator of the invest-ment in dwellings	Difference of our estimates from the official estimates (as ratio to official estimates)
1950	401117		0.135	
1951	428456		0.156	
1952	458617		0.167	

[30]One could argue that the difference would have been bigger had the starting value been computed for 1970 instead of 1960. The reason that the starting values was computed for 1960 was because there were no data for the output of dwellings for 1970. In any case, although generally one would expect that the difference may have been bigger had the two series been started at the same year, this is not expected to happen in our case, for had the difference been bigger, the small depreciation rate would have preserved the largest part of it and this would have been manifested in our comparisons. The fact that this does not happen, indicates that although the difference might have been bigger, if we computed the starting value for 1970, it wouldn't be significally so.

[31]Data for years earlier to 1959 were computed using the PIM backwards. The depreciation rate that was used for those years was 1.75% which correspond to the implicit average depreciation rate of recent to 1959 years.

1953	496349		0.162	
1954	538494		0.163	
1955	583509		0.171	
1956	629884		0.176	
1957	676212		0.182	
1958	723497		0.188	
1959	778861	1138732	0.198	-0.316
1960	841447	1201317	0.213	-0.300
1961	933023	1292893	0.229	-0.278
1962	988393	1348263	0.248	-0.267
1963	1055654	1415525	0.260	-0.254
1964	1143373	1503244	0.273	-0.239
1965	1232356	1592227	0.284	-0.226
1966	1300919	1660789	0.293	-0.217
1967	1403873	1763743	0.287	-0.204
1968	1495507	1855377	0.297	-0.194
1969	1705351	2065222	0.316	-0.174
1970	1711479	2071350	0.371	-0.174
1971	1785147	2145017	0.409	-0.168
1972	1887696	2247567	0.436	-0.160
1973	1991816	2351686	0.466	-0.153
1974	2053692	2413562	0.496	-0.149
1975	2138384	2498254	0.504	-0.144
1976	2145104	2504974	0.545	-0.144
1977	2343493	2703364	0.547	-0.133
1978	2416085	2775955	0.581	-0.130
1979	2528836	2888707	0.634	-0.125
1980	2562010	2921881	0.697	-0.123
1981	2613065	2972935	0.735	-0.121
1982	2637675	2997545	0.758	-0.120
1983	2744579	3104449	0.775	-0.116
1984	2806759	3166629	0.798	-0.114
1985	2878114	3237985	0.805	-0.111
1986	2944872	3304742	0.817	-0.109
1987	2987929	3347800	0.834	-0.107
1988	3058578	3418449	0.851	-0.105
1989	3140107	3499977	0.881	-0.103
1990	3207815	3567685	0.936	-0.101
1991	3274579	3634450	1.000	-0.099

Source of primary data: Volkswirtschaftliche Gesamtrechnungen , Statistisches Bundesamt.

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1961

Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
Constant	2654.2	326.55	8.128	0.0000	0.8685
Trend	586.40	44.370	13.216	0.0000	0.9458

$R^2 = 0.945848$ $F(1, 10) = 174.67$ [0.0000] $\sigma = 530.588$

RSS = 2815236.946 for 2 variables and 12 observations

The two sets of estimates are also presented diagrammatically in diagram 4.4 below:

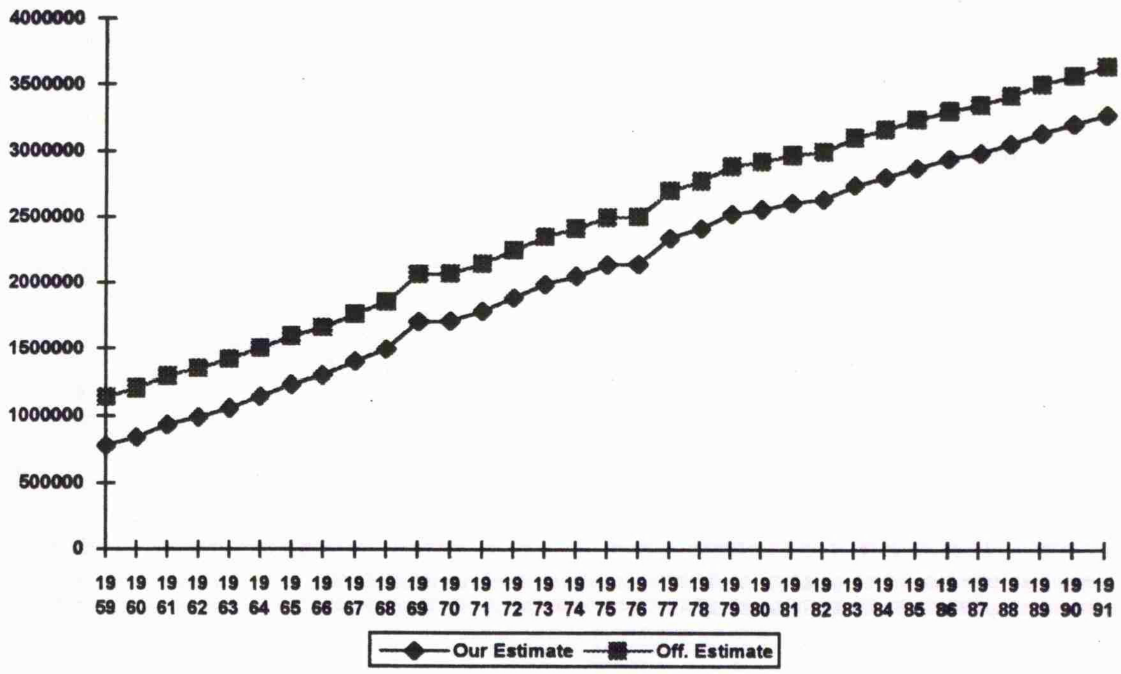


Diagram 4.4.

The average absolute discrepancy of our estimates from the official ones is 16.6% and it is the third larger after the one obtained for Belgium and for USA. Again the difference is not too big and if we exclude the first ten years (i.e. 1959-1968), it comes down to 13%.

The case of Greece

For Greece we have:

(million drachmas)

Year	Stock of dwellings (our estimates) (prices 1970)[32]	Stock of dwellings (Official estimates) (prices 1970)	Implicit deflator of the invest-ment in dwellings	Difference of our estimates from the official estimates (as ratio to official estimates)
1950	118101		0.359	
1951	121268		0.417	
1952	124563		0.437	
1953	129424		0.477	
1954	134245		0.549	
1955	139967	159574	0.608	-0.123
1956	146364	165971	0.630	-0.118
1957	151468	171076	0.647	-0.115
1958	158404	178011	0.664	-0.110
1959	164307	183914	0.669	-0.107
1960	170816	190423	0.674	-0.103
1961	178223	197831	0.674	-0.099
1962	184916	204523	0.725	-0.096
1963	193642	213250	0.727	-0.092
1964	205123	224730	0.739	-0.087
1965	218121	237729	0.781	-0.082
1966	231434	251041	0.865	-0.078
1967	242604	262211	0.878	-0.075
1968	259092	278699	0.879	-0.070
1969	279394	299001	0.908	-0.066
1970	296002	315609	1.000	-0.062
1971	316139	335746	0.998	-0.058
1972	342424	362032	1.087	-0.054
1973	369013	388621	1.359	-0.050
1974	380839	400446	1.750	-0.049
1975	397106	416713	1.855	-0.047
1976	414560	434168	2.167	-0.045
1977	436339	455946	2.618	-0.043

[32]Data for years earlier to 1955 were computed using the PIM backwards. The depreciation method that is followed by Greece is the declining balance method. The constant implicit depreciation rate is 1.01% and this rate is applied to the net stock of each **current** year. In other words instead of $d \cdot K_{t-1}$, the formula that was used for the computation of the depreciation was $d \cdot K_t$. For this reason we adjusted our relevant formulas, E.4.4 and E.4.9, to take this change into account.

1978	461486	481093	3.218	-0.041
1979	487951	507558	4.151	-0.039
1980	509932	529539	5.039	-0.037
1981	525889	545496	5.891	-0.036
1982	540671	560278	6.633	-0.035
1983	555753	575360	7.717	-0.034
1984	567087	586694	8.910	-0.033
1985	578190	597797	10.415	-0.033
1986	591440	611047	12.800	-0.032
1987	605106	624714	14.312	-0.031
1988	619337	638944	15.915	-0.031
1989	634510	654117	18.556	-0.030

Source of primary data: 1955-1980: Net fixed capital stock , depreciation , and capital formation , Ministry of Co-ordination. For later years OECD does not give information about the source.

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1961

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	6291.8	43.229	145.545	0.0000	0.9995
Trend	363.19	5.8737	61.833	0.0000	0.9974

$R^2 = 0.997391$ $F(1, 10) = 3823.4$ [0.0000] $\sigma = 70.2388$

RSS = 49334.9021 for 2 variables and 12 observations

The estimates are also presented diagrammatically below:

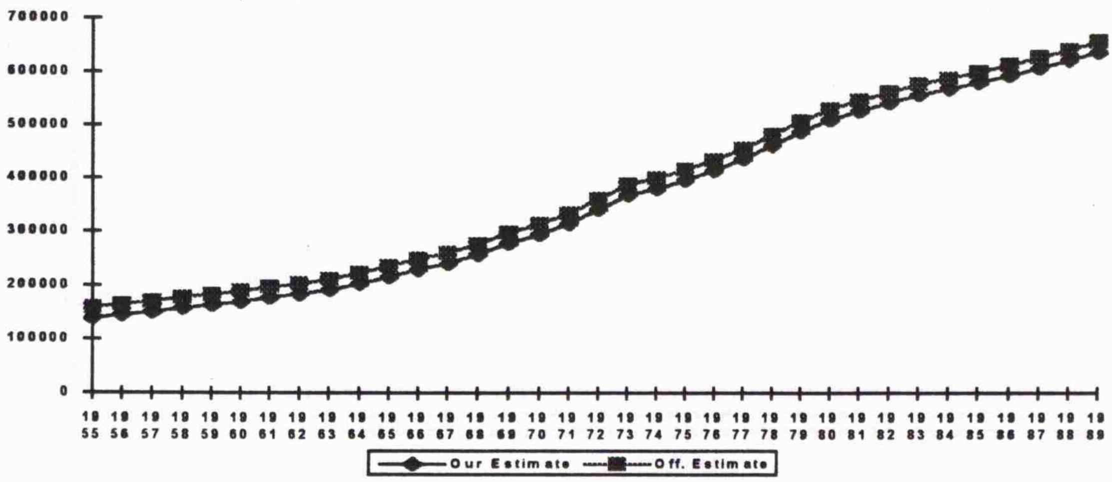


Diagram 4.5

As it can be seen from the above diagram as well as from the table, the estimates are moving very close to each other. This is also indicated by the average absolute difference of our estimates from the official ones. This difference is only 6.4% , and excluding the first 10 years (1955-1964) it comes down to only 4.8%.

The case of Norway

For the case of Norway we have:

millions of kroner

Year	**Stock of dwellings (our estimates) (prices 1985)**[33]	**Stock of dwellings (Official estimates) (prices 1985)**	**Implicit deflator of the invest-ment in dwellings**	**Difference of our estimates from the official estimates (as ratio to the official estimates)**
1951	146332		0.138	
1952	150472		0.157	
1953	155481		0.160	
1954	160579		0.161	
1955	165493		0.165	
1956	168960		0.172	
1957	173153		0.185	
1958	176751		0.191	
1959	180329		0.196	
1960	183872		0.203	
1961	187947		0.211	
1962	192167	165116	0.219	0.164
1963	197099	170048	0.225	0.159
1964	202187	175136	0.233	0.154
1965	207493	180442	0.247	0.150
1966	213394	186343	0.260	0.145
1967	220735	193684	0.274	0.140
1968	228015	200964	0.281	0.135
1969	235861	208810	0.296	0.130
1970	244136	217085	0.328	0.125
1971	254119	227068	0.339	0.119

[33]Data for years earlier to 1962 were computed using the PIM backwards. The depreciation rate that was used for those years was 1.78% which correspond to the implicit average depreciation rate of recent to 1962 years.

1972	265076	238025	0.357	0.114
1973	275904	248853	0.387	0.109
1974	286178	259127	0.451	0.104
1975	297678	270627	0.502	0.100
1976	309554	282503	0.549	0.096
1977	321624	294573	0.604	0.092
1978	335307	308256	0.631	0.088
1979	349272	322221	0.657	0.084
1980	362572	335521	0.714	0.081
1981	375973	348922	0.784	0.078
1982	390221	363170	0.858	0.074
1983	404355	377304	0.917	0.072
1984	418121	391070	0.960	0.069
1985	432243	405192	1.000	0.067
1986	448388	421337	1.080	0.064
1987	464865	437814	1.210	0.062
1988	480462	453411	1.279	0.060
1989	492668	465617	1.252	0.058
1990	501629	474578	1.232	0.057
1991	506656	479605	1.205	0.056

Source of Primary data: Nasjonal-Regnskap, Central Bureau of Statistics , Oslo

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1951 to 1962

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	919.85	18.097	50.830	0.0000	0.9961
Trend	22.434	2.4589	9.124	0.0000	0.8927

$R^2 = 0.892749$ $F(1, 10) = 83.239$ [0.0000] $\sigma = 29.4037$ DW = 1.98

RSS = 8645.785548 for 2 variables and 12 observations

The estimates are also presented diagrammatically below:

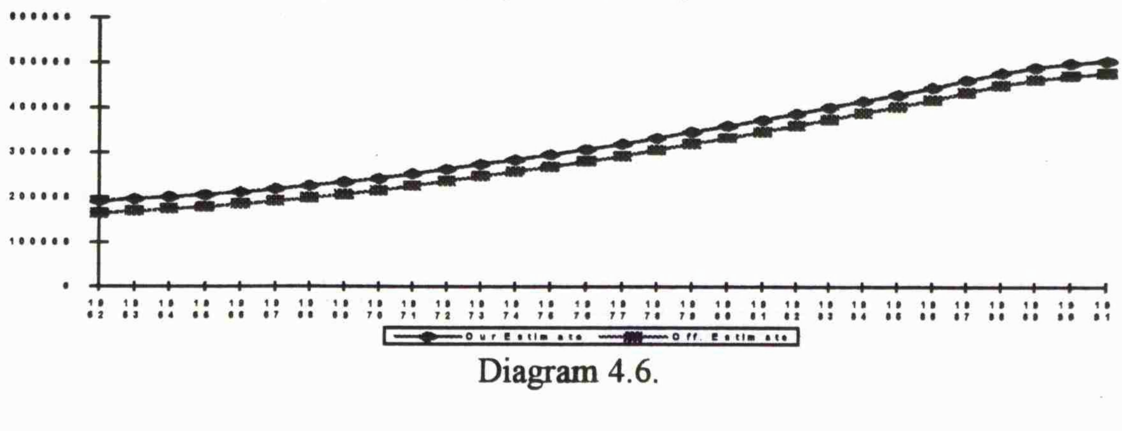


Diagram 4.6.

As it can be seen from the table and from the diagram, the estimates are very close to each other. The average difference is only 10.4% of the official estimates and it comes down to 7.92% if we exclude the first ten years.

The case of the UK

For the UK we have:

(millions of pounds sterling)

Year	Stock of dwellings (our estimates) (prices 1985)[34]	Stock of dwellings (Official estimates) (prices 1985)	Implicit deflator of the investment in dwellings	Difference of our estimates from the official estimates (as ratio to the official estimates)
1950	140142		0.076	
1951	141913		0.088	
1952	144499		0.096	
1953	151293		0.094	
1954	155495		0.093	
1955	159179	150787	0.099	0.0557
1956	159432	151040	0.104	0.0556
1957	161607	153215	0.106	0.0548
1958	163293	154900	0.107	0.0542
1959	169492	161100	0.104	0.0521
1960	175578	167186	0.105	0.0502
1961	180854	172461	0.108	0.0487
1962	186454	178062	0.113	0.0471
1963	182019	173627	0.123	0.0483
1964	192997	184605	0.126	0.0455
1965	202756	194364	0.128	0.0432
1966	207570	199178	0.133	0.0421
1967	222528	214136	0.133	0.0392
1968	231940	223548	0.139	0.0375

[34]Data for earlier to 1955 years were computed using the PIM backwards. The depreciation rate that was used for those years was 1.7% which correspond to the implicit average depreciation rate of recent to 1955 years.

1969	245961	237569	0.145	0.0353
1970	257087	248695	0.155	0.0337
1971	272709	264317	0.169	0.0317
1972	302757	294365	0.190	0.0285
1973	324186	315794	0.235	0.0266
1974	320933	312541	0.303	0.0269
1975	317713	309321	0.364	0.0271
1976	324521	316129	0.403	0.0265
1977	335431	327039	0.437	0.0257
1978	355170	346778	0.481	0.0242
1979	375218	366826	0.563	0.0229
1980	363180	354788	0.701	0.0237
1981	345973	337581	0.794	0.0249
1982	348926	340534	0.818	0.0246
1983	360444	352052	0.853	0.0238
1984	356679	348287	0.934	0.0241
1985	357592	349200	1.000	0.0240
1986	367049	358657	1.057	0.0234
1987	383569	375177	1.128	0.0224
1988	399811	391419	1.247	0.0214
1989	402797	394404	1.398	0.0213
1990	396190	387798	1.508	0.0216
1991	386706	378314	1.554	0.0222
1992	404157	395765	1.535	0.0212

Source of primary data: National Income and Expenditure , Central Statistical Office

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1950 to 1961

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	888.48	7.2920	121.843	0.0000	0.9993
Trend	17.566	0.99079	17.730	0.0000	0.9692

$R^2 = 0.969168$ $F(1, 10) = 314.34$ [0.0000] $\sigma = 11.8481$

RSS = 1403.785548 for 2 variables and 12 observations

The estimates are also presented diagrammatically below:

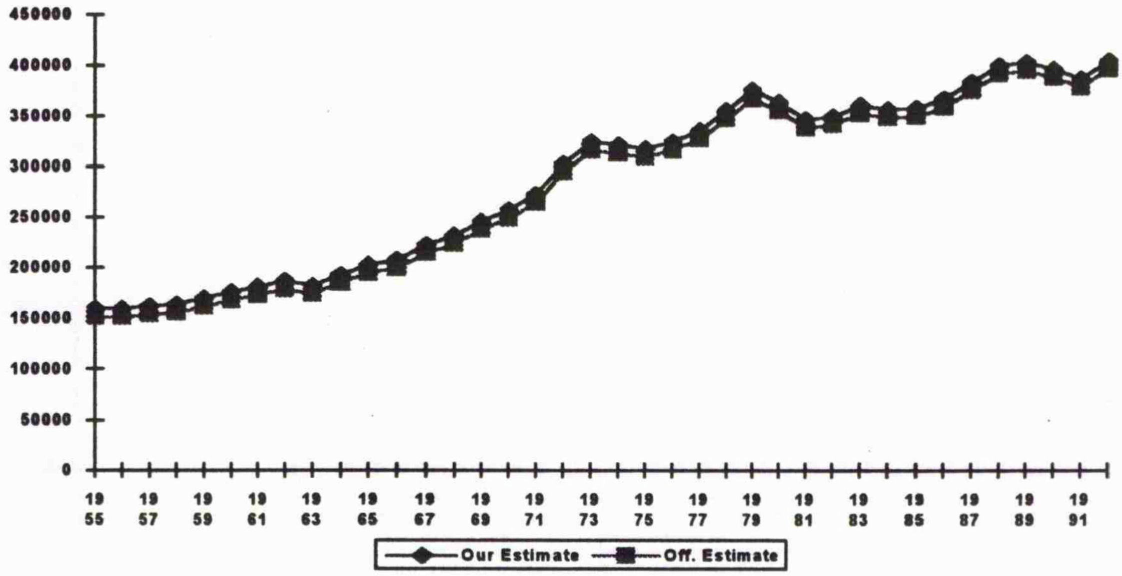


Diagram 4.7

From the table and from the diagram, it can be seen that the two sets of estimates are very close to each other. The average difference is only 3.37% and it comes down to only 2.75% if we exclude the 10 first years.

<u>The case of the USA</u>

For USA we have:

(millions dollars)

Year	Stock of dwellings (our estimates) (prices 1985)[35]	Stock of dwellings (Official estimates) (prices 1985)	Implicit deflator of the invest-ment in dwellings	Difference of our estimates from the official estimates (as ratio to the official estimates)
1950	333214		0.201	
1951	407181		0.217	
1952	477271		0.222	
1953	547730		0.225	
1954	624360		0.221	

[35]Data for years earlier to 1964 were computed using the PIM backwards. The depreciation rate that was applied for those years was 2.62% which correspond to the implicit average depreciation rate of recent to 1964 years.

1955	712421		0.227	
1956	786611		0.238	
1957	852473		0.244	
1958	921502		0.244	
1959	1003744		0.252	
1960	1071405		0.255	
1961	1137311		0.256	
1962	1209476		0.261	
1963	1290786		0.259	
1964	1378508	1931897	0.260	-0.286
1965	1436777	1990166	0.264	-0.278
1966	1526890	2080279	0.273	-0.266
1967	1605198	2158587	0.282	-0.256
1968	1759819	2313208	0.296	-0.239
1969	1784556	2337945	0.322	-0.237
1970	1838884	2392273	0.332	-0.231
1971	1991304	2544693	0.348	-0.217
1972	2279488	2832877	0.365	-0.195
1973	2347957	2901346	0.409	-0.191
1974	2398076	2951465	0.452	-0.187
1975	2428274	2981663	0.491	-0.186
1976	2540946	3094335	0.527	-0.179
1977	2649321	3202710	0.591	-0.173
1978	2761753	3315142	0.667	-0.167
1979	2891431	3444820	0.739	-0.161
1980	2944751	3498140	0.812	-0.158
1981	2923127	3476516	0.877	-0.159
1982	2856445	3409834	0.923	-0.162
1983	2909647	3463036	0.947	-0.160
1984	2987268	3540657	0.974	-0.156
1985	3085711	3639100	1.000	-0.152
1986	3195026	3748415	1.041	-0.148
1987	3319038	3872427	1.088	-0.143
1988	3236734	3790123	1.134	-0.146
1989	3334639	3888028	1.174	-0.142
1990	3418946	3972335	1.207	-0.139
1991	3519432	4072821	1.221	-0.136
1992	3639646	4193035	1.238	-0.132

(Primary source of the official data: USA, Bureau of Economic Analysis, Fixed reproducible Tangible Wealth in the US. See OECD (1994), p.7)

The regression equation that was used for the estimation of the trend output of dwellings

The present sample is: 1956 to 1968					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
Constant	6915.4	1374.7	5.030	0.0004	0.6970
Trend	2430.8	88.924	27.335	0.0000	0.9855
$R^2 = 0.985492$ $F(1, 11) = 747.22$ [0.0000] $\sigma = 1199.65$					
RSS = 15830769.23 for 2 variables and 13 observations					

The second and third columns of the above table present our estimates and the official estimates respectively. These two series are also presented below in diagram 4.8:

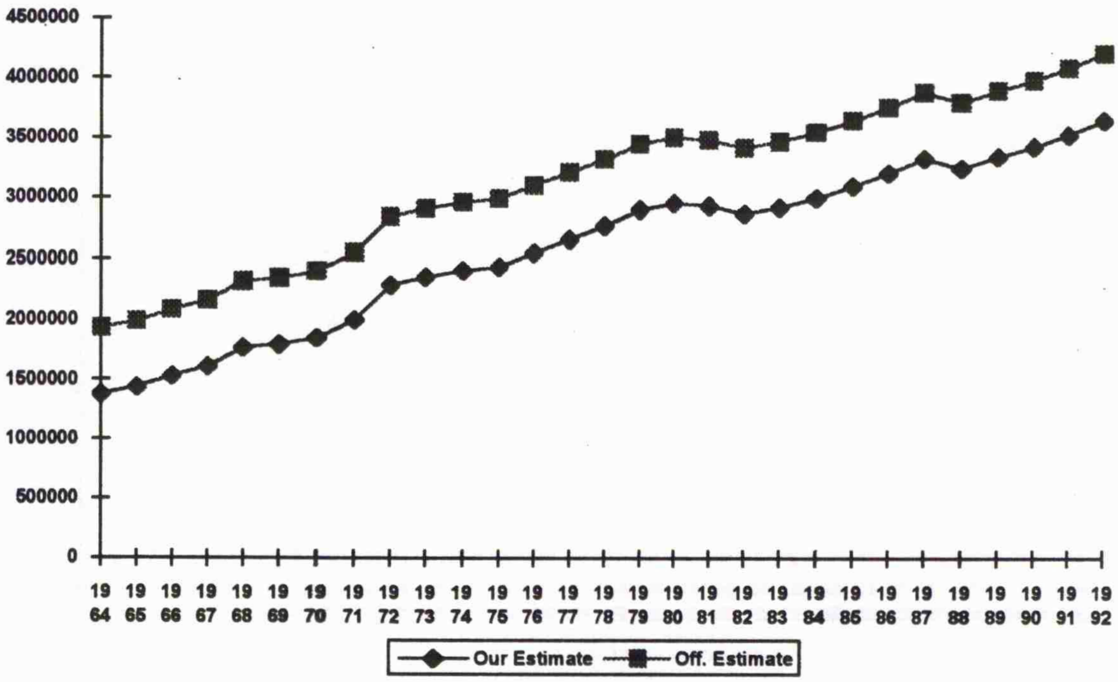


Diagram 4.8

The average absolute difference of our estimates from the official ones, as a percentage of the later, is 18.56%. Although this is not a big difference (if we exclude the ten first years it comes down to 15.72%), it is the second biggest out of the eight cases that were examined.

A discussion of the results.

In the previous section we compared the estimates of the stock of dwellings that were derived based on method that uses capital-output ratios for the estimation of a benchmark value, with official estimates for eight OECD countries. The main results of these comparisons are summarised below:

Table T.4.2

Country	Average absolute difference for the whole period	Average absolute difference excluding the 10 first years
Belgium	48.3%	38.8%
Finland	1.16%	0.8%
France	2.6%	2%
Germany	16.6%	13%
Greece	6.4%	4.8%
Norway	10.4%	7.92%
UK	3.37%	2.75%
USA	18.56%	15.72%

As it can be seen from this table, in only one case the average absolute difference was above 20%. Moreover, in four out of eight cases, it was less than 10% and even for those countries that it was more than 10%, the corresponding percentage declined significally after the first ten years.

From the above, it is clear that the method that was developed in this chapter is a satisfactory way to estimate a benchmark value of the stock of dwellings. Indeed, the satisfactory performance of the method, its theoretical consistency and the fact that it can be applied easily and it is operationally cheap, relative to alternative methods, make it very attractive.

5. Conclusion.

The purpose of this chapter was to face, instead of abandoning unsolved, the problem of unavailability of data on the stock of dwellings. To face this problem, we exploited the fact that most of the countries of our sample publish data on the output produced in the dwellings industry. Then, based on a relationship drawn from the theory of economic growth we derived a relationship where the stock of dwellings in a year is a function of known variables. Based on this relationship, we derived initial estimates of the stock of dwellings and then we used these estimates to apply the PIM and to derive estimates for as many years as the data on gross investment permitted us.

To evaluate the reliability of our estimates, we compared them with the official ones for eight countries for which official data were available. In an overall perspective the results of that comparison were very encouraging. In seven out of eight countries the difference was less than 20% while in four of those countries it was less than 10%. These results give validity to the approach undertaken here and, if we take into account its simplicity and its theoretical consistency, we can say that this approach consists a satisfactory resolution to the problem caused by the lack of official data on the stock of dwellings.

PART B

In this part we will empirically apply what was said in the previous chapters. The presentation is done alphabetically and it regards 10 OECD countries that are presented as separate case studies. The sources and the definitions of the data are presented in the data appendix that follows the conclusion of the thesis

CASE STUDY 1

BELGIUM

1.1 The integration properties of the data

As it was said in section 6 of the third chapter, before any further statistical analysis takes place it is needed to examine the order of integration of the variables of the analysis. The variables that will be used in the long run model are: private consumption (c_t), households' disposable income (y_t), households' wealth [it is defined either as total wealth (w_t) or as household's liquid assets (la_t)] and the ratio of the monetary erosion to disposable income (MNERRAT = $\frac{\pi^e{}_t MNAS_t}{Y_t}$).

With the exception of the last variable, all the other variables are in logarithms and in real per capita terms. The reason that we have two definitions of wealth is because both of these definitions have been used in the literature. Thus, it is probably better, instead of predetermining which of these two definitions is the best, to try both of them and to make a decision on empirical grounds. Therefore, unit roots tests were performed for both definitions of wealth. Also, in the absence of any other better alternative, and since this is the choice of most of the literature on our topic[1], the expected inflation rate was defined as a two year moving average of the actual inflation rate. Nevertheless, we also tried the realised inflation rate since this variable has also been used. Therefore, unit roots tests were performed for both versions of MNERRAT that correspond to the two definitions of the expected inflation rate.

Cointegration requires the variables to be integrated of the same order. If this does not happen, cointegration still can make sense. However, as W. Charemza and D. Deadman say[2]:

"If variables in a long run relationship are of a different order of integration and the order of integration of the dependent variable is lower than the highest order of

[1]For example see: HUS (1981), U-S (1982), Lester (1993).
[2]See W. Charemza and D. Deadman, 1992, p. 148.

integration of the explanatory variables, there must be at least two explanatory variables integrated of this highest order if the necessary condition for stationarity of the error term is to be met".

Now, regarding the short run model, the stationarity of the variables is consider as necessary. Thus, if all the variables of the long run model are integrated of first order, then in order to enter in the short run model they should be differentiated once to become stationary. Of course, additional variables can also be added. As such candidate variables one could suggest the real interest rate and the unemployment rate[3]. However, although it is reasonable for one to expect that the variables of the long run model will be integrated of first order[4], this doesn't happen for the unemployment rate and the real interest rate. Indeed, both of these variables are expected to be stationary since it does not make much sense a case where the unemployment rate and/or the real interest rate grow without bounds and without any tendency to return to a constant mean, as non-stationarity implies[5]. Nevertheless, because of sampling reason it may happen that in some cases these variables may appear as non-stationary. Thus, we will test the stationarity of these variables as well and if, according to the tests, they are non-stationary they will be differentiated before they enter the short run model.

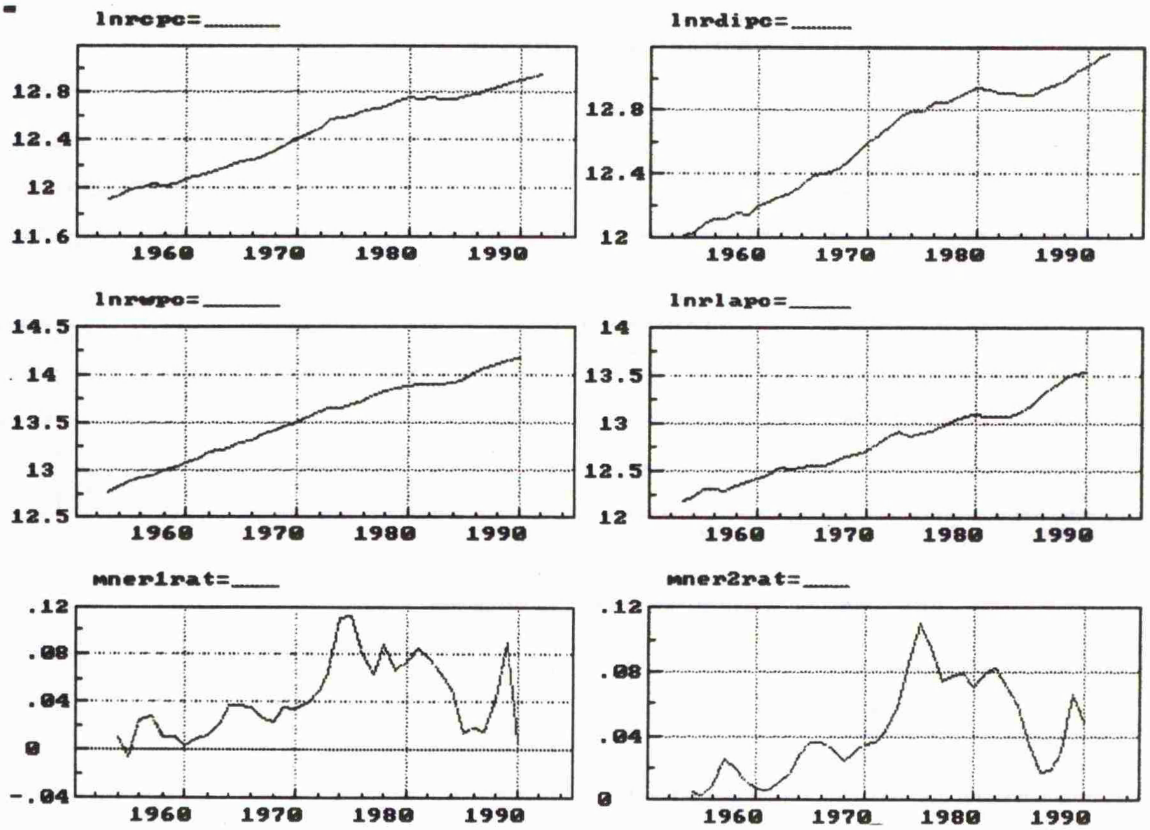
Having made clear all the above, it is now time to examine the stationarity of the variables of the analysis. A first idea about the stationarity of the variables can be given by a visual inspection of the relevant plots. If a variable is non-stationary, then it will grow through time with rare changes in its trend. On the other hand, a stationary variable is rather volatile around the zero line, though it

[3]For the role of these two variables in the consumption function see G. Hadjimatheou (1987), pp. 87-119

[4]The reason is that these variables grow through time, and therefore it is rather implausible to satisfy the conditions required for stationarity.

[5]I would like to thank Prof. W. Charemza for mentioning this point to me.

may also be so around a constant term and/or a time trend. Diagram BL1 below presents the plots of the variables in levels. The notation is as follows: lnrcpc = logarithm of real consumption per capita, lnrdipc = logarithm of real disposable income per capita, lnrwpc = logarithm of total (housing stock + liquid assets) real wealth per capita, lnrlapc = logarithm of real liquid assets per capita, mner1rat = ratio of monetary erosion to disposable income where the monetary erosion is computed using the realised inflation rate, mner2rat = ratio of monetary erosion to disposable income, where the monetary erosion is computed using a two years moving average of the realised inflation rate, lnun = logarithm of the unemployment rate, rintrt = real interest rate.



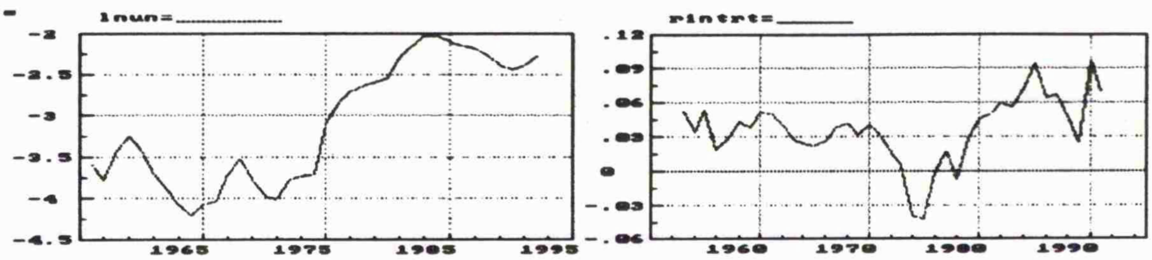


Diagram BL.1

As it can be seen from the above diagram, all the variables are rather non-stationary and this seems to be true for the unemployment rate and the real interest rate as well. These conclusions are also confirmed by the DF/ADF tests. The results of these tests are given below, in table T.BL1. In the ADF test we assumed that two lags were enough to eliminate autocorrelation. This hypothesis was examined in more detail only when the results were affected by the lag-length[6].

Table T.BL.1: Unit Root Tests

Variable	ADF(2)	ADF(1)	DF	Period	C,TR
lnrcpc	-1.5163	-1.2981	-0.82835	1956-1992	C,TR
lnrdipc	-1.7855	-1.2394	-0.95230	1956-1992	C,TR
lnrwpc	-1.3237	-1.5483	-1.1237	1956-1990	C,TR
lnrlapc	-2.7786	-3.1006	-1.4951	1956-1990	C,TR
mner1rat	-1.5888	-2.0071	-2.1584	1957-1990	C
mner2rat	-1.6331	-2.1547	-1.6783	1957-1990	C
lnun	-2.7491	-3.1763	-1.8661	1959-1992	C,TR
rintrt	-1.5803	-1.8295	-2.2844	1956-1991	C

[6] As it was said in the third chapter, the power of this test to reject the null hypothesis of a unit root, weakens as the number of lags increases. Therefore, one would expect that if the null hypothesis is rejected for a certain number of lags, the same will happen for a smaller number of lags as well. The problem is when the null is rejected for a short lag-length but not for a larger one.

dlnrcpc	-2.2392	-3.1041*	-4.211**	1957-1992	C
dlnrdipc	-2.0323	-2.6528	-4.5724**	1957-1992	C
dlnrwpc	-3.1409*	-3.5255*	-3.8717**	1957-1990	C
dlnrlapc	-3.4008*	-3.8413**	-3.7847**	1957-1990	C
dmner1rat	-3.6972**	-4.9679**	-5.1689**	1958-1990	
dmner2rat	-3.6939**	-4.5687**	-4.1425**	1958-1990	
dlnun	-2.6612**	-3.809**	-3.378**	1960-1992	
drintrt	-3.2867**	-5.2982**	-7.1446**	1957-1991	

* denotes rejection of the null at the 5% level of significance while, ** denotes rejection at the 1% level. A variable with d as first letter corresponds to the first difference of the respective variable in levels. C means that a constant term was included in the test while, C,TR means that both a constant and a trend were included. These variables were included only when they were found statistically significant in the corresponding ADF regressions. The critical values, were taken from MacKinnon (1991) .

As it can be seen from table T.BL.1, regarding the variables in levels, the null hypothesis of a unit root is never rejected in favour of the alternative of stationarity. Therefore, it can be concluded that all the variables in levels are at least integrated of first order. The next step is to test the null hypothesis that the variables of our model are integrated of second order against the alternative that they are integrated of first order. This was done, through tests of the null hypothesis that the first difference of the corresponding variable is I(1). The null hypothesis is easily rejected for all variables and in many cases this happens at even the 1% level of significance. Nevertheless, the case of dlnrcpc and dlnrdipc is not so clear since the rejection is dependant on the lag length. Therefore, more investigation is needed. The results of this investigation showed that even in the absence of any lag, the residuals weren't autocorrelated. This means that the simple DF test is enough, which in turn means that lnrcpc and lnrdipc are integrated of first order and therefore, just one differentiation is enough to remove non-stationarity.

Having established, the order of integration of the variables the next step is to examine the lag-length of the VAR model that will be used in the cointegration analysis.

1.2 The lag length of the VAR model.

The first step of the Johansen procedure requires the specification of the lag-length of the respective VAR model. However, before we are in as position to do that we must first make a choice regarding the wealth and the monetary erosion variables that will be used. This was done by running the Johancen procedure experimentally with various VAR lengths and combinations of the available choices. Finally, the liquid assets and the MNER2RAT were chosen since they performed better than their corresponding alternatives.

Below, we present diagnostics regarding the presence of autocorrelation of various orders in the VAR model. The examination was done on an equation by equation basis. The particular coefficients of each equation of the VAR are not reported here, since we are not particularly interested in them. Also, we do not present tests for normality because decisions will not be based on whether the normality assumption is satisfied or not. The reason is because the effects of the violation of the normality assumption on the Johancen procedure are not known[7]. The shortest lag length for which we didn't have any problem with autocorrelation was two. For this lag-length the autocorrelation tests gave the following results:

[7]See Johansen and Juselius (1990) and C. Karfakis and A. Parikh (1993), p. 59.

Table T.BL.2 VAR Diagnostics (lag length = 2)

Dependant Variable	**AR1-1**	**AR1-2**	**AR1-3**	**ARCH 1**
lnrcpc	0.4009	0.0871	0.1797	0.0913
lnrdipc	0.2147	0.2532	0.4291	0.6185
mner2rat	0.4491	0.6103	0.8089	0.1208
lnrmnaspc	0.0821	0.2278	0.2984	0.5316

AR1-1 stands for the LM test (F-version) for first order autocorrelation. AR1-2 is the same test for second order autocorrelation and the AR1-3 for third order autocorrelation. ARCH1 stands for the Autoregressive Conditional Heteroscedasticity test for the presence of autocorrelated squared residuals of first order (see Doornik-Hendry (1994), p. 334-335). The numbers in the cells are the p-values or the marginal level of significance for which the null hypothesis (no autocorrelation) is rejected.

Therefore a two lags VAR will be used in the Johansen procedure.

1.3 The Long Run Consumption Function

Having established the lag length of the VAR, the next step is to test for the number of the statistically significant cointegrating vectors using the Johansen technique. As we have explained in part A, the way that this will be done is through the trace and the maximal eignevalue tests. The results of these tests are presented below at tables T.BL3.1 and T.BL3.2:

Table T.BL3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
35 observations from 1956 to 1990. Maximum lag in VAR = 2.				
List of variables included in the cointegrating vector:				
LNRCPC	LNRDIPC	MNER2RAT	LNRLAPC	Intercept
List of eigenvalues in descending order:				
.66095	.41327	.30382	.10693	.0000

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	37.8559	28.1380	25.5590
r<= 1	r = 2	18.6617	22.0020	19.7660
r<= 2	r = 3	12.6749	15.6720	13.7520
r<= 3	r = 4	3.9582	9.2430	7.5250

Table T.BL3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
35 observations from 1956 to 1990. Maximum lag in VAR = 2. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC Intercept List of eigenvalues in descending order: .66095 .41327 .30382 .10693 .0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	73.1507	53.1160	49.6480
r<= 1	r>= 2	35.2948	34.9100	32.0030
r<= 2	r>= 3	16.6331	19.9640	17.8520
r<= 3	r = 4	3.9582	9.2430	7.5250

As it can be seen from the above tables, the two tests gave different results. Thus, while the maximal eignevalue test shows that there is one cointegrating vector at the 5% level of significance, the trace test shows two cointegrating vectors. However, only one of these cointegrating vectors makes economic sense. Moreover, the second is only marginally significant. As Tyrvainen (1995) says[8]: assuming the existence of one cointegrating vector when there are possibilities that there are two "makes the tests more stringent and the corresponding p-values are definitely the low limits of the appropriate ones". Bearing this in mind, the analysis below will assume one cointegrating vector.

[8]See Tyrvainen (1995), p. 282

Normalising this one cointegrating vector on lnrcpc we get the following long run consumption function:

lnrcpc=0.01865+0.97671*lnrdipc- 0.84813*mner2rat + 0.01513*lnrlapc E.BL.1

In the above long run consumption function, all the coefficients have the expected sign and they are also of logical magnitude except for the lnrlapc variable whose coefficient is rather low. Now, regarding the long run degree of income correction, its indirect estimate is 0.84813/0.97671 = 0.86 which is very near to the expected long run value (i.e. 1).

One of the many virtues of the Johansen procedure is that it permits the performance of statistical tests about the value of the long run parameters. Such tests are presented at Table T.BL.4 below. As it can be seen from this table, the constant term as well as the lnrlapc are not significally different from zero. The inability to reject the null hypothesis for lnrlapc does not give support to the life cycle theory of consumption. Regarding now the coefficient of our especial interest i.e. the degree of income correction it is not statistically different from one while it is statistically different from zero.

TABLE T.BL.4[9]

Null hypothesis	**p-value**
$a_0 = 0$	0.958
$a_1 = 0$	0
$a_2 = 0$ ($\Rightarrow \delta_L = 0$)	0.011

[9]In table T.BL.4 the p-value denotes the level of significance at which the respective null hypothesis can be rejected. For example the null hypothesis that the coefficient of lnrlapc is equal to zero cannot be rejected at any level of significance lower than 0.845. In other words, the higher the p-value the most difficult to reject the null.

$a_2 = -a_1$ ($\Rightarrow \delta_L = 1$)	0.682
$a_3 = 0$	0.845

To check the null hypothesis that the degree of income correction is zero, we checked the hypothesis that the coefficient of mner2rat is equal to zero, since if we denote this coefficient by a_2 then $a_2 = -a_1 * \delta_L$ (δ_L is the long run degree of income correction) which means that if δ_L was zero, then this would make the coefficient of mner2rat equal to zero as well. As it can be seen in our case, a_2 is both high in magnitude and statistically significant. Therefore we can easily reject the hypothesis that the degree of income correction is zero. On the other hand, to test if the degree of income correction is full we can test the validity of the following restriction: $a_2 = -a_1$. The reason is that since the degree of income correction is defined as $\delta_L = -a_2/a_1$, if δ_L is equal to one then the above restriction will be satisfied. Imposing this restriction on our long run equation gave a p-value equal to 0.682 which means that the restriction cannot be rejected at any conventional level of significance. This in turn means that we cannot reject the null hypothesis that the long run degree of income correction is full.

Now since we found that we cannot reject none of the following null hypotheses: $a_0 = 0$, $a_3 = 0$, $a_2 = -a_1$, it is interesting to impose all of these restrictions simultaneously. The relative test gave a p-value equal to 0.722. This means that we cannot reject the null hypothesis of the simultaneous validity of these restrictions at any conventional level of significance. The model that comes as a result of these restrictions is as follows:

$$lnrcpc \stackrel{-}{=} 0.99420*lnrdipc - 0.99420*mner2rat \qquad \text{E.BL.2}$$

In E.BL.2 the elasticity of consumption with respect to corrected income is almost one which is consisted with a constant ratio of consumption to corrected income.

To conclude: it can be said that the long run degree of income correction is almost full and that the long run elasticity of consumption with respect to corrected (as well as to ordinary) income is almost one.

1.4 The Short Run Consumption Function.

The short run behaviour of consumption will be modelled through an error correction model (ECM henceforth). The fact that there is cointegration guarantees the existence of a valid ECM[10]. In this ECM the error correction term was formulated using E.BL.2[11]. Then, a very general model was estimated, using various variables that could affect consumption and which may not appear in the long run, namely the unemployment rate and the real interest rate. Except for the error correction term, all the other variables were differentiated once to become stationary[12].

All these variables initially entered the model with many lags. Then the general to specific method was applied to give us a parsimonious equation. The final equation with which we ended up, is presented at table T.BL.5 below.

[10] According to the Granger representation theorem cointegration implies the existence of an error correction model and conversely.

[11] One could ask why we didn't use the unrestricted model as the long run equation. The reason is that first the restrictions imposed on E.BL.1 were not rejected and second equation E.BL.2 performed better as error correction term than equation E.BL.1.

[12] The error correction term is stationary by definition of cointegration.

Table T.BL.5: The Error Correction Model

The present sample is: 1958 to 1990					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
Constant	-0.0063308	0.0032040	-1.976	0.0593	0.1351
dlnrdipc	0.38467	0.063531	6.055	0.0000	0.5946
dlnun	-0.029926	0.0081418	-3.676	0.0011	0.3508
dlnun_1	0.041539	0.0080009	5.192	0.0000	0.5188
drintrt	0.26334	0.082693	3.185	0.0039	0.2886
dmner2rat	0.26880	0.16584	1.621	0.1176	0.0951
dlnrlapc	0.14037	0.051846	2.707	0.0121	0.2267
ect_1	-0.44822	0.070227	-6.383	0.0000	0.6197

$R^2 = 0.891052$ $F(7, 25) = 29.21$ [0.0000] $\sigma = 0.00723649$ DW = 1.94
RSS = 0.001309168836 for 8 variables and 33 observations
Information Criteria: SC = -9.28723; HQ = -9.52795; FPE = 6.50617e-005
AR 1- 1F(1, 24) = 0.08823[0.9284]
AR 1- 2F(2, 23) = 0.01195 [0.9881]
ARCH 1 F(1, 23) = 0.97241 [0.3343]
Normality Chi²(2) = 0.58437 [0.7466]
Xi² F(14, 10) = 0.41051 [0.9376]
RESET F(1, 24) = 0.80273 [0.3792]

R^2 is the squared multiple correlation coefficient. F is the F-statistic that tests the null hypothesis that all the regression coefficients are zero. RSS is the residual sum of squares and σ is the standard error of the equation. SC is the Schwarz information criterion, HQ is the Hanna-Quinn criterion and FPE is the Final Prediction Error. The smaller the SC or HQ or the FPE the better the model, at least in terms of parsimony. AR1-r is the Langrange Multiplier (LM) test for r-th order residual autocorrelation. ARCHr tests for autocorrelated squared residuals of r order. Normality Chi square is the statistic that tests whether the skewness and kyrtosis of the residuals corresponds to that of a normal distribution. Xi^2 tests the null hypothesis of unconditional homoscedasticity. Finally, the RESET test tests the null hypothesis of correct specification.

Before we start analysing the characteristics of the above model we have first to examine if OLS is really an appropriate method of estimation. The reason that we need an examination like this is because it may be that the variables of the model are determined simultaneously i.e. they may be endogenous. If something like this happens then we will have to use the Instrumental Variables Method (IVM). To examine the exogeneity issue, the Hausman-Wu exogeneity test was applied. The implementation of this test requires[13] the regression of the first difference of each regressor on a set of instruments such as lagged regressors from the ECM as well as lagged variables in levels, say, from the long run equation. The predicted values of these regressions are saved and an F-test for their inclusion in the ECM is conducted. If the test statistic is above the corresponding critical value the null hypothesis of weak exogeneity is rejected. This test can be also performed using, instead of the predicted values, the residuals from each of the reduced form equations. We preferred to use the predicted values.

Following the above steps we found that the null hypothesis of weak exogeneity cannot be rejected since the F test gave a value equal to 1.7248 which in turn corresponds to a p-value equal to 0.1773. Therefore, the null hypothesis cannot be rejected at any conventional level of significance. This means that the usage of the IVM is not necessary.

As it can be seen from table T.BL.5, our ECM fits the data very well, especially if we take into account the fact that we work with variables in differences. The fact that the model fits the data very well, can also be seen from diagram BL.2 below, where the actual and the fitted values are presented together with the standardised residuals.

[13]See R. C. Craigwell and L. L. Rock, p. 245 , G. S. Maddala (1989), pp. 439-441, A. Spanos (1993), p. 653, J. Stewart (1991), pp. 144-145.

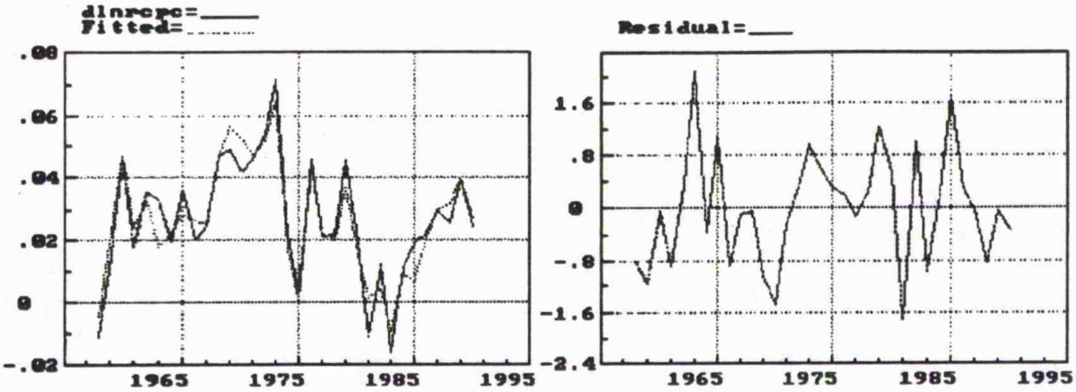


Diagram BL.2 Actual-fitted values and standardised residuals

In addition to its good fitness, the model also passes a variety of tests regarding the satisfaction of the classical assumptions of regression. Actually, as it can be seen from table T.BL.5, the model not only passes all these tests but it also passes them with high p-values.

Regarding the individual coefficients, it can be seen that the error correction term is large and strongly significant. The short run elasticity of consumption with respect to income is 0.385 which is much lower than the almost unitary long run elasticity. Also, changes in the unemployment rate affect the changes in consumption positively (the sum of the corresponding coefficients is 0.011) while the same is also true for changes in the real interest rate. Both of these results are compatible with some empirical evidence about the role of these two variables in the consumption function[14]. Now, regarding the parameter of our special interest, though one would expect it to be 1, if there was no money illusion, it is negative and equal to -0.26880/0.38467 = -0.7[15]. Nevertheless, it is not significally different

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[14]In fact, the empirical evidence regarding the effects of these two variables on consumption is rather contradictory. For a theoretical analysis and for a review of the empirical evidence about the role of these two variables see: G. Hadjimatheou (1987), pp. 87-119.

[15]As previously, the degree of income correction was computed indirectly as the negative quotient of the coefficient of dmner2rat to the coefficient of dlnrdipc.

from zero [p-value = 0.1176 for the OLS and 0.1659 for the NLS[16]]. This means that we cannot reject the null hypothesis that in the short run the degree of income correction is zero. Similarly, we can test the null hypothesis that the short run degree of income correction is full by imposing the restriction that the coefficient of dlnrdipc is equal to the negative of the coefficient of dmner2rat. This restriction was strongly rejected [p-value = 0.0002 (OLS) and 0.0019 (NLS)].

Based on the above results, we can say that although in the long run the degree of income correction is almost full, in the short run it is not different from zero. This result justifies our approach to discriminate between the short run and the long run degree of income correction.

1.4.1 The stability and the forecasting accuracy of the model

In today's econometrics, great attention is paid to the stability and the forecasting accuracy of a model. To examine the stability of our model, our preferred equation was re-estimated using recursive least squares (RLS). The stability of the model was evaluated using the following four tests[17].

i) 1-step recursive residuals

ii) 1-step Chow - Test

iii) Break point F-tests (N↓ Step Chow - Tests)

iv) Forecast F-tests (N↑ Step Chow - Tests)

The results of these tests are presented below at diagram BL.3. Instability will be serious if the value of the corresponding statistic (residuals in the case of

[16]In addition to the indirect tests regarding the value of the degree of income correction, we also performed direct tests using NLS. Certainly the later are more robust since they use a direct estimate of the standard error of the degree of income correction.

[17]For these tests see: J.A. Doornik and D.F. Hendry (1994), pp. 328-329

test i)) passes the corresponding critical value (in the case of the first test this is the ±2∗S.E bound, where S.E. means standard error). As it can be seen from diagram BL.3, this never happens for our model which means that our ECM does not suffer from parameter instability.

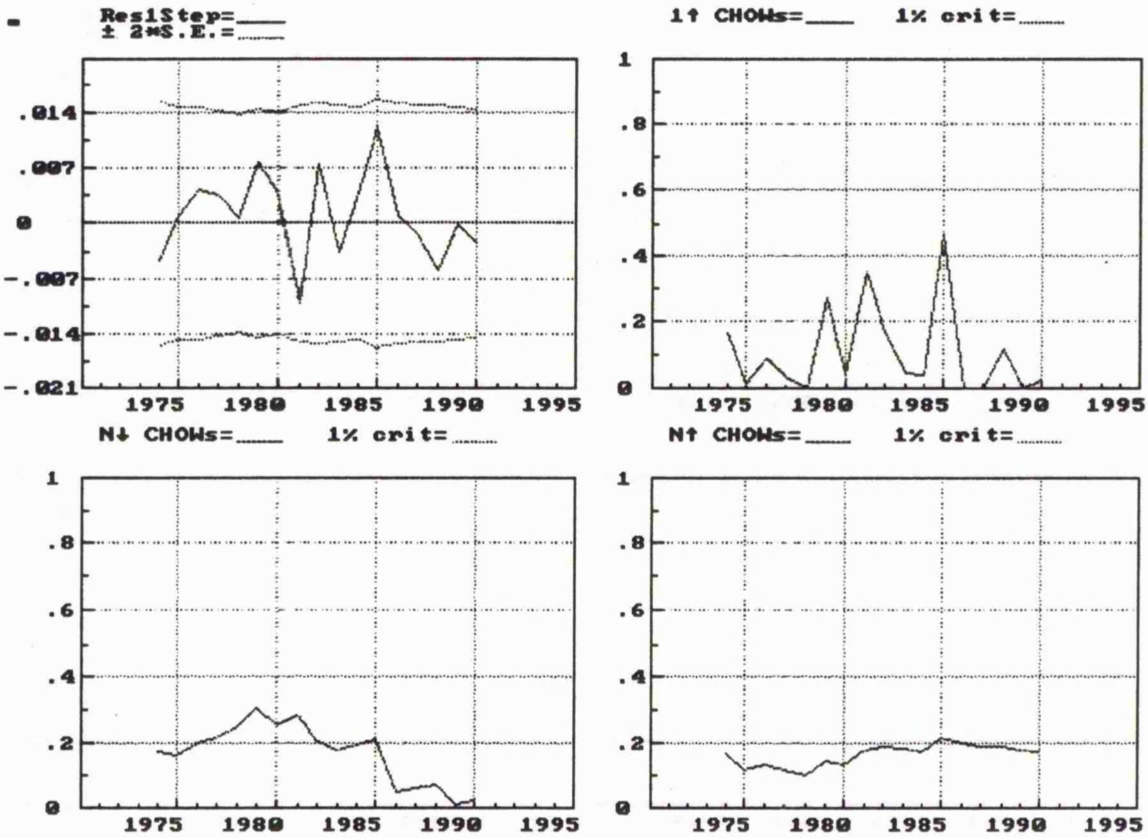

Diagram BL.3

Except for the above tests, conclusions about the stability of the individual coefficients can also be drawn from a visual examination of the recursive estimates of the coefficients. These recursive estimates are presented below at diagram BL.4.

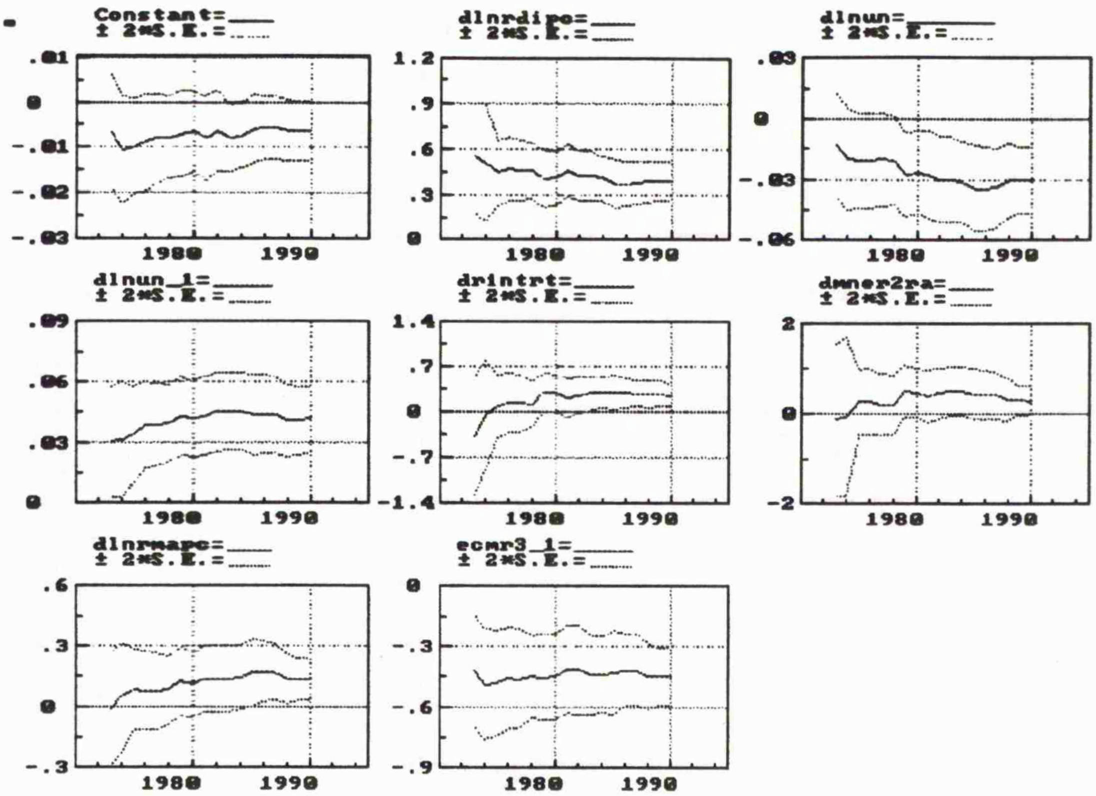

Diagram BL.4

As it can be confirmed from the above diagram, the coefficients of our model do not seem to suffer from any serious instability.

Having confirmed that our model is stable, we can move ahead to examine its forecasting ability. For this reason we re-estimated the model keeping five observations to make 1-step ahead forecasts. The forecasting accuracy of the model can be checked using the diagram BL.5 below, where the one step ahead forecasts are presented together with the 95% confidence interval for each forecast. If the line that corresponds to this interval does not cross the actual outcome, then the forecasting performance of the model is not satisfactory. In our case, as diagram BL.5 shows, the actual values were always well within the 95% confidence interval which means that the forecasting ability of the model is good.

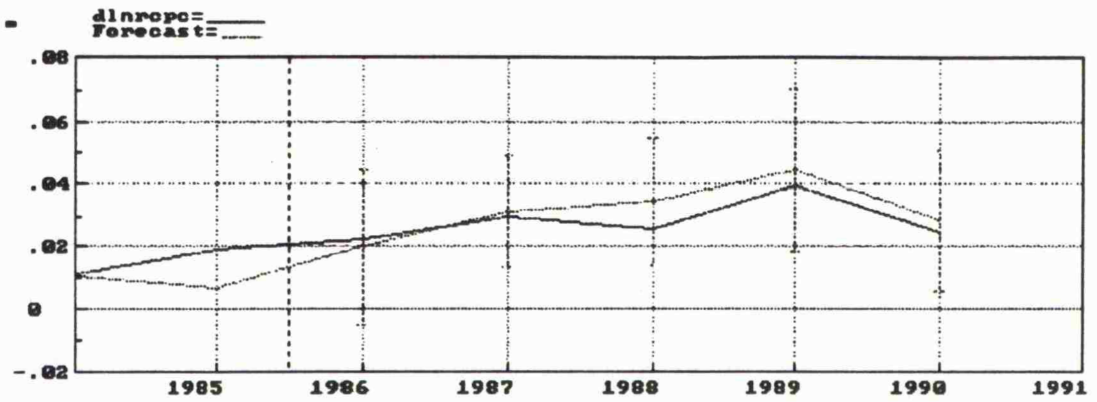

Diagram BL.5

The same conclusion is also drawn from the Forecast χ^2 test[18] since it gave a value equal to 1.9416 with a corresponding p-value equal to 0.8572. The same results were also obtained for the relevant Chow test: the p-value was very high: 0.9497.

1.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB).

1.5.1. A look at the paths of the main variables of the analysis.

In the previous sections, we estimated the degree of income correction for the long run and the short run. Now, it is time to use these estimates to correct the CAB of the government for the effects of inflation, thus deriving ex-ante estimates of the CAB.

However, before we estimate the ex-ante inflation corrected CAB, it would be helpful to first have a look at the paths that the main variables of the analysis followed during the period of our sample. So, in diagram BL.6 below, and starting

[18]The null hypothesis that is tested by this test is that there is no structural change in any parameter (the variance included) between the sample and the forecast periods. See: J.A. Doornik and D.F. Hendry (1994), p. 318

from the top left to the right, the plots of the following variables are presented: net financial liabilities (finlb), gross interest payments (intpaym), net saving (ntsavggv), net lending (ntlndggv), gross foreign debt (frdbt) and inflation rate (infl). The first four variable are expressed as ratios to GDP and refer to the general government, while the fifth variable is expressed as a ratio to the net financial liabilities and refers to the central government. The data were for the period 1970-1991 since only for this period we could find reliable data for the net financial liabilities of the government.

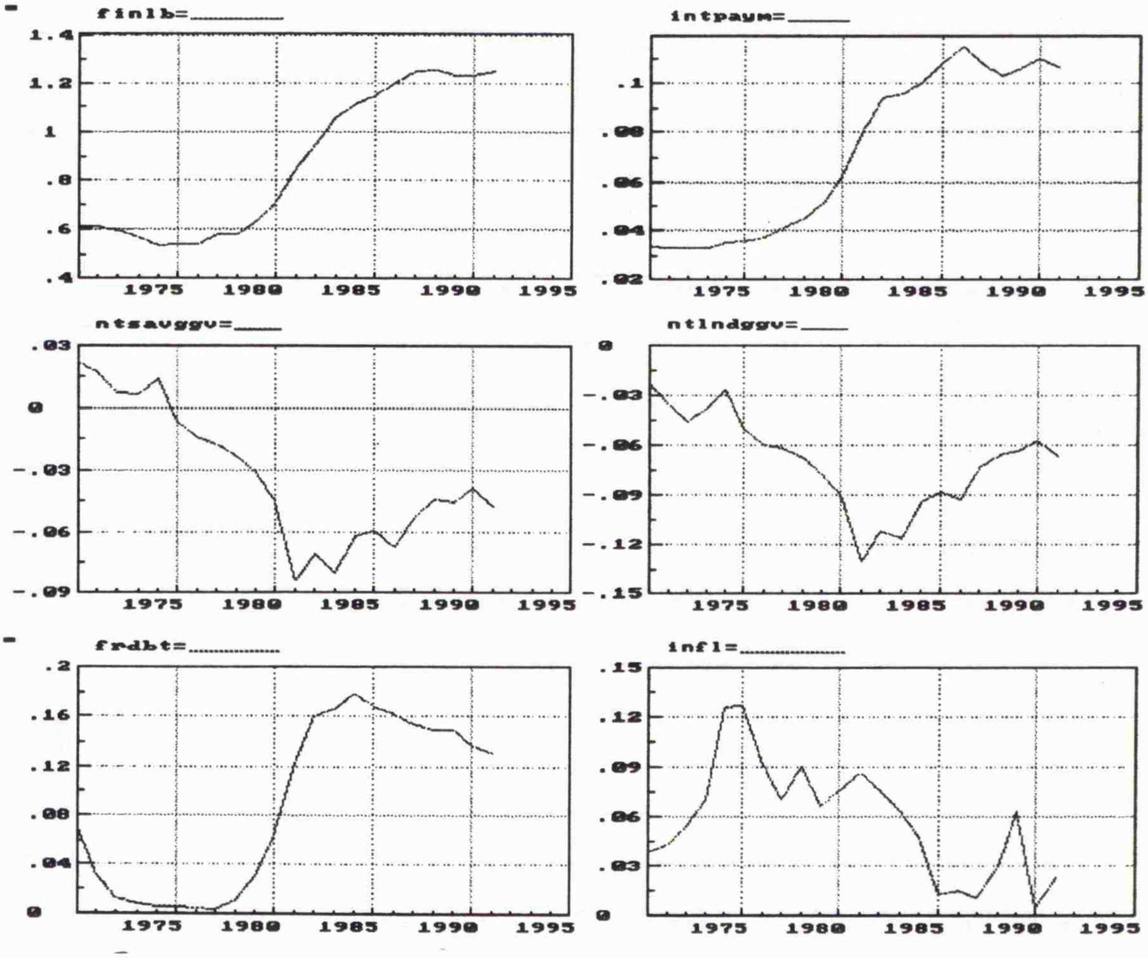

Diagram BL.6

To draw better conclusions the above diagram is also accompanied by some descriptive statistics given in table T.BL.6 below:

Table T.BL.6

Variable	Minimum (Year)	Maximum (Year)	Average
Net Fin. Liabil. (% GDP)	53.7 (1974)	124.5 (1991)	86.576
Interest Payments (% GDP)	3.3 (1972)	11.52 (1986)	7.147
Net Saving (% GDP)	-8.4528 (1981)	2.186 (1970)	-3.3139
Net Lending (% GDP)	-13.0287 (1981)	-2.331 (1970)	-6.9463
Foreign Debt (% Tot. Debt)	0.3883 (1977)	17.846 (1984)	8.7483
Inflation (%)	0.4382 (1990)	12.7155 (1975)	5.8868

As it can be seen from the above diagram, the net financial liabilities and the gross[19] interest payments followed parallel paths, increasing very rapidly after 1975. The maximum value of the net financial liabilities was taken in 1992 where it was 124.5% of GDP. The average value of this variable was 86.576% which again is very high and, other things equal, means that inflation correction has a significant role to play, since the higher the net financial liabilities the higher the inflation correction. Regarding the CAB, it was always negative after 1975 taking an average value for the whole period equal to -3.3139%. Very similar to the path of the CCAB was the path of the net lending with the difference that the corresponding percentage was always smaller than the one obtained for the CCAB. This is not something surprising given the differences of these two variables. Finally, regarding the inflation rate, it was rather moderate, having an average value equal to 5.89% and a maximum value equal to 12.72% (1975).

[19]Data for the net interest payments were not available.

1.5.2 Estimates of the ex-ante inflation corrected CAB.

After the examination of the plots of the main variables of the analysis, it is now time to use the concepts developed in chapter 1, together with the estimates of the degree of income correction obtained above, to correct the current account balance for the effects of inflation. However, before doing so we must decide about the treatment of the part of the debt that is in foreign hands. It is clear that since interest payments on this debt go to foreigners, they are not corrected by people that live in the domestic economy, since the later will never receive them. Certainly the foreigners will adjust their behaviour on the basis of how much money illusion they have, but this adjustment will not affect the economy of the country that made these interest payments. The problem is that although the right treatment would be to exclude the external debt, data for the net foreign debt of the general government were not available. The only available data is for the gross debt of the central government. One solution would be to use these data as an approximation to the net debt of the general government. The problem is that this solution implicitly assumes that the foreign assets of the government and the net debt owned by the local government and the social security funds are negligible. Because these assumptions may be unreliable, especially for countries that are significant lenders as Germany, Japan etc. we preferred to compute the ex-ante inflation correction based on the total net financial liabilities[20].

To compute the ex-ante figures the following formula was applied:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.BL.3}$$

where: CORCAB is the ex-ante inflation corrected CAB,

[20]However, application of the above given solution is not difficult at all. In fact we apply that solution in the derivation of the ex-post inflation corrected figures.

CCAB is the conventional CAB,

DB is the mid-year net financial liabilities of the government and

δ is the degree of income correction.

Definition E.BL.3 gives a measure of the CAB as it is perceived by people when there is inflation. This is done through the entrance of the coefficient δ that takes into account the perceptions that people have regarding the erosion that inflation causes in the real value of the debt that they own. In other words, although the realised erosion does not depend on the perceptions of the people, it is the perceived erosion the one that has to be used if we want to derive corrected measures of the government CAB that have behavioural meanings.

As it has already been said, when one considers ex-ante magnitudes, it makes sense to discriminate between the short run and the long run. This is valid in our case as well since, the long run degree of income correction may not be the same with the short run one. The reason is because in the long run, where the economic agent is in equilibrium, the degree of income correction is expected to be larger than in the short run where adjustments, that could affect the perceptions of the people, take place. As Tanzi et al. says[21]: "Money illusion is difficult to rationalise on a significant scale and beyond a short period of time when the inflation rate is high and stable. But when inflation is a new phenomenon, or when the rate of inflation is changing rapidly, there must likely be some of these effects. For sure, some individuals will be unable to distinguish between real and nominal interest payments so that their consumption will be affected."

From the above it is clear that there are very good reason to make us to expect different degrees of income correction in the short run and in the long run. and in fact, to expect the short run degree of income correction to be less than or at

[21]See Tanzi et al. (1987), p. 807

most equal to the long run one. Therefore, it is legitimate to distinguish the long run from the short run degree of income correction and consequently to estimate two ex-ante inflation corrected balances: one that gives the long run inflation corrected CAB and one that gives the short run inflation corrected CAB. The long run and the short run degrees of income correction have already been computed above. The point estimate of the long run degree of income correction was 0.86. In fact, δ can take values only within the unit interval. Therefore, if we find estimates that do not fall in that interval we will constrain them to the nearest possible value. This happens for the short run degree of income correction which was found negative. Therefore, we constrained it to be equal to the nearest possible value which is zero. Estimates of the ex-ante inflation corrected CAB are given below in table T.BL.7 together with estimates of the conventional CAB. They are also presented diagrammatically at diagram BL.7

Table T.BL.7: The conventional and the ex-ante inflation corrected CAB

Year	**Conventional Current Account Balance (CCAB)**	**Long Run Ex-Ante Inflation Erosion**	**Long Run Ex-Ante Inflation Corrected CAB**
1970	0.021	0.0207	0.0426
1971	0.017	0.0205	0.0376
1972	0.006	0.0240	0.0308
1973	0.006	0.0293	0.0353
1974	0.013	0.0430	0.0566
1975	-0.007	0.0559	0.0486
1976	-0.014	0.0479	0.0333
1977	-0.017	0.0375	0.0200
1978	-0.023	0.0389	0.0151
1979	-0.030	0.0403	0.0096
1980	-0.045	0.0402	-0.005
1981	-0.084	0.0540	-0.030
1982	-0.070	0.0612	-0.009
1983	-0.080	0.0589	-0.021
1984	-0.062	0.0504	-0.011
1985	-0.059	0.0288	-0.031

1986	-0.067	0.0142	-0.053
1987	-0.052	0.0141	-0.038
1988	-0.044	0.0220	-0.022
1989	-0.045	0.0483	0.00253
1990	-0.039	0.0348	-0.0044
1991	-0.047	0.0145	-0.0330

(All figures are ratios to GDP)

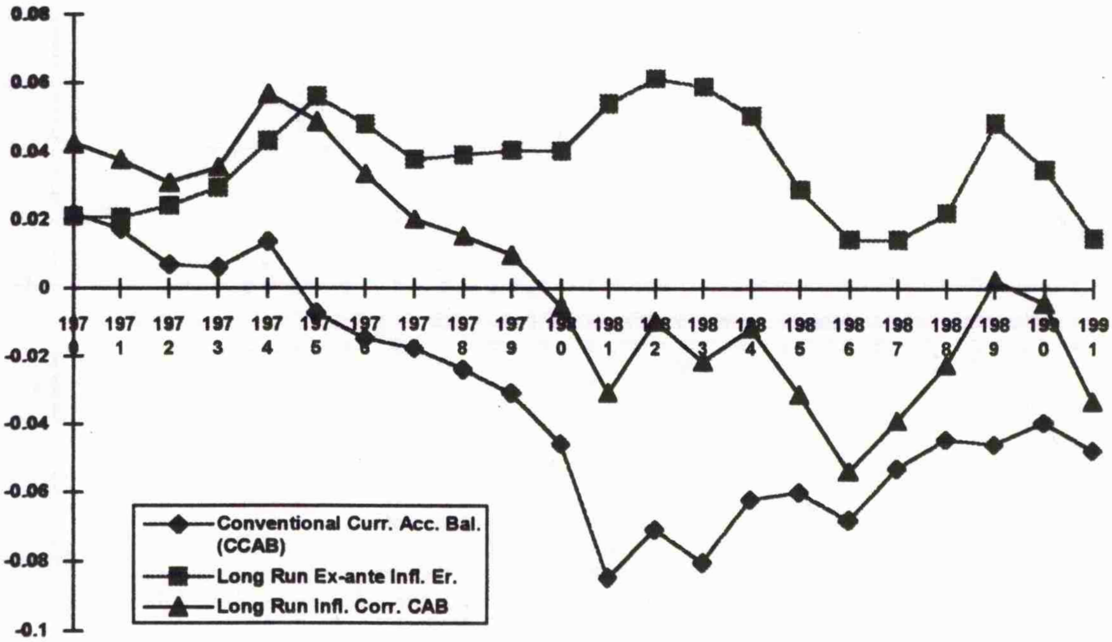

Diagram BL.7

The reason that the short run inflation corrected CAB is not given is because it coincides with the conventional CAB, since we found a zero short run degree of income correction. From both the table and the diagram it can be seen that the long run ex-ante inflation correction was rather large as a percentage of GDP. Its maximum value was as much as 6.12% of GDP in 1982. This made the long run inflation corrected CAB to be positive until 1980, though the conventional CAB was negative from 1975. Generally, the long run ex-ante inflation correction was significant as a percentage to GDP over all the period of our sample. The reasons have to do with the fact that although for most of the period the inflation rate was rather moderate, the net financial liabilities and the long run degree of income correction were high enough to make the inflation erosion, as it is perceived by people in the long run, a significant percentage of the GDP. This fact also shows that the CAB as it perceived by people may be much different from the conventional one.

1.5.3 Estimates of the ex-post inflation corrected CAB

In the above sub-section we computed ex-ante figures of the short run and the long run inflation corrected CAB. In this section we will consider the ex-post inflation corrected CAB. The formula that was applied for the computation of the ex-post inflation corrected CAB is as follows:

$$CORDEF3 = CCAB + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.BL.4}$$

where:

CORDEF3 is the ex-post inflation corrected CAB as it is computed by E.BL.4,

CCAB is the conventional CAB,

DB_i is the domestically denominated net financial assets of the government,

DB_e is the non-domestically denominated net financial assets of the government

and e_t: is the rate of change of the exchange rate of the currency in which DB_e is denominated.

As it can be seen from E.BL.4, it is the realised and not the expected inflation rate that is used. This is consisted with the ex-post meaning of E.BL.4. Also it can be seen that the external debt is taken into account as well.

Although definition E.BL.4 is the right way to go if we want ex-post inflation corrected figures of the government savings, most of the authors prefer to ignore the rate of change in the exchange rate and to use in their computations the realised inflation rate for both the foreign and the domestic assets. This means that the formula that is usually applied is:

$$CORDEF2 = CCAB + \pi DB \qquad E.BL.5$$

where:

CORDEF2 is the ex-post inflation corrected CAB as it is computed by E.BL.4 and DB is the total (external and internal) debt.

In this thesis we will compute ex-post figures using both E.BL.4 and E.BL.5. Nevertheless, we don't know whether estimates based on E.BL.4 will be near to what it is supposed that they express, because we do not know the reliability of the data about the foreign debt. It is more probable that estimates based on E.BL.5 are more reliable. However, it is interesting to have some estimates based on E.BL.4. and for this reason such estimates will be derived and it will be left to the reader to evaluate their reliability. The discussion here will be based on estimates derived by E.BL.5. Table T.BL.8 below presents estimates of the inflation corrected CAB according to E.BL.4[22] and E.BL.5. These estimates are reproduced in diagram BL.8 together with the conventional and the ex-ante estimates.

Table T.BL.8: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Inflation Correction According to E.BL.5	CORDEF2	Inflation Correction According to E.BL.4	CORDEF3
1970	0.0218	0.0237	0.0455	0.0232	0.0451
1971	0.0170	0.0262	0.0422	0.0258	0.0428
1972	0.0068	0.0328	0.0381	0.0320	0.0388

[22]To derive estimates according to E.BL.4 we used the dollar exchange rate.

1973	0.0060	0.0398	0.0443	0.0391	0.0451
1974	0.0135	0.0678	0.0779	0.0678	0.0813
1975	-0.007	0.0688	0.0580	0.0686	0.0613
1976	-0.014	0.0497	0.0321	0.0499	0.0352
1977	-0.017	0.0406	0.0203	0.0405	0.0229
1978	-0.023	0.0532	0.0275	0.0523	0.0285
1979	-0.030	0.0428	0.0090	0.0414	0.0106
1980	-0.045	0.0537	0.0038	0.0535	0.0078
1981	-0.084	0.0748	-0.0172	0.0968	0.0122
1982	-0.070	0.0728	-0.0041	0.1012	0.0304
1983	-0.080	0.0673	-0.0181	0.0863	0.0060
1984	-0.062	0.0538	-0.0113	0.0767	0.0146
1985	-0.059	0.0149	-0.0456	0.0193	-0.0405
1986	-0.067	0.0190	-0.0497	-0.0441	-0.1119
1987	-0.052	0.0145	-0.0389	-0.0225	-0.0754
1988	-0.044	0.0385	-0.0071	0.0355	-0.0087
1989	-0.045	0.0781	0.0298	0.0905	0.0447
1990	-0.039	0.0054	-0.033	-0.0253	-0.0644
1991	-0.047	0.0293	-0.019	0.0326	-0.0149

All figures are ratios to GDP

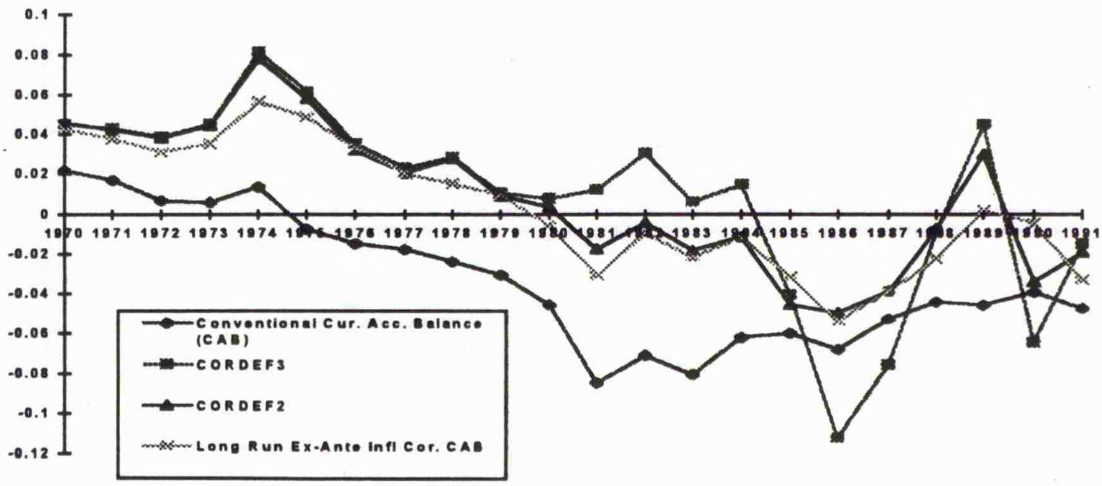

Diagram BL.8

As it can be seen from this diagram, the ex-post[23] and the long run ex-ante inflation corrected CAB are very close to each other and both are significally different from the conventional CAB. The reason that the ex-post and the ex-ante

[23]It is repeated that all the discussion refers to the CORDEF2 definition.

estimates are so close to each other is because of the high long run degree of income correction. When this happens, then the main difference between the ex-post and the ex-ante estimates is that the ex-post ones use the realised inflation rate while the ex-ante ones use the expected inflation rate. However, because of the way that the expected inflation is computed, differences caused by this reason are not expected to be significant. On the other hand, the reason that the corrected figures differ significally from the conventional ones is because of the very big percentage of net financial liabilities to GDP. This fact made the inflation correction significant despite the fact that the inflation rate was moderate.

1.6 Summary of the results

The main results of the analysis can be summarised as follows:

i) All the variables of the analysis are I(1).

ii) Wealth does not matter in the long run.

iii) The point estimate of the long run degree of income correction is 0.86 and we could not reject that it is equal to one.

iv) The long run elasticity with respect to income is almost one.

v) The short run degree of income correction is not significally different from zero. This justifies our approach to discriminate between the short run and the long run degree of income correction.

vi) The error correction model performed very well in all aspects and it passed all the usual statistical tests.

vii) We derived ex-post and ex-ante inflation corrected estimates of the CAB. The conclusion from those figures is that inflation correction matters since the inflation corrected figures differed significally from the conventional ones.

CASE STUDY 2

FRANCE

2.1 The integration properties of the data

Tests of the stationarity of the variables were performed in the same fashion as for the case of Belgium and generally, what was said there is also valid here[1]. Before we present the results of DF and ADF tests it is good to have a look at the plots of the variables in levels. As it was said, in many cases the visual examination provides a quick way to get results that are not too far from reality.

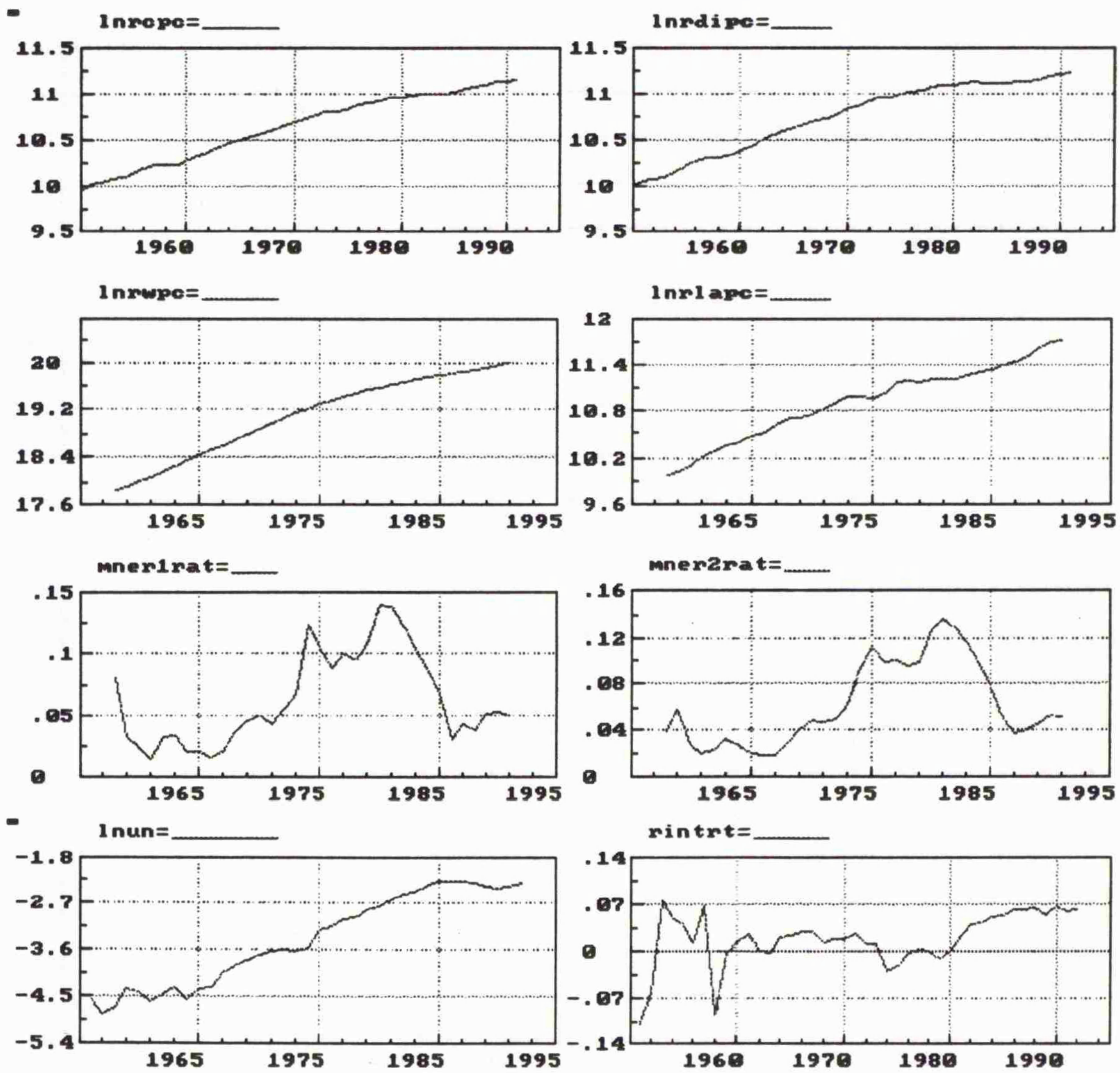

Diagram FR.1

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[1]This also happens for the notation.

As it can be seen from the above diagram, all the variables, except probably for the real interest rate, seem to be non-stationary. However, this is just an informal conclusion. Table T.FR.1 below presents the results of the DF/ADF statistical tests.

Table T.FR. 1: Unit Root Tests

Variable	**ADF(2)**	**ADF(1)**	**DF**	**Period**	**C, T**
lnrcpc	-0.20122	-0.48795	0.063657	1953-1991	C , T
lnrdipc	-0.3416	-0.51063	-0.19590	1953-1991	C , T
lnrwpc	-0.58763	-0.95423	-0.82088	1961-1991	C , T
lnrlapc	-2.2157	-2.5947	-2.3599	1961-1991	C , T
mner1rat	-1.7515	-1.66	-1.4661	1961-1991	C
mner2rat	-1.8938	-2.2492	-1.1473	1961-1991	C
lnun	-3.5812**	-3.2119**	-3.6136**	1961-1991	
rintrt	-2.9440	-2.7770	-4.354**	1952-1992	C , T
dlnrcpc	-3.6119*	-4.3811**	-4.3119**	1954-1991	C , T
dlnrdipc	-3.5269	-4.4875**	-5.3659**	1954-1991	C , T
dlnrwpc	-2.6178	-4.4642**	-3.8472*	1962-1991	C , T
dlnrlapc	-2.7759	-4.6379**	-4.0927**	1962-1991	C
dmner1rat	-3.3927**	-3.6038**	-4.7567**	1962-1991	
dmner2rat	-2.7960**	-3.6515**	-2.8599**	1962-1991	
drintrt	-6.6645**	-3.6515**	-10.884**	1955-1992	

As it can be seen from this table, the null hypothesis that the corresponding variable in levels is I(1) is rejected only in the case of lnun. Except for this variable, where it is clear from the table that it is stationary[2], the null hypothesis is

[2]However, this was not clear from the plot of this variable.

also rejected for the real interest rate but only for the simple DF test. Therefore, we should investigate whether this type of test is the appropriate one. By doing so, it was discovered that the second lag is necessary for the elimination of autocorrelation and therefore, the appropriate type of test is the ADF(2), according to which rintrt is non-stationary.

Now, regarding the null hypothesis that the corresponding variable in levels is integrated of second order, this hypothesis was rejected for all the variables that were found at least integrated of first order. In the cases of dlnrdipc, dlnrwpc, dlnrlapc where the ADF(2) shows no rejection of the null, more detailed examination shows that even without any lag there is no autocorrelation. This means that the simple DF test is enough. According to this test dlnrdipc, dlnrwpc and dlnrlapc are stationary.

Summarising the above, it can be said that all the variables are I(1), except for the lnun which is I(0).

2.2 The lag length of the VAR model

In this section we will try to define the lag length of the VAR model that will be used in the cointegration analysis. As wealth and monetary erosion variables we respectively chose the lnrwpc and the mner2rat, since preliminary examination showed that these variables performed better than their alternatives. The lag length that we chose was three. The diagnostics about autocorrelation of various orders in the equations of the VAR are presented below at table T.FR.2.

Table T.FR.2. VAR Diagnostics (lag length = 3)

Dependant variable	AR1-1	AR1-2	AR1-3	ARCH1
lnrcpc	0.3923	0.1853	0.3215	0.6330

lnrdipc	0.6664	0.5225	0.6424	0.9768
lnrwpc	0.3472	0.5618	0.5265	0.0301*
mner2rat	0.9152	0.8515	0.4326	0.4928

(The numbers in the cells are p-values)

As it can be seen from this table, for a lag length equal to three there is no problem with autocorrelation except for the ARCH1 test of the lnrwpc equation which is statistically significant at the 5% level. On the other hand, for a smaller lag length the problem of autocorrelation becomes apparent. Therefore, we will continue with a lag length equal to 3.

2.3 The Long Run Consumption Function.

Having defined the lag-length of the VAR model we can now move to the application of the Johansen procedure, starting from tests about the number of the statistically significant cointegrating vectors. Tables T.FR.3.1 and T.FR.3.2 below present the results of the maximal eigenvalue test and the trace test respectively:

Table T.FR.3.1

Johansen Maximum Likelihood Procedure
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

31 observations from 1961 to 1991. Maximum lag in VAR = 3.
List of variables included in the cointegrating vector:
LNRCPC LNRDIPC MNER2RAT LNRWPC
List of eigenvalues in descending order:
.69209 .42393 .27467 .0032464

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	36.5168	27.0670	24.7340
r<= 1	r = 2	17.0974	20.9670	18.5980
r<= 2	r = 3	9.9549	14.0690	12.0710
r<= 3	r = 4	.10080	3.7620	2.6870

Table T.FR.3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
31 observations from 1961 to 1991. Maximum lag in VAR = 3. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRWPC List of eigenvalues in descending order: .69209 .42393 .27467 .0032464				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	63.6699	47.2100	43.9490
r<= 1	r>= 2	27.1530	29.6800	26.7850
r<= 2	r>= 3	10.0557	15.4100	13.3250
r<= 3	r = 4	.10080	3.7620	2.6870

As it can be seen from these two tables, both tests reject the null hypothesis that there is no cointegration in favour of the alternative that there is one cointegrating vector. In turn, the tests are unable to reject at the 5% level of significance the null hypothesis that there is at most one cointegrating vector when the alternative is two or at least two cointegrating vectors. Therefore, the analysis will continue assuming one cointegrating vector. Normalising this cointegrating vector on consumption we get the following long run consumption function:

lnrcpc = 0.67474*lnrdipc - 0.55749*mner2rat + 0.20817*lnrwpc   E.FR.1

From equation E.FR.1 it can be seen that the signs of the parameters are the expected ones and that their magnitude is within the logical boundaries, though one could say that the coefficient of lnrdipc is rather low. Regarding the point estimate of the long run degree of income correction, it is equal to 0.8262 which is high and close to one.

Having estimated the long run consumption function, the next step is to impose restrictions on the cointegrating vector and to test their validity. The results of the corresponding tests are presented at table T.FR.4. As it can be seen from this table in France, in contrast to Belgium, the wealth is significant in the long run which is in accordance with the life cycle model. The real disposable income is also highly significant. Regarding now the degree of income correction, testing indirectly the null hypothesis that it is zero shows that this null is rejected at any level of significance.

Table T.FR.4

Restriction	p-value
$a_1 = 0$	0
$a_3 = 0$	0.032
$a_2 = 0$ ($\Rightarrow \delta_L = 0$)	0
$a_2 = - a_1$ ($\Rightarrow \delta_L = 1$)	0.028
$a_2 = - 0.95^* a_1$ ($\Rightarrow \delta_L = 0.95$)	0.084

However, the null hypothesis that $a_2 = - a_1$ i.e that the degree of income correction is full is also rejected. Nevertheless, we cannot reject at the 5% level the null hypothesis that the long run degree of income correction is 0.95.

Having estimated the long run consumption function the next step is to use the residuals of this function to formulate an error correction model (ECM).

2.4. The Short Run Consumption Function.

The arrive at the final equation we applied the general to specific method. More analytically, we started from a-fairly general model with many stationary variables each of which entered the model with two lags. Then by imposition of zero restrictions we arrived at the final equation. The final model is presented below at table T.FR.5.

Table T.FR.5 The Error Correction Model

Modelling dlnrcpc by OLS The present sample is: 1960 to 1991					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
lnun_1	0.035651	0.011195	3.185	0.0041	0.3060
lnun_2	-0.034329	0.010658	-3.221	0.0038	0.3109
Constant	0.28545	0.11597	2.461	0.0218	0.2085
dlnrdipc	0.43336	0.078404	5.527	0.0000	0.5705
dlnrdipc_1	0.15925	0.088280	1.804	0.0844	0.1239
dmner2rt	-0.15228	0.12201	-1.248	0.2245	0.0634
dmner2rt_1	-0.27430	0.10457	-2.623	0.0152	0.2303
drintrt	0.24114	0.10048	2.400	0.0249	0.2003
ect_1	-0.23025	0.094576	-2.435	0.0231	0.2049

R^2 = 0.86767 F(8, 23) = 18.851 [0.0000] σ = 0.00621797 DW = 2.15
RSS = 0.0008892535278 for 9 variables and 32 observations
Information Criteria: SC = -9.51613; HQ = -9.79172; FPE = 4.95372e-005
AR 1- 1F(1, 22) = 0.62406 [0.4380]
AR 1- 2F(2, 21) = 0.60086 [0.5575]
ARCH 1 F(1, 21) = 2.7379 [0.1129]
Normality $Chi^2(2)$= 0.15364 [0.9261]
Xi^2 F(16, 6) = 0.34108 [0.9601]
RESET F(1, 22) = 0.21671 [0.6461]

1. For explanation of the various symbols see the corresponding table for Belgium.

As it can be seen from the above table, the lagged disposable income variable is statistically significant. Thus, to identify the short run degree of income correction non-linear methods have to be used. Below, we present the non-linear model as well as the results from its estimation by Non-linear Least Squares (NLS).

dlnrcpc=&0+&1*(dlnrdipc-&2*dmner2rt)+&3*(lag(dlnrdipc,1)-
&2*lag(dmner2rt,1))+&4*lag(lnun,1)+&5*lag(lnun,2)+&6*drintrt+

+ &7*lag(ect,1); E.FR.2

where: lag(x, r)=x_{t-r}

Table T.FR.6

Modelling dlnrcpc by RNLS The present sample is: 1960 to 1991					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
&0	0.31366	0.12269	2.556	0.0173	0.2140
&1	0.33478	0.093212	3.592	0.0015	0.3496
&2	0.96291	0.42170	2.283	0.0316	0.1785
&3	0.17515	0.086300	2.030	0.0536	0.1465
&4	0.027734	0.011235	2.469	0.0211	0.2025
&5	-0.027588	0.010416	-2.649	0.0141	0.2262
&6	0.20534	0.10221	2.009	0.0559	0.1440
&7	-0.25509	0.10063	-2.535	0.0182	0.2112

R^2 = 0.850096 F(7, 24) = 19.443 [0.0000] σ = 0.00647867 DW = 1.79
RSS = 0.00100735489 for 8 variables and 32 observations
Information Criteria: SC = -9.49973; HQ = -9.7447; FPE = 5.24664e-005
ARCH 1 F(1, 22) = 0.85961 [0.3639]
Normality Chi²(2)= 0.31335 [0.8550]
AR 1- 1F(1, 23) = 1.433 [0.2435]
AR 1- 2F(2, 22) = 2.0688 [0.1502]
Xi² F(14, 9) = 0.50852 [0.8761]

Before we start commenting on the results given in the above table, we have first to check the validity of the exogeneity assumption. The test that will be used for this purpose is the Hausman-Wu exogeneity test. The way to perform this test has already been explained for the case of Belgium. According to the results obtained, the null hypothesis of weak exogeneity cannot be rejected at any of the conventional levels of significance [p-value=0.9612 when the test was performed on the basis of the OLS estimated equation and 0.9797 when it was performed on the basis of the NLS equation]. Therefore, the analysis will continue with the results obtained above.

As for Belgium so for France, the estimated ECM is very satisfactory. The coefficient of determination is high for a model in differences. This shows that the model fits the data well. The same fact can also be seen from diagram FR.3 below, where the actual and the fitted values are plotted, together with the plot of the scaled residuals.

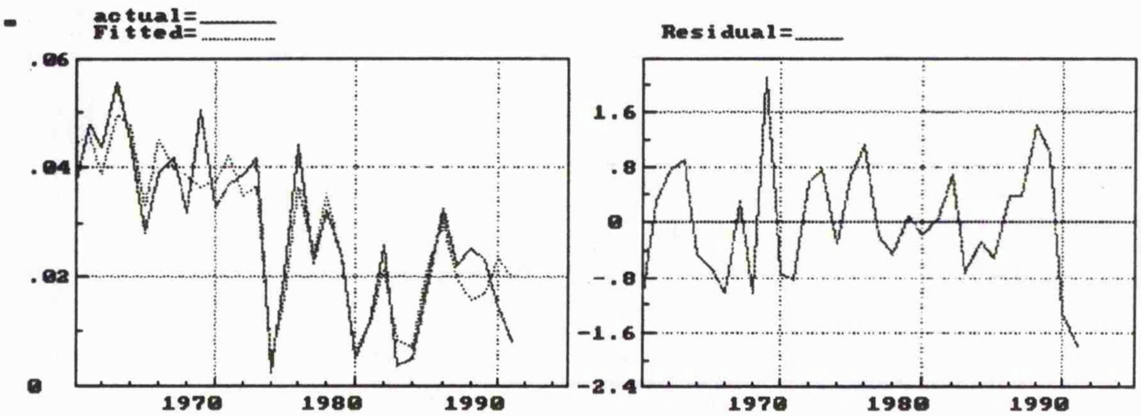


Diagram FR.2

From the above diagram, it can also be seen that the residuals are white noise, as it is the assumption of the classical regression model. This informal conclusion is confirmed by having a look at the series of tests presented at table T.FR.6. Indeed, as it can be seen, the model passes all the tests successfully.

Now, regarding the parameter estimates and their statistical significance, we can see that the error correction term is strongly significant which again indicates a robust long run relationship. Also, the short run degree of income correction, for which we are particularly interested, is equal to 0.963 which is almost full. As we may remember, the long run degree of income correction was also very high. Although the point estimate of the short run degree of income correction is higher than the corresponding estimate for the long run degree, it is not statistically different from it [p-value = 0.7480]. Regarding tests about the value of the short run degree of income correction, since for the estimation of the model we used NLS, these tests can only be direct. As it can be seen from table T.FR.6, the null hypothesis that the degree of income correction is zero ($a_2 = 0$) is rejected at the 5% level of significance. On the other hand, the null hypothesis that this degree is equal to one i.e. full cannot be rejected at any conventional level of significance (p-value = 0.9306).

2.4.1 The stability and the forecasting accuracy of the model.

Two more characteristics of our model that should be tested is its stability and its forecasting accuracy. The stability of the model was evaluated through the following four tests the results of which are presented at diagram FR.3 below

i) 1-step recursive residuals

ii) 1-step Chow - Test

iii) Break point F-tests (N↓ Step Chow - Tests)

iv) Forecast F-tests (N↑ Step Chow - Tests)

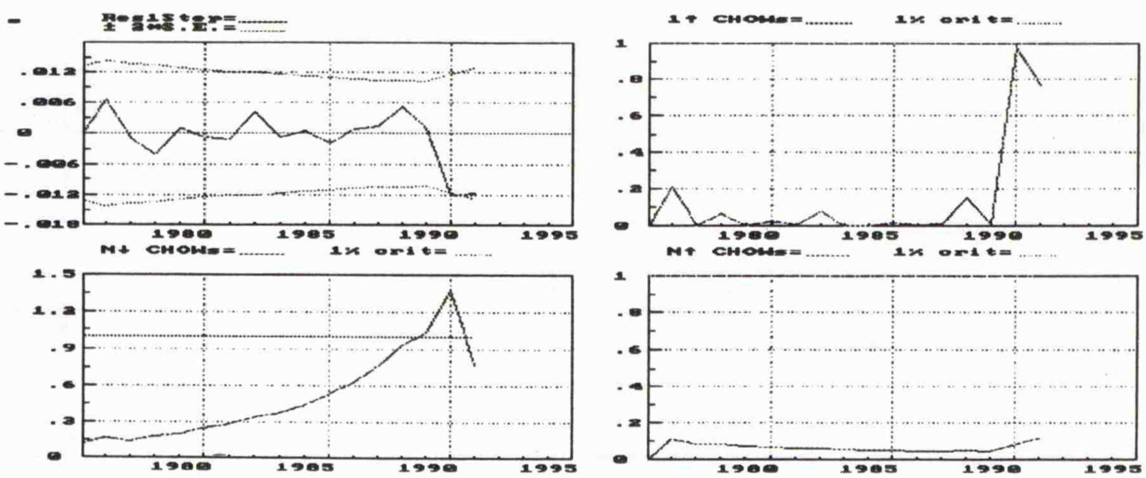


Diagram FR. 3

As it can be seen from the above diagram, the model looks generally stable if one excepts a serious instability observed for 1990. Indeed for this year, the 1-step recursive residuals reached the critical boundary of the ± 2 standard errors while the 1 - step Chow test increased radically though it didn't exceed the 1% critical value. The same is also obvious from the N↓ Chows test where the value of the test exceeded the 1% critical value. Therefore, it is probable that the model is unstable for this year.

Regarding the forecasting accuracy of the model, we re-estimated our preferred equation without the last five observations. The corresponding forecast Chi square test gave a p-value of 0.0017. This value shows that the forecasting ability of the model is not good. However, the problem may be the instability observed for 1990. From Diagram FR.4 we also can see that the forecasting accuracy of the model is not very good for the last two years of the sample which may be the result of a structural break. To account for this fact the model was re-estimated, excluding the last two years from the sample. This increased the p-value to 0.6362 which shows that the problem with the forecasting accuracy of the model is created by the instability at the last two years of the sample. Nevertheless, this instability didn't affect the estimate of the short run degree of income correction that was 0.96119 when we excluded the last two years i.e. almost identical with the one obtained for the whole sample.

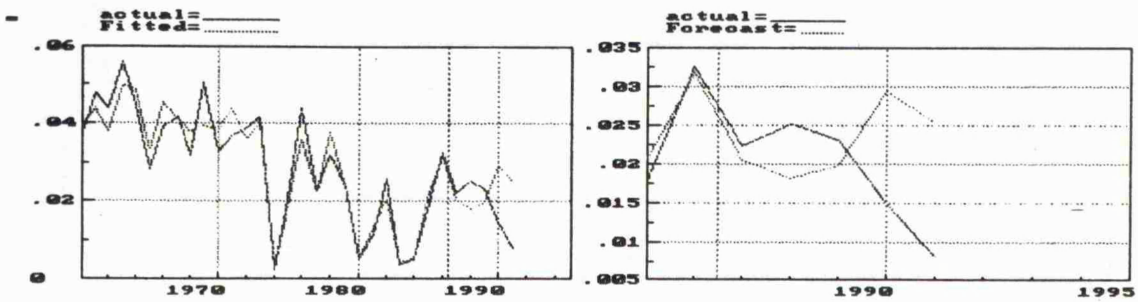


Diagram FR. 4

The examination of the stability and the forecasting accuracy of the model completed the analysis of the long run and the short run French consumption function.

2.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB)

In the previous two sections we examined the French consumption function and we found that the long run degree of income correction is 0.83 while the short run one is 0.963. However, before we utilise these estimates for the estimation of the ex-ante inflation corrected CAB it is probably better to first have a look at the paths that the main variables of the analysis followed during the period of our sample.

2.5.1 A look at the paths of the main variables of the analysis.

Diagram FR.5 below presents the plots of the following variables (from the top left to the right): net monetary liabilities (monlb)[3], gross interest payments, net saving, net lending, gross foreign debt and the inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government while the fifth variable is expressed as a ratio to the net monetary liabilities and refers to the central government. Except for this diagram, useful conclusions can also be drawn from table T.FR.7 which presents some elementary statistics about the above mentioned variables.

[3]In the case of France the relevant variable is net **monetary** liabilities and not net financial liabilities as in most other cases. Needless to say, this variable is better than the net financial liabilities.

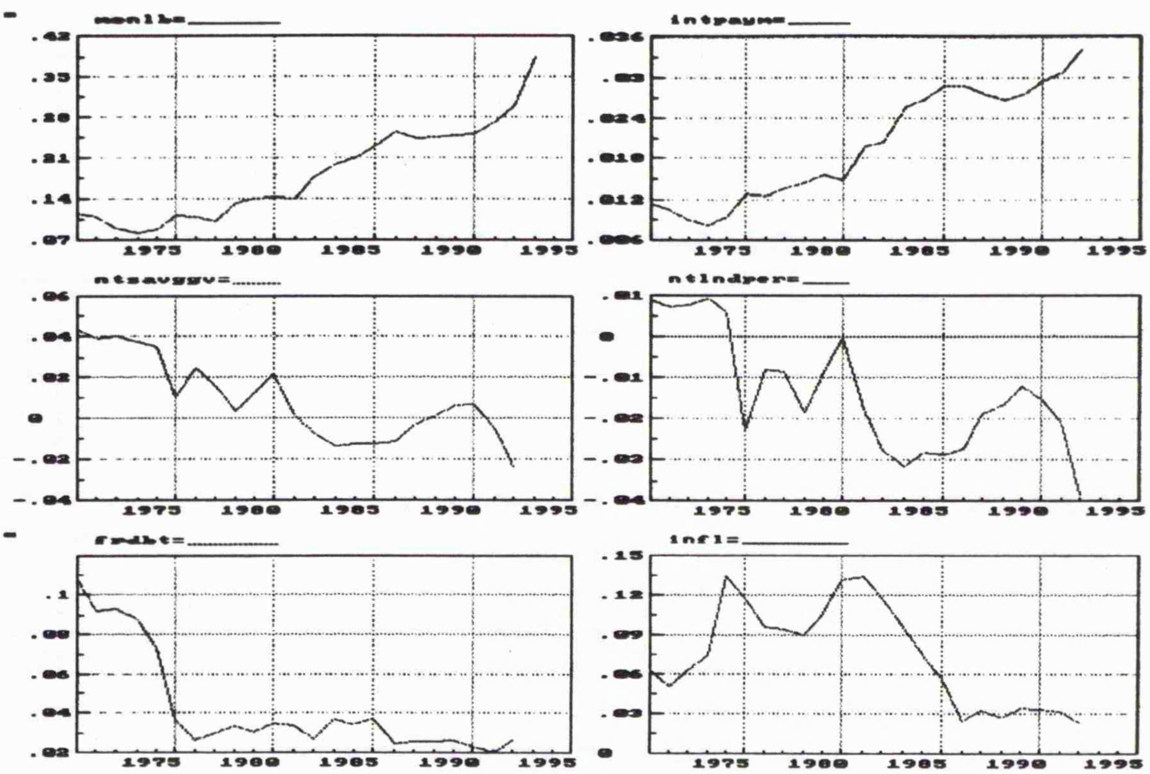


Diagram FR.5

Table T.FR.7

Variable	Minimum (Year)	Maximum (Year)	Average
Net Mon. Liabil. (% GDP)	8.3 (1973)	38.46 (1993)	18.304
Interest Payments (% GDP)	0.8218 (1973)	3.4136 (1992)	2
Net Saving (% GDP)	-2.3646 (1992)	4.3395 (1970)	0.9257
Net Lending (% GDP)	-3.8386 (1992)	0.9195 (1973)	-1.345
Foreign Debt (% Tot. Debt)	2.0481 (1991)	10.7784 (1970)	4.2825
Inflation (%)	2.4147 (1992)	13.4868 (1974)	7.4673

Starting from the net monetary liabilities of the general government, we can see that this variable followed an upward trend for almost all the years of the sample. So from only 8.3% in 1973, it was 38.46% in 1993. Nevertheless, this percentage is low relatively to the percentages that some other countries experienced.

Regarding the ratio of the gross interest payments to GDP, it followed almost the same path as the net monetary liabilities taking an average value equal to 2% of GDP.

Moving to the next variable i.e. the conventional current account balance, apart from the period 1982-1987 and the last two years of the sample (1991-1992), it was positive in all the other years. In contrast to the CCAB that was positive for many years, the net lending was negative for most of the period, taking an average value equal to -1.345% of GDP. Also regarding the debt that is denominated in foreign currency, it never was a significant percentage of the net monetary liabilities, especially after 1975. Finally, the inflation rate was rather moderate for most of the period. Its average value was 7.46% while its maximum value, probably a result of the first oil shock, was 13.48% (1974).

2.5.2 Estimates of the ex-ante inflation corrected CAB

It is now time to use the estimates of the long run and the short run degree of income correction obtained above, to derive estimates of the short run and of the long run ex-ante inflation corrected government balance. The formula that will be used for this purpose is the one given for the case of Belgium i.e.

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.FR.3}$$

where the notation is as in the previous case study.

Depending on the degree of income correction that we use E.FR.3 will give estimates of the short run and the long run ex-ante inflation corrected CAB. In the below estimates the short run degree of income correction has been restricted to be equal to the long run one since theoretically this is the highest value that it can take[4]. The estimates given in table T.FR.8 are also presented diagrammatically at diagram FR.6.

Table T.FR.8
The conventional and the ex-ante inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Long Run and Short Run Ex-Ante Inflation Erosion	Long Run and Short Run Ex-ante Inflation Corrected CAB
1970	0.0433	0.0057	0.0491
1971	0.0393	0.0050	0.0443
1972	0.0402	0.0044	0.0446
1973	0.0372	0.0045	0.0418
1974	0.0355	0.0070	0.0425
1975	0.0103	0.0098	0.0202
1976	0.0249	0.0090	0.0340
1977	0.0160	0.0078	0.0239
1978	0.0033	0.0085	0.0119
1979	0.0127	0.0104	0.0232
1980	0.0217	0.0131	0.0348
1981	0.0015	0.0148	0.0164
1982	-0.0072	0.0157	0.0084
1983	-0.0135	0.0159	0.0024
1984	-0.0123	0.0139	0.0015
1985	-0.0124	0.0116	-0.0007
1986	-0.0113	0.0079	-0.0034
1987	-0.0031	0.0058	0.0027
1988	0.0014	0.0059	0.0074
1989	0.0062	0.0061	0.0124
1990	0.0069	0.0069	0.0138
1991	-0.004	0.0069	0.0023
1992	-0.0236	0.0065	-0.0171

(All figures are ratios to GDP)

[4]It is reminded that the short run degree of income correction was found a bit higher than the long run one. However it was not significally different from it.

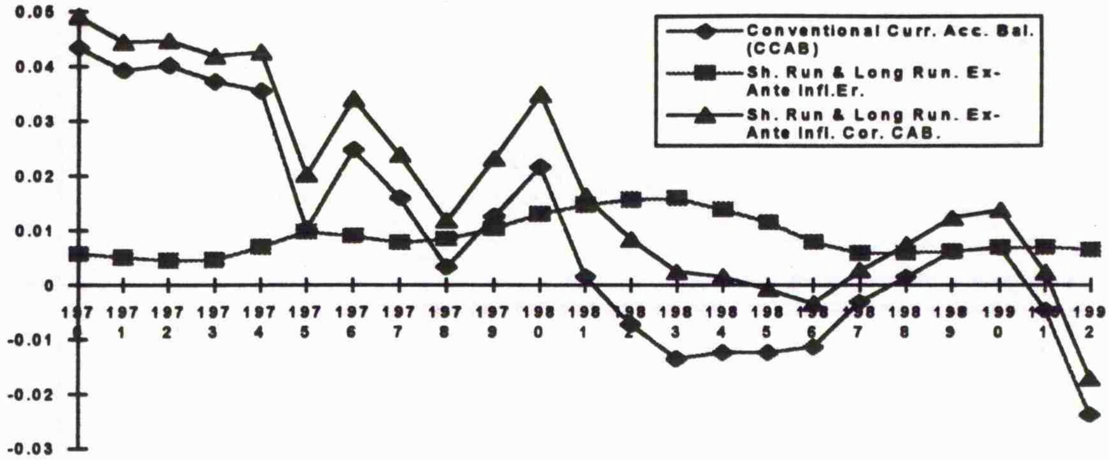


Diagram FR. 6

As it can be seen from the table and from the diagram, the CAB as it is perceived by people, was quite different from the conventional one. Actually, although the conventional CAB was negative for eight years, the ex-ante inflation corrected one was negative for only three years. However, although the inflation correction was enough to turn in many cases the negative conventional balance to positive, it wasn't too high in absolute terms for the reason that the general government's net liabilities and the inflation rate were rather moderate in size.

2.5.3 Estimates of the ex-post inflation corrected CAB.

Having derived in the previous sub-section estimates of the **ex-ante** inflation corrected CAB, we will continue in this subsection to derive estimates of the **ex-post** inflation corrected CAB. For this purpose two formulas will be used. The first one, that is given below, does not separate between external and internal liabilities. Although the right treatment would be to make a separation like this, very few have applied it empirically, probably because of lack of data. The relative formula is as follows:

$$CORDEF2 = CCAB + \pi DB \qquad \text{E.FR.4}$$

where the notation is as in the previous case study

The main reason that we estimated the ex-post inflation corrected CAB using two formulas, is because the existing data on the external liabilities are not reliable. Thus, the reliability of the corresponding results may also be doubtful. However, estimates based on a separation between external and internal liabilities are interesting and for this reason we tried to derive them leaving to the reader to decide upon their reliability[5]. The formula that was applied to derive these estimates is as follows:

$$CORDEF3 = CCAB + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.FR.5}$$

where the notation is as in the previous case study

Estimates of the ex-post inflation corrected CAB based on E.FR.4 and E.FR.5 are given below in the table T.FR.9

Table T.FR.9: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Inflation Erosion according to E.FR.4	CORDEF2	Inflation Erosion according to E.FR.5	CORDEF3
1970	0.0433	0.0075	0.0509	0.0083	0.0517
1971	0.0393	0.0054	0.0447	0.0054	0.0447
1972	0.0402	0.0060	0.0462	0.0052	0.0454
1973	0.0372	0.0059	0.0432	0.0049	0.0422
1974	0.0355	0.0109	0.0464	0.0114	0.0469
1975	0.0103	0.0111	0.0215	0.0105	0.0209

[5]Nevertheless all the discussion here will be done in terms of CORDEF2.

1976	0.0249	0.0098	0.0347	0.0101	0.0350
1977	0.0160	0.0094	0.0255	0.0094	0.0255
1978	0.0033	0.0100	0.0134	0.0097	0.0131
1979	0.0127	0.0137	0.0265	0.0135	0.0262
1980	0.0217	0.0175	0.0392	0.0175	0.0392
1981	0.0015	0.0180	0.0196	0.0190	0.0206
1982	-0.007	0.0178	0.0105	0.0186	0.0113
1983	-0.013	0.0173	0.0037	0.0181	0.0045
1984	-0.0123	0.0148	0.0024	0.0157	0.0033
1985	-0.0124	0.0121	-0.0002	0.0123	0
1986	-0.0113	0:0058	-0.0059	0.0037	-0.0075
1987	-0.0031	0.0080	0.0049	0.0071	0.0040
1988	0.0014	0.0064	0.0079	0.0064	0.0079
1989	0.0062	0.0083	0.0146	0.0087	0.0150
1990	0.0069	0.0082	0.0151	0.0071	0.0141
1991	-0.0046	0.0081	0.0035	0.0083	0.0037
1992	-0.023	0.0068	-0.0168	0.0063	-0.0172

(All figures are ratios to GDP)

These estimates are also plotted in diagram FR.7 below, together with the estimates of the ex-ante inflation corrected CAB that were derived earlier. As it can be seen from this diagram, the estimates of the ex-post inflation corrected CAB derived using E.FR.4 and E.FR.5 are almost identical to each other. This happens because the gross foreign liabilities of the central government were very small and therefore the weight that the last term of E.FR.5 carries is of minor importance.

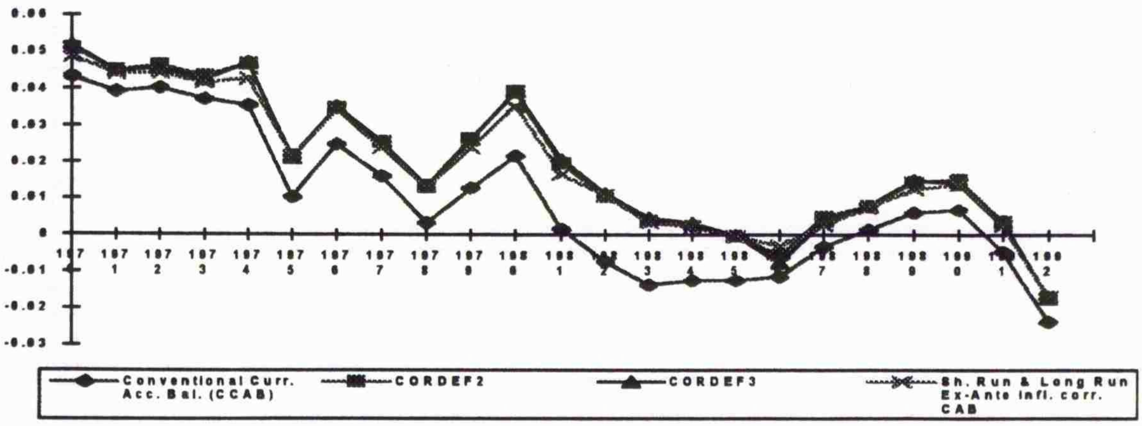


Diagram FR.7

Also, the comparison of the ex-post with the ex-ante figures, show that these estimates are close to each other. This is not surprising given the high degree of income correction that was estimated.

Generally, one could say that in the case of France the inflation correction was of moderate significance. The main reason that this happens is because the percentage of the monetary liabilities of the government and the inflation rate were rather low. Nevertheless, even under such conditions, the inflation correction was enough to turn many of the deficits of the CCAB to surpluses. This happened for both the ex-ante and the ex-post inflation corrected balances.

2.6. Summary of the results.

In this case study, we examined the case of France. The main results of the analysis can be summarised as follows:

i) Apart from lnun that was I(0), all the other variables were I(1).

ii) Wealth does matter in the long run.

iii) The long run elasticity of consumption with respect to income was 0.67474

iv) The point estimate of the long run degree of income correction was 0.8262, which although significally different from one it wasn't significally different from 0.95. In other words, the long run degree of income correction is pretty close to one.

v) The error correction model, performed very well passing all the statistical tests. However, it was rather unstable at the last two years of the sample.

vi) The short run degree of income correction was almost full which combined with the fact that the same was also true for the long run degree, it means that people in France do not suffer from money illusion, not only in the long run but even in the short run.

vii) Ex-ante and ex-post measures of the inflation corrected deficit were derived. The general conclusion from those estimates is that they move very close to each other and this is absolutely natural since the degree of income correction was almost full, both for the short run and for the long run. The inflation correction several times turned the conventional deficits to inflation corrected surpluses which shows that in the case of France the inflation correction matters, though it was not a large percentage of GDP.

CASE STUDY 3

GERMANY[1]

[1]All the discussion refers to the West Germany.

3.1 The integration properties of the data

Tests about the stationarity of the variables of the analysis were performed in a fashion similar to the previous two case-studies. Thus, the examination of this issue was done both visually, through the plots of the variables, and formally, through the DF/ADF statistical tests. Below at diagram GER.1 the plots of the main variables of the analysis are presented. The notation is the same as in the previous case studies.

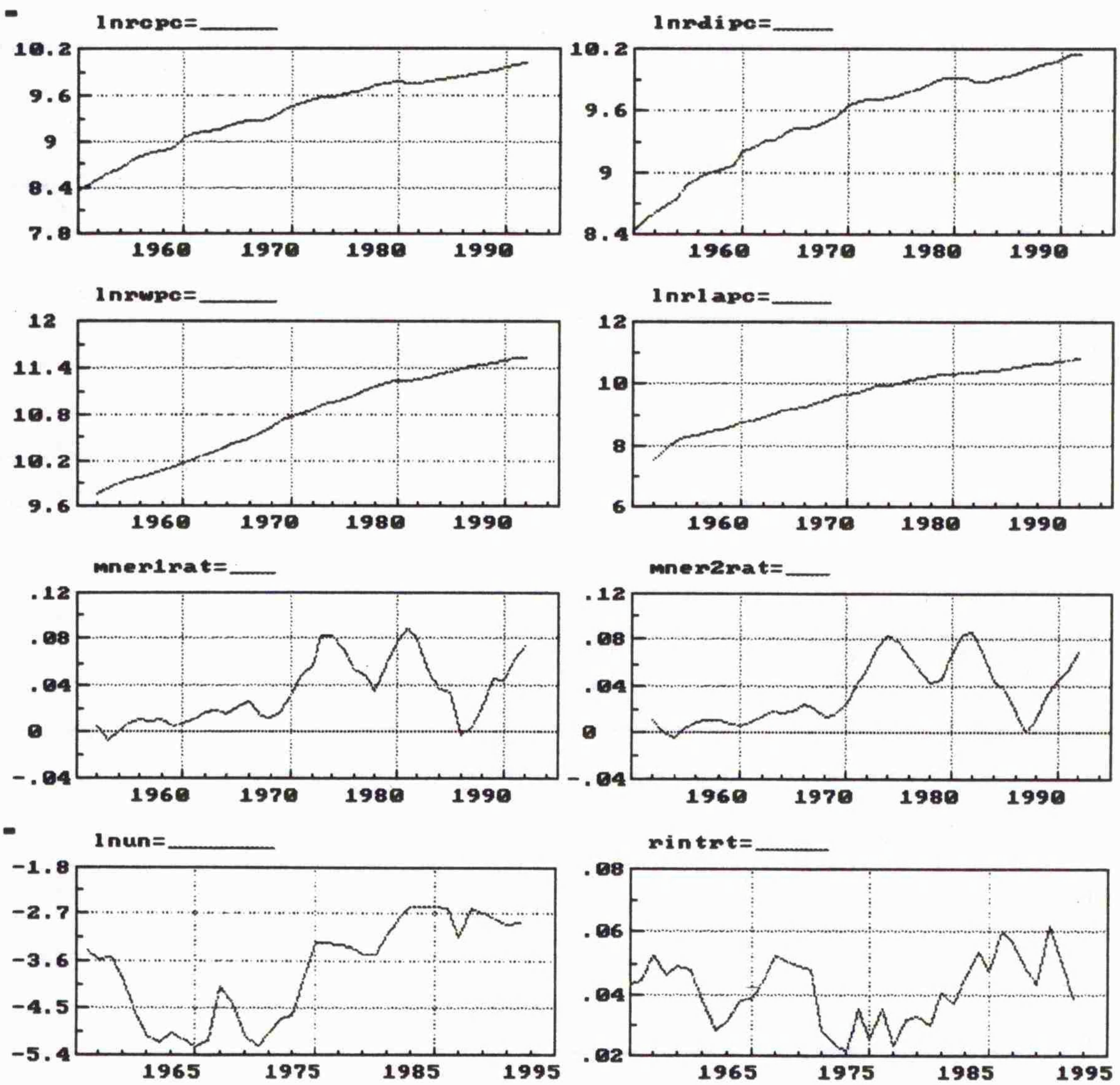


Diagram GER.1

As it can be seen from the above diagram, there is no doubt that the first four plotted variables are clearly non-stationary. Regarding the other four variables, although they show more variability than the first four, they are rather non-stationary as well. These visual conclusions are also confirmed by the results of the DF/ADF tests. These results are presented at table T.GER.1 below:

Table T.GER.1: Unit Root Tests

Variable	**ADF(2)**	**ADF(1)**	**DF**	**Period**	**C, T**
lnrcpc	-2.0393	-2.0386	-2.2413	1953-1992	C, T
lnrdipc	-2.3011	-2.3176	-2.4748	1953-1992	C, T
lnrwpc	0.97088	-0.10164	1.1411	1955-1992	C, T
lnrlapc	-0.88533	-0.24702	-0.54526	1955-1992	C, T
mner1rat	-2.9501	-2.9126	-1.8353	1955-1992	C, T
mner2rat	-2.3143	-4.0252*	-1.6244	1955-1992	C, T
lnun	-3.4415	-3.0141	-2.7532	1958-1992	C, T
rintrt	-2.234	-2.2471	-2.6808	1958-1992	C
dlnrcpc	-4.3569**	-4.7232**	-4.8088**	1954-1992	C, T
dlnrdipc	-4.3752**	-3.8502*	-5.1073**	1954-1992	C, T
dlnrwpc	-2.4195	-3.9727*	-2.9731	1955-1992	C, T
dlnrlapc	-4.9883**	-5.7996**	-4.0065*	1956-1992	C, T
dmner1rat	-3.6029**	-3.5137**	-4.0251**	1956-1992	
dmner2rat	-2.7834**	-4.3246**	-2.6138*	1956-1992	
dlnun	-3.2802**	-4.1767**	-4.5395*	1960-1992	
drintrt	-3.5062**	-4.396**	-7.0171**	1960-1992	

As it can be see from table T.GER.1, all the variables in levels are at least I(1). One could say that this may not happen for moner2rat since the null hypothesis of non-stationarity is rejected at the 5% level, when the ADF(1) tests is used. However, the ADF(1) is not the most appropriate test, since the second lag is necessary for the elimination of autocorrelation. Therefore, the most appropriate test is the ADF(2) and according to it, the null hypothesis of non-stationarity cannot be rejected.

Having seen that all the variables in levels are at least I(1), we should check whether they are I(2). This hypothesis is easily rejected for all variables except for dlnrwpc where the results are dependant on the lag length. Therefore, to draw conclusions about the stationarity of this variable it is needed to examine the necessity of the lags for the elimination of autocorrelation. Regarding the second lag, its elimination does not cause autocorrelation. However, this does not happen for the first lag. Therefore, the most appropriate test to use is the ADF(1) and according to this test the null hypothesis that total wealth is I(2) is rejected.

Thus, the final conclusion is that all the variables are integrated of first order which means that they need to be differentiated once, to become stationary.

3.2 The lag length of the VAR model

This step, that precedes the application of the Johansen method, aims to identify the lag length of the VAR model that will be used in the Johansen procedure. The relative decision will be made by evaluating the autocorrelation diagnostics for various lag-lengths. However, before we estimate the unrestricted VAR model and derive these diagnostics, it is first needed to choose which of the alternative wealth and monetary erosion variables will be used in the VAR. The choice is between lnrwpc and lnrlapc regarding the wealth variable and between mner1rat and mner2rat regarding the monetary erosion variable. Experimentation with the Johansen procedure showed that lnrwpc and mner2rat perform better than their alternatives. Table T.GER.2 below presents diagnostics for the presence of autocorrelation of various orders, for a lag length equal to four. Since this lag length was the shortest one for which autocorrelation was not a problem, we will continue assuming a VAR with such lag-length..

Table GER.2: VAR Diagnostics (lag length = 4)

Variable	AR1-1	AR1-2	AR1-3	AR1-4	ARCH1
lnrcpc	0.3724	0.6548	0.5976	0.6805	0.8761
lnrdipc	0.7148	0.8185	0.3613	0.2525	0.9271
lnrwpc	0.7217	0.5703	0.3980	0.0783	0.3642
mner2rat	0.7084	0.4905	0.6857	0.6797	0.8368

(the numbers in the cells are p-values).

3.3 The Long Run Consumption Function

Having established the lag-length of the VAR, we can now move to the Johansen approach starting from tests about the number of the statistically significant cointegrating vectors. The results of the two tests that were performed are presented below at tables T.GER.3.1 and T.GER.3.2.

Table T.GER.3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
37 observations from 1956 to 1992. Maximum lag in VAR = 4. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept List of eigenvalues in descending order: .60672 .54447 .49216 .15611 -.0000

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	34.5295	28.1380	25.5590
r<= 1	r = 2	29.0933	22.0020	19.7660
r<= 2	r = 3	25.0709	15.6720	13.7520
r<= 3	r = 4	6.2801	9.2430	7.5250

Table T.GER.3.2

Johansen Maximum Likelihood Procedure (Non-trended case) Cointegration LR Test Based on Trace of the Stochastic Matrix				
37 observations from 1956 to 1992. Maximum lag in VAR = 4. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept List of eigenvalues in descending order: .60672 .54447 .49216 .15611 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	94.9738	53.1160	49.6480
r<= 1	r>= 2	60.4442	34.9100	32.0030
r<= 2	r>= 3	31.3510	19.9640	17.8520
r<= 3	r = 4	6.2801	9.2430	7.5250

From both tables the conclusion is that there are three cointegrating vectors that are statistically significant at the 5% level. When these three cointegrating vectors were normalised on consumption only one had its coefficients with magnitudes and signs that conformed to what is expected from a long run consumption function.

The long run consumption function that corresponds to this vector is as follows:

lnrcpc=0.52114+0.84061*lnrdipc-0.45904*mner2rat+0.087832*lnrwpc E.GER.1

As it can be seen from E.GER.1, all the coefficients have the sign that is expected from economic theory. The long run elasticity of consumption with respect to income is 0.84061. Regarding the long run degree of income correction, it is 0.5461 i.e. it is only partial and rather low. A possible reason for this moderate degree of income correction is that the inflation rate that Germany experienced during the period of our sample was low. As it was said previously, one of the cases where there may be money illusion is when the inflation rate is low. The reason is because people are ussually more careful about the effects of inflation on the real value of their monetary assets, when these effects are rather high which happen when there is a high inflation rate (or better: a high expected inflation rate).

Now, regarding the performance of statistical tests, these will have the form of restrictions imposed on the whole cointegrating space i.e on all the three cointegrating vectors simultaneously. Actually, it is not possible to impose only one restriction in one cointegrating vector when there are more statistically significant vectors that span the cointegrating space. Results from the imposition of such restrictions are presented below at table T.GER.4.

Table T.GER.4

Restriction	p-value
$a_0 = 0$	0
$a_1 = 0$	0
$a_2 = 0$ ($\Rightarrow \delta_L = 0$)	0
$a_2 = -a_1$ ($\Rightarrow \delta_L = 1$)	0
$a_3 = 0$	0.735

As it can be seen from this table, apart from the wealth variable, all the other variables are statistically significant. Though the wealth variable is insignificant, taking it out distorts the results seriously. This means that this variable may play a significant role to the short run reactions of the system. The fact that wealth is not significant in the long run casts doubts in the validity of the life cycle model of consumption for Germany and it is the second case where this happens after Belgium. Now, regarding the results of the tests about the degree of income correction it can be seen that we can reject both the null hypothesis that this degree is full and the null hypothesis that it is zero.

Having seen that wealth does not matter in the long run we can restrict it to be zero in the long run. By doing so, the long run consumption function becomes as follows[1]:

lnrcpc = 0.58064 + 0.93527*lnrdipc - 0.26019*mner2rat E.GER.2

Since the restriction that was imposed on E.GER.1 to arrive at E.GER.2 is valid, it is better to continue with the restricted model E.GER.2 rather than with the unrestricted model E.GER.1. In E.GER.2 the long run elasticity of consumption with respect to income is 0.935 which is really close to one. On the other hand, restricting the wealth variable to be zero in the long run, changes significally the coefficient of mner2rat, which in turn changes also significally the implied degree of income correction. Indeed, this degree is now only 0.278 i.e. half the value that it was previously.

In the following analysis we will adopt the restricted version E.GER.2 as the long run consumption function.

3.4 The Short Run Consumption Function.

Having estimated the long run consumption function, we can now move to the estimation of an error correction model where the residuals of equation

[1]By imposing a zero restriction on this variable, we permit it to affect the short run reactions of the VAR.

E.GER.2 will play the role of the error correction term. To arrive at the final model we utilised the general to specific method. The final equation, as it was estimated by OLS, together with the results of the routinely computed statistical tests is presented at table T.GER.5 below.

Table T.GER.5: The Error Correction Model

Modelling dlnrcpc by OLS The present sample is: 1959 to 1992					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
dlnrdipc	0.61736	0.064077	9.635	0.0000	0.7747
dmner2rt	-0.09462	0.14088	-0.672	0.5075	0.0164
dlnun	-0.008819	0.0046731	-1.887	0.0699	0.1165
dlnun_2	0.014515	0.0043475	3.339	0.0025	0.2922
drintrt	-0.57893	0.19015	-3.045	0.0051	0.2556
drintrt_1	-0.38863	0.18717	-2.076	0.0475	0.1377
ect_1	-0.13265	0.025430	-5.216	0.0000	0.5019

$R^2 = 0.969638$ $\sigma = 0.00806709$ DW = 2.31
* R^2 does NOT allow for the mean *
RSS = 0.001757104989 for 7 variables and 34 observations
Information Criteria: SC = -9.14443; HQ = -9.35152; FPE = 7.84764e-005
AR 1- 1F(1, 26) = 0.9641 [0.3352]
AR 1- 2F(2, 25) = 0.91953 [0.4118]
ARCH 1 F(1, 25) = 0.45709 [0.5052]
Normality $Chi^2(2)$= 5.8287 [0.0542]
Xi^2 F(14, 12) = 1.4895 [0.2475]
RESET F(1, 26) = 3.4899 [0.0731]

Before we comment on the results given in the above table, we must first test the validity of the exogeneity hypothesis of exogeneity to see whether OLS is an adequate way to estimate the above model or it is required to use the Instrumental Variable Method (IVM). For the examination of the exogeneity issue we utilised the Hausman-Wu exogeneity test[2]. According to this test, the null hypothesis of weak exogeneity can not be rejected at any conventional level of

[2]For more about this test the reader is referred to the first case study.

significance (p-value = 0.2518). Therefore, we will continue our analysis using the results of the above table.

Starting from the general fit of the model, since the model does not have a constant term, conclusions is better to be drawn diagrammatically. Diagram GER.2 below presents the plots of the actual and the fitted values as well as the plots of the standardised residuals.

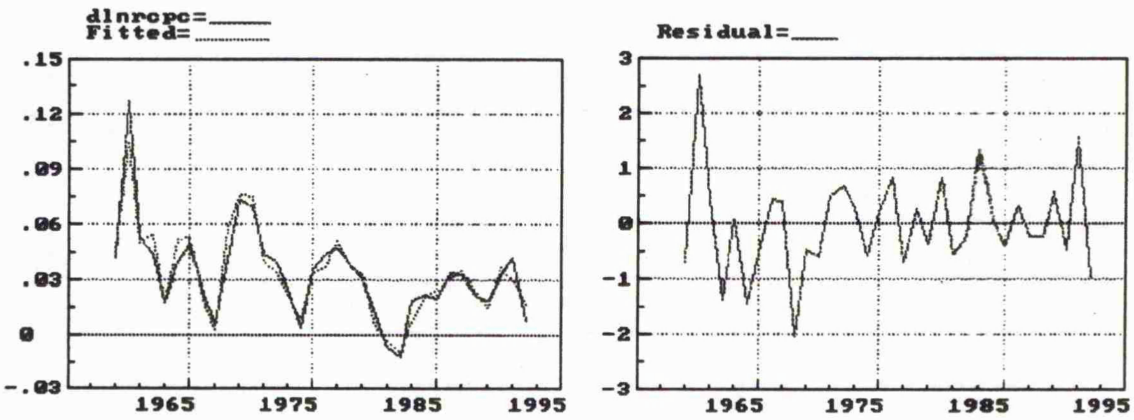


Diagram GER.2

As it can be seen from this diagram, the general fit of the model is very good since the actual and the fitted values were always very close to each other. Also the model passes successfully all the tests, though this happen only marginally for the normality test and to some extend for the RESET test as well.

Regarding the parameter estimates, it can be seen that changes in the unemployment rate and in the real interest rate play a significant role in the short run movements of the consumption. Also, although in the Johansen analysis the wealth variable seemed to affect the short run behaviour of the VAR system to the extend that results were distorted if it was taken out, it does not appear at all in the final ECM. However, this must not be surprising since the equation given in the above table is *a reduced form equation*, while the short run equations of the

Johansen approach are based on a *system approach*. Therefore, it is possible that the wealth variable is significant in the other error correction type equations of the VAR model, and not in the consumption equation. Regarding the error correction term, it can be seen that it is strongly significant. This also happens for the income variable as well, whose magnitude indicates that the short run elasticity of consumption with respect to income is 0.617. Finally, regarding the coefficient of our particular interest i.e the short run degree of income correction, it was found equal to 0.15326 which is low and lower than the long run estimate. In fact, the null hypothesis that this degree is equal to zero cannot be rejected at any conventional level of significance [p-value: 0.5132 (NLS), 0.5075 (OLS)]. On the other hand, the null hypothesis that the degree of income correction is full is easily rejected at even the 1% level of significance [p-value: 0.0011 (NLS), 0.0036 (OLS)].

3.4.1 The stability and the forecasting accuracy of the model.

To examine the stability and the forecasting accuracy of the model we utilised the four tests that have already been explained in the previous case studies.

Starting from the examination of the stability issue, we can see that all the four tests presented at diagram GER.3, agree that the model is stable. Indeed, the 1-step recursive residuals are well within the $\pm$ 2*S.E boundaries. The same also happens for the Chow tests that all gave values lower than the corresponding 1% critical value.

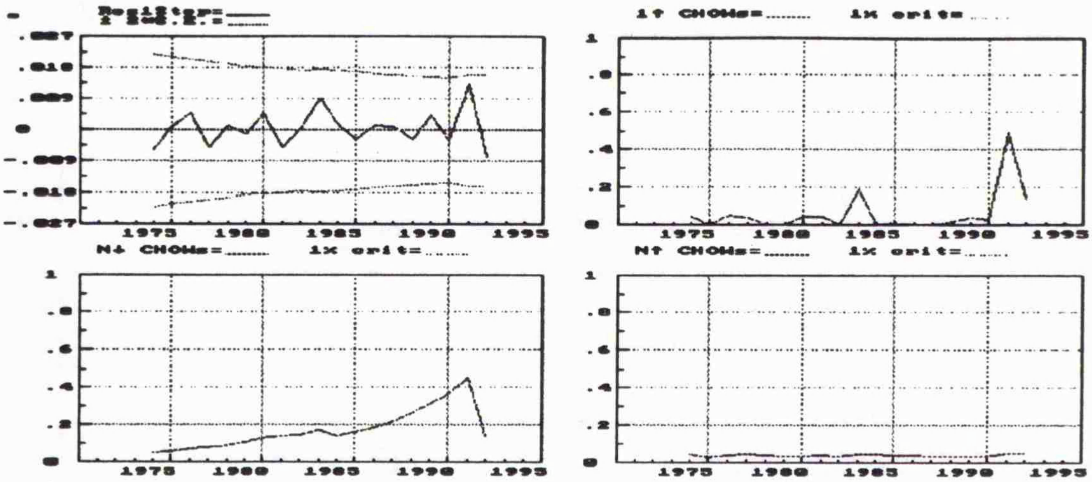


Diagram GER.3

The fact that the model is stable is also confirmed by the plots of the recursive estimates of the coefficients that are presented at diagram GER.4. As it can be seen from this diagram the coefficients are generally stable.

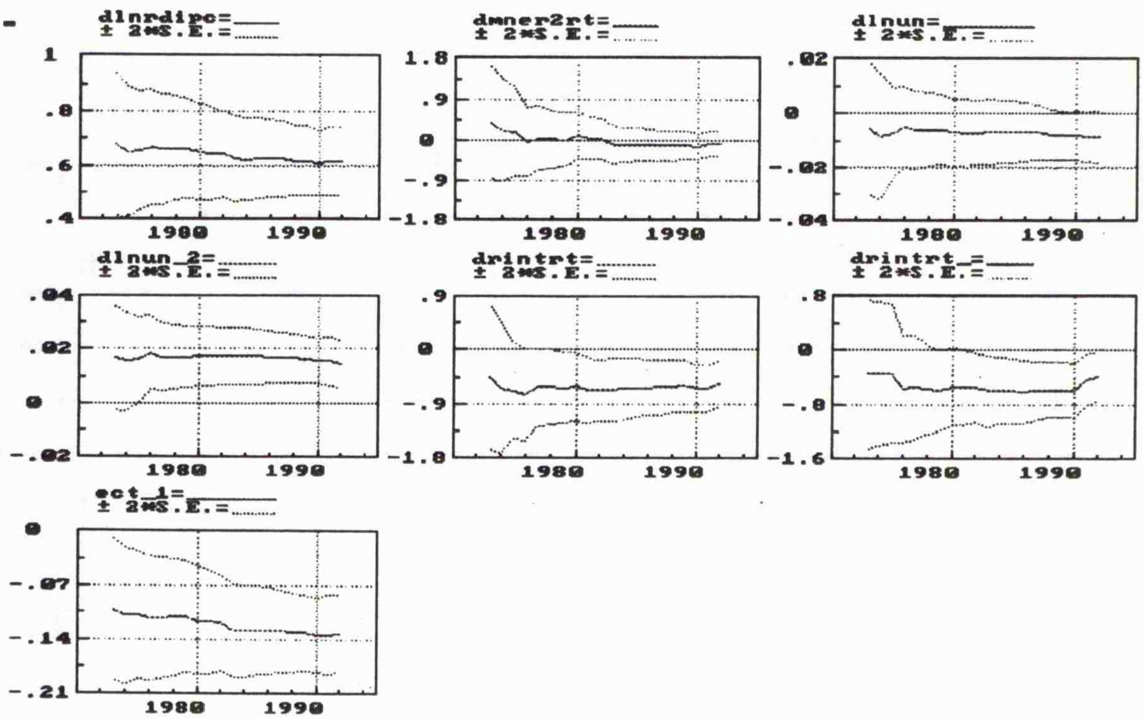


Diagram GER.4

Finally regarding the forecasting accuracy of the model, it can be seen from diagram GER.5 that the actual values were always within ± 2SE of the forecasted value. This indicates a model with good forecasting abilities. This is also evident from the Forecast Chi-square statistic that gave a p-value equal to 0.2333.

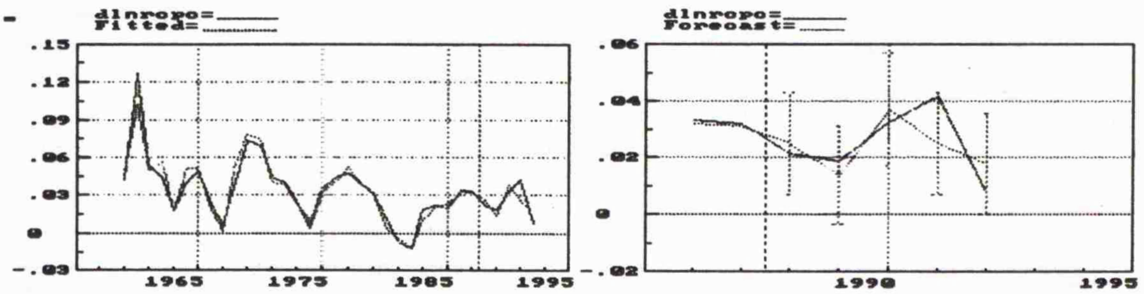


Diagram GER.5

3.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB).

3.5.1 A look at the paths of the main variables of the analysis.

Having estimated the long run and short run degree of income correction, it is now time to use these estimates to derive corresponding estimates of the ex-ante inflation corrected CAB. However, before doing so it will be good to have a look at the plots of some important variables of the analysis. These plots are given in diagram GER.6 below. In addition to this diagram, table T.GER.6 presents some useful descriptive statistics about the plotted variables. The variables that are presented at diagram GER.5 are (from the top left to the right): net financial liabilities, gross interest payments, net savings, net lending, foreign gross debt and inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government while the fifth variable is expressed as a ratio to the net financial liabilities and refers to the central government.

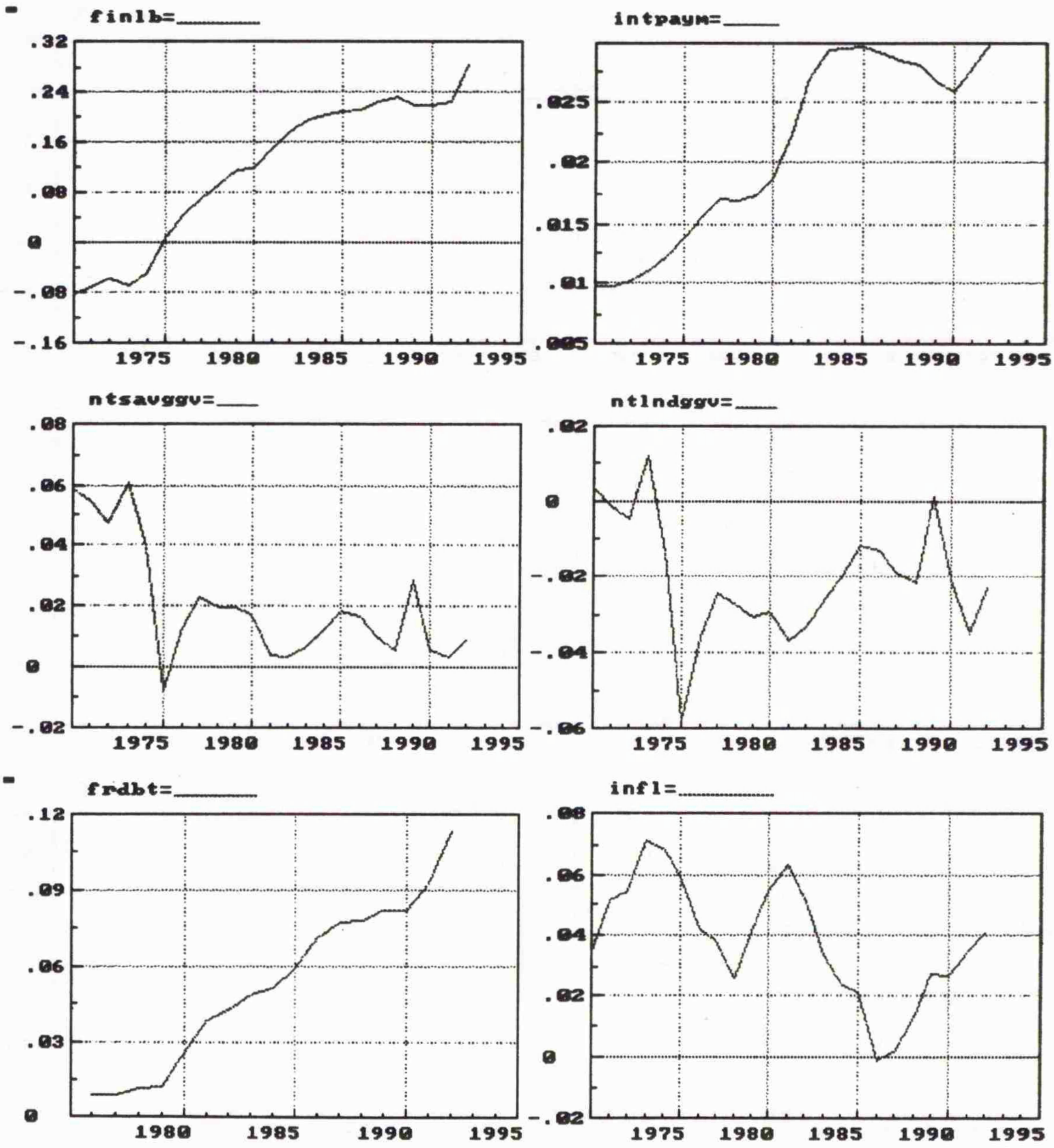


Diagram GER.6

Table T.GER.6

Variable	Minimum (Year)	Maximum (Year)	Average
Net Fin. Liabil. (% GDP)	-8.2 (1970)	28.3 (1992)	11.7
Interest Payments (% GDP)	0.9724 (1970)	2.99 (1992)	2.12
Net Saving (% GDP)	-0.7543 (1975)	6.106 (1973)	2.057
Net Lending (% GDP)	-5.78 (1975)	1.19 (1973)	-2.031
Foreign Debt (% Tot. Debt)	0.9 (1977)	11.29 (1992)	5.3
Inflation (%)	-0.1 (1986)	7.16 (1973)	3.83

As it can be seen from the first plot, the percentage of the net financial liabilities to GDP was increasing in almost all the years of our sample. However, it was negative in the first years of the sample and its highest value, taken in 1992, was no more than 28.3%. Regarding the average percentage, it was as low as 11.7%.

The percentage of the gross interest payments followed a similar path with that of the net financial liabilities. Again, as in the case of the net financial liabilities, this percentage was small. Before 1981, it was lower than 2% and its average value for the whole period was 2.12%. If we remind that this represents *gross* interest payments we have one more reason to believe that this percentage is small.

Regarding now the conventional current account balance as a percentage to GDP, it was positive for almost all the years of the sample turning to negative in 1975 only. The average value of this variable was 2.06%. On the other hand, the net lending of the government was negative for most of the years, taking an average value equal to -2.03%. Finally, concerning the inflation rate, it was rather low, manifesting the stability of the German economy. The average inflation rate was only 3.83%. The fact that both the inflation rate and the percentage of the net financial liabilities to GDP were small, together with the fact that the estimated degree of income correction was rather low, means that the ex-ante inflation correction will not be quantitatively important.

3.5.2 Estimates of the ex-ante inflation corrected CAB

It is now time to use the estimates of the long run and the short run degree of income correction that we derived previously to estimate the short run and the long run ex-ante inflation corrected government CAB. It is reminded that the long run degree of income correction was found equal to 0.278 while the short run one equal to 0.15326. The formula that will be applied for the estimation of the ex-ante CAB is the usual one:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \quad \text{E.GER.3}$$

where the notation is as in the previous case studies.

Applying E.GER.3 to German data, we arrived at the results given in table T.GER.7. The same results are also presented diagrammatically at diagram GER.7.

Table T.GER.7: The conventional and the ex-ante inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Long Run Ex-Ante Inflation Erosion.	Long Run Ex-ante Inflation Corrected CAB	Short Run Ex-Ante Inflation Erosion	Short Run Ex-ante Inflation Corrected CAB
1970	0.0585	-0.0006	0.0579	-0.0003	0.0582
1971	0.0547	-0.0008	0.0538	-0.0004	- 0.0542
1972	0.0472	-0.0009	0.0463	-0.0005	0.0467
1973	0.0610	-0.0010	0.0600	-0.0005	0.0604
1974	0.0396	-0.0010	0.0386	-0.0005	0.0390
1975	-0.0075	-0.0003	-0.0078	-0.0001	-0.0077

1976	0.0130	0.0003	0.0134	0.0002	0.0132
1977	0.0233	0.0006	0.0239	0.0003	0.0236
1978	0.0197	0.0007	0.0204	0.0003	0.0201
1979	0.0198	0.0009	0.0207	0.0005	0.0203
1980	0.0176	0.0015	0.0192	0.0008	0.0185
1981	0.0038	0.0021	0.0060	0.0011	0.0050
1982	0.0034	0.0025	0.0060	0.0014	0.0049
1983	0.0067	0.0021	0.0088	0.00119	0.0078
1984	0.0126	0.0015	0.0140	0.0008	0.0135
1985	0.0188	0.0012	0.0201	0.0007	0.0195
1986	0.0168	0.0005	0.0174	0.0003	0.0171
1987	0.0100	0	0.0101	0	0.0100
1988	0.0057	0.0004	0.0061	0.0002	0.0059
1989	0.0287	0.0012	0.0299	0.0006	0.0294
1990	0.0059	0.0016	0.0075	0.0008	0.0067
1991	0.0035	0.0018	0.0054	0.0010	0.0045
1992	0.0092	0.0025	0.0118	0.0014	0.0106

(All figures are ratios to GDP)

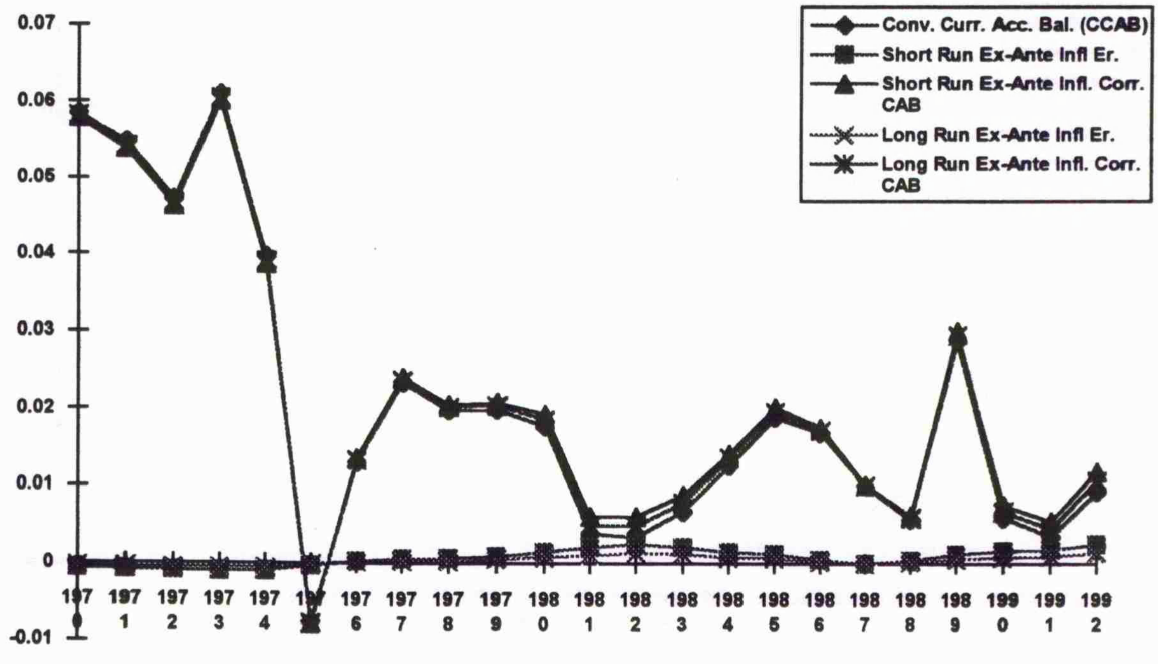


Diagram GER.7

As it can be seen from both the table and the diagram, the ex-ante figures do not differ significally from the conventional ones. This happens because in the case of Germany all the factors that determine the magnitude of the corrected CAB, namely: the degree of income correction (short run or long run as the case may be), the percentage of the net financial liabilities and the expected rate of inflation, are all quantitatively low, which in turn makes the inflation correction of minor importance. Therefore, it can be said that in the case of Germany the conventionally defined CAB is a rather good indicator of the effects of the fiscal policy, since the degree of income correction in this country is low and generally all the factors tend to make the inflation correction quantitatively insignificant.

3.5.3 Estimates of the ex-post inflation corrected CAB

For the case of Germany as well as for the other countries, we computed the ex-post inflation corrected CAB using the following two formulas:

$$CORDEF2 = CCAB + \pi DB \qquad \text{E.GER.4}$$

$$CORDEF3 = CCAB + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.GER.5}$$

The notation is the same as in the previous case studies and all that has been said there about the reliability of CORDEF3 is valid here as well. In the next table we present estimates of the inflation erosion and the ex-post inflation corrected CAB, as they are computed using the above two formulas. This table is followed by diagram GER.8 where all the derived inflation corrected measures (ex-post and ex-ante) are presented together with the conventional CAB.

Table T.GER.8: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Inflation Erosion according to E.GER.4	CORDEF2	Inflation Erosion according to E.GER.5	CORDEF3
1970	0.0585	-0.0028	0.0557	-0.0028	0.0557
1971	0.0547	-0.0037	0.0510	-0.0037	0.0510
1972	0.0472	-0.0033	0.0438	-0.0033	0.0438
1973	0.0610	-0.0042	0.0567	-0.0042	0.0567
1974	0.0396	-0.0037	0.0359	-0.0036	0.0360
1975	-0.007	-0.0010	-0.008	-0.0011	-0.008
1976	0.0130	0.0011	0.0142	0.0015	0.0145
1977	0.0233	0.0021	0.0254	0.0013	0.0246
1978	0.0197	0.0020	0.0218	0.0001	0.0199
1979	0.0198	0.0041	0.0239	0.0026	0.0224
1980	0.0176	0.0062	0.0239	0.0067	0.0244
1981	0.0038	0.0082	0.0121	0.0168	0.0207
1982	0.0034	0.0084	0.0119	0.0120	0.0155
1983	0.0067	0.0061	0.0128	0.0088	0.0155
1984	0.0126	0.0046	0.0173	0.0106	0.0233
1985	0.0188	0.0043	0.0232	0.0064	0.0253
1986	0.0168	-0.0004	0.0166	-0.0265	-0.009
1987	0.0100	0.0004	0.0105	-0.0157	-0.005
1988	0.0057	0.0029	0.0086	0.0010	0.0067
1989	0.0287	0.0060	0.0348	0.0120	0.0407
1990	0.0059	0.0056	0.0115	-0.009	-0.003
1991	0.0035	0.0074	0.0109	0.0108	0.0144
1992	0.0092	0.0100	0.0193	0.0048	0.0141

(all figures are ratios to GDP)

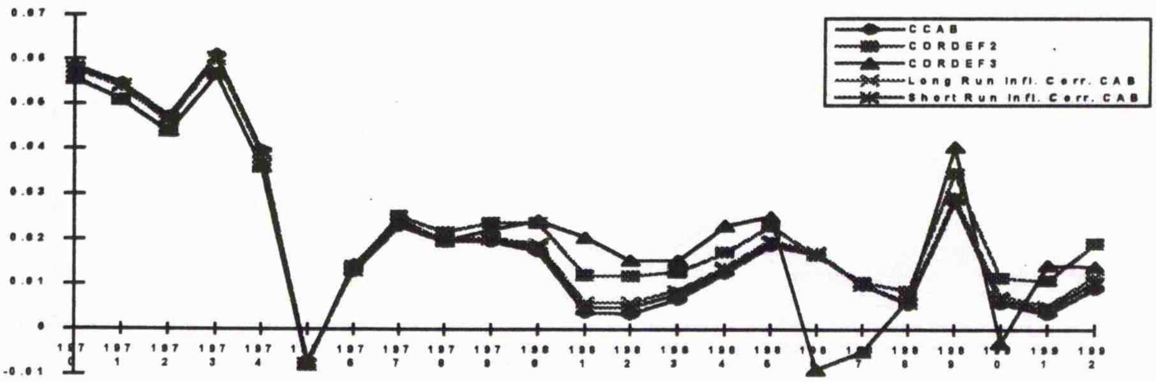


Diagram GER.8

From the above diagram the conclusion is that all the estimates were generally moving close to each other. The main reason for this is the small inflation rate which combined with the fact that the percentage of the net financial liabilities of the government to GDP was also small made the monetary erosion of the government debt small. In turn this makes the difference between conventional and inflation corrected magnitudes small as well.

3.6. Summary of the results

In this case study we examined the case of Germany. The main conclusions of this analysis are as follows:

i) All the variables of the analysis are I(1).

ii) The cointegration analysis showed the existence of three cointegrating vectors from which only one had its coefficients with signs and magnitudes in accordance to what is expected for a consumption function.

iii) Inference on the preferred cointegrating vector showed that wealth does not matter in the long run. The long run elasticity of consumption with respect to income, when the coefficient of wealth is restricted to zero, is 0.935 which is pretty close to one.

iv) The long run degree of income correction is 0.278 which is low and far from one. The cause of this may be the low inflation rate that the German economy experienced and which might have prevented the people from seeing the full effects that inflation had on the real value of their monetary assets.

v) The estimated ECM works well and satisfies all the criteria that make a model good.

vi) The short run degree of income correction is 0.1533 which again is low. This result together with what was found for the long run, is in agreement with the study of Nicolleti where for Germany he found complete money illusion[3].

vii) Finally we estimated the ex-ante and the ex-post inflation corrected CAB using the formulas developed in part A. The corresponding estimates do not differ greatly neither from each other nor from the conventional CAB. This is the combined result of the low inflation rate (expected and realised), the low degree of income correction (concerning ex-ante figures), and the low percentage of the net financial liabilities of the government.

[3]Nevertheless it is not in agreement with what U-S found for Germany.

CASE STUDY 4

GREECE

4.1 The integration properties of the data

The purpose of this section is the examination of the order of integration of the variables of the analysis. As in all previous case-studies, two approaches were followed. The first approach is visual since it is based on conclusions drawn from the plots of the variables, while the second is more formal and is based on the performance of the popular DF/ADF tests. Diagram GR.1 below, presents the plots of the main variables of the analysis.

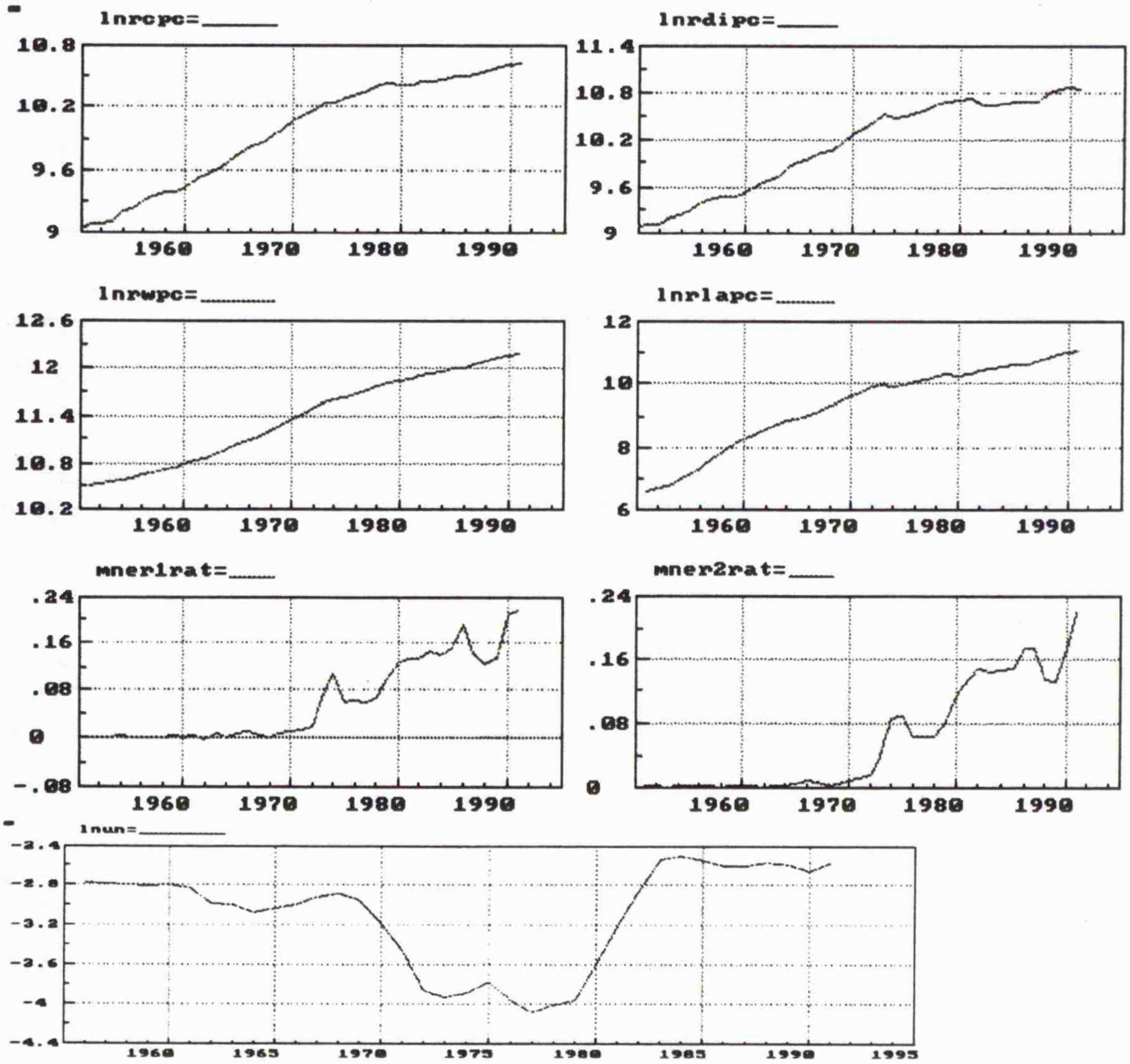


Diagram GR.1

As it can be seen from this diagram, none of the variables seems to be stationary. Nevertheless, let's see what the DF/ADF tests say. The results of these tests are presented at table T.GR.1 below.

Table T.GR.1: Unit Root Tests

Variable	ADF(2)	ADF(1)	DF	Period	C, T
lnrcpc	0.0508	0.08645	0.28533	1953-1991	C, T
lnrdipc	-0.61166	-0.70796	-0.38771	1953-1991	C, T
lnrwpc	-1.0739	-1.3142	0.10737	1954-1991	C, T
lnrlapc	-2.6543	-2.9074	-2.8470	1954-1991	C, T
mner1rat	-1.9883	-2.6298	-2.3845	1954-1991	C, T
mner2rat	-1.5632	-2.444	-1.6071	1954-1991	C, T
lnun	-1.7418	-2.0751	-0.72571	1959-1991	C
dlnrcpc	-2.9325	-4.5086**	-6.0289**	1954-1991	C, T
dlnrdipc	-3.1346	-3.8688*	-4.6252**	1954-1991	C, T
dlnrwpc	-1.8984	-2.4655	-2.2445	1955-1991	C
dlnrlapc	-2.798	-4.6592**	-4.1703*	1955-1991	C, T
dmner1rat	-4.8990**	-5.6685**	-5.6712**	1955-1991	C
dmner2rat	-3.6539**	-6.0577**	-3.2374*	1955-1991	C
dlnun	-2.9304**	-2.6180*	-2.3864*	1960-1991	C, T

As it can be seen from the above table, the null hypothesis of non-stationarity cannot be rejected for any of the variables in levels. On the other hand, the null hypothesis that the corresponding variable is integrated of second order is rejected in most of the cases. However, it cannot be rejected for the logarithm of the total real wealth per capita (lnrwpc). Something else that can be observed from table T.GR.1 is that in the cases of dlnrcpc, dlnrdipc and dlnrlapc, the ADF(2) test does not reject the null, though this does not happen for the ADF(1) and DF tests. Therefore, we have to examine whether the second lag in the ADF test is necessary for the elimination of autocorrelation. This lag will be necessary only if its omission causes autocorrelation in the corresponding ADF regression. Further examination showed that this lag is unnecessary since its omission never caused a problem. Thus, this lag can be safely omitted and decisions for the above mentioned variables can be based on the ADF(1) test. According to this test these three variables are I(1).

From the above analysis the conclusion is that apart from the lnrwpc[1], all the variables are I(1).

4.2 Lag length of the VAR.

Having established the order of integration of the variables, we can now move to the next step which is the choice of the lag length of the VAR. However, we must first make a choice regarding the monetary erosion variable that should be used. To make this choice, we ran the Johansen procedure experimentally under various VAR lengths. In all cases the moner2rat variable worked better than its alternative. Therefore, the analysis will continue with this variable.

The estimation of the VAR model showed that autocorrelation couldn't be eliminated even when a large lag length was employed. Under such conditions, one could suggest to choose the largest possible lag-length. However, the larger the lag length the greater the problem of the degrees of freedom. Therefore, the improvement (if any) that comes from the increase of the lag length must be evaluated against the problem of the degrees of freedom.

[1]The fact that lnrwpc is I(2) only by sampling reasons can be explained.

Table T.GR.2 below presents the times that we couldn't reject the null hypothesis of autocorrelation, under various lag-lengths. To construct table T.GR.2, the VAR was first estimated assuming the smallest possible lag-length (one lag). Then, we re-estimated the model increasing each time the lag length by one. The largest possible lag length was six lags. In each case we tested for autocorrelation of orders one to five. Thus the number of tests that were carried out for each lag -length was 20 while the total number of tests was 120.

Table T.GR.2

Lag length	Number of failings
1	10
2	8
3	4
4	9
5	4
6	3

As it can be seen from the above table, if one excludes the four lags case, where the number of failings increases sharply, the number of failings is rather constant after the third lag. Although the number of failings is the least for six lags, it is again positive and just one less than the corresponding number for three lags. However, the degrees of freedom are much less for a 6-lags VAR than for a 3-lags VAR. Under such conditions, a 3-lags VAR seems to be the best choice.

4.3. The Long Run Consumption Function

Having established that a VAR model with three lags is the most appropriate one, we can now move to the cointegration analysis, starting from tests about the number of the statistically significant cointegrating vectors. The results of these tests are presented at tables T.GR.3.1 and T.GR.3.2 below.

Table T.GR.3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
35 observations from 1957 to 1991. Maximum lag in VAR = 3 List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC Intercept List of eigenvalues in descending order: .66228 .60442 .45044 .33551 .0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	37.9940	28.1380	25.5590
r<= 1	r = 2	32.4587	22.0020	19.7660
r<= 2	r = 3	20.9524	15.6720	13.7520
r<= 3	r = 4	14.3057	9.2430	7.5250

Table T.GR.3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
35 observations from 1957 to 1991. Maximum lag in VAR = 3 List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC Intercept List of eigenvalues in descending order: .66228 .60442 .45044 .33551 .0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	105.7108	53.1160	49.6480
r<= 1	r>= 2	67.7168	34.9100	32.0030
r<= 2	r>= 3	35.2581	19.9640	17.8520
r<= 3	r = 4	14.3057	9.2430	7.5250

The conclusion from the above tables is that there are four cointegrating vectors that are statistically significant at the 5% level. When these cointegrating vectors were normalised on consumption, the first one had its coefficients in accordance to what is expected for a consumption function. The consumption function that corresponds to this cointegrating vector is:

lnrcpc=1.7482+0.68855*lnrdipc-0.34118*mner2rat+0.134431*lnrlapc E.GR.1

As it can be seen from this equation the long run elasticity of consumption with respect to income is 0.68855, while the corresponding elasticity with respect to wealth is 0.134431. Regarding the coefficient for which we are particularly interested i.e. the long run degree of income correction, it is 0.495 which, though positive, is pretty far from one.

Except for estimates of the distinct cointegrating vectors, the Johansen procedure has also the advantage that it permits the performance of statistical tests about the value of the long run parameters. Table T.GR.4 below, presents the restrictions as well as the marginal significance levels at which they are rejected[2]. In this table a_0 corresponds to the constant term, a_1 to the coefficient of lnrdipc, a_2 to the coefficient of mner2rat and a_3 to the coefficient of lnrlapc.

Table T.GR.4

Restriction	**p-value**
$a_0 = 0$	0.097
$a_1 = 0$	0.017
$a_2 = 0$ ($\Leftarrow \delta_L = 0$)	0.012
$a_2 = -a_1$ ($\Leftarrow \delta_L = 1$)	0.038
$a_3 = 0$	0

[2]For the performance of these tests the number of the cointegrating vectors had to be restricted to three.

As it can be seen from this table, all the variables of the model are statistically significant, though the constant term is so only at the 10% level. The long run degree of income correction, is significally different from both zero and one. From the table it can also be seen that the liquid assets variable is significantly different from zero. This evidence is in favour of the life cycle theory.

Having examined the long run consumption function we can now pass to the construction of an ECM.

4.4 The Short Run Consumption Function

To arrive at the final equation presented below, we started from a fairly general model which we then narrowed it down, by using the general to specific method. Table T.GR.5 below presents the final model as it was estimated by OLS.

Table T.GR.5: The Error Correction Model

Modelling dlnrcpc by OLS
The present sample is: 1957 to 1991

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
dlnrcpc_1	0.22817	0.084303	2.707	0.0114	0.2074
dlnrdipc	0.36907	0.070615	5.226	0.0000	0.4938
dmner2rt	-0.15249	0.14805	-1.030	0.3118	0.0365
ect_1	-0.20274	0.087645	-2.313	0.0283	0.1604
dlnrlapc	0.12779	0.038993	3.277	0.0028	0.2773
dummy71	-0.022089	0.011708	-1.887	0.0696	0.1128
dummy82	0.043230	0.014883	2.905	0.0071	0.2316

$R^2 = 0.953296$ $\sigma = 0.0108457$ DW = 1.59
* R^2 does NOT allow for the mean *
RSS = 0.003293624424 for 7 variables and 35 observations
Information Criteria: SC = -8.56005; HQ = -8.76373; FPE = 0.000141155
AR 1- 1F(1, 27) = 2.6648 [0.1142]
AR 1- 2F(2, 26) = 1.2839 [0.2939]
ARCH 1 F(1, 26) = 0.68059 [0.4169]
Normality Chi²(2) = 3.7079 [0.1566]
Xi² F(12, 15) = 1.1002 [0.4239]
RESET F(1, 27) = 0.056435 [0.8140]

dummy71 and dummy82 correspond to dummy variables for 1971 and 1982 respectively

Before we make any comment on the results of the above table we should first check the validity of the assumption of exogeneity, upon which the OLS is based. To test this assumption we used the Hausman-Wu exogeneity test[3]. According to the results of this test, the null hypothesis of weak exogeneity cannot be rejected at any conventional level of significance (p-value = 0.7149). This means that the results given above are valid and there is no need to use the Instrumental Variables Method.

Having verified the validity of the exogeneity assumption, we can now comment on the results of the above table starting from the general fit of the model. This is difficult to be evaluated by the R^2 coefficient since the model does not include a constant term. Therefore, it is better to draw conclusions based on the plots of the actual and the fitted values. Diagram GR.2 below presents these plots, together with a plot of the scaled residuals.

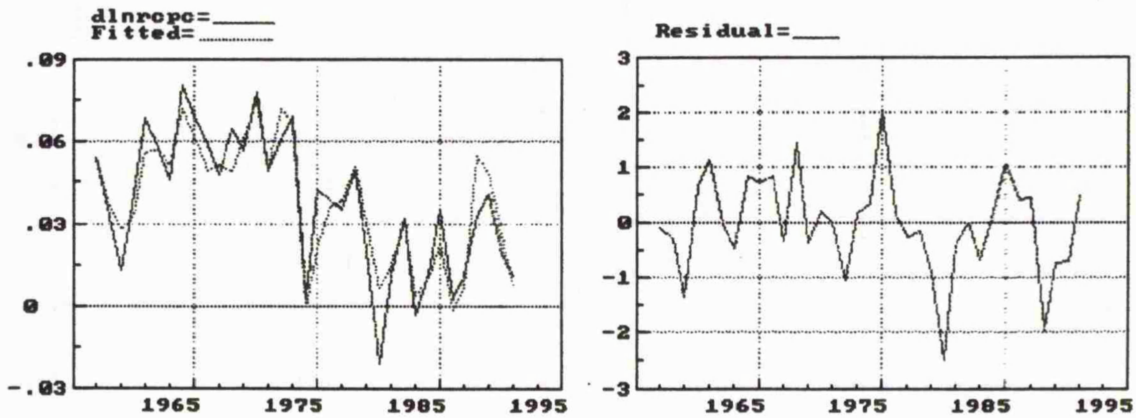


Diagram GR.2

As it can be seen from the left part of diagram GR.1, the general fit of the model is very good since the fitted values were, in most cases, very close to the

[3]For the way to perform this test the reader is referred to the first case study.

actual values. Also, the model passes successfully all the tests of the validity of the classical assumptions.

Now, regarding the individual coefficients, it can be seen that the lagged dependant variable is statistically significant. It is the first time that something like this happens in our study. Also, it can be seen that the dummy variables are statistically significant, though dummy71 is so only at the 10% level. The reason that we used these dummy variables was because of instability observed in 1971 and in 1982. The coefficient of the error correction term (ECT) is also statistically significant. The short run elasticity of consumption with respect to income is 0.36907 while the corresponding elasticity with respect to wealth is 0.12779.

Regarding the parameter of our special interest, i.e. the short run degree of income correction, its indirect estimate is 0.41317 which is rather small and smaller than the long run one, though not terribly so. The statistical tests about the value of this parameter showed that it is not statistically different neither from zero (p-value = 0.3118 (OLS) and 0.3651 (NLS)) nor from one (p-values: 0.2772 (OLS) and 0.2016 (NLS)). This fact indicates that the short run degree of income correction was not estimated accurately.

4.4.1 The stability and the forecasting accuracy of the model

The purpose of this section is to examine the stability and the forecasting accuracy of the model given in table T.GR.5. The problem, regarding the examination of the stability of our model is that the dummy variables do not permit the application of recursive least squares. Fortunately, this is not a problem if we remember that the model of the above table comes from an originally non-linear model. Application of Recursive Non-linear Least Squares (RNLS) to the non-linear model gave identical parameter estimates with those presented at table T.GR.5. However, the RNLS also gave useful recursive statistics that we present in the below diagram. As it can be seen from this diagram, according to all tests the model is stable. The 1-step recursive residuals never cross the ± 2*S.E lines and the 1-step Chow test and N-step (up and down) Chow tests are below the critical value for the 1% level[4]. So we could say that the model is generally stable.

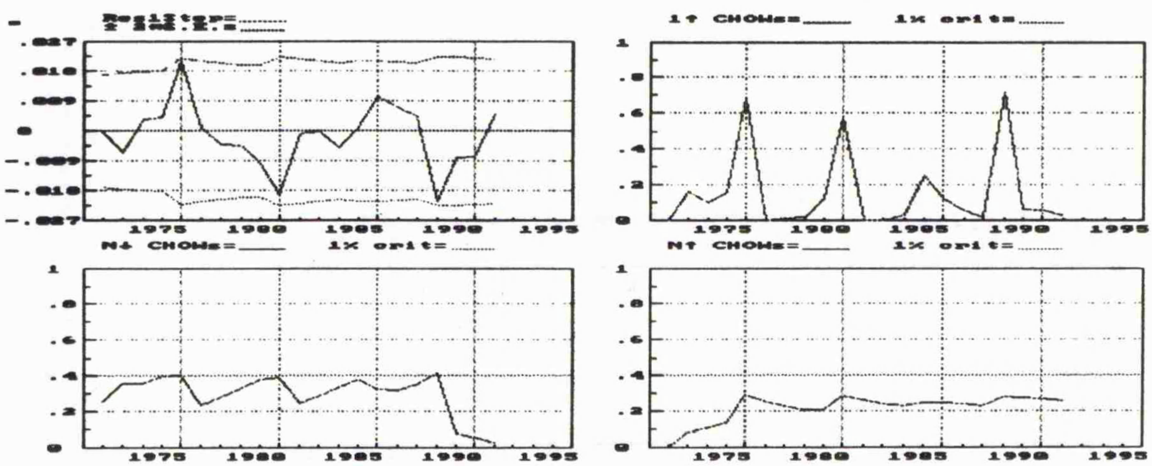


Diagram GR.3

To evaluate the forecasting accuracy of the model, we re-estimated it, reserving the five last observations to make one step ahead forecasts. These forecasts are presented at diagram GR.4 below, together with the ± 2*S.E of the corresponding forecast centred on the forecasted value. These forecasts are contrasted with the actual values. As it can be seen from the diagram, the model fails to forecast reasonably the dlnrcpc for 1988[5]. This affected the forecast Chi-square test since it was statistically significant at the 5% level (p-value = 0.0354). On the other hand, the corresponding Chow tests gave a p-value equal to 0.2024 which means that the null hypothesis of parameter constancy cannot be rejected.

[4]However, for the 5% level of significance, the 1-step Chow test is statistically significant for 1975, 1980 and 1988.

[5]This may happen because of the instability in this year that is indicated by the 1-step Chow test.

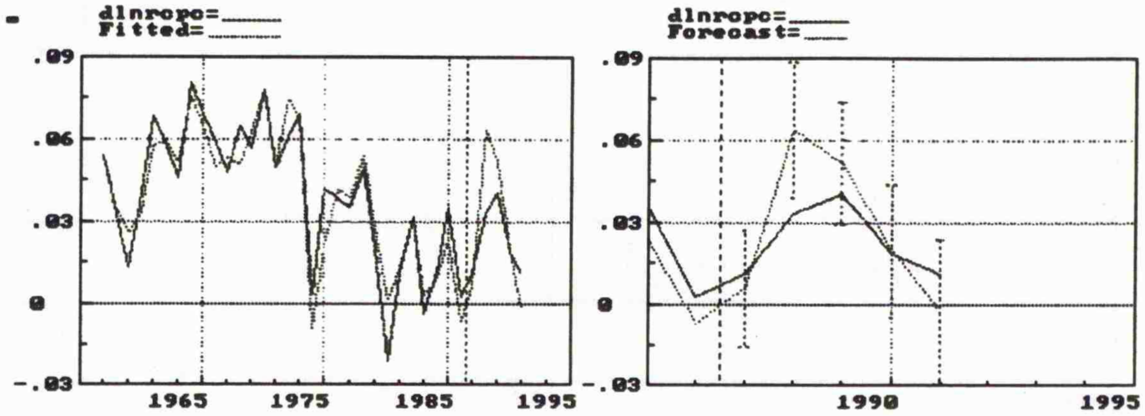


Diagram GR.4

From the above one could say that the model is fairly stable, though its forecasting abilities were not the best.

4.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB)

4.5.1. A look at the paths of the main variables of the analysis.

It is now time to utilise the estimates of the degree of income correction that were obtained in the previous sections, to estimate the short run and the long run ex-ante inflation corrected CAB. However before doing so, it is interesting to have a look at the paths that the main variables of the analysis followed during the last thirty years. For this purpose diagram GR.5 below, presents the plots of some important variables while table T.GR.6 gives some descriptive statistics about them.

At diagram GR.6_the plots of the following variables are presented (from the top left to the right): gross[6] financial liabilities, gross interest payments, net

[6]Data on net financial liabilities were not available.

savings, net lending, gross foreign debt and the rate of inflation. The first four variables are expressed as ratios to GDP and refer to the general government. In contrast to other case studies in this case study the fifth variable refers to the general government and not to the central government. This variable is expressed as a ratio to the gross financial liabilities.

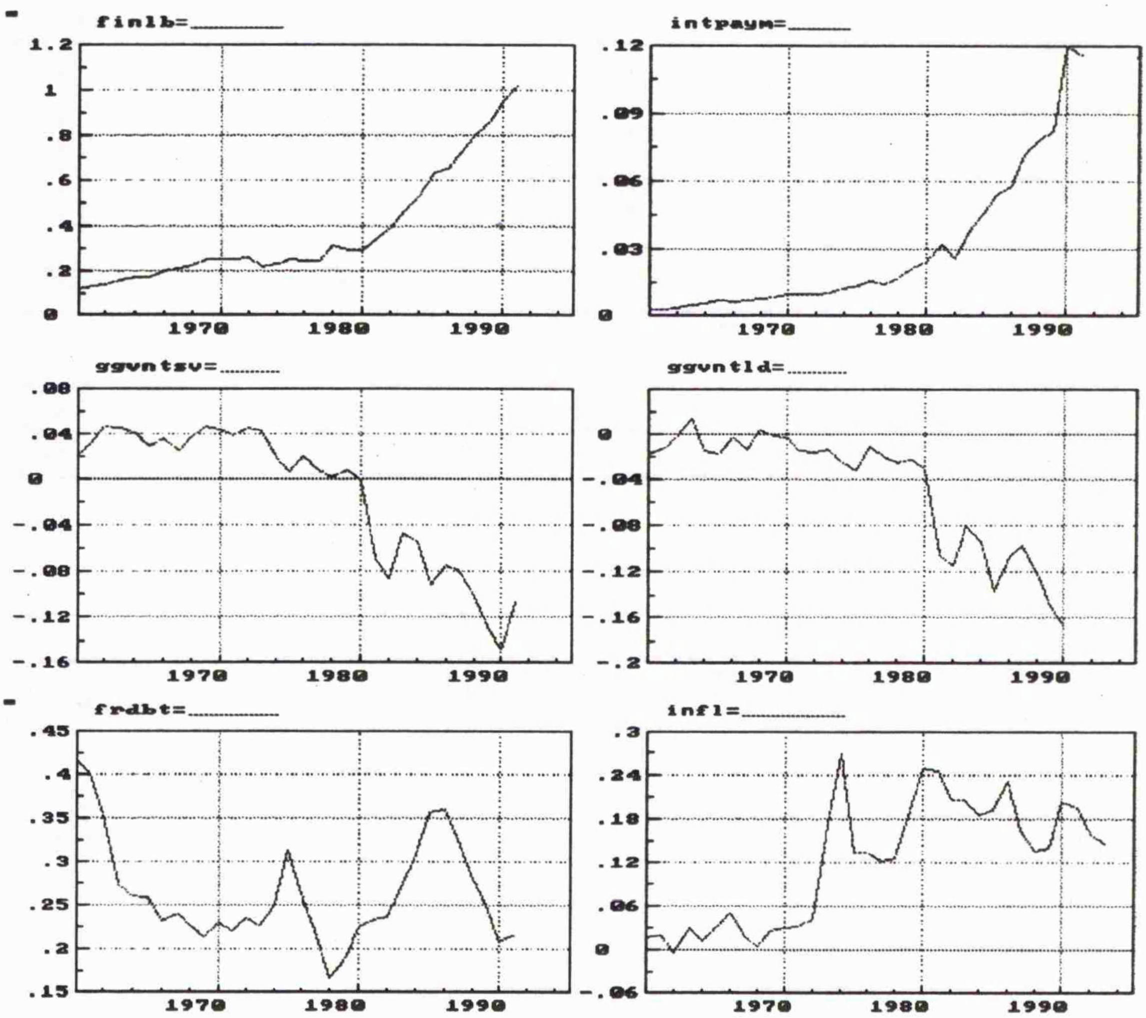


Diagram GR.5

Starting from the first plot, it can be seen that the percentage of the gross debt was increasing throughout the period of our sample and this increase was sharper after 1980. Also, as it can be seen from the plots of the interest payments, net saving and net lending, all these indicators deteriorated heavily after 1980. It is characteristic that the maximum percentage of the gross debt to GDP, taken in 1991, was 8.75 times the minimum percentage obtained in 1960. For the gross interesting payment the situation is even worse: The maximum value taken in 1990 was 42.6 times the minimum value. The percentages of the net savings and the net lending were not less worse especially in the later years of the sample.

Table T.GR.6

Variable	Minimum (Year)	Maximum (Year)	Average
Gross Debt (% GDP)	11.58 (1960)	101.37 (1991)	37.29
Interest Payments (% GDP)	0.28 (1960)	11.94 (1990)	2.92
Net Saving (% GDP)	-14.8 (1990)	4.8 (1962)	-1.16
Net Lending (% GDP)	-16.6 (1990)	1.6 (1963)	-4.5
Foreign Debt (% Tot. Debt)	16.7 (1978)	42 (1960)	26.3
Inflation (%)	-0.4 (1962)	26.91 (1974)	11.78

Regarding the foreign debt, for many years it was about a quarter of the total debt. This shows that the separate treatment of this item in the computation of the ex-post inflation corrected CAB may have special significance, especially for the latter years of the sample where the total debt was rather high. Finally, the rate of inflation is probably one of the highest in the countries of our sample. Although it was low until 1973, after this year it was always above 10%.

After the above discussion we can say that, other things equal, the inflation correction will be quantitatively important since both the inflation rate and the debt ratio are large. For the case of the ex-ante correction the effects of these two factors are moderated by the fact that the degree of income correction is rather small both in the long run and in the short run.

4.5.2 Estimates of the ex-ante inflation corrected CAB.

It is now time to use the degrees of income correction obtained in previous sections to estimate the ex-ante inflation corrected CAB. It is reminded that the long run degree of income correction was found equal to 0.495 while the short run one equal to 0.413. The formula that will be applied to estimate the ex-ante inflation corrected balance is given below:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.GR.2}$$

where all the notation is as in the previous case studies.

Depending on the degree of income correction that is used, we can derive estimates of the short run and the long run ex-ante inflation corrected CAB. Such estimates are presented below at table T.GR.7. The same estimates are also presented diagrammatically at diagram GR.6.

Table T.GR.7: The conventional and the ex-ante inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Short Run Ex-Ante Inflation Erosion.	Short Run Ex-ante Inflation Corrected CAB	Long Run Ex-Ante Inflation Erosion.	Long Run Ex-ante Inflation Corrected CAB
1960	0.0226	0.0005	0.0232	0.0006	0.0233
1961	0.0322	0.0004	0.0327	0.0005	0.0328
1962	0.0479	0.0002	0.0481	0.0003	0.0482
1963	0.0454	0.0004	0.0459	0.0005	0.0460
1964	0.0420	0.0009	0.0429	0.0010	0.0431
1965	0.0305	0.0010	0.0315	0.0012	0.0317
1966	0.0371	0.0021	0.0392	0.0026	0.0397
1967	0.0258	0.0020	0.0278	0.0024	0.0283

1968	0.0377	0.0007	0.0384	0.0008	0.0386
1969	0.0467	0.0010	0.0477	0.0012	0.0479
1970	0.0441	0.0020	0.0461	0.0024	0.0465
1971	0.0387	0.0022	0.0410	0.0027	0.0414
1972	0.0456	0.0027	0.0483	0.0032	0.0489
1973	0.0429	0.0065	0.0495	0.0079	0.0508
1974	0.0199	0.0137	0.0337	0.0166	0.0366
1975	0.0067	0.0129	0.0196	0.0155	0.0223
1976	0.0211	0.0086	0.0298	0.0104	0.0316
1977	0.0082	0.0089	0.0171	0.0107	0.0190
1978	0.0019	0.0105	0.0124	0.0127	0.0146
1979	0.0089	0.0143	0.0233	0.0173	0.0262
1980	-0.0006	0.0189	0.0182	0.0228	0.0222
1981	-0.0680	0.0227	-0.0453	0.0274	-0.0406
1982	-0.0853	0.0232	-0.0620	0.0281	-0.0572
1983	-0.0461	0.0247	-0.0214	0.0298	-0.0163
1984	-0.0538	0.0257	-0.0281	0.0310	-0.0227
1985	-0.0909	0.0272	-0.0636	0.0329	-0.0580
1986	-0.0738	0.0326	-0.0411	0.0394	-0.0343
1987	-0.0787	0.0346	-0.0440	0.0418	-0.0368
1988	-0.1018	0.0300	-0.0717	0.0363	-0.0655
1989	-0.1273	0.0319	-0.0954	0.0385	-0.0887
1990	-0.1480	0.0451	-0.1028	0.0545	-0.0934
1991	-0.1054	0.0579	-0.0474	0.0700	-0.0354

(All figures are ratios to GDP)

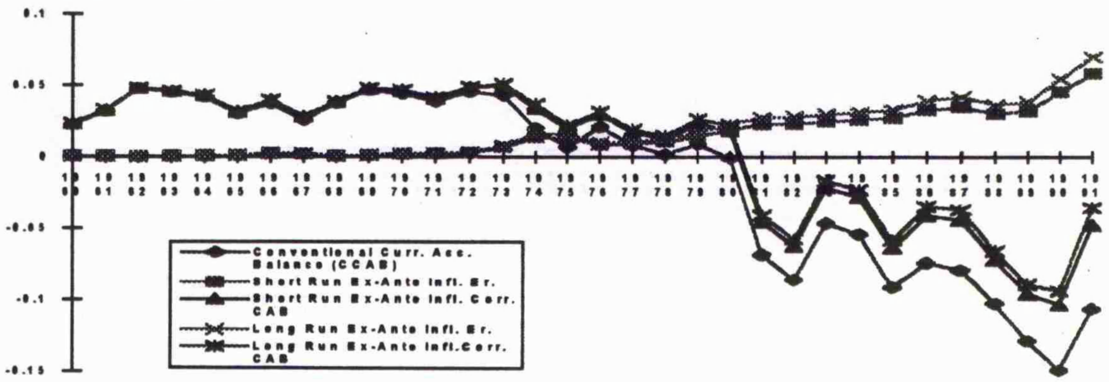


Diagram GR.6

The conclusion from both the table and the diagram is that the inflation erosion, as it is perceived by people, though it was a small percentage before 1973 it increased after this year and it was more than 5% in the last year of the sample. The reasons of this increase are the high inflation rate and the high debt ratios that followed the first oil shock. Something else that can be easily seen from the table and the diagram, is that the short run and the long run magnitudes were very close to each other. The reason of this is the similarity of the estimates for the short run and the long run degree of income correction. Finally, it is also evident that for the most part of the sample, the ex-ante inflation corrected balance was significally higher than the conventional balance. This means that if as an indicator of the fiscal policy we use the balance on the current account, then the actual effects of the fiscal policy were significally lower than the ones suggested by the conventional deficit, once the effects of inflation as they are perceived by people are taken into account.

4.5.3 Estimates of the ex-post inflation corrected CAB

The second set of inflation corrected balances that we will derive in this study are ex-post ones. For the case of Greece, as well as for the other countries, the ex-post inflation corrected CAB was computed applying the following two formulas:

$$\text{CORDEF2} = \text{CCAB} + \pi\text{DB} \qquad \text{E.GR.3}$$

$$\text{CORDEF3} = \text{CCAB} + \pi\text{DB}_i + (\pi_t - e_t)\text{DB}_e \qquad \text{E.GR.4}$$

The first formula does not account for the effects that changes in the exchange rate have on the real value of the external debt. In contrast, the second formula takes such effects into account[7]. Table T.GR.8 below presents estimates of the ex-post

[7]In the case of Greece CORDEF3 is more reliable than in the other case studies since the data refer to the general government and not just to the central government.

inflation corrected CAB as they were computed by the above two formulas. These estimates are contrasted in diagram GR.7 with the ex-ante ones as well as with the conventional figures.

Table T.GR.8: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	The Inflation Erosion as it is computed by E.GR.3	CORDEF2	The Inflation Erosion as it is computed by E.GR.4	CORDEF3
1960	0.0226	0.0018	0.0244	0.0018	0.0244
1961	0.0322	0.0022	0.0345	0.0022	0.0345
1962	0.0479	-0.0005	0.0473	-0.0005	0.0473
1963	0.0454	0.0038	0.0493	0.0038	0.0493
1964	0.0420	0.0016	0.0437	0.0016	0.0437
1965	0.0305	0.0050	0.0355	0.0050	0.0355
1966	0.0371	0.0084	0.0456	0.0084	0.0456
1967	0.0258	0.0034	0.0292	0.0034	0.0292
1968	0.0377	0.0007	0.0385	0.0007	0.0385
1969	0.0467	0.0054	0.0522	0.0054	0.0522
1970	0.0441	0.0068	0.0510	0.0068	0.0510
1971	0.0387	0.0071	0.0459	0.0026	0.0414
1972	0.0456	0.0099	0.0555	0.0099	0.0555
1973	0.0429	0.0329	0.0758	0.0280	0.0710
1974	0.0199	0.0557	0.0757	0.0545	0.0745
1975	0.0067	0.0292	0.0360	0.0207	0.0275
1976	0.0211	0.0294	0.0505	0.0274	0.0486
1977	0.0082	0.0272	0.0355	0.0271	0.0353
1978	0.0019	0.0319	0.0338	0.0277	0.0297
1979	0.0089	0.0515	0.0604	0.0478	0.0568
1980	-0.0006	0.0659	0.0653	0.0561	0.0555
1981	-0.0680	0.0712	0.0031	0.0625	-0.0055
1982	-0.0853	0.0677	-0.017	0.0553	-0.029
1983	-0.0461	0.0807	0.0346	0.0477	0.0016
1984	-0.0538	0.0843	0.0305	0.0552	0.0013
1985	-0.0909	0.1016	0.0106	0.0499	-0.0409
1986	-0.0738	0.1359	0.0621	0.1263	0.0525
1987	-0.0787	0.1056	0.0269	0.0940	0.0153
1988	-0.1018	0.0949	-0.0068	0.0707	-0.0310
1989	-0.1273	0.1068	-0.0204	0.0986	-0.0286

1990	-0.1480	0.1693	0.0213	0.1540	0.0060
1991	-0.1054	0.1755	0.0700	0.1530	0.0476

(All figures are ratios to GDP)

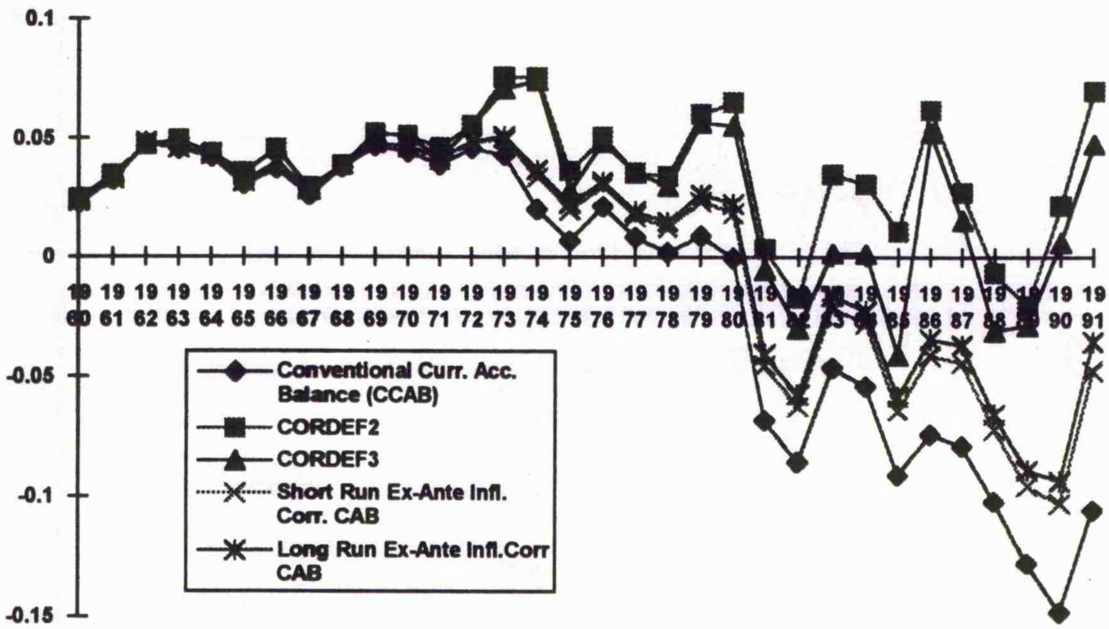


Diagram GR.7

As it can be seen from the table and from the diagram although the CCAB was negative for the last 12 years of the sample, the CORDEF2 was negative in only three years while the CORDEF3 in only five years. This happened despite the fact that the conventional CAB was not just negative but very negative (more than -10% of the GDP in some of the later years). However, because of the high inflation rate, part of the debt was implicitly depreciated and this depreciation reached the 17.5% of GDP in the last year of the sample. Contrasting the ex-post measures with the ex-ante ones, it can be seen that they differ significally from each other and the reason is the small degree (short run and long run) of income correction.

To conclude this section: Although the conventional CAB deteriorated heavily in the last 12 years, the ex-ante and the ex-post inflation corrected CAB were significally higher than it, especially after 1973. The reasons is the high inflation rate that was observed after that year and the high percentage of the financial liabilities to GDP. More concretely, as it can be seen from the above diagram, the ex-ante inflation corrected CAB was pretty higher than the conventional one though smaller than the ex-post inflation corrected one. These differences among the estimates given by the three measures points out the significance of the separate treatment of each of them, as well as the need to make clear what each of them means.

4.6 Summary of the results

In this section the case of Greece was examined. The main results of the analysis can be summarised as follows:

i) All the variables of the analysis were I(1) except for the total wealth variable which was I(2) according to DF/ADF tests.

ii) The Johansen cointegration procedure showed that there are four statistically significant cointegrating vectors. From those four cointegrating vectors, only one had its coefficients with signs and magnitudes that were in accordance to what is expected from a long run consumption function.

iii) According to this cointegrating vector, the long run elasticity of consumption with respect to income is 0.69 while the corresponding elasticity with respect to wealth is 0.1344. Inference in the cointegrating space shows that the wealth variable is highly significant which gives bonus to the validity of the life cycle model of consumption.

iv) Regarding the long run degree of income correction it was found equal to 0.495 which is only half the value that one would expect if there was no money illusion.

v) To model the short run consumption function an ECM was estimated. The Hausman-Wu exogeneity test was performed to test for the exogeneity of the independent variables. According to this test the null hypothesis of weak exogeneity could not be rejected and the analysis continued using the results of the OLS. The fitness of the equation was good, and the equation passed successfully all the usual statistical tests. The model was generally stable at the 1% level, while its forecasting accuracy was moderate since it was not successful to forecast accurately the change in the logarithm of consumption in 1988.

vi) The short run degree of income correction was 0.413 which is low and a bit lower that the long run one.

vii) Estimates of the ex-ante (long run and short run) and ex-post inflation corrected CAB were derived. The comparison of the corrected and conventional measures shows that they differ significally from each other. **This shows that all the computed measures have their own significance and each of them can answer questions that the others may not be able to answer.**

CASE STUDY 5

ITALY

5.1 The integration properties of the data

As in the previous case studies, the non-stationarity of the variables was tested by two ways. The first way is based on conclusions drawn from the plots of the variables in levels. The second, more formal way, is based on the performance of the DF and ADF statistical tests. Starting from the first of these ways, let's have a look at diagram IT.1 below.

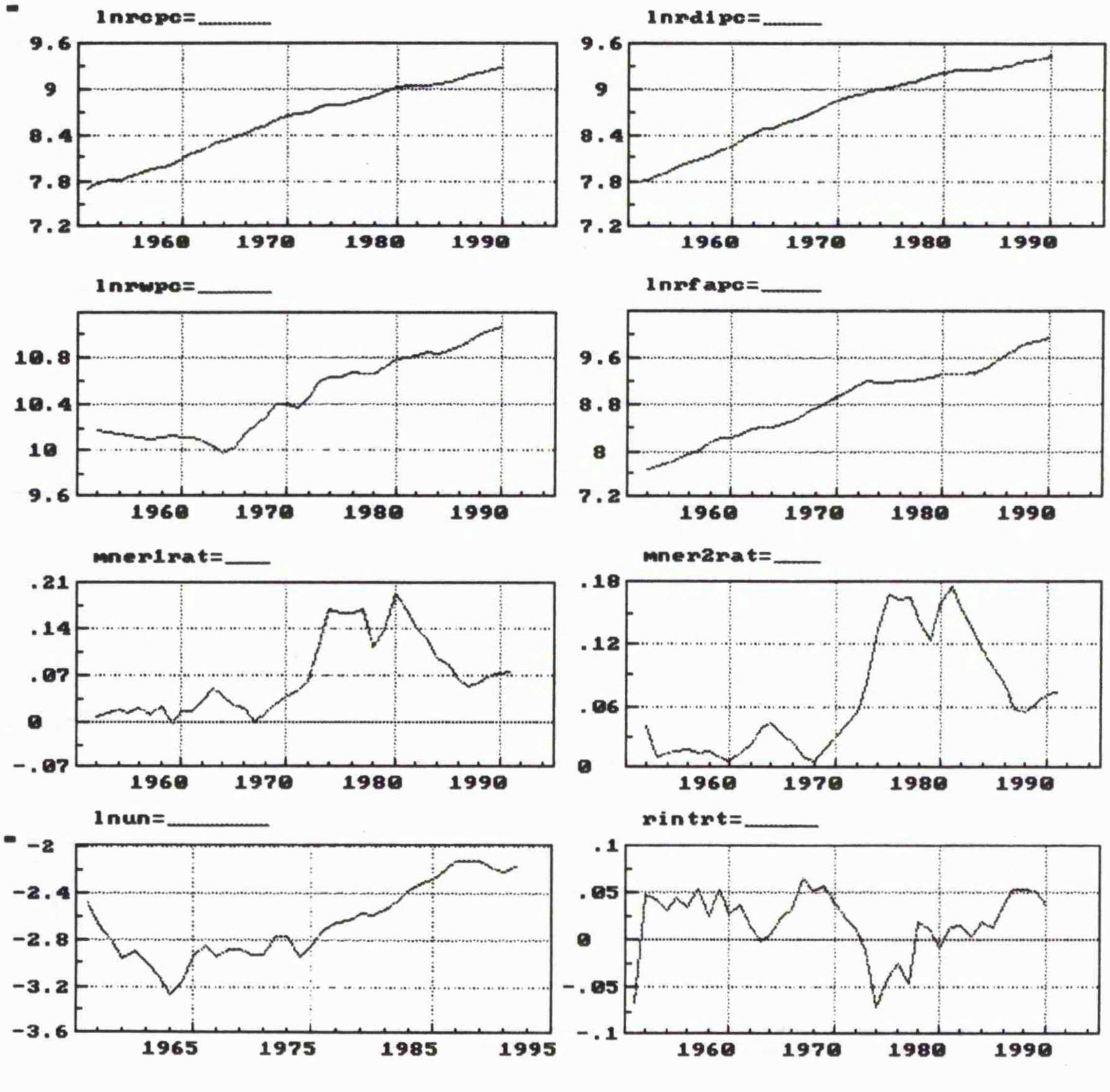


Diagram IT.1

The visual conclusion that can be drawn from the above diagram is that all the variables are non-stationary with the probable exception of the real interest rate. Of course, the above analysis is no more than descriptive and it can by no means substitute the performance of formal statistical tests as the DF/ADF tests. The results of these tests are presented at table T.IT.1 below.

Table T.IT.1: Unit Root Tests

Variable	ADF(2)	ADF(1)	DF	Period	C, TR
lnrcpc	-0.45626	-0.76169	-0.35617	1954-1990	C, TR
lnrdipc	-0.63002	-0.15586	-0.11396	1954-1990	C, TR
lnrwpc	-2.4625	-2.85	-2.4426	1955-1990	C, TR
lnrfapc	-2.2081	-2.6302	-1.5993	1955-1990	C, TR
mner1rat	-0.66257	-0.74713	-0.57369	1955-1991	
mner2rat	-0.66870	-0.93269	-0.31606	1955-1991	
lnun	-3.8405*	-3.6259*	-3.553*	1959-1992	C, TR
rintrt	-1.6070	-1.5752	-1.9475	1954-1990	
dlnrcpc	-2.1945	-3.6361**	-4.1486**	1955-1990	C
dlnrdipc	-3.4390	-3.3492	-5.7332**	1955-1990	C, TR
dlnrwpc	-2.4152	-4.1458**	-3.4303*	1956-1990	
dlnrfapc	-2.3321	-3.6237*	-3.2903*	1956-1990	C
dmner1rat	-2.8610**	-4.0753**	-4.9886**	1956-1991	
dmner2rat	-2.7951**	-3.7901**	-3.2014**	1956-1991	
dlnun	-3.7544**	-5.1967**	-4.7432**	1960-1992	
drintrt	-3.0589**	-4.3690**	-7.4740**	1955-1990	

(lnrfapc = logarithm of real financial assets per capita)

From the above table it can be seen that, apart from the lnun variable, all the other variables in levels are at least I(1). The fact that the unemployment rate is

I(0) is in accordance with economic theory that wants this variable stationary. In fact the real interest rate is also theoretically expected to be I(0). However, according to T.IT.1 this is not the case. As it was said previously, this only for sampling reasons can happen.

Now regarding the test of the null hypothesis that the corresponding non-stationary variable in levels is I(2), it can be seen from table T.IT.1 that this hypothesis is rejected for all variables. However, for dlnrcpc, dlnrdipc, dlnrwpc, dlnrfapc the rejection is dependant upon the number of the lags employed. Thus we have to examine the lag length in the ADF test in more depth. By doing this it was found that the ADF(1) test was enough for dlnrcpc, dlnrwpc and dlnrfapc. Also the simple DF test was enough for dlnrdipc. As it can be seen from the above table for those types of tests the null hypothesis is always rejected.

From the above analysis the conclusion is that, except for the unemployment rate which is I(0), all the other variables are I(1) which means that they must be differentiated once to become stationary.

5.2 The lag length of the VAR

Having established the order of integration of the variables, we can now move to the definition of the lag length of the VAR system. Before we estimate the individual equations of the VAR and derive the autocorrelation diagnostics, it is needed to make a choice about the wealth and the monetary erosion variables that will be used. Running the Johansen method experimentally, it was found that the lnrwpc and the mner2rat always performed better than their alternatives and for this reason they were chosen. Having made the choice of the wealth and the monetary erosion variables, we estimated each of the individual equations of the VAR model using OLS. As table T.IT.2 below makes clear, two lags are enough to eliminate any autocorrelation. Therefore a two lags VAR will be employed.

Table T.IT.2: VAR Diagnostics (lag length = 2)

Variable	AR1-1	AR1-2	AR1-3	AR1-4	ARCH1
lnrcpc	0.0825	0.2364	0.3494	0.2386	0.8987
lnrdipc	0.0723	0.1810	0.2087	0.1373	0.6172
lnrwpc	0.0843	0.1033	0.2166	0.1772	0.0942
mner2rat	0.4290	0.4763	0.5653	0.2521	0.5541

The numbers in the cells are p-values

5.3. The Long Run Consumption Function

Having defined the lag-length of the VAR, we can now apply the Johansen procedure. The first set of results is about the number of the distinct cointegrating vectors that are statistically significant. These results are given in the two tables that follow.

Table T.IT.3.1

Johansen Maximum Likelihood Procedure
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

37 observations from 1954 to 1990. Maximum lag in VAR = 2.
List of variables included in the cointegrating vector:
LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept
List of eigenvalues in descending order:
.71464 .47944 .33167 .083506 .0000

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r = 1	46.3979	28.1380	25.5590
r<= 1	r = 2	24.1554	22.0020	19.7660
r<= 2	r = 3	14.9102	15.6720	13.7520
r<= 3	r = 4	3.2264	9.2430	7.5250

Table T.IT.3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
37 observations from 1954 to 1990. Maximum lag in VAR = 2. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept List of eigenvalues in descending order: .71464 .47944 .33167 .083506 .0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	88.6900	53.1160	49.6480
r<= 1	r>= 2	42.2921	34.9100	32.0030
r<= 2	r>= 3	18.1366	19.9640	17.8520
r<= 3	r = 4	3.2264	9.2430	7.5250

According to these tables there are two cointegrating vectors that are statistically significant at the 5% level. When these two cointegrating vectors were normalised on consumption, the second one had its coefficients with signs and magnitudes that were in accordance with what is expected from a consumption function. The long run consumption function that corresponds to this vector is:

lnrcpc=-0.28063+0.83408*lnrdipc - 0.64139*mner2rat + 0.15930*lnrwpc E.IT.1

As it can be seen from E.IT.1 the long run elasticity of consumption with respect to income is 0.834 while the corresponding elasticity with respect to wealth is 0.1593. Regarding the parameter of our special interest, i.e. the long run degree of income correction, its indirect estimate is 0.77 which is fairly large.

Tests regarding the value of the parameters are presented at table T.IT.4 below. As it can be seen from this table, we were unable to reject the null hypothesis that the degree of income correction is equal to one. On the other hand, the null hypothesis that the long run degree of income correction is zero is rejected at the 5% level, though only marginally.

Table T.IT.4

Null Hypothesis	p-value
$a_0 = 0$	0
$a_1 = 0$	0.097
$a_2 = 0 \ (\Leftarrow \delta_L = 0)$	0.045
$a_2 = - a_1 \ (\Leftarrow \delta_L = 1)$	0.345
$a_3 = 0$	0

Also, it can be seen that all the variables were significally different from zero, though the income variable was so only at the 10% level and even in that case only marginally. This is rather surprising since one would expect this variable to be more strongly significant. On the other hand, wealth is strongly significant which gives validity to the life cycle model of consumption.

5.4. The Short Run Consumption Function.

Having estimated the long run relationship, the next step is the construction of an ECM for the modelling of the short run behaviour. Granger's representation theorem tells us that the existence of a long run relationship implies the existence of a valid ECM and conversely. To estimate the short run relationship the general to specific method was utilised. In other words, we started from a fairly general model and then, through t and F tests, we narrowed it down. The final model as it was estimated by OLS is presented at table T.IT.5 below:

Table T.IT.5: The Error Correction Model

Modelling dlnrcpc by RLS

The present sample is: 1954 to 1990

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
dlnrdipc	0.26238	0.099447	2.638	0.0137	0.2050
dmner2rat	0.81088	0.17727	4.574	0.0001	0.4366
drintrt_1	0.53436	0.12072	4.426	0.0001	0.4205
Constant	0.015592	0.0037708	4.135	0.0003	0.3877
ect_1	-0.10465	0.064549	-1.621	0.1166	0.0887
dlnrdipc_1	0.11624	0.10051	1.157	0.2576	0.0472
dmner2ra_1	-0.43694	0.10732	-4.071	0.0004	0.3804
drintrt	0.42261	0.12051	3.507	0.0016	0.3129
dummy54	-0.043298	0.0098465	-4.397	0.0002	0.4173
dummy63	0.043940	0.0093064	4.721	0.0001	0.4522

$R^2 = 0.853303$ $F(9, 27) = 17.45$ [0.0000] $\sigma = 0.00861388$ DW = 2.07

RSS = 0.002003372106 for 10 variables and 37 observations

Information Criteria: SC = -8.84792; HQ = -9.12981; FPE = 9.42527e-005

AR 1- 1F(1, 26) =	0.23184 [0.6342]
AR 1- 2F(2, 25) =	0.5309 [0.5946]
ARCH 1 F(1, 25) =	0.5509 [0.4649]
Normality Chi²(2) =	0.1768 [0.9154]
Xi² F(16, 10) =	0.3446 [0.9719]
RESET F(1, 26) =	0.235 [0.6319]

As it can be seen from this table, the model includes the lagged income variable. This means that if we want to have a unique estimate of the short run degree of income correction non-linear methods have to be used. The estimated form of the non-linear model is as follows:

dlnrdipc=&0+&1*(dlnrdipc-&2*dmner2rat)+&3*(lag(dlnrdipc,1)-
&2*lag(dmner2rat,1))+&4*drintrt+&5*lag(drintrt,1)
+&6*dummy54+&7*dummy63+&8*lag(ect,1) + residuals E.IT.2

where: lag(x, r) = x_{t-r}

and &0,......&8 correspond to the estimated coefficients.

The results from the estimation of E.IT.2 are presented at table T.IT.6 below:

Table T.IT.6

Modelling actual by NLS
The present sample is: 1954 to 1990

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
&0	0.020344	0.0031379	6.483	0.0000	0.6002
&1	0.16203	0.091066	1.779	0.0861	0.1016
&2	-5.7703	3.5332	-1.633	0.1136	0.0870
&3	-0.069539	0.041088	-1.692	0.1017	0.0928
&4	0.50096	0.11820	4.238	0.0002	0.3908
&5	0.65349	0.10793	6.055	0.0000	0.5670
&6	-0.040255	0.010398	-3.872	0.0006	0.3487
&7	0.046780	0.0096869	4.829	0.0000	0.4544
&8	-0.20625	0.043056	-4.790	0.0000	0.4504

$R^2 = 0.831004$ $F(8, 28) = 17.211$ [0.0000] $\sigma = 0.0090788$ DW = 1.98
RSS = 0.00230788825 for 9 variables and 37 observations

ARCH 1 F(1, 26) = 0.16779 [0.6854]
Normality Chi²(2)= 0.3455 [0.8413]
AR 1- 1F(1, 27) = 0.024286[0.8773]
AR 1- 2F(2, 26) = 0.038869 [0.9619]
Xi² F(14, 13) = 0.55304 [0.8578]

Before we make any comment on the above results we have first to test the validity of the exogeneity assumption. To test this assumption we applied the Hausman-Wu exogeneity test[1]. According to this test the null hypothesis of weak exogeneity cannot be rejected at any of the conventional levels of significance (p-value = 0.2197).

Having verified the validity of the exogeneity assumption, we can now comment on the results presented at table T.IT.6. As it is evident from both the R^2 coefficient and the diagram IT.2 below, the fitness of the model is very good especially if we recall that we have to do with a model in differences.

[1]Details of how to perform this test can be found at the first case study.

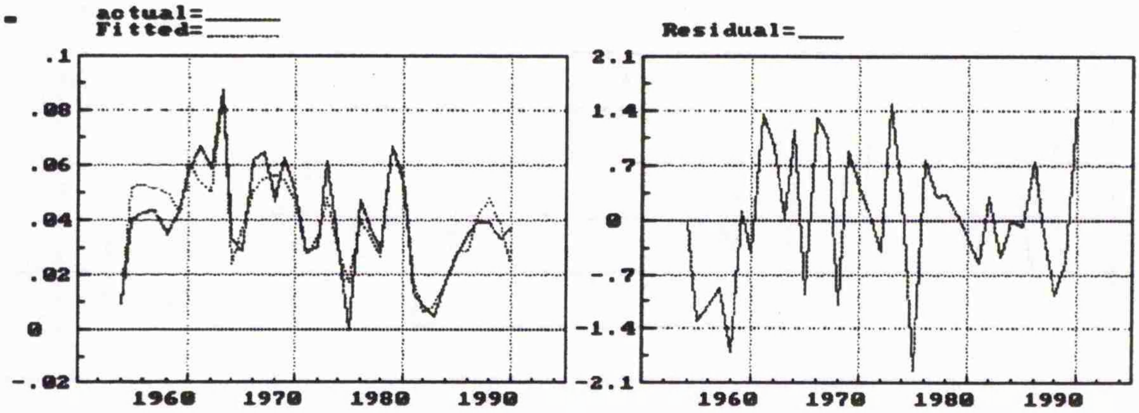


Diagram IT.2

Apart from the goodness of fit, the model passed successfully all the usual statistical tests. In fact, not only passed them but also it managed to pass them with high p-values i.e. very easily.

Regarding the individual coefficients and their significance, it can be seen that the current income variable is statistically significant only at the 10% level while the lagged income variable is not statistically significant even at that level though that this happen only marginally. We must here remind the reader that in the long run function the income variable was also only marginally significant at the 10% level. In contrast, the error correction term is significant at any level. The dummy variables were added to the model as a solution to the great divergence between actual and fitted values that were observed in 1954 and 1963. Both are strongly significant. Strongly significant is also the real interest rate. Regarding the variable of our special interest i.e. the short run degree of income correction, though it is of illogical size, it is not statistically significant. Since the nearest possible value that it can take is zero in the correction of the current account balance, we will restrict it to zero. The fact that the degree of income correction is zero in the short run is in contradiction with the large corresponding degree that we estimated for the long run. This justifies the discrimination that we make between the short run and the long run degree of income correction.

5.4.1 The stability and the forecasting accuracy of the ECM

As it has already been said, great importance has been given in recent years in the stability and the forecasting accuracy properties of a model. Starting from the examination of the stability issue conclusions can be drawn using the 1-step recursive residuals and the 1-step and N-steps (up and down) Chow tests. The results of these tests are presented at diagram IT.3 below. As it can be seen from this diagram there is no instability in our model. Indeed, the 1-step recursive residuals are well within the ± 2∗S.E. boundaries while the Chow tests gave values that are all well below the critical value for the 1% level[2].

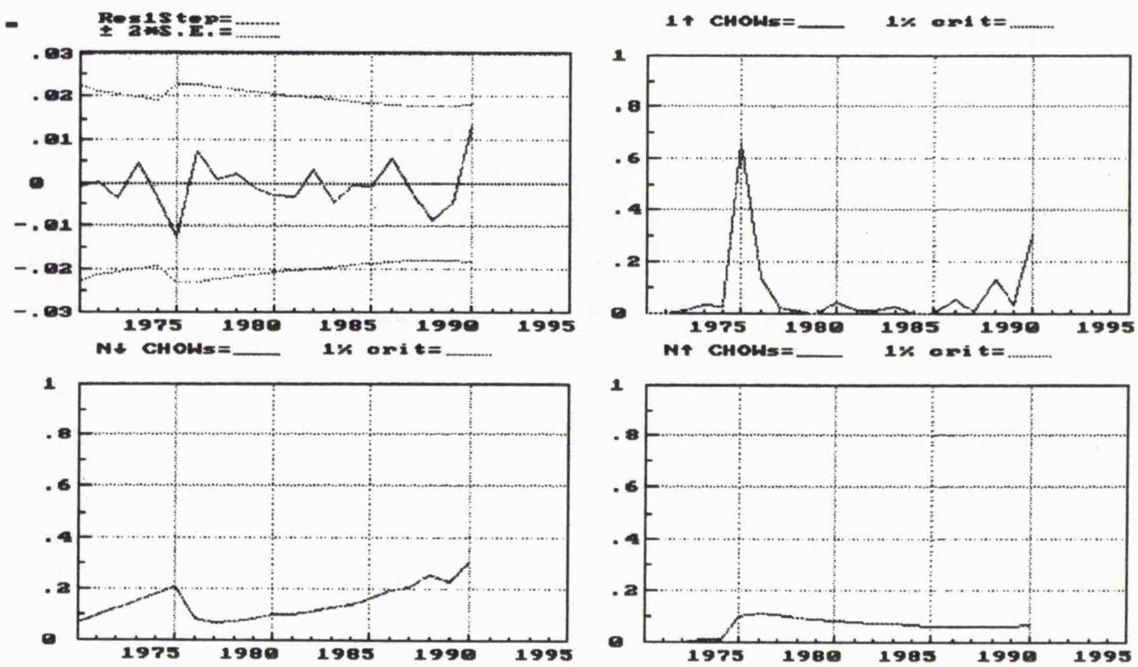


Diagram IT.3

[2]Nevertheless, it has to be said that the 1-step Chow test was significant at the 5% level for 1975.

Regarding now the forecasting abilities of the model, to draw conclusions we re-estimated the model reserving the five last observations to make one step forecasts. Diagram IT.4 presents the forecasted and the actual values.

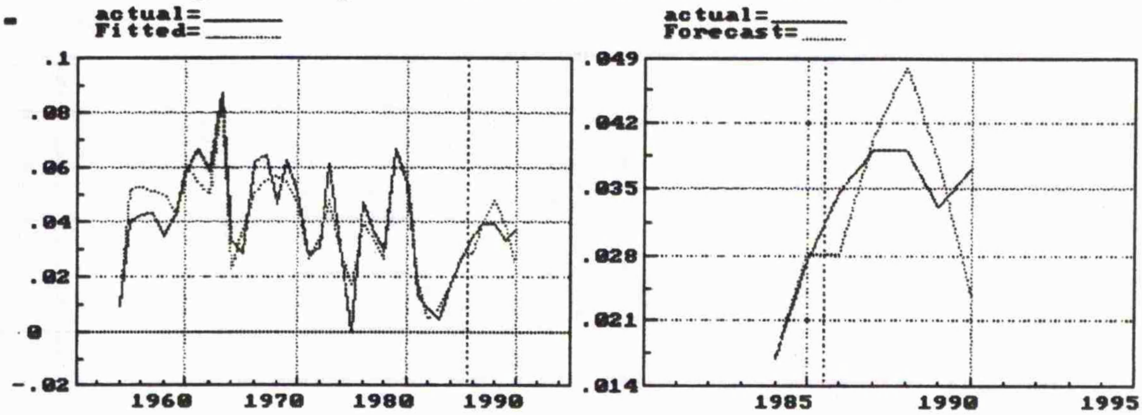


Diagram IT.4

As it can be seen from this diagram, the forecasted and the realised values are close to each other. The good forecasting ability of the model is also clear from the fact that the Forecast Chi-square statistic gave a p-value equal to 0.5494.

From the above we could conclude that the model is stable and with good forecasting abilities.

5.5 The ex-ante and ex-post inflation corrected Current Account Balance (CAB).

5.5.1. A look at the paths of the main variables of the analysis.

Having estimated the long run and the short run degree of income correction, it is now time to use these estimates to derive corresponding estimates of the ex-ante inflation corrected CAB. Nevertheless, before we derive these estimates it would be helpful to have a look at the paths that the main variables of the analysis followed during the period of our sample. This is done at diagram IT.6

where from the top left to the right we present the plots of the following variables[3]: net financial liabilities, gross interest payments, net saving, net lending, and inflation rate. The first four of these variables refer to the general government and they are expressed as ratios to GDP. In addition to this diagram, table T.IT.7 below presents some useful descriptive statistics about the variables under discussion.

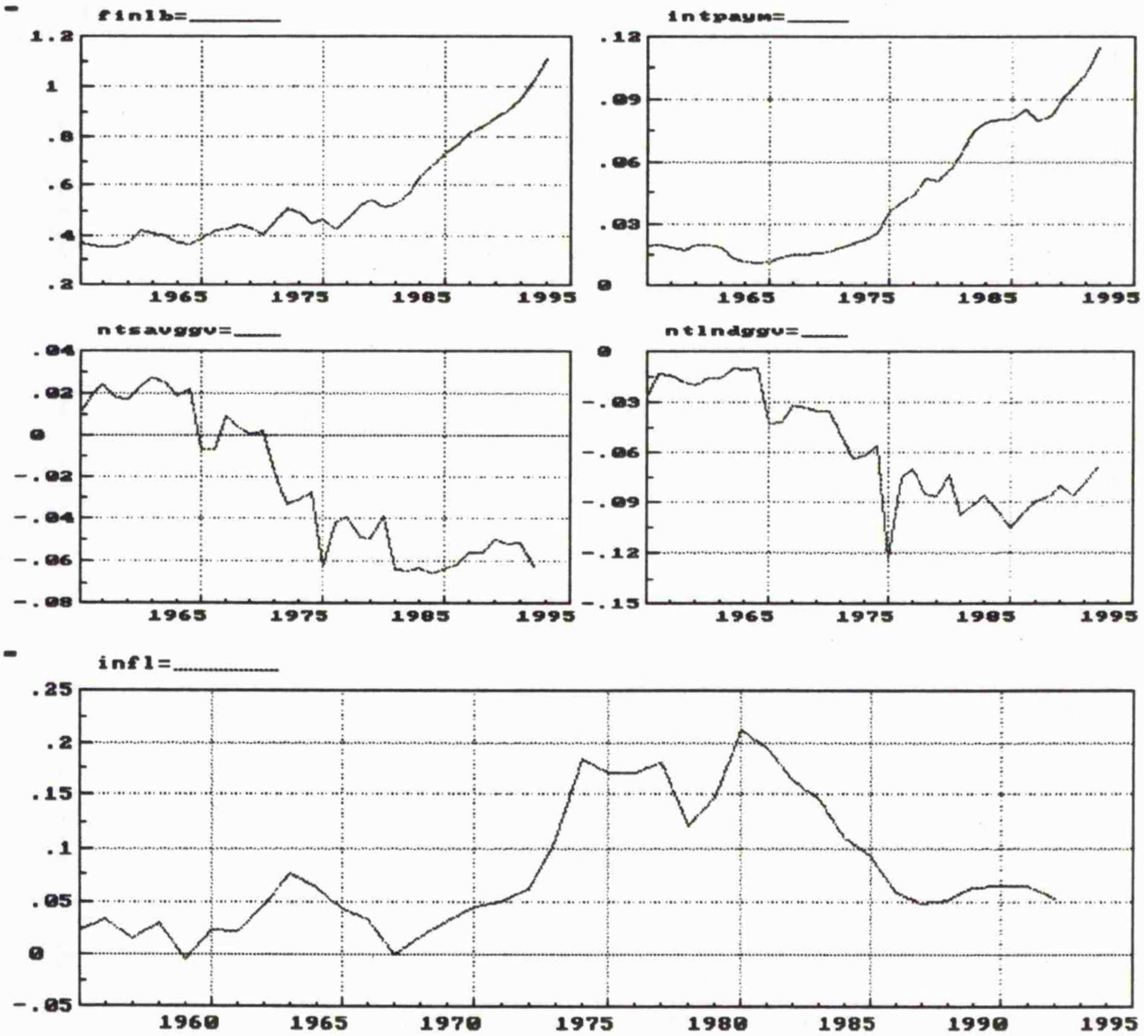


Diagram IT.5

[3]Unfortunately, data about the external debt were not available for a sufficient long period of time. Evidence from some sources as Giavazzi and Spaventa (1988), p. 11 and EEC (Eurostat, Money and Finance, various issues) show that the external debt was insignificant and therefore we could safely ignore it.

Table T.IT.7

Variable	Minimum	Maximum	Average
Net Debt (% GDP)	35.07 (1957)	110.73 (1993)	55.16
Interest Payments (% GDP)	1.11 (1964)	11.44 (1992)	4.33
Net Saving (% GDP)	-6.5 (1984)	2.7 (1961)	-2.3
Net Lending (% GDP)	-12.35 (1975)	-0.9 (1964)	-5.6
Inflation (%)	-0.52 (1959)	21.3 (1980)	7.9

As it can be seen from the above diagram, with the exception of the ten first years, the net financial liabilities were increasing and this increase was sharper after 1976. The same comments apply to the gross interest payments as well. Both of these variables got their minimum values in the early years of the sample and their maximum values in the last year of the sample.

Regarding the net financial lending, it can be seen that it was always negative and with clear tends of deterioration through time. The path of the CCAB was very similar to the one of the net lending though it was constantly negative only after 1970. Finally, the last diagram shows that the inflation rate was rather high relative to other countries and for quite a few years after the two oil shocks it was above 10%.

The fact that the inflation rate was not insignificant together with the fact that the net financial liabilities of the government were really huge indicates that the inflation correction will be quantitatively important.

5.5.2 Estimates of the ex-ante inflation corrected CAB.

To estimate the ex-ante inflation corrected CAB the following formula will be applied:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.IT.3}$$

where the notation is as in the previous case studies.

Depending on the degree of income correction, E.IT.3 will give estimates of the short run and the long run ex-ante inflation correction CAB. Here it is reminded that the short run degree of income correction was restricted to zero while the long run one was found equal to 0.77. Applying these estimates to equation E.IT.3 we got the following estimates of the ex-ante inflation corrected CAB.

Table T.IT.8
The conventional and the ex-ante inflation corrected CAB

Year	**Conventional Current Account Balance (CCAB)**	**Long Run Ex-Ante Inflation Erosion.**	**Long Run Ex-Ante Inflation Corrected CAB**
1955	0.0112	0.0072	0.0185
1956	0.0196	0.0072	0.0268
1957	0.0246	0.0061	0.0307
1958	0.0181	0.0056	0.0237
1959	0.0179	0.0031	0.0211
1960	0.0237	0.0026	0.0263
1961	0.0277	0.0065	0.0342
1962	0.0248	0.0097	0.0346
1963	0.0189	0.0168	0.0357
1964	0.0224	0.0186	0.0411
1965	-0.006	0.0145	0.0081
1966	-0.0063	0.0110	0.0046
1967	0.0094	0.0049	0.0144
1968	0.0046	0.0025	0.0071
1969	0.0008	0.0073	0.0081
1970	0.0022	0.0114	0.0136
1971	-0.0173	0.0150	-0.0022
1972	-0.0327	0.0198	-0.0129
1973	-0.0308	0.0298	-0.0009
1974	-0.0272	0.0471	0.0199

1975	-0.0630	0.0586	-0.0044
1976	-0.0414	0.0521	0.0106
1977	-0.0389	0.0552	0.0162
1978	-0.0483	0.0532	0.0048
1979	-0.0489	0.0499	0.0009
1980	-0.0384	0.0655	0.0270
1981	-0.0636	0.0746	0.0109
1982	-0.0641	0.0701	0.0060
1983	-0.0628	0.0672	0.0044
1984	-0.0654	0.0607	-0.0046
1985	-0.0638	0.0519	-0.0119
1986	-0.0610	0.0411	-0.0198
1987	-0.0553	0.0307	-0.0245
1988	-0.0557	0.0299	-0.0257
1989	-0.0498	0.0361	-0.0137
1990	-0.0514	0.0414	-0.0100
1991	-0.0507	0.0437	-0.0069
1992	-0.0625	0.0429	-0.0195

(all figures are ratios to GDP)

Table T.IT.8 does not present separate estimates of the short run inflation erosion and the short run inflation corrected CAB, for the reason that, since the short run degree of income correction is zero, the former is zero and therefore the later coincides with the conventional CAB. The estimates given in the above table are also presented diagrammatically below:

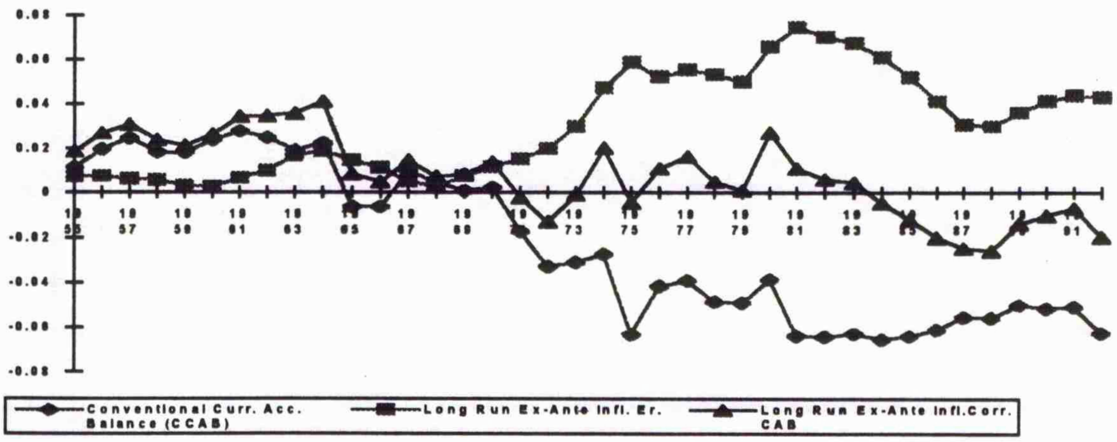


Diagram IT.6

As it can be seen from the table and from the diagram, the inflation erosion, as it was perceived by people in the long run, was really a large percentage of GDP. This should have been expected since all the factors that determine the magnitude of the inflation erosion (the inflation rate, the degree of income correction, and the size of the net financial liabilities) were high in magnitude. It is characteristic that while the conventional CAB was negative in 23 years of the sample the long run ex-ante inflation corrected one was so only in 12 years. However, even in those years it was much less negative than the conventional CAB. This means that although the conventional CAB may give an adequate picture of what is perceived as CAB in the short run, it may be a heavily distorted measure when the purpose is to measure what is perceived as CAB in the long run.

5.5.3 Estimates of the ex-post inflation corrected CAB

The second set of inflation corrected balances refers to ex-post ones. Although in the previous case studies we computed two estimates of the ex-post inflation corrected CAB, discriminating between internal and external liabilities, a discrimination like this was not able to be done in this case study, because of lack of data regarding the external liabilities. Thus the ex-post estimates will be computed only by the following formula:

$$CORDEF2 = CCAB + \pi DB \qquad \text{E.IT.4}$$

where the notation is as in the previous case studies

Estimates of the ex-post inflation corrected CAB derived by the above formula are given below in table T.IT.9 and are also presented diagrammatically at diagram IT.8 below.

Table T.IT.9: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	The Inflation Erosion as it is computed by E.IT.4	CORDEF2
1955	0.0112	0.0080	0.0193
1956	0.0196	0.0113	0.0309
1957	0.0246	0.0048	0.0294
1958	0.0181	0.0098	0.0279
1959	0.0179	-0.001	0.0161
1960	0.0237	0.0087	0.0324
1961	0.0277	0.0080	0.0357
1962	0.0248	0.0175	0.0424
1963	0.0189	0.0271	0.0460
1964	0.0224	0.0218	0.0443
1965	-0.006	0.0152	0.0088
1966	-0.0063	0.0124	0.0060
1967	0.0094	0	0.0094
1968	0.0046	0.0065	0.0111
1969	0.0008	0.0127	0.0135
1970	0.0022	0.0176	0.0198
1971	-0.017	0.0206	0.0033
1972	-0.0327	0.0283	-0.0041
1973	-0.0308	0.0497	0.0188
1974	-0.0272	0.0771	0.0498
1975	-0.0630	0.0730	0.0099
1976	-0.0414	0.0677	0.0262
1977	-0.0389	0.0738	0.0348
1978	-0.0483	0.0551	0.0067
1979	-0.0489	0.0714	0.0224
1980	-0.0384	0.1005	0.0620
1981	-0.0636	0.0926	0.0289
1982	-0.0641	0.0834	0.0193
1983	-0.0628	0.0819	0.0191
1984	-0.0654	0.0675	0.0021
1985	-0.0638	0.0616	-0.0022
1986	-0.0610	0.0414	-0.0195
1987	-0.0553	0.0359	-0.0194
1988	-0.0557	0.0405	-0.0151
1989	-0.0498	0.0514	0.0015
1990	-0.0514	0.0542	0.0027
1991	-0.0507	0.0568	0.0061
1992	-0.0625	0.0501	-0.0123

(All figures are ratios to GDP)

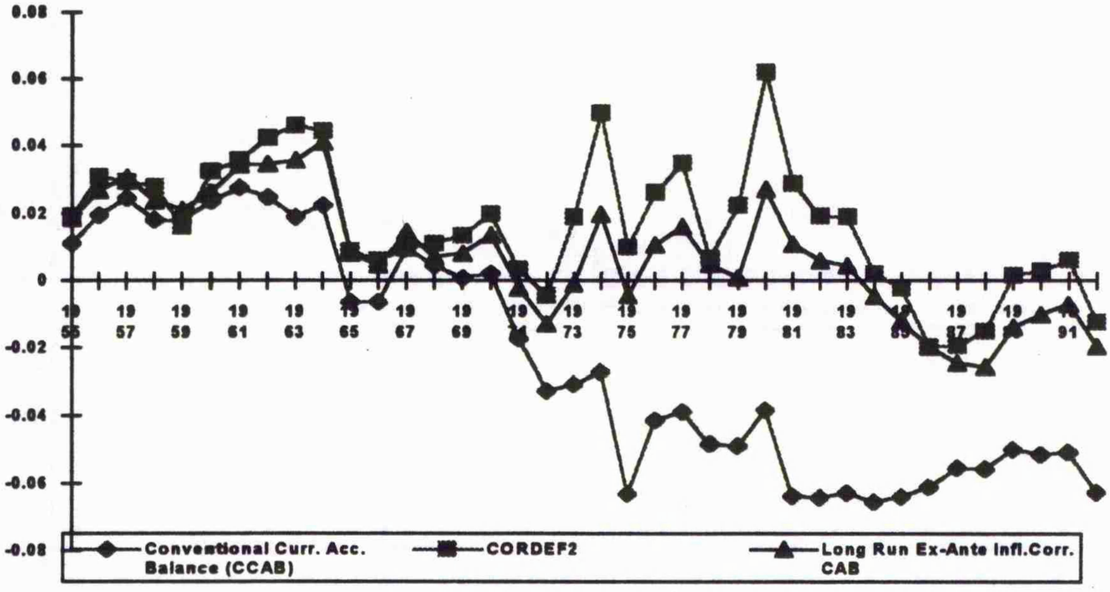


Diagram IT.7

As it can be seen from the table and from the diagram the difference between the ex-post and the conventional CAB is really high. Indeed, although the conventional CAB was negative in 23 years of the sample the ex-post inflation corrected one was negative in only six years. In contrast, the differences between the ex-post and the long run ex-ante inflation corrected CAB are not large and the reason is the large degree of income correction.

Having estimated both the ex-post and the ex-ante inflation corrected CAB, the conclusion is that in Italy, the inflation correction has a significant role to play, since when it was taken into account the derived estimates were much different from the conventional ones, with the exception of the short run ex-ante inflation corrected CAB which coincided with the conventional CAB.

5.6. Summary of the results

In this section the case of Italy was examined. The main results of the analysis can be summarised as follows:

i) Except for the unemployment rate which is I(0), all the other variables of the analysis are I(1).

ii) According to the Johansen procedure there are two cointegrating vectors, one of which had its coefficients with signs and magnitudes in accordance to what is expected from a consumption function.

iii) According to the chosen cointegrating vector, the long run elasticity of consumption with respect to income is 0.83 while the corresponding elasticity with respect to wealth is 0.159 and statistically significant. The significance of the wealth variable adds support to the life cycle model.

iv) The long run degree of income correction was fairly large and equal to 0.77. In fact, the null hypothesis that this degree is equal to one (no money illusion at all) could not be rejected at any conventional level of significance. On the other hand, the null hypothesis that the long run degree of income correction is zero was rejected at the 5% level.

v) Based on the estimated long run relationship, we formulated an ECM to model the short run dynamics. According to the final form of the model, which was non-linear, there is fulfilment of all the classical regression assumptions, with the exogeneity assumption included. The fitness of the model was very good as well. Also the model was stable and with good forecasting abilities.

vi) The point estimate of the short run degree of income correction was illogical (negative), yet not significally different from zero. Thus for the estimation of the short run ex-ante inflation corrected CAB this degree was restricted to zero. The difference of the short run degree of income correction from the long run one points out the need for discrimination of these two degrees.

vii) Finally we derived estimates of the short run and the long run ex-ante inflation corrected CAB as well as estimates of the ex-post inflation corrected CAB. With the exception of the short run ex-ante inflation corrected CAB, the corrected estimates differed greatly from the conventional CAB. The main reason for this is that the long run degree of income correction was large (this reason applies to the long run ex-ante inflation corrected CAB only) and the same was true for the inflation rate and the debt of the government.

CASE STUDY 6

JAPAN

6.1 The integration properties of the data

As in all previous case studies, before any further examination it is required to establish the order of integration of the various variables of the analysis. For this purpose two methods will be used: the first is based on the visual examination of the plots of the variables, while the second on the performance of the DF/ADF statistical tests. Starting from the first method, diagram JP.1 below presents the plots of the variables in levels[1].

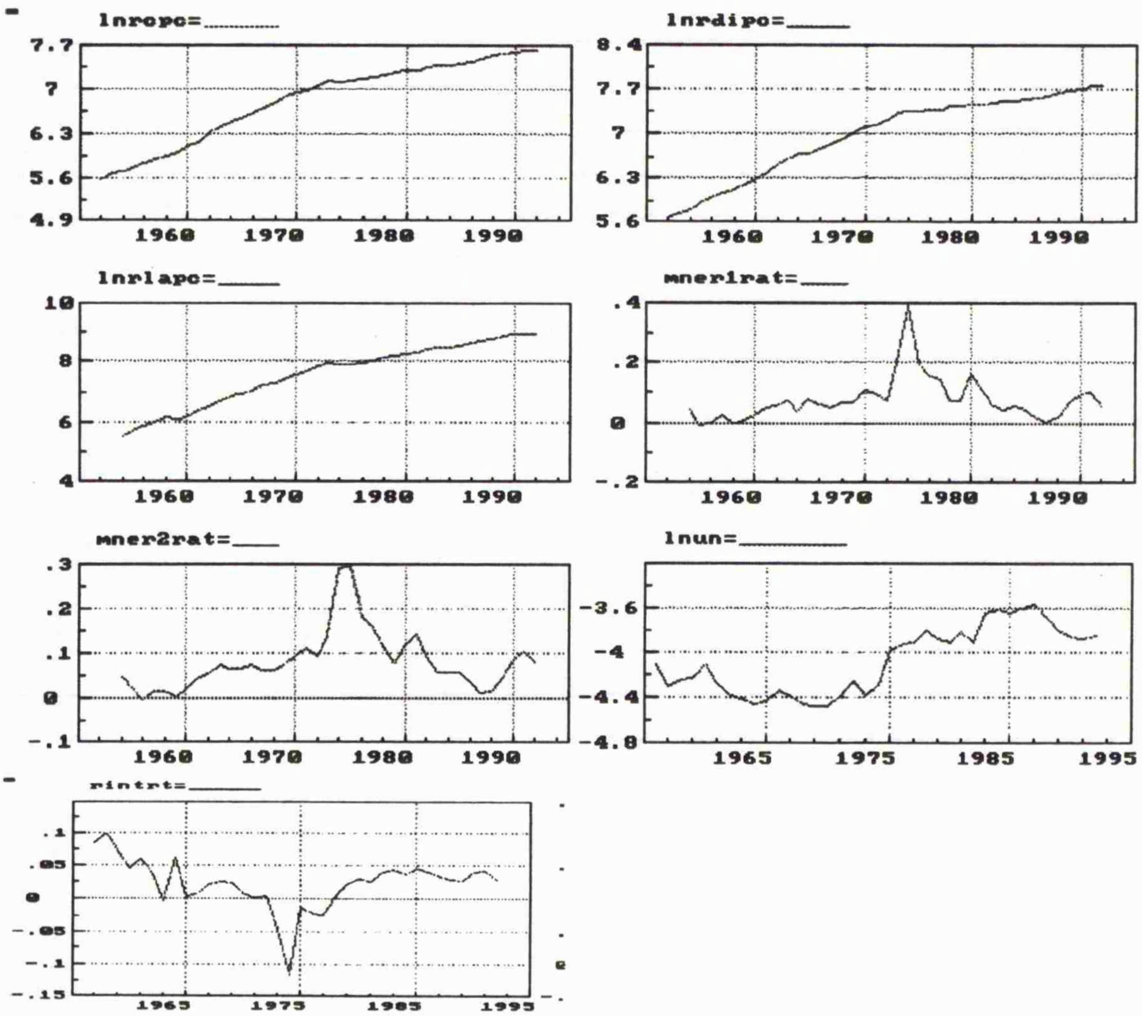


Diagram JP.1

[1]Data for the stock of dwellings were impossible to be derived. Therefore, the choice of the total wealth variable is unavailable.

As it can be seen from this diagram, the first three variables are clearly non-stationary. Regarding the other variables, though the mner1rat and the mner2rat are more volatile relative to the first three, they are also rather non-stationary. For the unemployment rate and the real interest rate the answer is more difficult since theoretically these variables are expected to be stationary. However, it is not clear from the plots whether they are so or not. In any case, conclusions drawn from the plots of the variables can in no way be definite and they should be confirmed by the results of formal statistical tests. Such results, derived by the application of the DF/ADF tests, are presented at table T.JP.1 below

Table T.JP.1: Unit Root Tests

Variable	**ADF(2)**	**ADF(1)**	**DF**	**Period**	**C, T**
lnrcpc	-0.94546	0.74970	-0.43334	1955-1992	C, T
lnrdipc	-1.3145	-1.2705	-1.1430	1955-1992	C, T
lnrlapc	-0.67326	-0.85597	-0.65677	1957-1992	C, T
mner1rat	-1.9970	-2.7481	-2.7687	1957-1992	C
mner2rat	-1.7977	-2.7479	-2.0682	1957-1992	C
lnun	-1.8589	-1.9745	-1.8192	1959-1992	C, T
rintrt	-2.0975*	-2.3595*	-2.8364**	1960-1992	
dlnrcpc	-2.5429	-2.9939	-4.5258**	1956-1992	C, T
dlnrdipc	-3.0369	-3.2387	-4.3513**	1956-1992	C, T
dlnrlapc	-3.3722	-4.3059**	-4.4575**	1958-1992	C, T
dmner1rat	-3.9255**	-6.1344**	-6.2957**	1958-1992	
dmner2rat	-3.0989**	-5.7360**	-4.4772**	1958-1992	
dlnun	-2.9383**	-4.1975**	-5.3820**	1960-1992	

According to the results given in table T.JP.1, apart from the real interest rate, the null hypothesis that the corresponding variable in levels is I(1) cannot be rejected for any of the variables. The fact that the rintrt is stationary is not something surprising since, as we said, this had to be expected on theoretical grounds. On the same grounds we would expect lnun to be also I(0). However, according to the above table, this does not happen. The only logical cause of this result is sampling reasons.

Now, regarding the null hypothesis that the corresponding non-stationary variable in levels is I(2), it can be seen from the above table that this hypothesis is clearly rejected for dmner1rat, dmner2rat and dlnun at even the 1% level of significance. However, for the other variables, the results are dependant on the lag length and thus more examination is needed. This examination showed that for: dlnrcpc, dlnrdipc the lags were totally insignificant and their deletion didn't not cause autocorrelation. Therefore, the simple DF test is enough, and according to this test the null hypothesis is rejected. Similarly, for the dlnrlapc it was found that the second lag is insignificant and therefore the ADF(1) is the most appropriate test. According to this test the null hypothesis is rejected.

To conclude, all the variables are I(1) except for the real interest rate which is I(0).

6.2 The lag length of the VAR

Having established the order of integration of the variables of the analysis, the next step is to define the lag length of the VAR that will be used in the Johansen procedure. However, before we are able to make this decision it is first needed to decide which of the two monetary erosion variables will be used. Running the Johansen method experimentally it was found that the mner2rat, performed always better than its alternative. Having made this decision, we estimated the individual equations of the VAR using various lag-lengths. Finally, a lag length equal to three was chosen. Table T.JP.2 below, presents autocorrelation diagnostics for this lag-length. As it can be seen, except for two cases autocorrelation is not a problem in any of the equations of the VAR[2].

Table T.FR.2: VAR Diagnostics (lag length = 3)

Dep. Variable	**AR1-1**	**AR1-2**	**AR1-3**	**AR1-4**	**ARCH1**
lnrcpc	0.5622	0.4901	0.5695	0.5497	0.8679
lnrdipc	0.0775	0.1125	0.2338	0.3869	0.9930
lnrlapc	0.2071	0.1953	0.1816	0.2913	0.8796
mner2rat	0.2136	0.0346*	0.0539	0.044*	0.6354

(The numbers in the cells are p-values)

In the next, the analysis will continue assuming a lag length equal to three.

6.3. The Long Run Consumption Function

Having established the lag length of the VAR, the next step is to test for the number of the statistically significant cointegrating vectors. The way to do this is through the maximal eighnvalue test and the trace test. The results of these tests are presented at tables T.JP.3.1 and T.JP.3.2 below:

[2]Increase of the lag length didn't improve the situation

Table T.JP.3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
36 observations from 1957 to 1992. Maximum lag in VAR = 3, chosen r = 2. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC Intercept List of eigenvalues in descending order: .58011 .46894 .21130 .13829 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	31.2393	28.1380	25.5590
r<= 1	r = 2	22.7838	22.0020	19.7660
r<= 2	r = 3	8.5454	15.6720	13.7520
r<= 3	r = 4	5.3580	9.2430	7.5250

Table T.JP.3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
36 observations from 1957 to 1992. Maximum lag in VAR = 3, chosen r = 2. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC Intercept List of eigenvalues in descending order: .58011 .46894 .21130 .13829 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	67.9265	53.1160	49.6480
r<= 1	r>= 2	36.6872	34.9100	32.0030
r<= 2	r>= 3	13.9034	19.9640	17.8520
r<= 3	r = 4	5.3580	9.2430	7.5250

According to the above two tables, there are two cointegrating vectors that are statistically significant at the 5% level. Therefore, if for the estimation of the long run parameters we used the OLS method, the results would be clearly distorted. When these two cointegrating vectors were normalised on lnrcpc, one had its coefficients with magnitudes and signs that were in accordance with what is expected from a long run consumption function.

The estimated long run consumption function that corresponds to this cointegrating vector is as follows:

lnrcpc=-0.10929+0.88389*lnrdipc-0.33561*mner2rat+0.095369*lnrlapc E.JP.1

As it can be seen from the above equation, the long run elasticity of consumption with respect to income is 0.88. The corresponding elasticity with respect to liquid assets is 0.095. Regarding the long run degree of income correction it is equal to 0.38 which is low and far from the value that would be expected if there was no money illusion. A possible reason for this is the low inflation rate that the Japanese economy experienced and which might have made difficult for people to realise the effects of inflation on the real value of their monetary assets.

As it was said previously, one of the major advantages of the Johansen procedure is that it permits the performance of statistical tests about the value of the long run parameters. Such tests are presented below at table T.JP.4. In this table: a_0 corresponds to the first variable of the right hand side of E.JP.1 (i.e. the constant term), a_1 to the second variable and so on.

Table T.JP.4

Restriction	p-value
$a_0 = 0$	0.018
$a_1 = 0$	0
$a_2 = 0$ ($\Leftarrow \delta_L = 0$)	0.001
$a_2 = - a_1$ ($\Leftarrow \delta_L = 1$)	0.004
$a_3 = 0$	0.009

As it can be seen from this table, all the variables are statistically significant and this is valid for the liquid assets variable as well. This gives validity to the life cycle model of consumption. Regarding the parameter of our special interest i.e. the long run degree of income correction, both the null hypothesis that this degree is one and the null hypothesis that it is zero are clearly rejected.

6.4 The Short Run Consumption Function.

Having established the long run consumption function, the next step is to model the short run dynamics and to do this we will employ an error correction model. To arrive at the final model presented below at table T.JP.5 the general to specific method was used. This means that we started from a fairly general model and then we narrowed it down using t and F tests.

Table T.JP.5: The Error Correction Model

Modelling dlnrcpc by OLS
The present sample is: 1958 to 1992

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	0.0074995	0.0038117	1.968	0.0599	0.1296
dlnrcpc_2	0.21312	0.087937	2.424	0.0226	0.1843
dlnrdipc	0.85488	0.065077	13.136	0.0000	0.8691
dmner2rat	-0.19712	0.055838	-3.530	0.0016	0.3240
ect_1	-0.27893	0.087247	-3.197	0.0036	0.2822
rintrt	0.18831	0.073438	2.564	0.0165	0.2018
rintrt_1	-0.15039	0.070590	-2.130	0.0428	0.1486
dummy65	0.046745	0.012370	3.779	0.0008	0.3545
dummy63	0.017293	0.0091829	1.883	0.0709	0.1200

$R^2 = 0.945404$ F(8, 26) = 56.278 [0.0000] $\sigma = 0.00846119$ DW = 2.15
RSS = 0.001861383597 for 9 variables and 35 observations
Information Criteria: SC = -8.92755; HQ = -9.18944; FPE = 9.0001e-005
AR 1- 1F(1, 25) = 0.68129 [0.4170]
AR 1- 2F(2, 24) = 0.40307 [0.6727]
ARCH 1 F(1, 24) = 0.40476 [0.5307]
Normality Chi²(2)= 0.22307 [0.8945]
Xi² F(14, 11) = 0.47365 [0.9054]
RESET F(1, 25) = 0.005387 [0.9421]

Before we comment on the results of the above table, it is first needed to examine the exogeneity of the variables of the analysis. The way that this was done was through the Hausman-Wu exogeneity test[3]. According to this test, the null hypothesis of weak exogeneity cannot be rejected at any conventional level of significance (p-value = 0.6645). Thus, the analysis will continue based on the above results.

A look at the results of the above table shows that the model is very successful in explaining the variability of the depended variable. Indeed, the coefficient of determination is very high for a model formulated in differences. The goodness of fit of the model is also confirmed by taking a look at diagram JP.2 below, where the actual and fitted values are given, together with the scaled residuals.

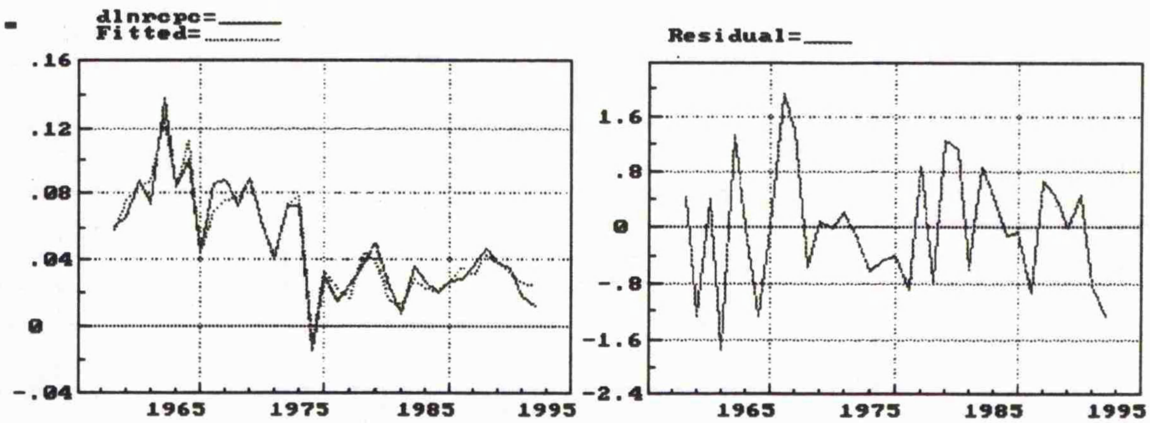


Diagram JP.2

Except for the goodness of fit, the model is also very successful in passing all the statistical tests about the validity of the classical regression assumptions. In

[3]For the specific way to implement this test the reader is referred to the first case study.

fact, the model not only passed all of these tests but it also passed them with high p-values.

Regarding now the individual coefficients, it can be seen that the impact elasticity of consumption with respect to income is 0.85488 which is very high relative to the one obtained in other case studies. The two dummy variables were added to face structural breaks observed in 1963 and in 1965 and they are also statistically significant. The error correction term is also highly significant.

Regarding the coefficient of our particular interest i.e. the short run degree of income correction, its indirect estimate is 0.23 which is low and lower than the corresponding long run degree (0.38). Despite the fact that the short run degree of income correction was so low, the null hypothesis that it is zero is rejected at the 1% level of significance [p-value = 0.0016 (OLS) and 0.0031 (NLS)]. The same also happens for the null hypothesis that this degree is one [p-value = 0 (OLS, NLS)]. These results show that the short run degree of income correction was estimated accurately.

Generally, the results given in table T.JP.5 are satisfactory in all aspects. However, for a model to be "good", it must also be stable and with good forecasting abilities.

6.4.1 The stability and the forecasting accuracy of the model.

The examination of the stability of our model was done through the evaluation of the 1-step recursive residuals, and the 1-step and N-step (up and down) Chow tests. These tests are presented at diagram JP.3 below:

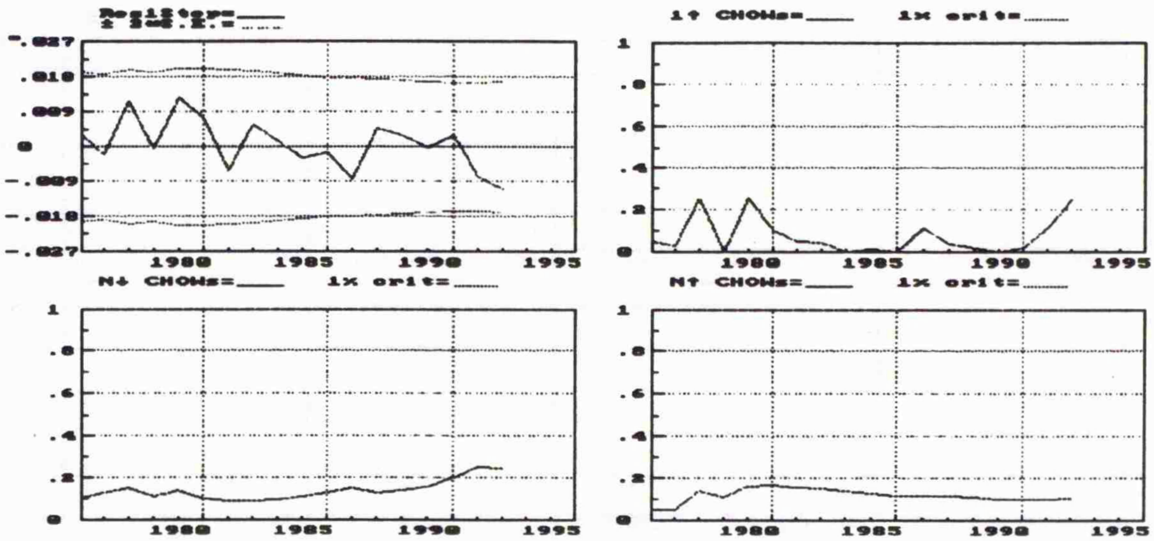


Diagram JP.3

As it can be seen from this diagram our model is stable. The stability of the model is also evident at diagram JP.4 below, where the recursive estimates of the individual coefficients are presented.

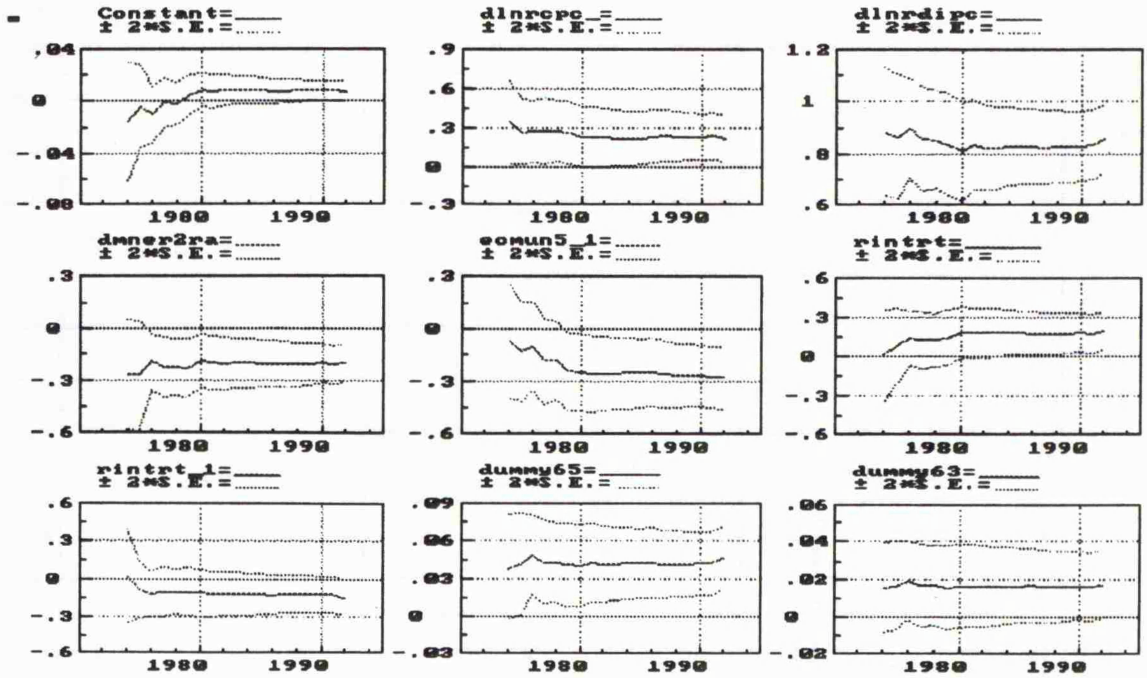


Diagram JP.4

As it can be seen from this diagram, if one excludes the first few years none of the parameters appears to suffer from instability[4].

Regarding now the forecasting accuracy of the model, conclusion can be drawn from diagram JP.5 below that presents the actual values together with the forecasted values and the ± 2*SE of the corresponding forecast error centred on the forecasted value.

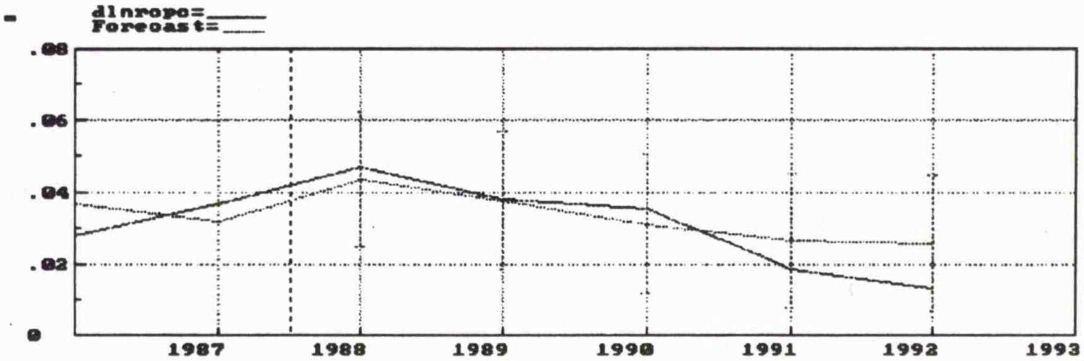


Diagram JP.5

As it can be seen, the forecasting ability of the model was really very good. In all cases the actual value was well within the ± 2*SE bounds of the forecasted value. The good forecasting ability of our model is also manifested from the forecast Chi-square test, that gave a p-value equal to 0.6744.

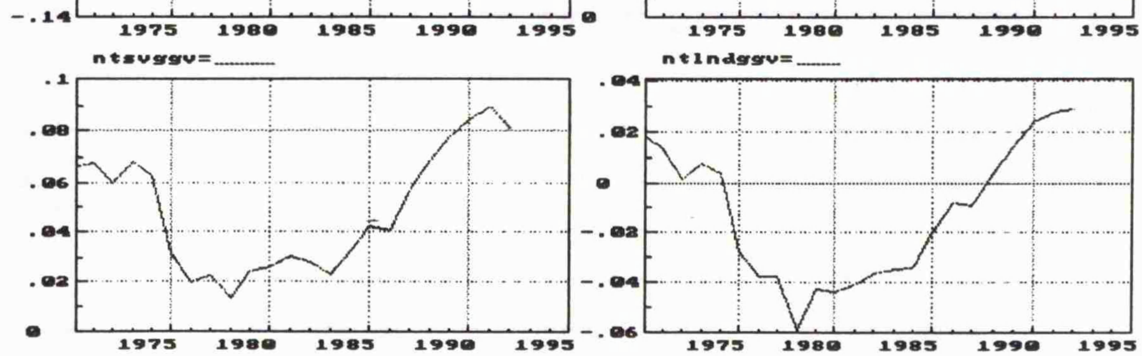
After the above analysis, the conclusion is that the model is stable and with good forecasting abilities. Taking also into account what was said in the previous section, we can conclude that the model is very good in every aspect.

[4]The instability of the first years is caused by the small number of observations that were available to obtain the corresponding estimates.

6.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB)

6.5.1 A look at the paths of the main variables of the analysis.

Having estimated the long run and the short run degree of income correction it is now time to use these estimates to derive estimates of the long run and the short run ex-ante inflation corrected CAB. However, before doing so it is good to examine the paths that the main variables of the analysis followed, as well as some basic statistics about these variables. This is done through diagram JP.6 and table T.JP.6 below. Starting from diagram JP.6 the plots of the following variables are presented (from the top left to the right): net financial liabilities, gross interest payments, net saving, net lending, gross foreign debt and the inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government while the fifth variable is expressed as a ratio to the net financial liabilities and refers to the central government.



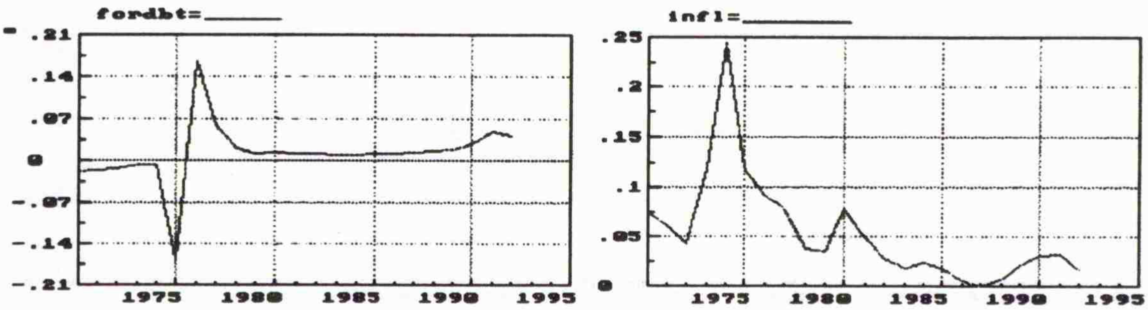


Diagram JP.6

Table T.JP.6

Variable	**Minimum (Year)**	**Maximum (Year)**	**Average**
Net Fin. Liabil. (% GDP)	- 7.3 (1971)	27 (1984)	10.3
Interest Payments (% GDP)	0.6 (1970)	4.4 (1985)	2.85
Net Saving (% GDP)	1.38 (1978)	8.96 (1991)	4.86
Net Lending (% GDP)	-5.87 (1978)	2.88 (1992)	-1.25
Foreign Debt (% Tot. Debt)	-16.6 (1975)	16.6 (1976)	1.29
Inflation (%)	0.08 (1987)	24.34 (1974)	5.4

From both the diagram and the table, it can be seen that the percentage of the net financial liabilities of the general government was negative in the first six years of the sample taking its lowest value in 1971 where it was -7.3% of GDP. However, after that year it was increasing until it got its maximum value in 1984 where it was 27% of GDP. Then, it started falling and it was less than 10% in the later years of the sample. Therefore, one could say that the net financial liabilities of the government were a rather small percentage of GDP. This is also evident from the average value of this variables which was only 10.3% of GDP.

Regarding the percentage of the gross interest payments, it followed a path similar to the one of the net financial liabilities. The average value of this variable was 2.85% with the highest value be 4.4% of GDP in 1985 and the lowest one 0.6% in 1970.

Regarding the percentage of the CCAB to GDP it was positive for all the period taking an average value equal to 4.86%. Similar to the path of the CCAB was the path followed by the percentage of the net lending to GDP, though this time the relative percentage was negative for many years after the first oil shock. Its average value for all the period was -1.25 % with the highest value be 2.88% of GDP in 1992 and the lowest one -5.87% in 1978.

Finally, the inflation rate was less than 10% for all the period except for the 2-3 years after the first oil sock. The low inflation rate is also reflected in the average value of this variable which was only 5.4%.

6.5.1 Estimates of the ex-ante inflation corrected CAB

Having described the paths that the variables of the analysis followed, it is now time to give estimates of the ex-ante inflation corrected CAB. To estimate the corresponding figures the following formula was applied:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.JP.2}$$

where the notation is as in the previous case studies.

Table T.JP.7 below presents estimates of the ex-ante inflation correction and of the ex-ante inflation corrected CAB both for the short run and for the long run. For comparison reasons we also present figures for the conventional CAB.

Table T.JP.7: The conventional and the ex-ante inflation corrected CAB

Year	**Conventional Current Account Balance (CCAB)**	**Short Run Ex-Ante Inflation Erosion**	**Short Run Ex-ante Inflation Corrected CAB**	**Long Run Ex-Ante Inflation Erosion**	**Long Run Ex-ante Inflation Corrected CAB**
1970	0.0664	-0.0009	0.0655	-0.0016	0.0648
1971	0.0676	-0.0010	0.0665	-0.0017	0.0659
1972	0.0599	-0.0007	0.0591	-0.0012	0.0586
1973	0.0678	-0.0010	0.0667	-0.0017	0.0660
1974	0.0627	-0.0021	0.0605	-0.0036	0.0591
1975	0.0315	-0.0014	0.0301	-0.0024	0.0291
1976	0.0196	0	0.0197	0	0.0197
1977	0.0224	0.0007	0.0231	0.0011	0.0235
1978	0.0137	0.0011	0.0148	0.0018	0.0155
1979	0.0241	0.0010	0.0252	0.0017	0.0259
1980	0.0258	0.0020	0.0279	0.0033	0.0292
1981	0.0305	0.0027	0.0332	0.0044	0.0349
1982	0.0279	0.0018	0.0298	0.0031	0.0311
1983	0.0231	0.0013	0.0244	0.0021	0.0252
1984	0.0322	0.0012	0.0335	0.0020	0.0343
1985	0.0426	0.0012	0.0438	0.0020	0.0446
1986	0.0409	0.0007	0.0417	0.0012	0.0422
1987	0.0569	0.0001	0.0571	0.0003	0.0572
1988	0.0684	0.0001	0.0686	0.0002	0.0687
1989	0.0783	0.0005	0.0788	0.0008	0.0791
1990	0.0840	0.0007	0.0847	0.0011	0.0852
1991	0.0896	0.0005	0.0901	0.0008	0.0904
1992	0.0815	0.0003	0.0818	0.0005	0.0820

(All figures are ratios to GDP)

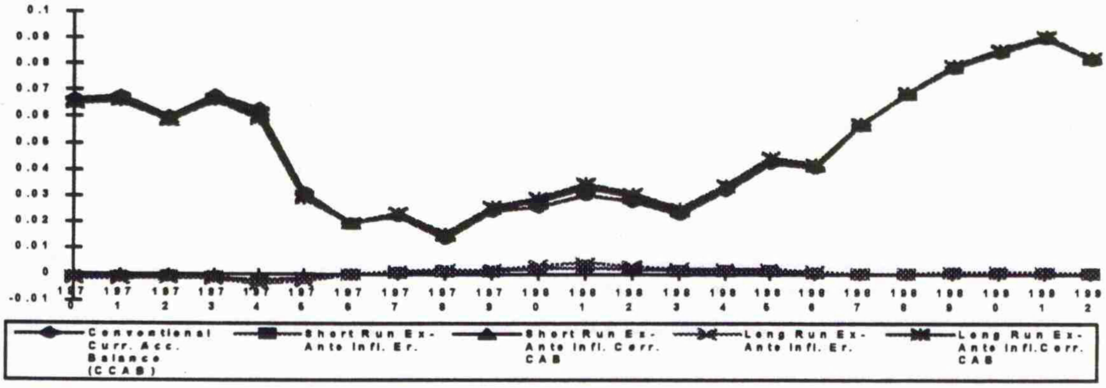


Diagram JP.7

The estimates given in table T.JP.7 are also reproduced in diagram JP.7 above. From both the table and the diagram the conclusion is that the ex-ante inflation erosion is insignificant as a percentage of GDP. Indeed its maximum value was no more than just 0.27% of GDP in the short run and 0.44% in the long run. This must not be surprising since in the Japanese case, all the factors that determine the magnitude of inflation erosion were of minor importance. Indeed, both the net financial liabilities and the inflation rate were low. Additionally, the degree of income correction was small both in the short run and in the long run. Since the inflation correction as a percentage of GDP is the product of the percentage of net financial liabilities to GDP, the expected inflation rate and the corresponding degree of income correction and since all these factors were small in magnitude, it is not surprising that the inflation correction is also small.

6.5.2 Estimates of the ex-post inflation corrected CAB

Having estimated the ex-ante inflation corrected CAB it is interesting to estimate the ex-post one as well. To derive the ex-post estimates the following two formulas were applied:

$$CORDEF2 = CAB + \pi DB \qquad \text{E.JP.3}$$

$$CORDEF3 = CAB + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.JP.4}$$

where the notation is as in the previous case studies.

The differences and the reliability of the above two measures have already been discussed in other case studies and they will not be repeated here. Estimates of the inflation erosion and of the ex-post inflation corrected CAB, based on both E.JP.3 and E.JP.4 are given in table T.JP.8 below.

Table T.JP.8: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance	Inflation Erosion according to E.JP.3	CORDEF2	Inflation Erosion according to E.JP.4	CORDEF3
1970	0.0664	-0.0050	0.0614	-0.0050	0.0614
1971	0.0676	-0.0041	0.0635	-0.0040	0.0636
1972	0.0599	-0.0028	0.0571	-0.0027	0.0571
1973	0.0678	-0.0067	0.0610	-0.0067	0.0611
1974	0.0627	-0.0127	0.0499	-0.0121	0.0499
1975	0.0315	-0.0041	0.0274	-0.0041	0.0273
1976	0.0196	0	0.0197	0.0001	0.0198
1977	0.0224	0.0028	0.0252	0.0034	0.0258
1978	0.0137	0.0030	0.0168	0.0035	0.0173
1979	0.0241	0.0045	0.0287	0.0040	0.0282
1980	0.0258	0.0122	0.0380	0.0125	0.0384
1981	0.0305	0.0090	0.0395	0.0088	0.0393
1982	0.0279	0.0059	0.0339	0.0058	0.0337
1983	0.0231	0.0046	0.0277	0.0046	0.0278
1984	0.0322	0.0060	0.0383	0.0058	0.0381
1985	0.0426	0.0047	0.0473	0.0053	0.0480
1986	0.0409	0.0016	0.0426	0.0022	0.0432
1987	0.0569	0.0001	0.0571	0.0008	0.0578
1988	0.0684	0.0013	0.0698	0.0013	0.0697
1989	0.0783	0.0034	0.0817	0.0030	0.0813
1990	0.0840	0.0036	0.0877	0.0038	0.0878
1991	0.0896	0.0023	0.0919	0.0025	0.0921
1992	0.0815	0.0009	0.0824	0.0009	0.0824

(All figures are ratios to GDP)

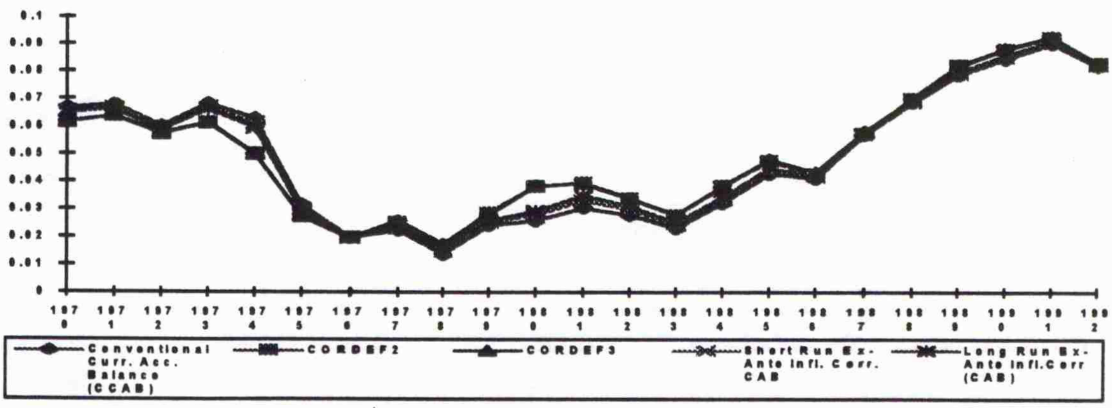


Diagram JP.8

The estimates given in table T.JP.8 are also presented at diagram JP.8 above, together with the ex-ante and the conventional figures. As it can be seen from that diagram, the inflation erosion, either ex-post or ex-ante, is not quantitatively important.

6.6 Summary of the results

In this study we examined the case of Japan. The main results of the analysis are as follows:

i) All the variables are I(1) except for the real interest rate which is I(0).

ii) According to the Johansen procedure there are two cointegrating vectors that are statistically significant at the 5% level. The fact that for one more time we found more than one cointegrating vectors signifies the danger of using the OLS when more than two variables are employed in the analysis. From those two cointegrating vectors one had its coefficients with signs and magnitudes that were in accordance to what is expected from a consumption function.

iii) According to the chosen cointegrating vector, the long run elasticity of consumption with respect to income is 0.884 while the corresponding elasticity with respect to wealth 0.095. Wealth, in the form of liquid assets, is statistically significant.

iv) The long run degree of income correction was found equal to 0.3797 which is rather low. A possible reason for this is that the inflation erosion that the households experienced during the period of our sample was small since the inflation rate was small. For this reason people might not have been fully aware of the effects of the inflation in the real value of their monetary assets.

v) Based on the chosen cointegrating vector an ECM was formulated for the representation of the short run dynamics. The exogeneity of the independent variables was verified using the Hausman-Wu exogeneity test. The performance of the ECM was very good in all aspects.

vi) The short run degree of income correction was found equal to 0.23 which is low and lower than the long run degree. However, the null hypothesis that this degree is equal to zero was rejected.

vii) Finally, estimates of the ex-ante and ex-post inflation corrected CAB were derived. From those estimates the conclusion is that the inflation correction is not quantitatively important for Japan, since all the factors that determine its size are not quantitatively important. Therefore, one could say that the conventional CAB is not much distorted and conclusions drawn from it will not be much different from the conclusions drawn from its inflation corrected counterparts (ex-post and ex-ante).

CASE STUDY 7

THE NETHERLANDS

7.1 The integration properties of the data

As in all previous case-studies, the order of integration of the variables was examined visually and statistically. Starting from the visual examination, conclusions can be drawn from diagram NTH.1 below that presents the plots of the variables in levels.

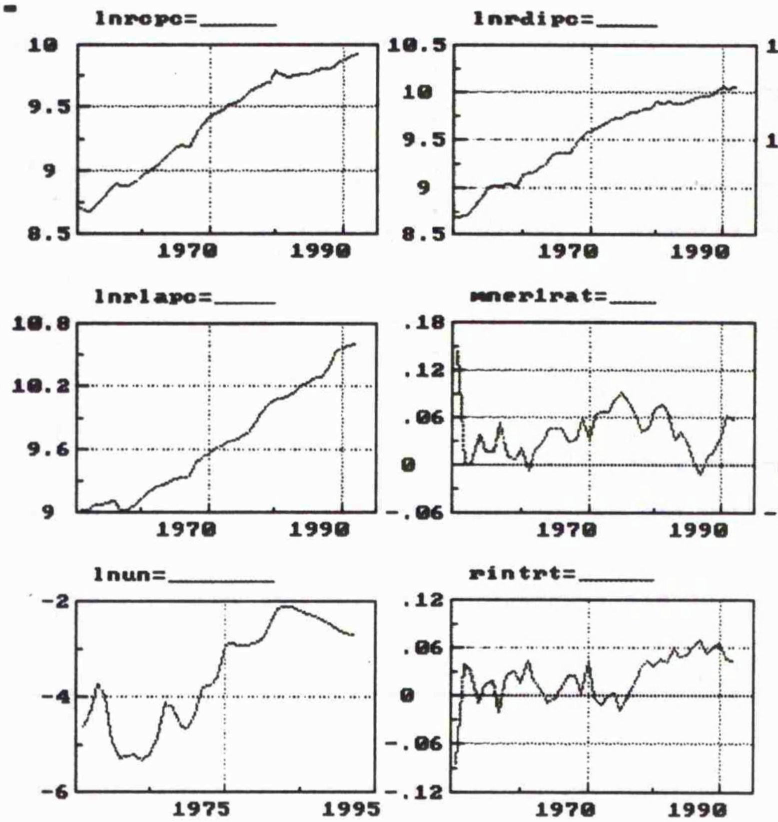


Diagram NTH.1

As it can be seen from this diagram, the first four variables are clearly non-stationary. Regarding the monetary erosion variables (fifth and sixth plot), though they are more volatile they are rather non-stationary as well. Finally, regarding the lnun and the rintrt, though it is theoretically expected that they are stationary, both of them show clear signs of non-stationarity. This is more evident for the unemployment variable and if there is a case to be stationary this will happen only around a time trend and/or a constant. On the other hand, the case of the real interest rate is really more difficult since it does not seem to follow any specific trend, at least for the first twenty five years of the sample. However, after that it is clearly a bit trendy.

Therefore, the conclusion from the diagrammatic analysis is that with the exception of the variables that are theoretically expected to be stationary and for which visual conclusions are not very clear, all the other variables are rather non-stationary. However, this conclusion must also be confirmed by formal statistical tests. Table T.NTH.1 below presents the results of the DF/ADF unit root tests.

Table T.NTH.1: Unit Root Tests

Variable	ADF(2)	ADF(1)	DF	Period	C, T
lnrcpc	-0.70181	-0.96658	-0.85215	1954-1992	C, T
lnrdipc	-1.3811	-1.4820	-1.5590	1954-1992	C, T
lnrlapc	-2.9868	-3.2825	-2.9519	1954-1992	C, T
lnrwpc	-2.9671	-3.2518	-2.7326	1954-1992	C, T
mner1rat	-0.50091	-0.76242	-1.0435	1954-1992	
mner2rat	-0.35743	-0.43090	-0.35155	1954-1992	
lnun	-2.8032	-3.8554*	-2.5620	1959-1992	C, T
rintrt	-0.29118	-1.1237	-1.7158	1954-1992	
dlnrcpc	-4.0031*	-4.6206**	-5.6008**	1955-1992	C, T
dlnrdipc	-4.6929**	-4.7976**	-6.6650**	1955-1992	C, T
dlnrlapc	-4.3502**	-4.4112**	-4.5255**	1955-1992	C, T
dlnrwpc	-3.8991*	-4.2249**	-4.1241*	1955-1992	C, T
dmner1rat	-3.3786**	-5.599**	-7.7529**	1955-1992	

dmner2rat	-2.9104**	-4.1059**	-4.3717**	1955-1992	
drintrt	-4.0664**	-7.1814**	-9.6290**	1955-1992	

As it can be seen from the above table, the first six variables are non-stationary. Regarding the two variables that we expect to be stationary, the one of them, the real interest rate, is non-stationary according to all types of tests, while for the other (the unemployment rate) the conclusion is dependant on the lag length and therefore more examination is needed. By doing this examination, it was found that the second lag in the ADF regression is unnecessary and its elimination doesn't cause autocorrelation. Thus, the most appropriate test is the ADF(1) according to which the unemployment rate is non-stationary[1].

Having established that apart from the lnun, the null hypothesis that the corresponding variable in levels is I(1) cannot be rejected for any of the variables the next step is to test the hypothesis that the corresponding non-stationary variable is I(2). This is done by testing the hypothesis that the first difference of the corresponding non-stationary variable is I(1). According to the results presented at table T.NTH.1, none of the variables is I(2) since the corresponding null hypothesis is always rejected.

Therefore the conclusion from the above analysis is that, apart from the unemployment rate, all the variables of the analysis are I(1).

7.2 The lag length of the VAR

Having established the order of integration of the various variables of the analysis, we can now move to the second step of the analysis: the determination of the lag length of the VAR model. To establish this lag length, we must first decide

[1]Elimination of the first lag causes autocorrelation at the 1% level of significance.

which of the available wealth and monetary erosion variables will be used. To make this decision, the Johansen procedure was run experimentally using various lag lengths and alternative definitions of the wealth and the monetary erosion variables. In all cases, the lnrlapc and the mner2rat performed better than their corresponding alternatives. Thus, the analysis will continue with these two variables.

Having made the choice of the wealth and the monetary erosion variables we can now estimate the individual equations of the VAR using various lag-lengths and evaluating the corresponding autocorrelation diagnostics. By doing this it was found that the shortest lag length for which there is no problem with autocorrelation is two. Table T.NTH.2 below presents autocorrelation diagnostics for this lag-length

Table T.NTH.2: VAR diagnostics (VAR length = 2)

Variable	AR1-1	AR1-2	AR1-3	AR1-4	ARCH1
lnrcpc	0.1935	0.2369	0.3246	0.4520	0.2523
lnrdipc	0.6052	0.8674	0.9549	0.9186	0.8524
lnrlapc	0.5712	0.6235	0.7774	0.508	0.8609
mner2rat	0.5483	0.8149	0.8358	0.4137	0.6463

(the numbers in the cells are p-values)

The analysis below will continue assuming a lag-length equal to two.

7.3. The Long Run Consumption Function

Having established the lag length of the VAR, we can now apply the Johansen approach starting from tests about the number of the statistically which of the available wealth and monetary erosion variables will be used. To make this decision, the Johansen procedure was run experimentally using various lag lengths and alternative definitions of the wealth and the monetary erosion variables. In all cases, the lnrlapc and the mner2rat performed better than their corresponding alternatives. Thus, the analysis will continue with these two variables.

Having made the choice of the wealth and the monetary erosion variables we can now estimate the individual equations of the VAR using various lag-lengths and evaluating the corresponding autocorrelation diagnostics. By doing this it was found that the shortest lag length for which there is no problem with autocorrelation is two. Table T.NTH.2 below presents autocorrelation diagnostics for this lag-length

Table T.NTH.2: VAR diagnostics (VAR length = 2)

Variable	**AR1-1**	**AR1-2**	**AR1-3**	**AR1-4**	**ARCH1**
lnrcpc	0.1935	0.2369	0.3246	0.4520	0.2523
lnrdipc	0.6052	0.8674	0.9549	0.9186	0.8524
lnrlapc	0.5712	0.6235	0.7774	0.508	0.8609
mner2rat	0.5483	0.8149	0.8358	0.4137	0.6463

(the numbers in the cells are p-values)

The analysis below will continue assuming a lag-length equal to two.

7.3. The Long Run Consumption Function

Having established the lag length of the VAR, we can now apply the Johansen approach starting from tests about the number of the statistically significant cointegrating vectors. These tests are presented at tables T.NTH.3.1 and T.NTH.3.2 below.

Table T.NTH.3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
40 observations from 1953 to 1992. Maximum lag in VAR = 2. List of variables included in the cointegrating vector: LNRCPC LNRDIPC LNRLAPC MNER2RAT Intercept List of eigenvalues in descending order: .55822 .42842 .38940 .20060 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	32.6778	28.1380	25.5590
r<= 1	r = 2	22.3743	22.0020	19.7660
r<= 2	r = 3	19.7322	15.6720	13.7520
r<= 3	r = 4	8.9558	9.2430	7.5250

Table T.NTH. 3.2

Johansen Maximum Likelihood Procedure (Non-trended case) Cointegration LR Test Based on Trace of the Stochastic Matrix				
40 observations from 1953 to 1992. Maximum lag in VAR = 2. List of variables included in the cointegrating vector: LNRCPC LNRDIPC LNRLAPC MNER2RAT Intercept List of eigenvalues in descending order: .55822 .42842 .38940 .20060 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	83.7401	53.1160	49.6480
r<= 1	r>= 2	51.0623	34.9100	32.0030
r<= 2	r>= 3	28.6880	19.9640	17.8520
r<= 3	r = 4	8.9558	9.2430	7.5250

As it can be seen from the above tables, there are three cointegrating vectors at the 5% level of significance. When these three vectors were normalised on consumption, the first had its coefficients with signs and magnitudes that were in accordance to what is expected from a long run consumption function.

The long run consumption function that corresponds to this cointegrating vector is as follows:

lnrcpc=-0.39+0.98918*lnrdipc+0.035585*lnrlapc - 0.15154*mner2rat E.NTH.1

As it can be seen from E.NTH.1, the long run elasticity of consumption with respect to income is about 0.99 while the corresponding elasticity with respect to wealth is 0.0356. Generally, the long run elasticity with respect to wealth is rather low. Regarding the coefficient of our particular interest, i.e. the long run degree of income correction, it is equal to 0.1529 which is very low and denotes significant money illusion in the long run[2].

One of the many virtues of the Johansen approach is that it permits the performance of statistical tests about the value of the long run parameters. The results of these tests are presented at table T.NTH.4 below. In that table a_0 corresponds to the constant term, a_1 to the coefficient of lnrdipc and so on.

Table T.NTH.4

Restriction	**p-value**
$a_0 = 0$	0.014
$a_1 = 0$	0.001
$a_2 = 0$	0.024
$a_3 = 0 \ (\Leftarrow \delta_L = 0)$	0.018
$a_3 = - a_1 \ (\Leftarrow \delta_L = 1)$	0.003

[2]For information reasons it may be worthy to refer that the long run degree of income correction implied by the other cointegrating vectors was highly negative.

As it can be seen from the above table, all the variables that appear in the long run function E.NTH.1 are statistically significant. This also happens for the mner2rat, tests on which can be interpreted as indirect tests about the value of the degree of income correction. Thus, according to the above table, the long run degree of income correction is statistically different from zero despite the fact it was found very low in E.NTH.1. However, it is very probable that this happens because in the other two cointegrating vectors the corresponding degree was highly negative. Therefore, the rejection of a zero degree of income correction may not be in favour of a positive one but in favour of a negative one. On the other hand, the rejection of the null hypothesis that $\delta = 1$ surely is not surprising at all.

Finally, it is worth to mention that the wealth variable is statistically significant, despite the fact that it is small in magnitude. This fact gives support to the life-cycle theory of consumption.

7.4 The Short Run Consumption Function.

Having established the long run consumption function the next step is to use the residuals of this function to formulate an ECM. To arrive at the final form of the model, we applied the general to specific method. Following this method, we started from a fairly general model where each variable was initially introduced with two lags. Then, by using t/F tests we narrowed down the model until we arrived at the final equation that is presented at table T.NTH.5 below:

Table T.NTH.5: The Error Correction Model

Modelling dlnrcpc by OLS The present sample is: 1956 to 1992					
Variable	**Coefficient**	**Std.Error**	**t-value**	**t-prob**	**PartR²**
Constant	-0.023939	0.0088574	-2.703	0.0112	0.1958
dlnrdipc	0.49585	0.089754	5.525	0.0000	0.5043
dmner2rat	-0.41514	0.19299	-2.151	0.0396	0.1336
dummy80	0.061829	0.014287	4.328	0.0002	0.3844
ect_1	-0.48438	0.10921	-4.435	0.0001	0.3961
lnun	-0.010515	0.0024059	-4.371	0.0001	0.3890
dlnrlapc	0.11853	0.069938	1.695	0.1005	0.0874

$R^2 = 0.828884$ F(6, 30) = 24.22 [0.0000] $\sigma = 0.012927$ DW = 1.69
RSS = 0.005013229082 for 7 variables and 37 observations
Information Criteria: SC = -8.22345; HQ = -8.42077; FPE = 0.000198723
AR 1- 1F(1, 29) = 0.38451 [0.5400]
AR 1- 2F(2, 28) = 0.98308 [0.3867]
ARCH 1 F(1, 28) = 1.4256 [0.2425]
Normality Chi²(2)= 0.2049 [0.9026]
Xi² F(11, 18) = 0.9574 [0.5139]
Xi*Xj F(21, 8) = 0.95154 [0.5683]
RESET F(1, 29) = 1.7697 [0.1938]

dummy80 is a dummy variable for 1980

Before we make any comment on the results of the above table, we should first check the exogeneity of the independent variables. The test that we used for this purpose was the Hausman-Wu exogeneity test[3]. According to this test, the null hypothesis of weak exogeneity cannot be rejected at any conventional level of significance (p-value = 0.3401). Therefore, the analysis will continue using the results of the above table.

According to these results the model fits the data very well. This is obvious both from the R^2 coefficient and the plots of the actual and fitted values that are given below in diagram NTH.2

[3]For details about how to perform this tests the reader is referred to the first case study.

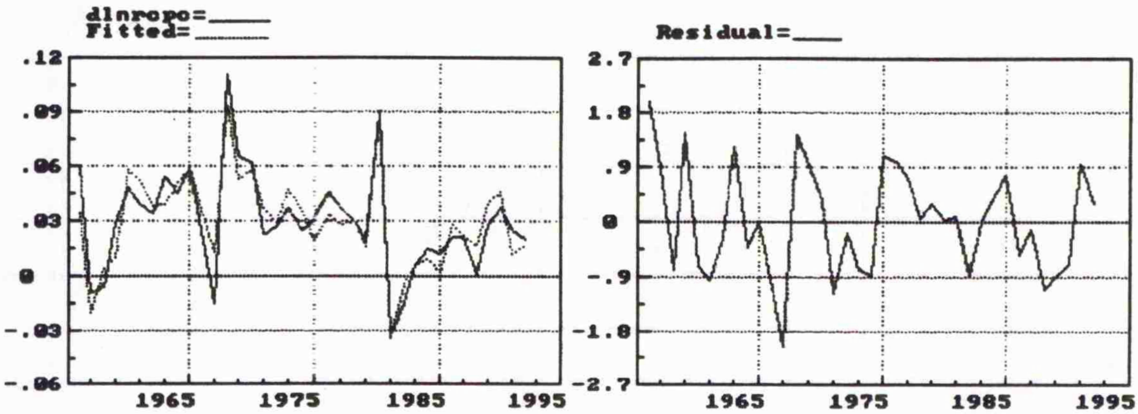


Diagram NTH.2

Apart from its goodness of fit, the model passed successfully all the usual statistical tests about the validity of the classical regression assumptions.

Regarding the individual coefficients and their significance, it can be seen that the error correction term is high both in magnitude and in significance. The impact elasticity of consumption with respect to income is 0.49585 while the corresponding elasticity with respect to wealth is 0.11853. The dummy variable, that was added because of instability in 1980, is strongly significant. Regarding the coefficient of our special interest, it was found equal to 0.837 which is more than five times higher than the corresponding long run estimate. This is a bit surprising since it is expected that the short run degree of income correction will be smaller or at most equal to the long run degree. However, though higher in absulute terms the short run degree of income correction is not statistically different from the long run one at the 5% level of significance (p-value = 0.0824 (OLS) and 0.0782 (NLS)). In the computations of the ex-ante inflation corrected CAB we will restrict this degree to be equal to the long run one.

7.4.1 The stability and the forecasting accuracy of the model.

The stability of the model was evaluated using the following four tests the results of which are presented at diagram NTH.3 below[4]

i) 1-step recursive residuals

ii) 1-step Chow - Test

iii) Break point F-tests (N↓ Step Chow - Tests)

iv) Forecast F-tests (N↑ Step Chow - Tests)

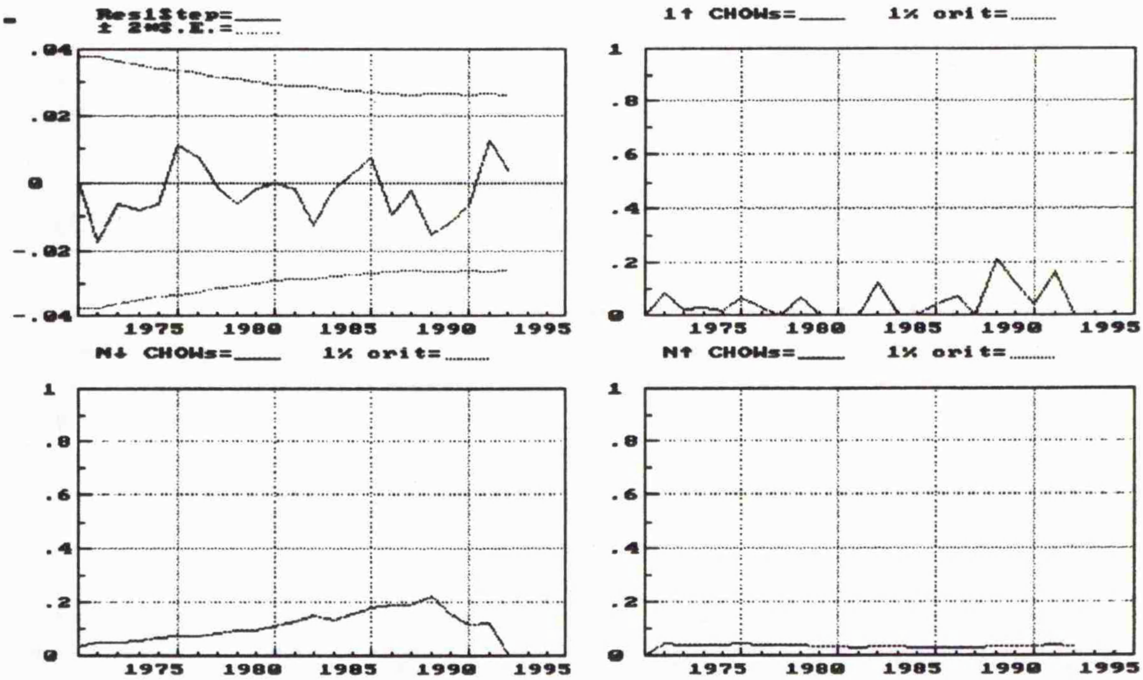


Diagram NTH.3

As it can be seen from the above diagram the model is stable.

Regarding the forecasting accuracy of the model, it was evaluated by re-estimating the model without the last five observations that were kept for 1-step

[4]The presence of the dummy variable didn't permit us to use recursive least squares. However, this is not a problem since the model can be transformed to a non-linear one and be estimated by non-linear recursive least squares (RNLS). The results of this section have been derived by RNLS.

ahead forecasts. As diagram NTH.4 below shows, the model has good forecasting abilities since for all years, the actual value was well within the lines that represent the ± 2*S.E of the corresponding forecast.

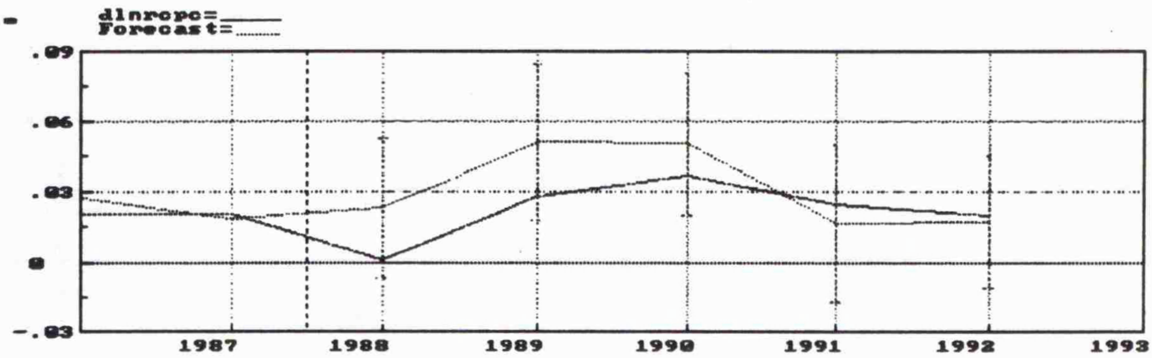


Diagram NTH.4

The good forecasting ability of the model is also obvious from the Forecast Chi-square statistic that gave a p-value equal to 0.1706.

From the above the conclusion is that the model is stable and with good forecasting abilities. This together with what we saw previously show a very satisfactory model.

7.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB)

7.5.1. A look at the paths of the main variables of the analysis.

Having obtained estimates of the long run and the short run degree of income correction, we can now use these estimates to derive corresponding estimates of the ex-ante inflation corrected Current Account government Balance (CAB). However, before doing so, it will be useful to have a look at the paths that the main variables of the analysis followed during the period of our sample. Diagram NTH.5 below presents the plots of the following variables (from the top left to the right): net financial liabilities, gross interest payments, net savings, net lending, gross foreign debt and inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government while the fifth variable is expressed as a ratio to the net financial liabilities and refers to the central government. The diagrammatic analysis is also accompanied with some descriptive statistics given in table T.NTH.6.

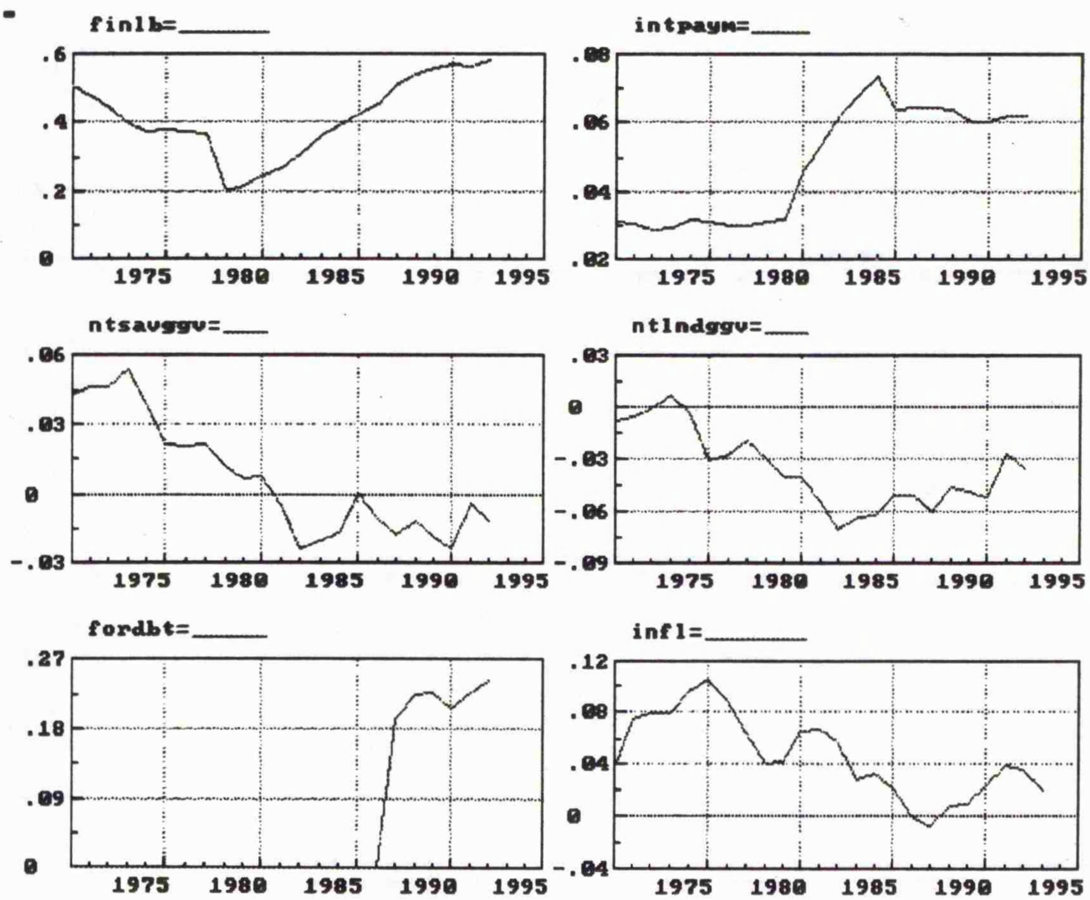


Diagram NTH.5

Table T.NTH.6

Variable	Minimum (Year)	Maximum (Year)	Average
Net Fin. Liabil. (% GDP)	19.7 (1978)	58 (1992)	41.3
Interest Payments (% GDP)	2.9 (1972)	7.3 (1984)	4.8
Net Saving (% GDP)	-2.37 (1990)	5.43 (1973)	0.7
Net Lending (% GDP)	-6.96 (1982)	0.8 (1973)	-3.5
Foreign Debt (% Tot. Debt)	0	24.34 (1992)	5.8
Inflation (%)	-0.72 (1987)	10.5 (1975)	4.6

As it can be seen from the first plot, the percentage of the net financial liabilities was falling till 1978 where it got its minimum value: 19.7% of GDP. After this year it increased steadily taking its highest value in the last year of the sample where it was 58%. The average value for the whole period was 41.3% which is rather moderate.

Regarding the percentage of the gross interest payments to GDP, though it was stable until 1979, within the next five years it more than doubled taking its highest value in 1984, where it was 7.3% of GDP. The average value of this variable was 4.8%, while the minimum value was 2.9% (1972).

Regarding the percentage of the CCAB to GDP, it was positive until 1980. However, after this year it became negative taking its lowest value in 1990 where it was -2.4% of GDP. The corresponding average value for all the period was 0.7%. However, this value was more the result of the balance of the positive percentages in the first 11 years of the sample with the negative ones of the later 12 years, than a value obtained frequently.

Similar to the path of the net savings was the path followed by the percentage of the net financial lending, with the difference that in most of the years it was negative, taking its lowest value in 1982 where it was nearly -7% of GDP. The average value of the net lending was -3.5%.

Finally, the inflation rate was rather low. Its highest value was 10.5% (1975), while the corresponding average value only 4.6%.

After the examination of the paths of the main variables the conclusion is that since the inflation rate was low and the net financial liabilities not terribly high, the inflation correction may not be high as a percentage of GDP.

7.5.1 Estimates of the ex-ante inflation corrected CAB

After the above descriptive analysis, it is now time to derive estimates of the ex-ante inflation corrected CAB. For this purpose we will use the estimates of the degree of income correction that were obtained previously. The formula that will be applied to derive the ex-ante inflation corrected figures is as follows:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.NTH.2}$$

where the notation is as in the previous case studies.

Table T.NTH.7 presents estimates of the short run and the long run ex-ante inflation corrected CAB together with figures of the conventional CAB. These estimates are also reproduced in diagram NTH.6

Table T.NTH.7

The conventional and the ex-ante inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Short Run and Long Run Ex-Ante Inflation Erosion	Short Run and Long Run Ex-Ante Inflation Erosion
1970	0.042	0.004	0.047
1971	0.046	0.003	0.050
1972	0.046	0.005	0.051
1973	0.054	0.004	0.059
1974	0.038	0.004	0.043
1975	0.021	0.005	0.026
1976	0.021	0.005	0.026
1977	0.021	0.004	0.025
1978	0.012	0.002	0.014
1979	0.006	0.001	0.008
1980	0.007	0.001	0.009
1981	-0.004	0.002	-0.002
1982	-0.023	0.002	-0.020
1983	-0.019	0.002	-0.017
1984	-0.016	0.001	-0.014
1985	0.001	0.001	0.002
1986	-0.010	0.0007	-0.009
1987	-0.017	-0.0002	-0.017
1988	-0.011	0	-0.011
1989	-0.017	0.0007	-0.017
1990	-0.023	0.001	-0.022
1991	-0.003	0.002	-0.000
1992	-0.011	0.003	-0.008

(all figures are ratios to GDP)

To produce the above figures we restricted the short run degree of income correction to be equal to the long run one.

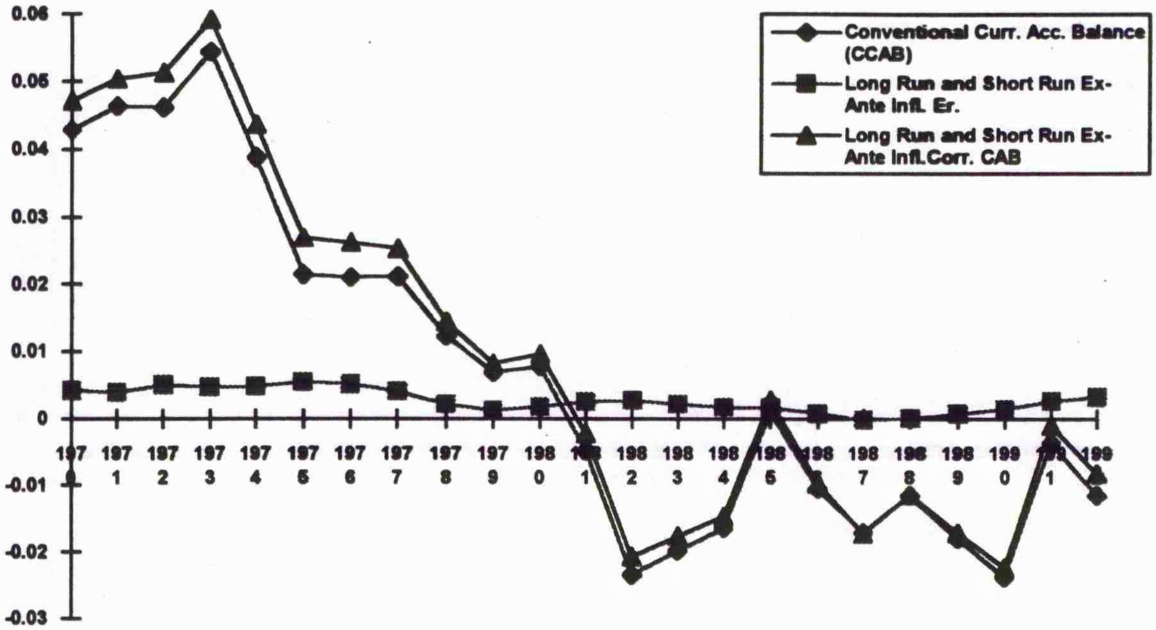


Diagram NTH.6

As it can be seen from the table and from the diagram, the ex-ante inflation corrected figures are moved very closely with the conventional figures. This means, that the perceived inflation erosion is of rather minor importance. The reason that this happens is because all the factors that determine the magnitude of the ex-ante inflation erosion are not quantitatively important. Indeed, the long run and short run degree of income correction were just 0.15. In addition, the inflation rate was also low and the same was true for the percentage of the net financial liabilities to GDP.

From the above analysis, the conclusion is that the usage of the conventional figures for the evaluation of the fiscal policy will not be too much distortive since, to a large extend, the erosion that inflation causes does not seem to be taken into account by people.

7.5.2 Estimates of the ex-post inflation corrected CAB

In the above section, the purpose was to derive estimates of the ex-ante inflation corrected CAB. In this section, we will consider the estimation of corresponding ex-post inflation corrected figures. The formulas that will be used for this purpose are given below:

$$CORDEF2 = CAB + \pi DB \qquad \text{E.NTH.3}$$

$$CORDEF3 = CAB + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.NTH.4}$$

where the notation is as in the previous case studies.

Table NTH.8 below, presents estimates of the inflation erosion and of the corrected ex-post figures of the CAB based on formulas E.NTH.3 and E.NTH.4. These figures are also presented at diagram NTH.7 together with the ex-ante figures derived in the previous section, and the conventional figures.

Table T.NTH.8: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance CCAB	Inflation Erosion according to E.NTH.3	CORDEF2	Inflation Erosion according to E.NTH.4	CORDEF3
1970	0.042	0.019	0.062	0.019	0.062
1971	0.046	0.034	0.080	0.034	0.080
1972	0.046	0.034	0.080	0.034	0.080
1973	0.054	0.031	0.085	0.031	0.085
1974	0.038	0.034	0.073	0.034	0.073
1975	0.021	0.037	0.059	0.037	0.059
1976	0.021	0.030	0.051	0.030	0.051
1977	0.021	0.022	0.044	0.022	0.044
1978	0.012	0.010	0.023	0.010	0.023
1979	0.006	0.008	0.015	0.008	0.015
1980	0.007	0.014	0.021	0.014	0.021
1981	-0.004	0.016	0.012	0.016	0.012

1982	-0.023	0.016	-0.006	0.016	-0.006
1983	-0.019	0.009	-0.010	0.009	-0.010
1984	-0.016	0.012	-0.004	0.012	-0.004
1985	0.001	0.008	0.010	0.008	0.0100
1986	-0.010	0.0004	-0.010	0.0004	-0.010
1987	-0.017	-0.003	-0.020	0.005	-0.011
1988	-0.011	0.004	-0.007	0.006	-0.004
1989	-0.017	0.005	-0.012	-0.003	-0.021
1990	-0.023	0.013	-0.010	0.030	0.006
1991	-0.003	0.021	0.017	0.018	0.014
1992	-0.011	0.020	0.009	0.028	0.016

(all figures are ratios to GDP)

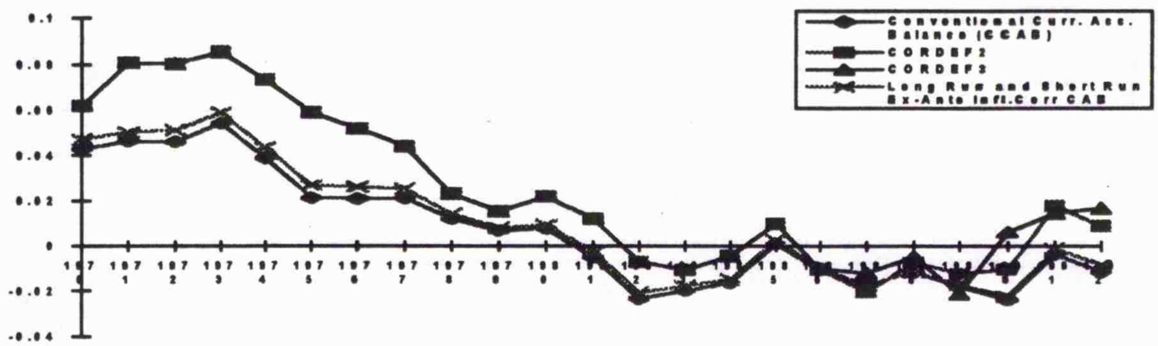


Diagram NTH.7

As it can be seen from the table and from the diagram, the inflation erosion is more significant in the case of the ex-post estimates than in the case of the ex-ante ones. It is characteristic that in 1975 the ex-post inflation erosion was as high as 3.77% of GDP i.e. a bit less than double the positive conventional CAB of that year (2.14%). Actually, in three cases the conventional CAB turned from negative to positive when the inflation erosion, as it is computed by E.NTH.3, was taken into account. The main reason that the ex-post inflation correction is significant and certainly much more significant than the corresponding ex-ante correction is because it is computed without taking into account the degree of income correction which only a decreasing role in the quantitative significance of the inflation correction can play. Finally, concerning the estimates of the ex-post figures that are based on E.NTH.4 these are not significally different from those derived by E.NTH.3 except for the later years of the sample. However, one has to bear in mind the reservations that were expressed about the reliability of these estimates.

Generally, the conclusion is that although the ex-ante inflation corrected figures are not significally different from the conventional ones, the reason being the low degree of income correction, this does not happen for the ex-post estimates. Indeed, the later are quantitatively different from the conventional ones. Therefore, although the conventional CAB does pretty well in giving the effects of the fiscal policy on the economy, it is not appropriate for the determination of the net position of the government in an inflation accounting sense.

7.6 Summary of the results

The results obtained in the above analysis can be summarised as follows:

i) Apart from the unemployment rate, all the variables are I(1) which means that they need to be differentiated once to become stationary.

ii) The Johansen cointegration analysis showed the existence of three cointegrating vectors at the 5% level of significance. This means that had the OLS method been applied the distortion of the estimates would have been significant. From these three cointegrating vectors, one had its coefficients with signs and magnitudes that were in accordance to what is expected from a long run consumption function.

iii) According to the chosen cointegrating vector, the long run elasticity of consumption with respect to income is 0.989 while the corresponding elasticity with respect to wealth is 0.0356. Wealth, in the form of liquid assets, appears to be significant in the cointegrating space which gives validity to the Life Cycle model of consumption.

iv) The long run degree of income correction was found only 0.153.

v) Based on the residuals of the chosen cointegrating vector an error correction model of consumption was estimated. The Hausman-Wu exogeneity test showed that there is no need to use the Instrumental Variables Method. The fitness of the model was very good and the model passed all the tests for the validity of the classical regression assumptions. Also the model was stable and with good forecasting abilities.

vi) The short run degree of income correction was found equal to 0.837 i.e. larger than the corresponding long run degree. However, it was not found statistically different from it. Since theoretically the short run degree of income correction should be less or equal to the long run one and since it was not statistically different from the long run one, in the estimates of the ex-ante inflation corrected CAB we restricted it to be equal to the long run one.

vii) Finally, estimates of the ex-ante and the ex-post inflation corrected CAB were derived. The ex-ante estimates didn't differ much from the conventional ones. The main reason for this is the low degree of income correction. In contrast, the ex-post inflation corrected figures differed significally from the conventional ones, which for one more time shows that it is not necessary all the inflation corrected measures to tell the same story.

CASE STUDY 8

NORWAY

8.1 The integration properties of the data

The purpose of this section is to examine the order of integration of the variables of the analysis. As in all previous cases, two approaches are followed. The first is based on conclusions from a visual exploration of the plots of the variables, while the second is more formal and is based on results from the performance of the popular DF/ADF tests. Diagram NOR.1 below presents the plots of the main variables of the analysis.

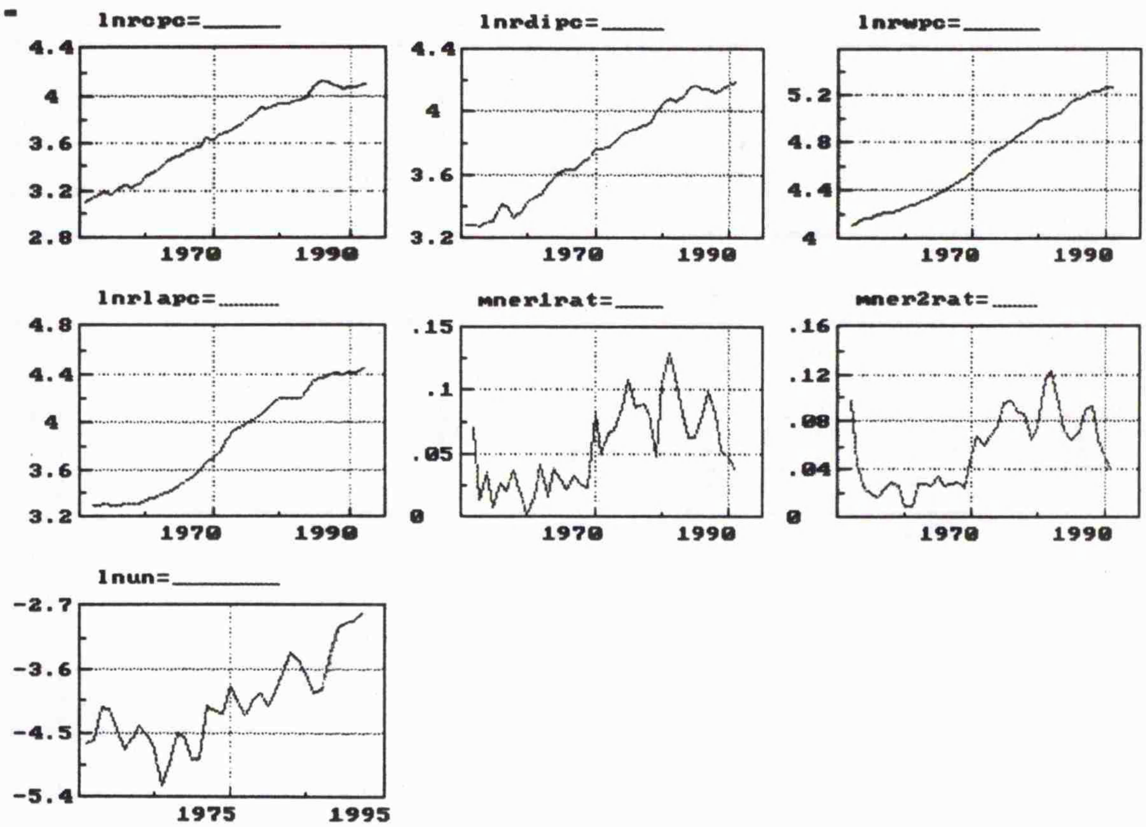


Diagram NOR.1

As it can be seen from the above diagram, the first four variables are clearly non-stationary. The monetary erosion variables, though they seem more volatile they are rather non-stationary as well. Finally, though the lnun variable is theoretically expected to be stationary, a look at the relative plot shows that it could be so only around a time trend and/or a constant.

Although, the visual examination is useful it can by no means substitute the performance of formal statistical tests. Table T.NOR.1 below presents the results obtained from the DF/ADF tests.

Table T.NOR.1: Unit Root Tests

Variable	**ADF(2)**	**ADF(1)**	**DF**	**Period**	**C, TR**
lnrcpc	-1.4052	-1.5388	-1.0047	1954-1992	C, TR
lnrdipc	-1.5535	-2.1622	-2.0375	1954-1991	C, TR
lnrlapc	-2.2964	-2.4369	-1.7739	1955-1992	C, TR
lnrwpc	-2.2985	-2.3822	-2.3095	1955-1991	C, TR
mner1rat	-0.70011	-0.80081	-1.0340	1955-1991	
mner2rat	-0.55372	-0.78641	-0.55880	1955-1991	
lnun	-2.1434	-3.6142*	-2.9384	1959-1992	C, TR
dlnrcpc	-3.7711**	-4.1876**	-5.2067**	1955-1992	C
dlnrdipc	-4.6160**	-5.3381**	-6.0218**	1955-1991	C
dlnrlapc	-2.6161	-3.5962*	-3.5466*	1956-1992	C
dlnrwpc	-1.5806	-2.5232	-2.5031	1956-1991	C
dmner1rat	-5.0325**	-5.5295**	-7.2601**	1956-1991	
dmner2rat	-4.4228**	-5.9279**	-4.4679**	1956-1991	
dlnun	-4.7624**	-6.7571**	-5.1277**	1960-1992	C, TR

As it can be seen from the above table, except for lnun, where the ADF(1) test rejects the null hypothesis, for all the other variables this hypothesis cannot be rejected which means that the corresponding variable is at least I(1). Regarding now the lnun variable, elimination of the second lag shows that there is autocorrelation at the 10% level of significance. Besides that, the value of the ADF(1) statistic is only marginally above the critical value for the 5% level of significance (-3.547). For this reason we decided to differentiate this variable before we use it in the ECM.

Having established that all the variables in levels are at least I(1), the next step is to check whether these variables are I(2). The way that this can be done is by testing the stationarity of the difference of each of the variables in levels. Results from the test of this null hypothesis are presented at the lower part of table T.NOR.1 (the variables in differences start with the letter d). As it can be seen from this table, the null hypothesis is rejected at the 1% level of significance for: dlnrcpc, dlnrdipc, dmner1rat, dmner2rat and dlnun. Regarding the two wealth variables, the null hypothesis is rejected only for the dlnrlapc variable and only for some types of tests. Yet, it can in no way be rejected for dlnrwpc. Regarding the dlnrlapc it is definitely I(0) since the first and the second lag in the ADF test are not necessary and therefore the simple DF test is enough. According to this test, dlnrlapc is stationary. Returning to the total wealth variable, the fact that it was found I(2) is contrary to the theoretical expectations, since if this variable is truly I(2) this means that its rate of growth is I(1)[1]. Since this case does not make sense one could assume that the cause of this result is sampling reasons.

From the above analysis the conclusion is that apart from total wealth, all the variables are I(1).

[1]If the variable in levels is I(2) then the variable that is derived from its first difference is I(1). Now since in our case the variable under examination is in logarithms, the first difference of this variable corresponds to the rate of growth. Therefore, if the total wealth variable was really I(2), its rate of growth would be I(1) which is not logical, from a theoretical point of view.

8.2 The lag length of the VAR.

After the establishment of the order of integration of the variables the next step is to define the lag length of the VAR model. However, prior to the estimation of the VAR and the evaluation of the relative diagnostics, we must choose the monetary erosion variable that will be used. This choice was made by running the Johansen procedure experimentally and using the two available choices alternatively. In all cases, mner2rat performed better than its alternative. Having made this choice, we estimated the VAR model for various lag lengths. Finally, a lag length equal to five was chosen. The autocorrelation diagnostics for this lag length are presented at table T.NOR.2 below.

Table T.NOR.2: VAR Diagnostics (lag length = 5)

Variable	AR1-1	AR1-2	AR1-3	AR1-4	AR1-5	ARCH1
lnrcpc	0.0527	0.0356*	0.0414*	0.0595	0.1204	0.8987
lnrdipc	0.7482	0.4742	0.4354	0.6133	0.5818	0.7083
lnrlapc	0.6369	0.2623	0.305	0.1956	0.2956	0.8184
mner2rat	0.7666	0.236	0.1073	0.1704	0.0377*	0.9535

(the numbers in the cells are p-values)

As it can be seen from this table, the null hypothesis of no autocorrelation is rejected in three out of twenty five cases. When we tried a larger lag-length this situation didn't improve at all. The possible reason for this, may be the problem of the degrees of freedom that becomes apparent with a large lag length. Therefore, the cointegration analysis will continue with a lag length equal to five.

8.3. The Long Run Consumption Function

Having defined the order of integration of the variables and the lag-length of the VAR model, we can now move to the Johansen procedure starting from tests about the number of the statistically significant cointegrating vectors. The results of the relative tests are given below in tables T.NOR.3.1 and T.NOR.3.2.

Table T.NOR.3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
35 observations from 1957 to 1991. Maximum lag in VAR = 5. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC List of eigenvalues in descending order: .50380 .29357 .19994 .063848				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	24.5272	27.0670	24.7340
r<= 1	r = 2	12.1636	20.9670	18.5980
r<= 2	r = 3	7.8074	14.0690	12.0710
r<= 3	r = 4	2.3092	3.7620	2.6870

Table T.NOR 3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
35 observations from 1957 to 1991. Maximum lag in VAR = 5. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRLAPC List of eigenvalues in descending order: .50380 .29357 .19994 .063848				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	46.8074	47.2100	43.9490
r<= 1	r>= 2	22.2802	29.6800	26.7850
r<= 2	r>= 3	10.1166	15.4100	13.3250
r<= 3	r = 4	2.3092	3.7620	2.6870

According to the first of the tables, the null hypothesis that there is no cointegration is not rejected at the 10% level of significance. However this happens only marginally. On the other hand, the trace test rejects this null hypothesis at the 10% level of significance in favour of the alternative that there is at least one cointegrating vector. Since the non-rejection in the case of the maximal eighnvalue test is only marginal and since the trace test is generally considered as more powerful than the maximal eigenvalue test, we assume that there is one cointegrating vector.

The long run consumption function that corresponds to this cointegrating vector is as follows:

lnrcpc = 0.75756*lnrdipc - 0.84605*mner2rat + 0.22866lnrlapc E.NOR.1

As it can be seen, the long run elasticity of consumption with respect to income is 0.75756 while the corresponding elasticity with respect to wealth is 0.22866 Regarding the long run degree of income correction, its indirect estimate is 1.117 which is above the maximum value that this coefficient can theoretically take. Restricting this coefficient to be equal to one (full degree of income correction) gave us the following long run consumption function:

lnrcpc = 0.77498*lnrdipc - 0.77498*mner2rat + 0.21048lnrlapc E.NOR.2

As it will be seen below this restriction cannot be rejected at any logical level of significance. From E.NOR.2, we can also see that the imposition of this restriction leaves almost unaffected the other coefficients. For these reasons, in the next section the error correction term will be formulated using E.NOR.2.

As it has already been said, one of the many virtues of the Johansen procedure is that it permits the performance of statistical tests about the value of the parameters. Table T.NOR.4 below, present the restrictions that were tested as well as the marginal significance level at which the corresponding restriction is rejected. All the tests were performed on the unrestricted cointegrating vector E.NOR.1.

Table T.NOR.4

Restriction	**p-value**
$a_1 = 0$	0.002
$a_2 = 0$ ($\Leftarrow \delta_L = 0$)	0.223
$a_2 = - a_1$ ($\Leftarrow \delta_L = 1$)	0.898
$a_3 = 0$	0.232

In the above table: a_1 corresponds to the first coefficient of E.NOR.1 (i.e. the coefficient of the disposable income) a_2 to the second coefficient (i.e to the one of mner2rat) and so on. As it can be seen from table T.NOR.4 the income variable is significant at the 1% level. However, this does not happen for the liquid assets variable which does not seem to be particularly significant. Regarding tests about the long run degree of income correction, these were carried out indirectly in a similar way with the one explained in the first case study. As it can be seen from the above table, the null hypothesis that the degree of income correction is equal to zero cannot be rejected. However, the same happens (though with much higher p-value) for the null hypothesis that this degree is equal to one. The inability of the tests to discriminate between full and zero degree of income correction means that the point estimate that was obtained is rather inaccurate.

8.4 The Short Run Consumption Function.

After the estimation of the long run consumption function, the next step is to use the residuals of the estimated long run equation to construct an ECM of consumption. To arrive at the final form of the model we utilised the general to specific method. At table T.NOR.5 below, we present the final equation as it was estimated by OLS.

Table T.NOR.5: The Error Correction Model

Modelling dlnrcpc by RLS
The present sample is: 1957 to 1991

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
dlnrdipc	0.25671	0.12520	2.050	0.0495	0.1266
dlnrlapc	0.56012	0.10782	5.195	0.0000	0.4820
dmner2rat	0.11026	0.25706	0.429	0.6711	0.0063
dlnun	-0.027216	0.012792	-2.128	0.0420	0.1350
ect_1	-0.27298	0.088996	-3.067	0.0046	0.2450
dummy70	-0.051451	0.022887	-2.248	0.0323	0.1484

$R^2 = 0.746184$ $\sigma = 0.0202594$ DW = 1.63
* R^2 does NOT allow for the mean *
RSS = 0.01190282015 for 6 variables and 35 observations
Information Criteria: SC = -7.37684; HQ = -7.55143; FPE = 0.000480804
AR 1- 1F(1, 28) = 1.1037 [0.3024]
AR 1-2F(2, 27)= 2.0147 [0.1529]
ARCH 1 F(1, 27) = 0.20354 [0.6555]
Normality Chi²(2)= 1.3553 [0.5078]
Xi² F(11, 17) = 0.36869 [0.9516]
RESET F(1, 28) = 0.83102 [0.3698]

dummy70 is a dummy variable for 1970

Before we comment on the results given in the above table, we must first check whether OLS is an appropriate method for the estimation of our model. As it was said, OLS is based on the assumption that the independent variables are exogenous and if this assumption is not valid then we will have to use the IVM. To test the validity of the exogeneity assumption, we used the Hausman-Wu exogeneity test[2]. According to this test the null hypothesis of weak exogeneity could not be rejected at any reasonable level of significance (p-value = 0.4348). Therefore, the analysis will continue using the results obtained by OLS.

Starting our comments on the above results from the goodness of fit, we must say that the R^2 coefficient given in the above table is rather inappropriate for the evaluation of the fitness of the model since the model does not have a constant term. More valid conclusions can be drawn from diagram NOR.2 below, where the actual and the fitted values are presented together with the scaled residuals. As it can be seen from this diagram, the fitness of the model is rather moderate if it is compared with what we obtained for other countries. However it is still good, especially if it is taken into account that the model is in differences.

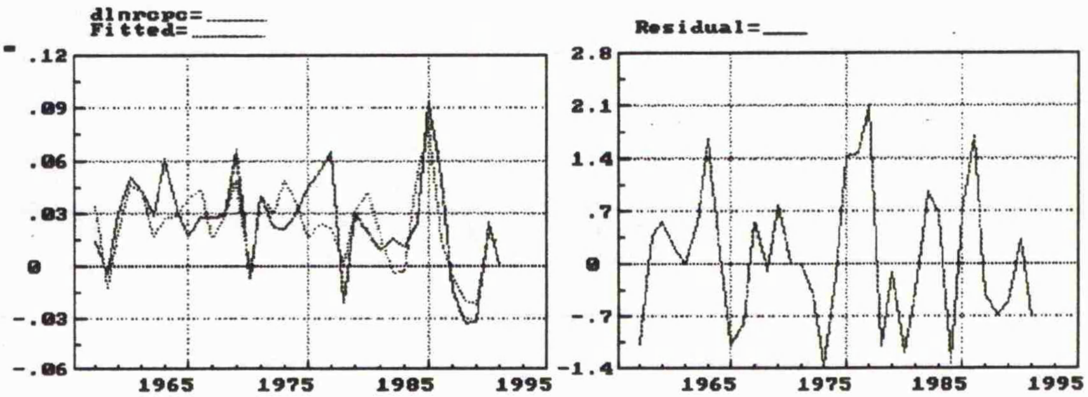


Diagram NOR.2

A look at table NOR.5 reveals that the models passes all the respective statistical tests successfully. In fact, not only it passes them but it also passes them with high p-values which leaves no doubt about the satisfaction of the classical regression assumptions.

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[2]For details about the specific way to perform this test the reader is referred to the first case study.

Regarding the individual coefficients, the short run elasticity with respect to income is 0.2567 while impression makes the magnitude of the corresponding elasticity with respect to liquid assets which is very high and equal to 0.56012. The error correction term is highly significant which also confirms the fact that E.NOR.2 is indeed a valid long run consumption function. Finally, the coefficient for which we are particularly interested i.e. the short run degree of income correction, is equal to -0.429 which is less than the minimum value that theoretically can take (zero). Actually this estimate is highly insignificant in both the direct and indirect types of tests [p-value = 0.6711 (OLS) and 0.6652 (NLS)]. However, it is also not significally different from one [p-value 0.2409 (OLS) and 0.1567(NLS)]. This shows that this degree was not estimated accurately. For the estimation of the ex-ante inflation corrected CAB we will assume that this degree is equal to the nearest possible value which is zero.

8.4.1. The stability and the forecasting accuracy of the model.

Regarding the stability of the model, this was examined by evaluation of the following four tests:

i) 1-step recursive residuals

ii) 1-step Chow - Test

iii) Break point F-tests (N↓ Step Chow - Tests)

iv) Forecast F-tests (N↑ Step Chow - Tests)

The results of these tests are presented at diagram NOR.3 below:

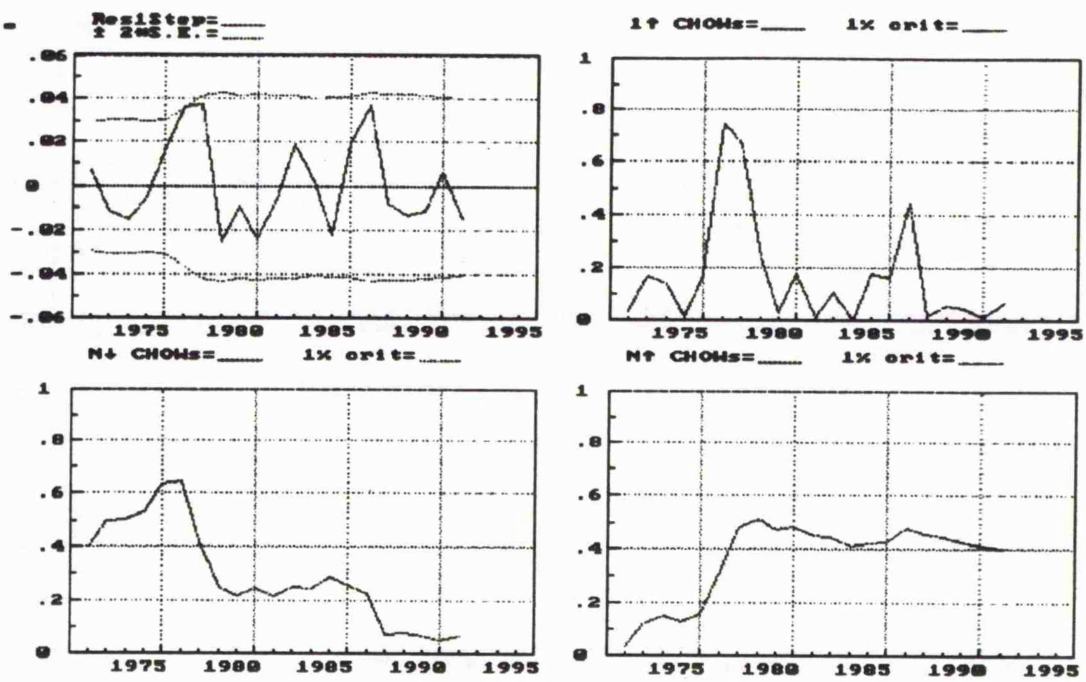


Diagram NOR.3

As it can be seen from this diagram, with the exception of the period 1976-1977 where the 1-step recursive residuals reached the +2*SE boundary[3] there is no problem of instability in our model.

Regarding now the forecasting ability of the model, it was tested by re-estimating the model without the five last observation that were kept for 1-step ahead forecasts. The actual values together with the forecasted values, and the ± 2SE of the forecast errors centred on the forecasted value, are presented below at diagram NOR.4. As it can be seen from this diagram, in all cases the forecasted and the actual values were very close to each other, which in turn indicates that the forecasts were very accurate. The ability of the model to give accurate forecasts is also evident from the fact that the corresponding forecast Chi-square statistic gave a p-value equal to 0.8869, which means that the null hypothesis of equality of all

[3]Though the 1-step Chow test is not statistically significant at the 1% level for the years 1976-1977, it is so at the 5% level

the coefficients (with the variance included) between the estimation and the forecast periods could not be rejected at any reasonable level of significance.

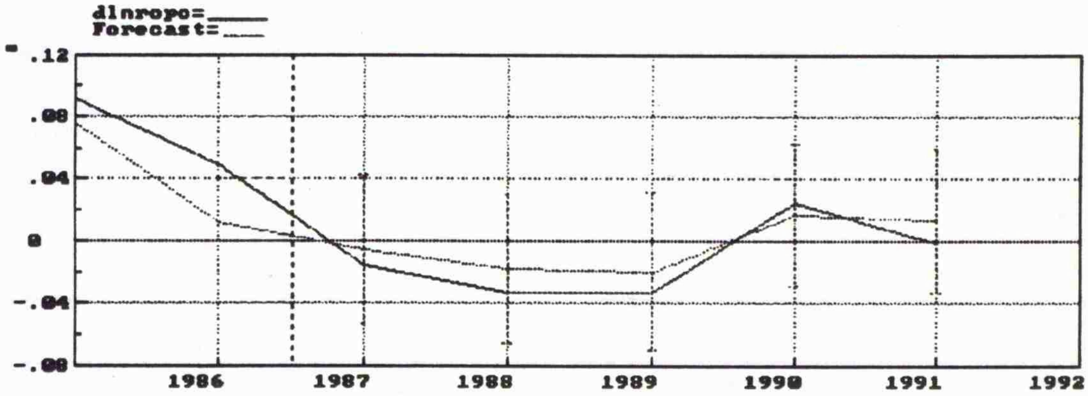


Diagram NOR.4

Therefore, we could say that the model is stable and able to give accurate forecasts.

8.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB)

8.5.1 A look at the paths of the main variables of the analysis.

Having estimated the degree of income correction in the short run and in the long run, we are now in a position to derive corresponding estimates of the ex-ante inflation corrected CAB. However, before doing so it is useful to have a look at the paths that the main variables of the analysis followed during the period of our sample. Diagram NOR.5 below gives the plots of the following variables (from the top left to the right): net financial liabilities, gross interest payments, net savings, net lending, gross foreign debt, and inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government, while the fifth variable is expressed as a ratio to the net financial liabilities and refers to the central government. To draw better conclusions, diagram NOR.5 is accompanied by table T.NOR.6 where some descriptive statistics for the above variables are presented.

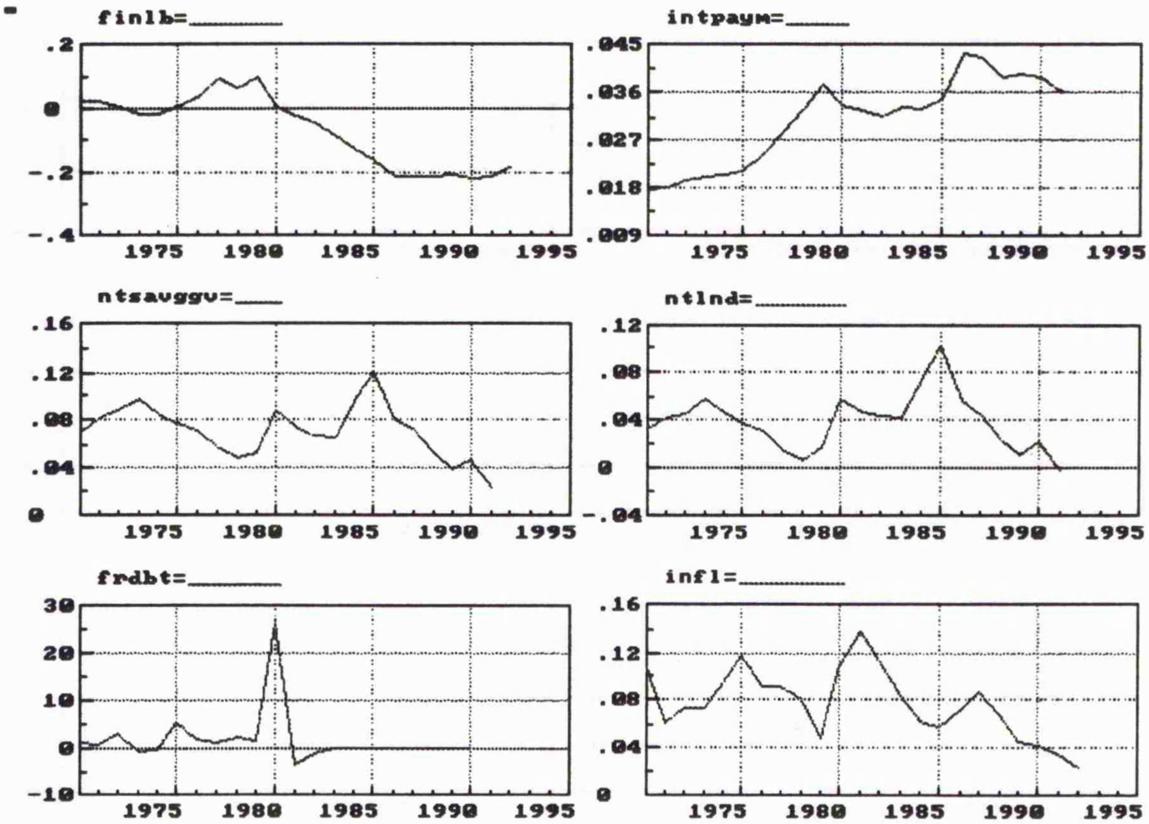


Diagram NOR.5

As it can be seen from diagram NOR.5, the path that the net financial liabilities followed during the period of our sample was opposite to the one followed by most of the other countries. Really, though in most of the countries the net financial liabilities increased through time, in Norway they decreased. More concretely, though the percentage of the net financial liabilities to GDP was positive during the first years of the sample taking its maximum value in 1979, (it was only 9.8% of GDP), it decreased rapidly after that year and it was negative for all the years after 1980. Its minimum value was -21.7% of GDP (1990) while its average value was -6.8%. The strong negativity of the net financial liabilities of the government means that the effects of inflation will be opposite from what would be the case if this percentage was positive. So, while if we had a positive debt the interest payments would be larger than what would be the case if there was no inflation, now, for the years that the net debt is negative, they will be lower.

Also, something else interesting is that although the net financial liabilities decreased throughout the period the gross interest payments as a percentage of GDP increased. However, this is not strange since the interest payments are gross, while the financial liabilities are net. Probably what happened is that the gross financial liabilities increased as a percentage of GDP, and this caused the increase of the percentage of the gross interest payments. On the other hand, the gross financial assets increased more than the liabilities and this produced the continuously decreasing net financial liabilities.

Table T.NOR.6

Variable	Minimum (Year)	Maximum (Year)	Average
Net Fin. Liabil. (% GDP)	-21.7 (1990)	9.8 (1979)	-6.8
Interest Payments (% GDP)	1.79 (1970)	4.34 (1986)	3.1
Net Saving (% GDP)	2.365 (1991)	12.08 (1985)	7.08
Net Lending (% GDP)	-0.271 (1991)	10.1712 (1985)	3.9047
Foreign Debt (% Tot. Debt)	-363.9 (1981)	26211 (1980)	164.05
Inflation Rate (%)	2.3197 (1992)	13.7786 (1981)	7.7648

Regarding now the net savings and the net lending both of them were positive in all the years of the sample, except for 1991 where the net lending was negative. The fact that the CAB was positive in all the years combined with the fact that the net financial liabilities were negative for many of the years of the sample implies that for those years the inflation corrected CAB will be less than the conventional one.

Finally, the inflation rate was rather moderate taking its maximum value in 1981, where it was 13.78% while its average value was 7.7648%.

From the above, one could say that the significance of the inflation correction will be rather moderate because of the combined effect of the moderate inflation rate and the moderate (in absolute values) percentage of the net financial liabilities.

8.5.2 Estimates of the ex-ante inflation corrected CAB.

It is now time to use the degrees of income correction obtained previously to estimate the ex-ante inflation corrected CAB. The formula that will be applied to estimate the ex-ante inflation corrected CAB is given below:

$$CORCAB = CCAB + \delta \pi^{e}_{t} DB \qquad \text{E.NOR.3}$$

where the notation is as in the previous case studies.

Depending on whether the short run or the long run degree of income correction is used, we can get respective estimates of the short run and the long run ex-ante inflation corrected CAB. Such estimates are presented at table T.NOR.7 and they are also reproduced in diagram NOR.6 below.

Table T.NOR.7
The conventional and the ex-ante inflation corrected CAB[4]

Year	Conventional Current Account Balance (CCAB)	Long Run Ex-ante Inflation Erosion	Long Run Ex-ante Inflation Corrected CAB
1970	0.069	0.001	0.071
1971	0.082	0.002	0.084
1972	0.088	0.0009	0.089
1973	0.097	-0.0003	0.096
1974	0.085	-0.001	0.083
1975	0.078	-0.0004	0.077
1976	0.071	0.002	0.073
1977	0.056	0.005	0.062
1978	0.047	0.006	0.054
1979	0.052	0.005	0.057
1980	0.089	0.003	0.092
1981	0.074	-0.001	0.073
1982	0.067	-0.004	0.063
1983	0.064	-0.006	0.058
1984	0.095	-0.007	0.088
1985	0.120	-0.008	0.112
1986	0.080	-0.011	0.068
1987	0.072	-0.015	0.056
1988	0.053	-0.016	0.037
1989	0.039	-0.011	0.028
1990	0.046	-0.008	0.037

(all figures are ratios to GDP)

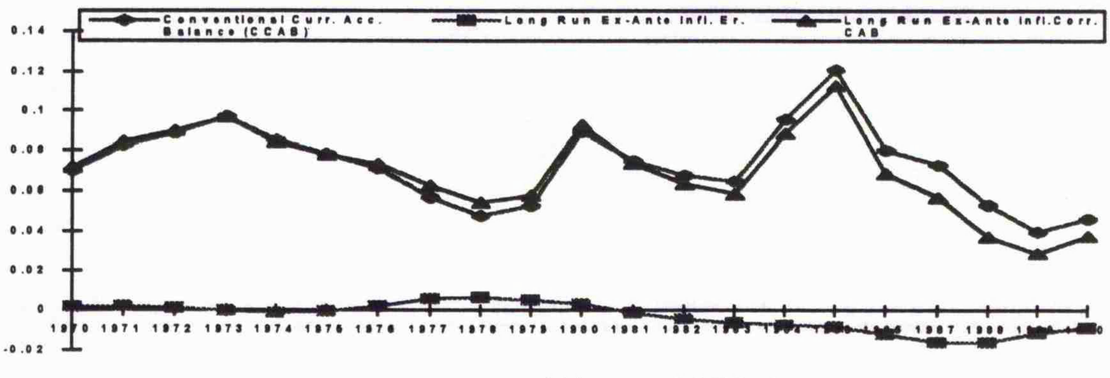


Diagram NOR.6

[4]The reason that we do not give separate estimates of the short run ex-ante inflation corrected CAB is because it coincides with the CCAB since the short run degree of income correction is zero.

As it can be seen from the table and from the diagram, the long run inflation correction was rather insignificant and only in four occasions was more than 1% of GDP in absulute values. Thus the similarity of the plot of the conventional CAB to the plot of the long run ex-ante inflation corrected CAB is not strange. The reason that the inflation correction seems to be of minor importance is because the inflation rate and the percentage of the net financial liabilities to GDP were small throughout all the period of our sample. The effects of these two factors couldn't be overbalanced by the full long run degree of income correction.

8.5.3 Estimates of the ex-post inflation corrected CAB

To estimate the ex-post inflation corrected CAB, we used the following two formulas:

$$CORDEF2 = DEF + \pi DB \qquad \text{E.NOR.4}$$

$$CORDEF3 = DEF + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.NOR.5}$$

where the notation is as in the previous case studies

The first of these formulas does not account for the effects that changes in the exchange rate have on the real value of the external debt. In contrast, the second formula takes such effects into account. Table T.NOR.8 below presents estimates of the inflation corrected ex-post CAB as it is computed by the above two formulas. These estimates are also presented at diagram NOR.7 together with the conventional and the ex-ante estimates:

Table T.NOR.8: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Inflation Erosion according to E.NOR.4	CORDEF2	Inflation Erosion according to E.NOR.5	CORDEF3
1970	0.0699	0.0027	0.0727	0.0027	0.0727
1971	0.0824	0.0015	0.0839	0.0017	0.0841
1972	0.0886	0.0010	0.0897	0.0021	0.0908
1973	0.0970	-0.0003	0.0967	0.0013	0.0983
1974	0.0852	-0.0014	0.0837	-0.0010	0.0841
1975	0.0783	-0.0005	0.0778	0.0007	0.0790
1976	0.0710	0.0018	0.0728	0	0.0709
1977	0.0569	0.0057	0.0627	0.0074	0.0644
1978	0.0479	0.0061	0.0540	0.0077	0.0556
1979	0.0528	0.0038	0.0566	0.0080	0.0609
1980	0.0892	0.0046	0.0939	0.0073	0.0965
1981	0.0747	-0.0012	0.0734	-0.0151	0.0596
1982	0.0674	-0.0038	0.0636	-0.0120	0.0554
1983	0.0648	-0.0053	0.0595	-0.0103	0.0544
1984	0.0954	-0.0062	0.0892	-0.0080	0.0873
1985	0.1207	-0.0078	0.1129	-0.0084	0.1123
1986	0.0801	-0.0131	0.0669	-0.0104	0.0696
1987	0.0727	-0.0177	0.0550	-0.0158	0.0569
1988	0.0531	-0.0141	0.0390	-0.0131	0.0399
1989	0.0397	-0.0090	0.0307	-0.0112	0.0285
1990	0.0462	-0.0085	0.0377	-0.0051	0.0410

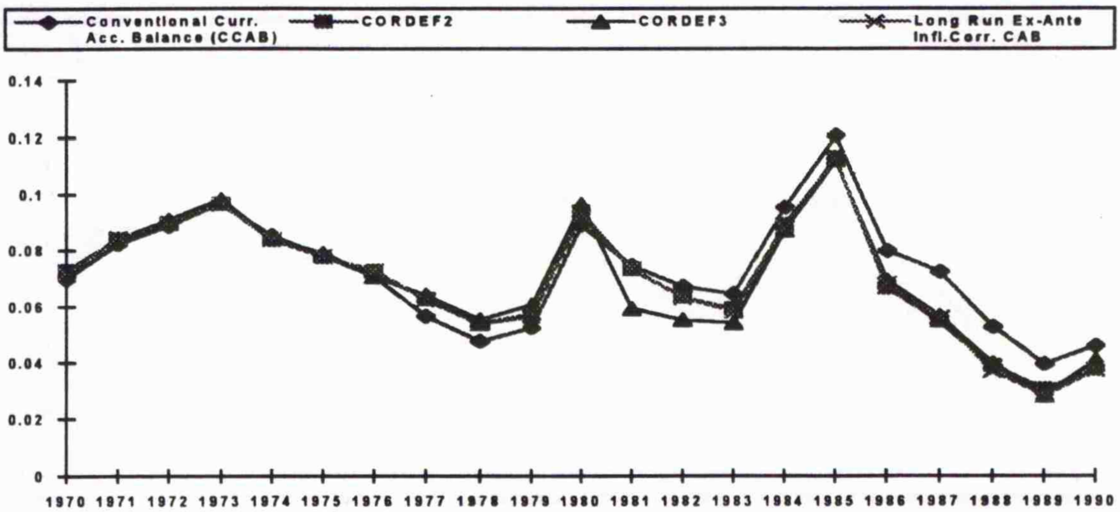


Diagram NOR.7

As it can be seen from the table and from the diagram, except for the period 1986-1990 where the inflation correction, as it is computed by E.NOR.4, was in absulute values higher than 0.8% of GDP, for all the other years the inflation corrected estimates (ex-post and ex-ante) were moving very closely with the conventional CAB.

Generally from the above discussion one could say that Norway's conventional CAB is not much distorted from inflation. The main reason for this is the small inflation rate and the small percentage of the net financial liabilities to GDP.

8.6 Summary of the results

In this case study we examined the case of Norway. The main results of the analysis can be summarised as follows:

i) All the variables of the analysis were I(1) except for the total wealth variable which was I(2) according to DF/ADF tests.

ii) The Johansen cointegration analysis showed that there is one cointegrating vector.

iii) According to this cointegrating vector the long run elasticity of consumption with respect to income is 0.75756 while the corresponding elasticity with respect to wealth is 0.22866.

iv) Regarding the long run degree of income correction, it was found equal to 1.117 and thus it was restricted to one which is the highest possible value that it can theoretically take.

v) To formulate the short run consumption function an ECM was estimated. The Hausman-Wu exogeneity test verified the validity of the exogeneity assumption. The goodness of fit of the model was moderate and the equation passed successfully all the statistical tests to which it was subjected. The model was also stable and with very good forecasting abilities.

vi) The short run degree of income correction was restricted to zero since it was found negative.

vii) Estimates of the ex-ante (long run and short run) and ex-post inflation corrected CAB were derived. Comparisons with the conventional CAB show that all these estimates are very similar to each other which means that the inflation distortion of the conventional CAB is not large. The reasons for this have to do with the low inflation rate, as well as with the low percentage of the net financial liabilities to GDP.

CASE STUDY 9

SPAIN

9.1 The integration properties of the data

This section aims at the examination of the stationarity of the variables of the analysis. To examine this issue two methods will be used. The first method is based on conclusions drawn from the visual examination of the variables of the analysis while the second is more formal and is based on the performance of the DF/ADF unit root tests. Starting from the first method, diagram SP.1 below presents the plots of the variables in levels:

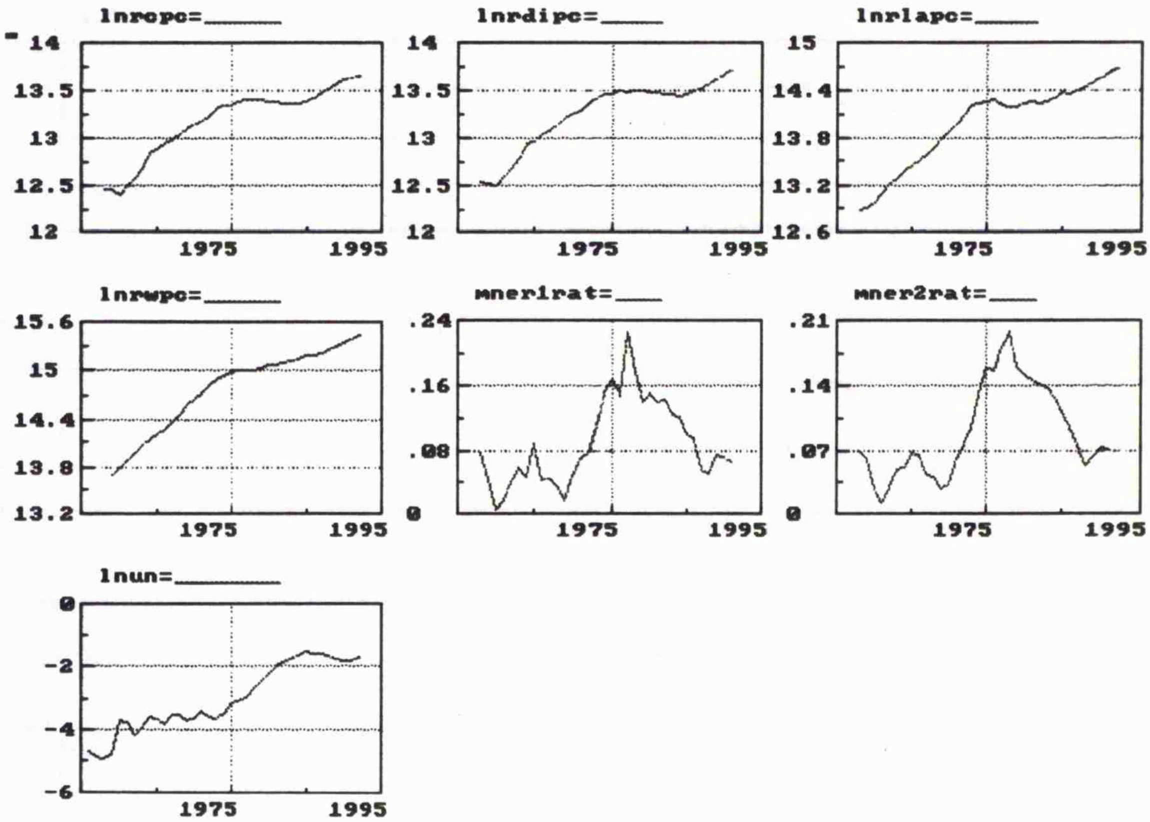


Diagram SP.1

As it can be seen from this diagram, the first six variables are clearly non-stationary. Regarding the last variable, i.e. the unemployment rate, it is theoretically expected to be stationary. However, it is not very clear from the above diagram whether it is so.

Although the visual examination is helpful, it can by no means substitute the performance of formal statistical tests. The most popular of these tests are the DF/ADF tests. Table T.SP.1 below presents the results of these tests. In all cases the null hypothesis is that the corresponding variable is integrated of first order.

Table SP.1: Unit Root tests

Variable	ADF(2)	ADF(1)	DF	Period	C, TR
lnrcpc	-3.1719	-2.6882	-3.3409	1962-1992	C, TR
lnrdipc	-2.9383	-2.4982	-3.2711	1962-1991	C, TR
lnrwpc	-1.7172	-1.7673	-6.0283**	1962-1992	C
lnrlapc	-1.4879	-1.4988	-3.3036*	1962-1992	C
mner1rat	-1.7169	-1.6825	-1.8764	1961-1992	C
mner2rat	-1.8599	-2.0008	-1.3041	1961-1992	C
lnun	-3.4863**	-2.5081*	-2.7057**	1959-1992	
dlnrcpc	-3.7374**	-3.8957**	-4.2140**	1962-1991	
dlnrdipc	-3.0486**	-3.1650**	-3.5123**	1962-1991	
dlnrwpc	-1.41	-1.4275	-1.4551	1963-1992	
dlnrlapc	-1.2796	-1.6473	-1.8654	1962-1992	
dmner1rat	-2.6911**	-3.9849**	-6.2401**	1962-1991	
dmner2rat	-2.2153*	-3.3221**	-3.4954**	1962-1991	

As it can be seen from this table, only for lnun is the null hypothesis of non-stationarity clearly rejected. The fact that this variable is I(0) is in accordance with the theoretical expectations. On the other hand, the null hypothesis was also rejected for the two wealth variables in the DF test. However, further investigation showed that this is not the most appropriate test, since inclusion of the first lag is necessary to eliminate autocorrelation. Therefore, the most appropriate test is the ADF(1). According to this test the null hypothesis cannot be rejected for any of these two variables.

Moving now to the examination of the null hypothesis that the corresponding variable in levels is I(2), we can see from the lower part of table SP.1 that this hypothesis is rejected by all tests for dlnrcpc, dlnrdipc, dmner1rat and dmner2rat. However it cannot be rejected for the wealth variables. As we have said there is no logical reason for this except for sampling reasons such as structural breaks[1]. Diagram BL2 below presents the plots of the variables under examination. As it can be seen there is clearly a change of the rate of growth of the wealth variables after the first oil shock. To examine whether this fact is truly the cause of the above strange results we used the Perron test[2] assuming a structural break in 1973.

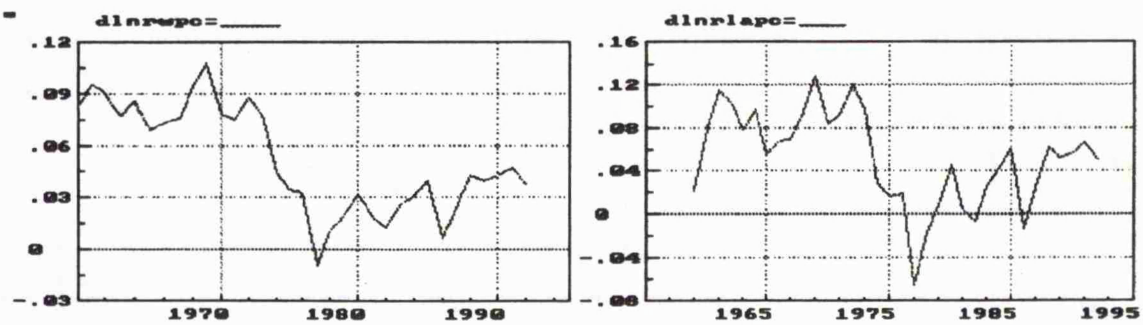


Diagram SP.2

The null hypothesis that the corresponding variable in levels is I(2) was always rejected in favour of the alternative hypothesis that it is I(1). More details

[1]See P. Perron in Rao (1994).

[2]For this test see: P. Perron (1989), Econometrica, pp. 1361-1401.

about the results as well as about the way to perform this test are given in the appendix to this case study.

Therefore, the conclusion is that apart from the unemployment rate that is I(0) all the other variables are I(1).

9.2 The lag length of the VAR

Having established the order of integration of the variables, the next step is to define the lag length of the VAR model. However, before we are able to estimate the VAR and to compute the various autocorrelation diagnostics it is first required to choose which of the wealth and the monetary erosion variables will be use. To make this choice, we ran the Johansen procedure experimentally, for various lag lengths and using each pair of choices alternatively. In all cases, the lnrwpc and the mner2rat performed better than their alternatives. The lag length that was finally chosen was five. The results of the autocorrelation tests, based on a VAR of such lag-length are presented below at table T.SP.2

Table T.SP.2 : VAR diagnostics (lag length = 5)

Variable	AR1-1	AR1-2	AR1-3	AR1-4	ARCH1
lnrcpc	0.8625	0.6535	0.0685	0.1404	0.9010
lnrdipc	0.6471	0.8789	0.4267	0.5796	0.5753
lnrwpc	0.0123*	0.044*	0.1233	0.0022**	0.9308
mner2rat	0.0367*	0.1051	0.2627	0.4747	0.8379

(p-values in the cells)

As it can be seen from this table, although the lag length is really long, the model still suffers from autocorrelation in two of its equations. Unfortunately, the problem couldn't be solved by increasing the already long lag length since any further increase made impossible the performance of tests for autocorrelation. For this reason, the analysis will continue with a lag length equal to five.

9.3 The Long Run Consumption Function

Having defined the order of integration of the variables and the lag length of the VAR, we can now move to the Johansen procedure, starting from tests about the number of the statistically significant cointegrating vectors. For this purpose two tests will be used: the maximal eigenvalue test and the trace test. Results of these two tests are presented at tables T.SP.3.1 and T.SP.3.2 below.

Table T.SP.3.1

Johansen Maximum Likelihood Procedure (Non-trended case)
Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix

28 observations from 1964 to 1991. Maximum lag in VAR = 5.
List of variables included in the cointegrating vector:
LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept
List of eigenvalues in descending order:
.91305 .76512 .62123 .31540 -.0000

Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	68.3886	28.1380	25.5590
r<= 1	r = 2	40.5629	22.0020	19.7660
r<= 2	r = 3	27.1835	15.6720	13.7520
r<= 3	r = 4	10.6099	9.2430	7.5250

Table T.SP.3.2

Johansen Maximum Likelihood Procedure (Non-trended case)
Cointegration LR Test Based on Trace of the Stochastic Matrix

28 observations from 1964 to 1991. Maximum lag in VAR = 5.
List of variables included in the cointegrating vector:
LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept
List of eigenvalues in descending order:
.91305 .76512 .62123 .31540 -.0000

Null	Alternative	Statistic	95% Critical Value	90% Critical Value
r = 0	r>= 1	146.7450	53.1160	49.6480
r<= 1	r>= 2	78.3564	34.9100	32.0030
r<= 2	r>= 3	37.7934	19.9640	17.8520
r<= 3	r = 4	10.6099	9.2430	7.5250

A look at the above tables shows that there are four cointegrating vectors that are statistically significant at the 5% level. The fact that for one more time we find multiple cointegrating vectors shows that had the OLS been applied the resulting estimates would be wrong, since they would be no more than a linear combination of the parameters of the four cointegrating vectors.

When those four cointegrating vectors were normalised on consumption, the third one had its coefficients with signs and magnitudes that we re in accordance to what is expected from a long run consumption function. The long run consumption function that corresponds to the preferred cointegrating vector is as follows:

lnrcpc = 0.74628 + 0.81080*lnrdipc - 0.52795*mner2rat + 0.121*lnrwpc   E.SP.1

As it can be seen from E.SP.1, the long run elasticity of consumption with respect to income is 0.811 while the corresponding elasticity with respect to wealth is 0.121. Regarding the parameter of our particular interest, i.e. long run degree of income correction, it is equal to 0.652. This is a rather moderate estimate since one would expect that, if there was no money illusion in the long run, this coefficient would be equal to one.

One of the many virtues of the Johansen procedure is that it can be used to test the validity of restrictions imposed on the long run parameters. Table T.SP.4 below presents these restrictions as well as the marginal significance level at which they are rejected. In that table, a_0 corresponds to the first coefficient of E.SP.1 i.e. to the constant term, a_1 to the second coefficient (i.e. to the coefficient of lnrdipc) and so on[3].

Table T.SP.4

Restriction	**p-value**
$a_0 = 0$	0
$a_1 = 0$	0
$a_2 = 0$ ($\Leftarrow \delta_L = 0$)	0
$a_2 = - a_1$ ($\Leftarrow \delta_L = 1$)	0
$a_3 = 0$	0

As it can be seen from table T.SP.4, all the variables are statistically significant. Especially the significance of the wealth variable gives credit to the life cycle model of consumption. Regarding the tests about the value of the long run degree of income correction these tests were carried out indirectly. As it can be seen from T.SP.4 both the null hypothesis that this degree is zero and the null hypothesis that it is one are rejected.

9.4 The Short Run Consumption Function

The step that naturally follows the estimation of the long run consumption function is the estimation of an ECM. This is what this section is all about. To arrive at the final equation, we used the general to specific method. Thus, we started from a fairly general model where each variable entered with two lags.

[3]In order to carry out those tests the number of the cointegrating vectors had to be restricted to three.

Then, through t and F tests we narrowed down the model until we arrived at the final equation that is given in table T.SP.5 below:

Table T.SP.5: The Error Correction Model

Modelling dlnrcpc by OLS
The present sample is: 1961 to 1991

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	-0.0045	0.0028853	-1.559	0.1339	0.1038
dlnrdipc	0.81869	0.050573	16.188	0.0000	0.9258
dlnrdipc_1	0.13471	0.045151	2.984	0.0071	0.2977
dlnrdipc_2	0.040726	0.039762	1.024	0.3174	0.0476
dmner2rat	-0.23443	0.090265	-2.597	0.0168	0.2431
dmner2ra_1	-0.073745	0.089038	-0.828	0.4168	0.0316
dmner2ra_2	0.41219	0.073269	5.626	0.0000	0.6011
dlnrwpc_1	-0.56379	0.090277	-6.245	0.0000	0.6500
ect_1	-0.54105	0.080734	-6.702	0.0000	0.6814
dummy89	0.024395	0.0070248	3.473	0.0023	0.3648

R^2 = 0.981093 F(9, 21) = 121.07 [0.0000] σ = 0.00623509 DW = 2.65
RSS = 0.0008164020993 for 10 variables and 31 observations
Information Criteria: SC = -9.43685; HQ = -9.74864; FPE = 5.1417e-005
AR 1- 1F(1, 20) = 6.2735 [0.0210] *
ARCH 1 F(1, 19) = 0.88738 [0.3580]
Normality $Chi^2(2)$= 1.4979 [0.4729]
Xi^2 F(17, 3) = 0.26224 [0.9706]
RESET F(1, 20) = 2.1288 [0.1601]

(dummy89 is a dummy variable for 1989)

As it can be seen from the above table, since income enters with two lags in the final equation, the short run degree of income correction needs non-linear methods to be identified. The corresponding non-linear model showed that the second lag of the corrected income, the constant term and the dummy variable were insignificant and thus a new non-linear model had to be estimated without them. This model is as follows:

dlnrcpc=&1*(dlnrdipc-&2*dmner2rat)+&3*(lag(dlnrdipc,1)-&2*lag(dmner2rat,1))
+ &4*lag(dlnrwpc, 1) + &5*lag(ect,1)   E.SP.2

where lax(x, r) = x_{t-r}

The results from the estimation of E.SP.2 are presented at table T.SP.6 below:

Table T.SP.6

Modelling dlnrcpc by RNLS
The present sample is: 1961 to 1991

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
&1	0.80339	0.066842	12.019	0.0000	0.8475
&2	0.18932	0.11932	1.587	0.1247	0.0883
&3	0.17924	0.065769	2.725	0.0113	0.2222
&4	-0.49548	0.13310	-3.723	0.0010	0.3477
&5	-0.42470	0.10421	-4.076	0.0004	0.3898

R^2 = 0.941542 F(4, 26) = 104.69 [0.0000] σ = 0.00985302 DW = 2.24
RSS = 0.002524134298 for 5 variables and 31 observations
Information Criteria: SC = -8.86198; HQ = -9.01787; FPE = 0.00011274
ARCH 1 F(1, 24) = 0.060533 [0.8077]
Normality $Chi^2(2)$= 1.1364 [0.5666]
AR 1- 1F(1, 25) = 1.2743 [0.2697]
AR 1- 2F(2, 24) = 0.71457 [0.4995]
Xi^2 F(8, 17) = 1.1112 [0.4033]
Xi*Xj F(14, 11) = 1.8048 [0.1650]

Before we make any comment on the results of the above table, we must first check the validity of the exogeneity assumption. To do this, we used the Hausman-Wu exogeneity test[4]. A problem that we met in carrying out this test, was that it wasn't possible to perform it directly on the equation given above because of singularity. The way to solve this problem was to adopt the estimated degree of income correction i.e. 0.18932 and to estimate a corrected income variable which was then used to transform the non-linear model to linear. The

[4]For the way to implement this test the reader is referred to the first case study.

estimated linear model gave almost identical estimates as those given in table SP.6. The introduction of the fitted values of dlnrdipc and dmner2rat didn't cause any problem this time. The null hypothesis of weak exogeneity could not be rejected at any reasonable level of significance (p-value = 0.6955). Except for this way, we also estimated the underlying unrestricted linear version of the above non-linear model. Again the null hypothesis could not be rejected at any reasonable level of significance (p-value = 0.3666). Therefore, the conclusion is that the independent variables of our model are exogenous. Having examined this issue, we can now comment on the results given in the above table.

Starting from the goodness of fit, table T.SP.5 that includes the constant term shows a very high R^2 coefficient. The very good fitness of our model is also shown by diagram SP.3 below that presents the actual and the fitted values together with the scaled residuals. As it can be seen from the left part of this diagram, the fitted values and the actual ones were always very close to each other.

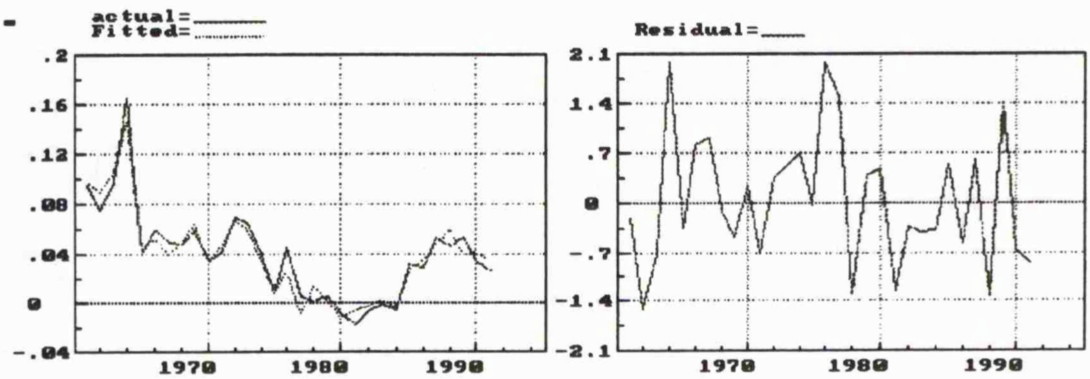


Diagram SP.3

Apart from the goodness of fit, the model is also very successful in passing all the tests regarding the validity of the classical regression assumptions. Indeed, as it can be seen there is no sign of autocorrelation, heteroscedasticity or non-normality and the model manages to pass most of the tests with high p-values.

Regarding now the individual coefficients, the sum of the coefficients of the contemporaneous and lagged income variables is 0.98263 which is really very high. Lagged wealth was also statistically significant and with a large, in absulute terms, coefficient. The coefficient of the error correction term was also large and highly significant. Finally, regarding the parameter of our special interest i.e. the short run degree of income correction, it was found equal to 0.189 which is a low and not significally different from zero. On the other hand, the null hypothesis that the degree of income correction is full i.e. equal to one is rejected at any level of significance. Thus we could say that the short run degree of income correction is low.

9.4.1 The stability and the forecasting accuracy of the model.

To test the stability of the model we used the 1-step recursive residuals, and the 1-step and N-steps (up and down) Chow tests. The results from all these tests are presented at diagram SP.4 below.

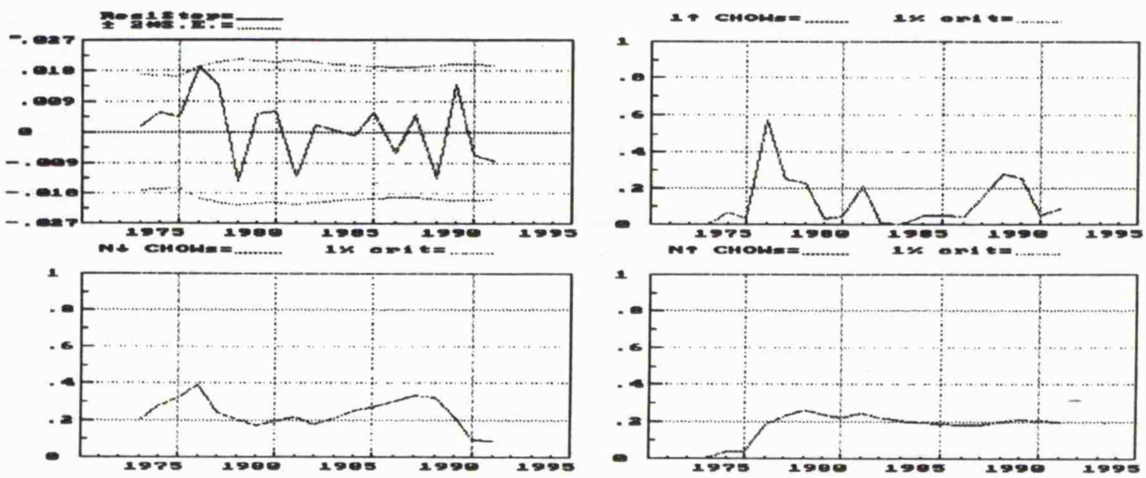


Diagram SP.4

As it can be seen from this diagram the model is generally stable. The recursive residuals are well within the ± 2 S.E bounds, though for 1976 they reach the upper bound. However, there is no problem at the 1% level of significant according to the other tests[5].

Regarding now the forecasting ability of the model, this was tested by re-estimating the model, reserving the last 5 observations for 1-step ahead forecasts. These forecasts are presented at diagram SP.5 below. As it can be seen from this diagram, the model gave very good forecasts. The good forecasting ability of the model is also evident from the forecast Chi-square statistic which gave a p-value equal to 0.3462.

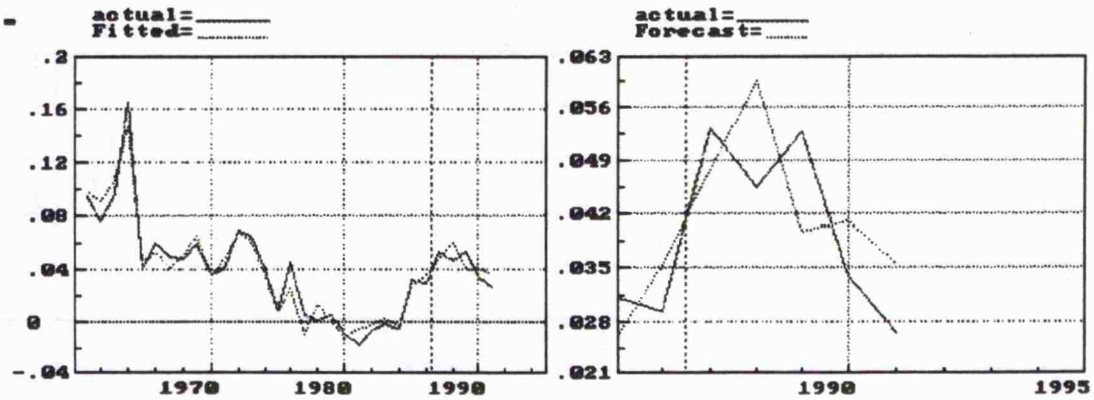


Diagram SP.5

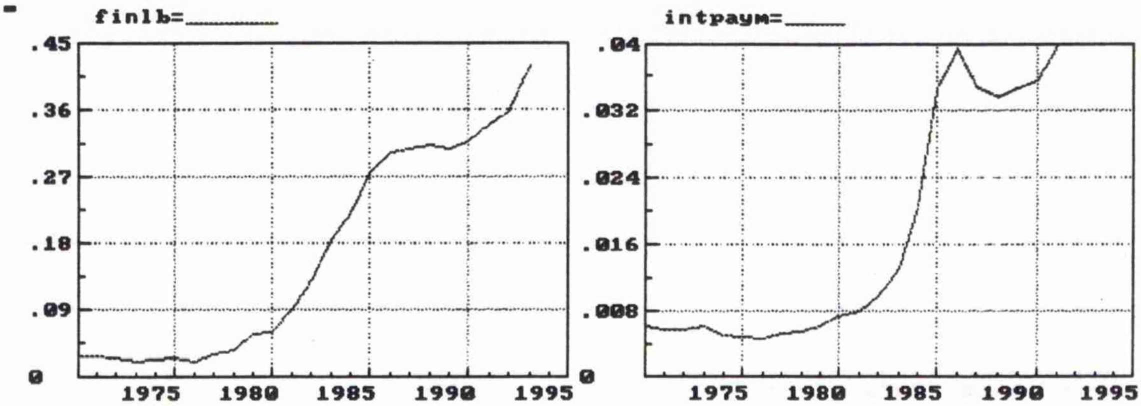
After the above analysis, the general conclusion is that the estimated ECM is stable and with good forecasting abilities.

[5]Nevertheless, for 1976 the 1-step Chow test is statistically significant at the 5% level (p-value = 0.0370).

9.5 The ex-ante and the ex-post inflation corrected Current Account Balance (CAB).

9.5.1. A look at the paths of the main variables of the analysis.

Having estimated the short run and long run degree of income correction we can now move to the next step which is the estimation of the ex-ante inflation corrected CAB. However, before we move to this step it will be helpful to first have a look at the path that the main variables followed during the period of our sample. This is done in diagram SP.6 below, where the plots of the following variables are presented (from the top left to the right): net financial liabilities, gross interest payments, net saving, net lending, gross foreign debt and inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government while the fifth one is expressed as a ratio to the net financial liabilities and refers to the central government. The above diagram is also accompanied by table T.SP.7 that presents some descriptive statistics for the variables under examination.



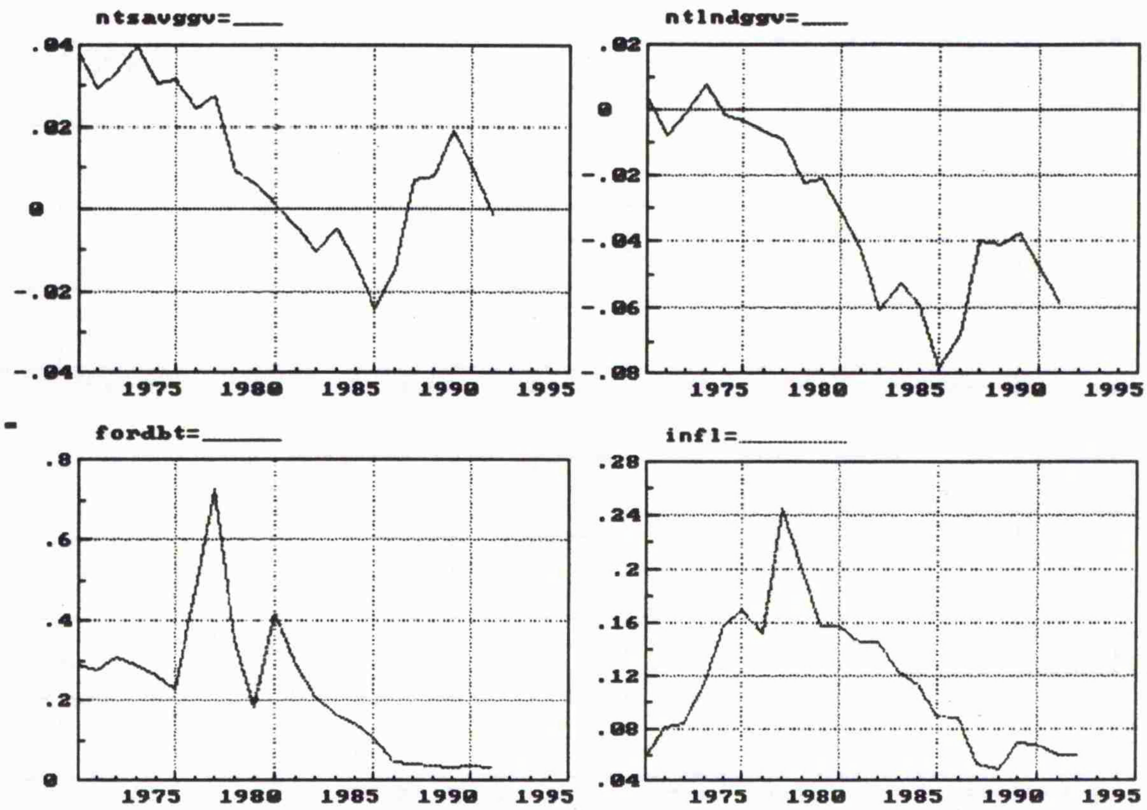


Diagram SP.6

Table T.SP.7

Variable	Minimum (Year)	Maximum (Year)	Average
Net Fin. Liabil. (% GDP)	2 (1976)	42.2 (1993)	16.4
Interest Payments (% GDP)	0.448 (1976)	3.96 (1991)	1.658
Net Saving (% GDP)	-2.41 (1985)	3.98 (1973)	1.0802
Net Lending (% GDP)	-7.79 (1985)	0.83 (1973)	-3.0585
Foreign Debt (% Tot. Debt)	3.13 (1989)	72.89 (1977)	22.63
Inflation (%)	4.803 (1988)	24.5 (1977)	11.40

As it can be seen from the first plot of diagram SP.6, after the first 7-8 years of the sample where the percentage of the net financial liabilities of the government to GDP was very small, it increased very rapidly and it was 27% in 1985. Then, and until 1988 the rate of increase was significally lower. However, in 1989 the situation changed again and the rate of growth was again increasing. Characteristically, though the minimum value was only 2% in 1976, the maximum value was 42.2% in 1993 i.e. 21 times the minimum value. Despite this very rapid increase, the average percentage of the net financial liabilities to GDP was no more than 16.4%.

Regarding the gross interest payments, they followed a very similar path to the one followed by the net financial liabilities. The average value of this variable was 1.658% of GDP with a large difference between the minimum (0.448%) and the maximum value (3.96%).

Concerning the percentage of the CCAB, it was almost continuously falling in the first fifteen years of the sample, taking its minimum value in 1985, where it was -2.41% of the GDP. Then, it recovered until 1989 after which it started falling again.

Exactly similar was the pattern followed by the percentage of the net lending to GDP, with the difference that the corresponding percentage was negative in all but two years, taking an average value equal to -3.06% of the GDP.

Finally , the inflation rate was higher than in many other countries of the sample, reaching its highest level in 1977 where it was 24.5%. Its average value was 11.4%.

From the above discussion the conclusion is that the low net financial liabilities of the government and the rather high inflation rate work contrary to each other for the determination of the significance of the inflation correction.

9.5.2 Estimates of the ex-ante inflation corrected CAB.

The purpose of this section is to estimate the Spanish ex-ante inflation corrected CAB for the period 1970-1991. To derive these estimates the following formula will be used:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.SP.3}$$

where the notation is as in the previous case studies.

Having estimated the long run and the short run degree of income correction, we can substitute these two estimates in E.SP.3 to derive the long run and the short run ex-ante inflation corrected CAB. It is reminded that the long run degree of income correction was found equal to 0.652 while the short run one was 0.189. Table T.SP.8 below presents estimates of the short run and the long run ex-ante or perceived inflation erosion together with estimates of the short run and the long run ex-ante inflation corrected CAB. These estimates are also presented diagrammatically at diagram SP.7 below.

Table T.SP.8: The conventional and the ex-ante inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Short Run Ex-Ante Inflation Erosion	Short Run Ex-Ante Inflation Corrected CAB	Long Run Ex-Ante Inflation Erosion	Long Run Ex-ante Inflation Corrected CAB
1970	0.037	0.0002	0.0372	0.0007	0.0377
1971	0.029	0.0003	0.0293	0.001	0.030
1972	0.033	0.0004	0.0334	0.001	0.034
1973	0.039	0.0004	0.0394	0.001	0.040
1974	0.030	0.0005	0.0305	0.002	0.032
1975	0.031	0.0006	0.0316	0.002	0.033
1976	0.024	0.0006	0.0246	0.002	0.026
1977	0.027	0.0008	0.0278	0.002	0.029
1978	0.008	0.001	0.009	0.004	0.012

1979	0.005	0.001	0.006	0.005	0.010
1980	0.0006	0.001	0.0016	0.005	0.0056
1981	-0.004	0.002	-0.002	0.007	0.003
1982	-0.010	0.002	-0.008	0.009	-0.0001
1983	-0.005	0.003	-0.002	0.013	0.008
1984	-0.013	0.004	-0.009	0.014	0.001
1985	-0.024	0.004	-0.02	0.015	-0.009
1986	-0.015	0.004	-0.011	0.015	0.0006
1987	0.006	0.003	0.009	0.013	0.019
1988	0.008	0.002	0.010	0.009	0.017
1989	0.019	0.003	0.022	0.011	0.030
1990	0.010	0.003	0.013	0.013	0.023
1991	-0.001	0.003	0.002	0.012	0.011

(all figures are ratios to GDP)

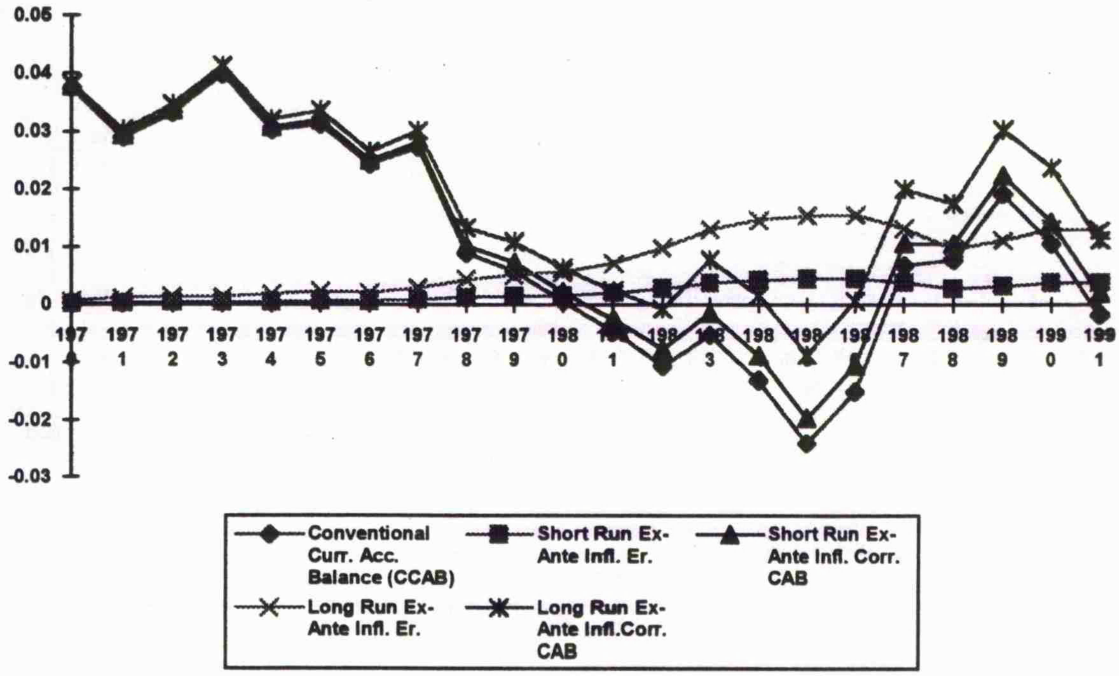


Diagram SP.7

As it can be seen from the table and from the diagram, the inflation erosion was insignificant in the first seven to eight years of the sample and the ex-ante inflation corrected magnitudes were almost identical with the conventional ones. The main reason for this is the fact that in those years the percentage of the net financial liabilities of the general government was very small. The changing of this situation, especially in eighties, together with the fact that the inflation rate continued to be high in most of this period made the inflation erosion more significant. Thus, although the conventional CAB was negative in seven years after 1981 the long run ex-ante inflation corrected one was so in only two of those years which means that in the remaining, the inclusion of the inflation erosion as it is perceived by people in the long run, was enough to turn the small conventional deficit to a small ex-ante surplus.

9.5.3 Estimates of the ex-post inflation corrected CAB

In the previous section we derived estimates of the ex-ante inflation corrected CAB. In this section we will derive estimates of the ex-post inflation corrected CAB. To derive these estimates we will use the following two formulas:

$$CORDEF2 = CAB + \pi DB \qquad \text{E.SP.4}$$

$$CORDEF3 = CAB + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.SP.5}$$

where the notation and the differences between these two measures have already been explained in the first case study.

Table T.SP.9 below gives estimates of the ex-post inflation corrected CAB as they are computed using E.SP.4 and E.SP.5. These estimates are also presented diagrammatically at diagram SP.8 together with the conventional and the ex-ante estimates.

Table T.SP.9: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Inflation Erosion according to E.SP.4	CORDEF2	Inflation Erosion according to E.SP.5	CORDEF3
1970	0.037	0.001	0.0371	0.001	0.039
1971	0.029	0.002	0.031	0.002	0.031
1972	0.033	0.002	0.035	0.002	0.035
1973	0.039	0.002	0.041	0.003	0.042
1974	0.030	0.003	0.033	0.003	0.033
1975	0.031	0.003	0.034	0.003	0.034
1976	0.024	0.003	0.027	0.001	0.026
1977	0.027	0.005	0.032	0.003	0.030
1978	0.008	0.005	0.013	0.005	0.014
1979	0.005	0.006	0.012	0.008	0.014
1980	0.0006	0.008	0.009	0.007	0.008
1981	-0.004	0.010	0.005	0.003	-0.001
1982	-0.010	0.015	0.004	0.010	-0.0002
1983	-0.005	0.018	0.013	0.009	0.004
1984	-0.013	0.021	0.008	0.018	0.005
1985	-0.024	0.020	-0.003	0.019	-0.004
1986	-0.014	0.023	0.008	0.027	0.012
1987	0.006	0.015	0.021	0.016	0.023
1988	0.007	0.014	0.021	0.014	0.022
1989	0.019	0.020	0.039	0.019	0.039
1990	0.010	0.020	0.030	0.021	0.031
1991	-0.001	0.018	0.016	0.018	0.016

(all figures are ratios to GDP)

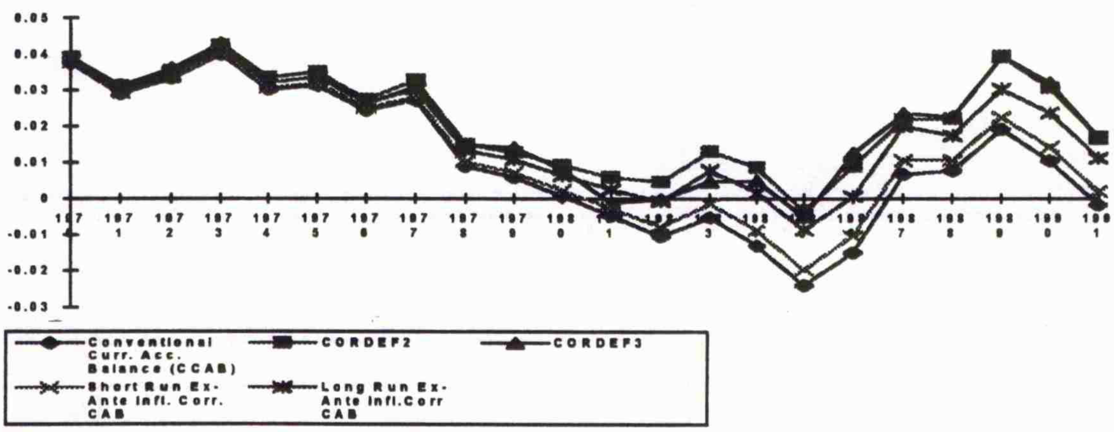


Diagram SP.8

As it can be seen from the above diagram, until 1978 all the estimates were moving together. This means that for that period the conventional CAB was a good proxy of both the ex-ante and the ex-post CAB. However, the situation changed after this year and eventually the gap between the conventional and the inflation corrected (ex-post and ex-ante) estimates started to become bigger and bigger. In all cases, the ex-post inflation corrected CAB as it is computed by E.SP.4 (this is the most reliable ex-post estimate) was higher than both the ex-ante (long run and short run) and the conventional CAB. Characteristically, while the conventional CAB was negative in seven years, the ex-post inflation corrected one was so in only one.

From the above analysis one could say that indeed the inflation correction matters since in many cases it turned the conventional deficit to ex-post and ex-ante surplus. However, it is not a big percentage of the GDP and the reason is the moderate percentage of the net financial liabilities and, as it concerns the ex-ante figures, the moderate degree of income correction.

9.6 Summary of the results

The conclusions of the above analysis can be summarised as follows:

i) All the variables were I(1), apart from the unemployment rate that was I(0).

ii) According to the Johansen procedure, there are four cointegrating vectors that are statistically significant at the 5% level. From those four cointegrating vectors, one had its coefficients with signs and magnitudes that were in accordance to what is expected from a long run consumption function. This vector was the chosen one.

iii) The long run elasticity of consumption with respect to income was 0.81 while the corresponding elasticity with respect to wealth was 0.121. Both were significally different from zero. In the case of wealth this gives credit to the Life - Cycle model.

iv) The long run degree of income correction was 0.652 which means that the income correction is only partial. This degree was significally different both from one and from zero.

v) Based on the preferred long run equation, an ECM was constructed which was estimated using NLS. The estimated model was good in all aspects: i.e. goodness of fit, satisfaction of the classical regression assumptions (including weak exogeneity), stability and forecasting accuracy.

vi) The short run degree of income correction was found equal to 0.189 and it was not significally different from zero. This estimate is almost a third of the one obtained for the long run and justifies the separation that was made between the short run and the long run.

vii) Finally, estimates of the ex-ante and the ex-post inflation corrected CAB were derived. According to these estimates, though the inflation erosion was not a large percentage of GDP it was enough to turn in many cases the conventional deficit to ex-ante and ex-post inflation corrected surplus.

APPENDIX

The model that was employed for our tests corresponds to model A of the Perron's paper and it has as follows:

$$y_t = \mu + \theta DU_t + \beta T + dDTB + ay_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$$

where if TB is the year of the structural break then:

DU = 1 if t > TB and 0 otherwise,

DTB = 1 if t = TB+1 and 0 otherwise

T is time trend

and y is the variable whose stationarity we want to check.

Under the null hypothesis of a unit root:

$\mu \neq 0$, $\theta = 0$, $\beta = 0$, $d \neq 0$ and $a = 1$

while under the alternative hypothesis of stationarity:

$\mu \neq 0$, $\theta \neq 0$, $\beta \neq 0$, $d = 0$ and $a < 1$

Bellow we present the results of the Perron test assuming a structural break for 1973

The regressions for the Perron Test:

Modelling dlnrwpc by OLS
The present sample is: 1961 to 1992

Variable	Coefficient	Std.Error	t-value	t-prob	PartR^2
Trend	0.0008217	0.00050029	1.642	0.1121	0.0908
DU	-0.056564	0.015143	-3.735	0.0009	0.3407
DTB	0.012408	0.017087	0.726	0.4740	0.0192
Constant	0.052799	0.015153	3.484	0.0017	0.3102
dlnrwpc_1	0.24407	0.17653	1.383	0.1781	0.0661

$R^2 = 0.856887$ $F(4, 27) = 40.415$ [0.0000] $\sigma = 0.0125362$ DW = 1.98
RSS = 0.004243211352 for 5 variables and 32 observations

[The null that a=1 is rejected at any level of significance]

Modelling dlnrlapc by OLS
The present sample is: 1960 to 1992

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
DU	-0.11026	0.028494	-3.870	0.0006	0.3484
DTB	0.023387	0.033855	0.691	0.4954	0.0168
Constant	0.046983	0.015930	2.949	0.0064	0.2370
Trend	0.002899	0.0011411	2.540	0.0169	0.1873
dlnrlapc_1	0.10519	0.17496	0.601	0.5525	0.0127

$R^2 = 0.703699$ $F(4, 28) = 16.625$ [0.0000] $\sigma = 0.0258704$ DW = 1.90
RSS = 0.01873977796 for 5 variables and 33 observations

Information Criteria: SC = -6.94384; HQ = -7.09429; FPE = 0.000770684

[The null that a=1 is rejected at any level of significance]

As it can be seen, in both cases the null hypothesis of a unit root is rejected which in turn means that the wealth variables are I(1).

CASE STUDY 10

UNITED KINGDOM

10.1 The integration properties of the data

The purpose of this section is to examine the order of integration of the variables of the analysis. As in all other cases, two approaches were followed. The first is based on conclusions from a visual exploration of the plots of the variables while the second is more formal and is based on results from the performance of the popular DF/ADF tests. The plots of the main variables of the analysis are presented below at diagram UK.1.

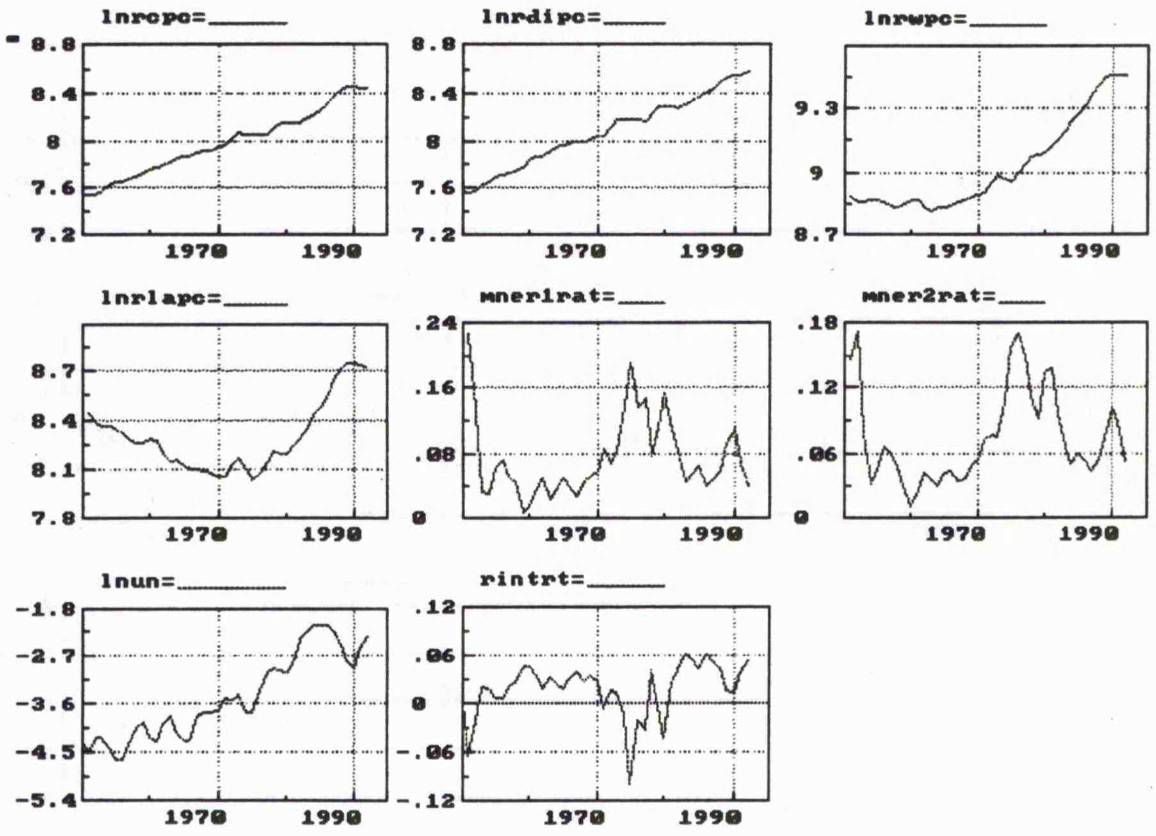


Diagram UK.1

As it can be seen from this diagram, at least the first four variables are surely non-stationary. Regarding the remaining variables: mner1rat and mner2rat are rather non-stationary, though they are more volatile than the first four variables. For the real interest rate and the lnun variables the answer is more difficult since theoretically they are expected to be stationary. For the lnun, it seems that although it grew in the period of our sample it may be stationary around a time trend and/or a constant. On the other hand, based on the relative plots it seems that the rintrt has more probabilities to be stationary than any of the other variables of the analysis. But let's see, whether these conclusions are confirmed by formal statistical tests.

The results of the DF/ADF tests, that test the null hypothesis that the corresponding variable is I(1), are presented at table UK.1 below:

Table T.UK.1: Unit Root Tests

Variable	**ADF(2)**	**ADF(1)**	**DF**	**Period**	**C, TR**
lnrcpc	-2.7416	-3.4681	-2.0819	1953-1991	C, TR
lnrdipc	-2.9906	-2.9004	-2.8586	1953-1992	C, TR
lnrlapc	-0.62383	-1.3909	-0.95016	1954-1992	C, TR
lnrwpc	-1.5021	-1.7682	-1.5586	1954-1992	C, TR
mner1rat	-0.96310	-1.0796	-1.1017	1954-1992	
mner2rat	-0.62225	-1.1886	-0.99751	1954-1992	
lnun	-2.8101	-4.1188*	-2.5960	1953-1992	C, TR
rintrt	-2.7209	-3.1431*	-3.5187*	1953-1992	
dlnrcpc	-4.0620*	-4.2267**	-3.8947*	1954-1992	C, TR
dlnrdipc	-4.4422**	-5.284**	-4.9324**	1954-1992	C, TR
dlnrlapc	-3.3426	-5.7878**	-3.7469*	1955-1992	C, TR
dlnrwpc	-3.1347	-5.5768**	-3.562*	1955-1992	C, TR
dmner1rat	-5.6935**	-5.7329**	-6.1973**	1955-1992	
dmner2rat	-3.7510**	-7.2830**	-4.5485**	1955-1992	

As it can be seen from the above table, the null hypothesis that the corresponding variable *in levels* is I(1) cannot be rejected for any of the first six variables, confirming by this way the visual conclusions drawn from the plots. On the other hand, regarding the lnun and the rintrt, the results were dependant on the lag length that was employed and therefore more examination is needed. This examination showed that the second lag is unnecessary for the elimination of the autocorrelation. Regarding the first lag, it was necessary for the lnun and unnecessary for the rintrt. Thus the most appropriate test is the ADF(1) for the lnun and the DF for the rintrt. According to these tests the rintrt and the lnun are stationary.

Regarding now the variables that were found at least I(1), we have to check whether they are I(2) or they are definitely I(1). This test can be done by testing if the first difference of these variables are I(1). The corresponding results are presented at the lower part of table UK.1 (the variables in differences start from the letter d). According to that table, the null hypothesis is rejected in all cases (the second lag is unnecessary for dlnrwpc and dlnrlapc).

Therefore, the conclusion of the above analysis is that except for lnun and rintrt that are stationary, all the other variables are I(1).

10.2 The lag length of the VAR

Having established the order of integration of the variables, the next step is to establish the lag length of the VAR model that will be used in the cointegration analysis. However before doing so, we have to make a choice regarding the wealth and the monetary erosion variables that will be used. To make this choice, the Johansen procedure was run experimentally using various lag lengths and alternative choices of the variables. In all cases, the lnrwpc and the mner2rat performed better than their corresponding alternatives and for this reason were the chosen ones. Having made this choice, we estimated the individual equations of the VAR for various lag lengths. Finally the best results regarding the problem of autocorrelation were obtained for a lag length equal to three. The corresponding diagnostics are presented at table T.UK.2 below.

Table T.UK.2: VAR-diagnostics (lag-length = 3)

Dependant Variable	AR1-1	AR1-2	AR1-3	AR1-4	ARCH1
lnrcpc	0.9653	0.8164	0.5897	0.0439*	0.7190
lnrdipc	0.5172	0.5395	0.6013	0.1034	0.2841
lnrwpc	0.7405	0.6750	0.5924	0.4699	0.627
mner2rat	0.4755	0.323	0.5168	0.377	0.8461

(p-values in the cells)

As it can be seen, with the exception of the first equation where the AR1-4 is statistically significant, there is no autocorrelation in any of the equations. Regarding the problem with the AR1-4 test in the first equation, we tried a larger lag length but the situation didn't improve at all. Because of this and since a larger lag length strengthens the problem of the degrees of freedom we decided to continue with a lag length equal to three.

10.3 The Long Run Consumption Function

After establishing the order of integration of the variables and the lag length of the VAR, we can now move to the Johansen procedure starting from tests about the number of the statistically significant cointegrating vectors. The tests that were used were the maximal eigenvalue test and the trace test. The results of these tests are presented at tables T.UK.3.1 and T.UK.3.2 below.

Table T.UK.3.1

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix				
39 observations from 1954 to 1992. Maximum lag in VAR = 3, List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept List of eigenvalues in descending order: .70941 .55412 .40585 .20307 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r = 1	48.1976	28.1380	25.5590
r<= 1	r = 2	31.5005	22.0020	19.7660
r<= 2	r = 3	20.3043	15.6720	13.7520
r<= 3	r = 4	8.8525	9.2430	7.5250

Table T.UK.3.2

Johansen Maximum Likelihood Procedure Cointegration LR Test Based on Trace of the Stochastic Matrix				
39 observations from 1954 to 1992. Maximum lag in VAR = 3. List of variables included in the cointegrating vector: LNRCPC LNRDIPC MNER2RAT LNRWPC Intercept List of eigenvalues in descending order: .70941 .55412 .40585 .20307 -.0000				
Null	**Alternative**	**Statistic**	**95% Critical Value**	**90% Critical Value**
r = 0	r>= 1	108.8549	53.1160	49.6480
r<= 1	r>= 2	60.6573	34.9100	32.0030
r<= 2	r>= 3	29.1568	19.9640	17.8520
r<= 3	r = 4	8.8525	9.2430	7.5250

The conclusion from both of these tables is that there are three cointegrating vectors that are statistically significant at the 5% level. When these three cointegrating vectors were normalised on consumption the first one had, its coefficients with signs and magnitudes that corresponded to those expected from a long run consumption function. The long run consumption function that corresponds to the chosen cointegrating vector is as follows:

lnrcpc=-0.4089+0.73267*lnrdipc-0.16297*mner2rat+0.27754*lnrwpc   E.UK.1

As it can be seen from E.UK.1, the long run elasticity of consumption with respect to income is 0.73267, while the corresponding elasticity with respect to wealth is 0.27754. Regarding the long run degree of income correction, its indirect estimate is 0.222 which of course is very low.

Moving to the performance of statistical tests, various null hypotheses were tested. These null hypotheses together with the corresponding p-values are presented at table UK.4 below.

Table UK.4

Restriction	p-value
$a_0 = 0$	0.001
$a_1 = 0$	0
$a_2 = 0$ ($\Leftarrow \delta_L = 0$)	0.005
$a_2 = - a_1$ ($\Leftarrow \delta_L = 1$)	0
$a_3 = 0$	0

As it can be seen from this table, all the variables that appear in E.UK.1 are highly significant. Especially the significance of the wealth variable gives validity to the Life-Cycle model of consumption. Regarding the degree of income correction the relative tests were performed indirectly. According to these tests, both the null hypothesis that this degree is equal to zero, and the null hypothesis that it is equal to one are rejected.

10.4 The Short Run Consumption Function.

Having estimated the long run consumption function we can now formulate a corresponding ECM. To arrive at the final equation, we applied the general to specific method. The final equation, as it was estimated by OLS is as follows:

Table T.UK.5: The Error Correction Model

Modelling dlnrcpc by OLS
The present sample is: 1954 to 1992

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
Constant	-0.0044	0.0046413	-0.946	0.3519	0.0299
dlnrcpc_1	0.55139	0.17898	3.081	0.0045	0.2466
dlnrdipc	0.79651	0.097681	8.154	0.0000	0.6963
dlnrdipc_1	-0.49883	0.15661	-3.185	0.0034	0.2592
dlnrdipc_2	-0.18546	0.10789	-1.719	0.0963	0.0925
dlnrwpc	0.16974	0.096251	1.763	0.0884	0.0968
dmner2rat	0.45044	0.18367	2.452	0.0204	0.1718
dmner2ra_1	-0.0047	0.099060	-0.047	0.9625	0.0001
dmner2ra_2	0.34538	0.11340	3.046	0.0049	0.2424
ect_1	-0.71759	0.16811	-4.269	0.0002	0.3859

$R^2 = 0.844051$ $F(9, 29) = 17.44$ [0.0000] $\sigma = 0.0100869$ DW = 2.07
RSS = 0.002950614138 for 10 variables and 39 observations
Information Criteria: SC = -8.54993; HQ = -8.82344; FPE = 0.000127834
AR 1- 2F(2, 27) = 0.53693 [0.5907]
ARCH 1 F(1, 27) = 0.89813 [0.3517]
Normality $Chi^2(2)$= 2.3227 [0.3131]
Xi^2 F(18, 10) = 0.50938 [0.8977]
RESET F(1, 28) = 1.027 [0.3195]

As it can be seen from table T.UK.5, both the lagged income variables are statistically significant. Therefore, to identify the short run degree of income correction non-linear methods have to be used. The non-linear equation that corresponds to the above model is as follows:

dlnrcpc=&0+&1*lag(dlnrcpc,1)+&2*(dlnrdipc-&3*dmner2rat)+
&4*(lag(dlnrdipc,1)-&3*lag(dmner2rat,1))+&5*(lag(dlnrdipc,2)-
&3*lag(dmner2rat,2))+&6*dlnrwpc + &7*lag(ect,1); E.UK.2
where lag(x, r) = x_{t-r}

The estimation of the above equation by NLS showed that the coefficients &0 and &5 were entirely insignificant (t-values: 0.9950 for &0 and 0.5890 for &5). The joint hypothesis that &0=&5=0 gave a p-value equal to 0.7922. Deleting the second lag of the corrected income and the constant term we have the following model:

dlnrcpc=&1*lag(dlnrcpc,1)+&2*(dlnrdipc-&3*dmner2rat)+
+ &4*(lag(dlnrdipc,1)-&3*lag(dmner2rat,1))+&6*dlnrwpc +
+&7*lag(ect,1); E.UK.3

The results from the estimation of this model are presented at table T.UK.6 below:

Table T.UK.6

Modelling dlnrcpc by NLS
The present sample is: 1953 to 1992

Variable	Coefficient	Std.Error	t-value	t-prob	PartR²
&1	0.41015	0.19318	2.123	0.0411	0.1171
&2	0.63680	0.084646	7.523	0.0000	0.6247
&3	0.094125	0.13302	0.708	0.4840	0.0145
&4	-0.35259	0.15474	-2.279	0.0291	0.1325
&6	0.16655	0.094125	1.769	0.0858	0.0843
&7	-0.27872	0.10167	-2.741	0.0097	0.1810

$R^2 = 0.787146$ $F(5, 34) = 25.147$ [0.0000] $\sigma = 0.0109664$ DW = 1.86
RSS = 0.004088916642 for 6 variables and 40 observations
Information Criteria: SC = -8.63502; HQ = -8.79676; FPE = 0.000138302
ARCH 1 F(1, 32) = 0.12795 [0.7229]
Normality $Chi^2(2)$= 1.9095 [0.3849]
AR 1- 1F(1, 33) = 0.19104 [0.6649]
AR 1- 2F(2, 32) = 0.12711 [0.8811]
Xi^2 F(10, 23) = 0.36754 [0.9485]
Xi*Xj F(20, 13) = 0.34953 [0.9830]

Before we start commenting on the results of the above table we should first test the validity of the exogeneity assumption. To do this we used the Hausman- Wu exogeneity test[1]. According to this test the null hypothesis of weak exogeneity cannot be rejected at any conventional level of significance (p-value = 0.7962)

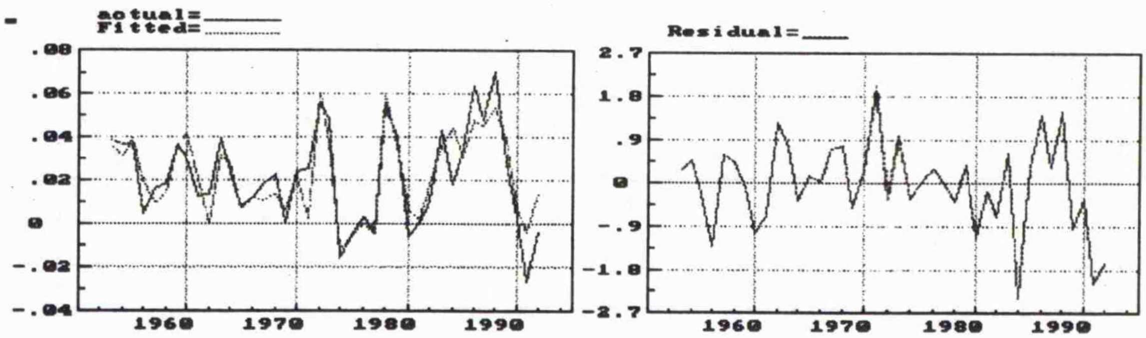


Diagram UK.2

Having verified the validity of the exogeneity assumption we can now comment on the results given in the above table. Regarding the goodness of fit, the above diagram that presents the actual and the fitted values shows that despite the fact that the dlnrcpc was rather volatile, the model was able to catch this volatility and generally the actual and the fitted values were close to each other.

[1]For the specific way to implement this test the reader is referred to the first case study.

Regarding the satisfaction of the classical regression assumptions, the table T.UK.6 shows that the model is successful in passing all the corresponding tests with high p-values.

Turning now to the individual coefficients, it can be seen that the error correction term is highly significant. Significant, at the 5% level, is also the lagged income variable and the same happens for the lagged dependant variable as well. Regarding the coefficient of our particular interest, i.e. the short run degree of income correction it is equal to 0.094 which again is very low and less than the long run one. Actually, as it can be seen from table T.UK.6 the null hypothesis that the short run degree of income correction is equal to zero cannot be rejected at any conventional level of significance. On the other hand, the null hypothesis that this degree is equal to one is rejected at any level of significance (p-value = 0). The fact that for the UK we found low degrees of income correction is not something that happens for first time. Indeed, Nicolleti (1988) found a zero degree of income correction, while HUS estimated this coefficient equal to 0.5. On the other hand, U-S (1981) found a degree of income correction equal to 0.85 which is the highest value that has been obtained. The evidence presented here supports the low estimates obtained.

10.4.1 The stability and the forecasting accuracy of the model.

To examine the stability of the model we used the following tests the results of which are presented at diagram UK.3 below:

i) 1-step recursive residuals

ii) 1-step Chow - Test

iii) Break point F-tests (N↓ Step Chow - Tests)

iv) Forecast F-tests (N↑ Step Chow - Tests)

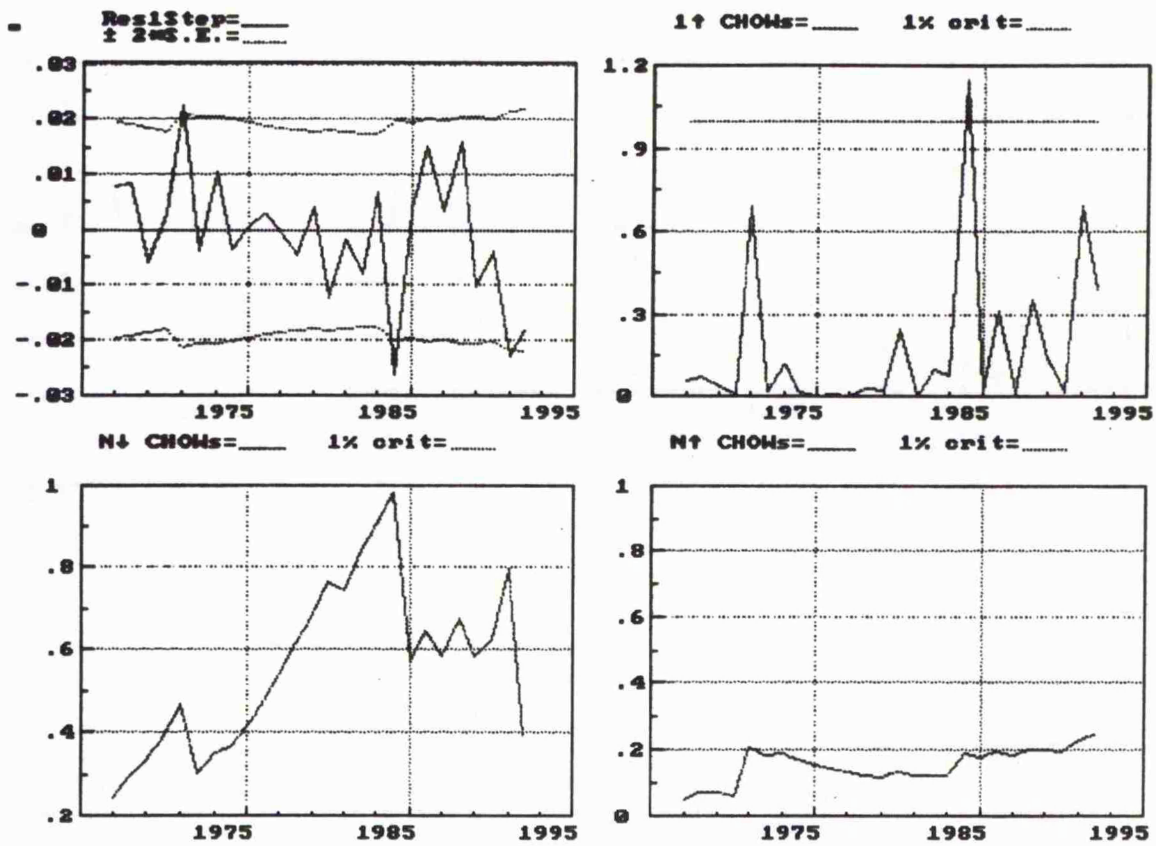


Diagram UK.3

The conclusion from the above diagram is that the stability of the model is moderate. Though the N-steps Chow tests do not show any problems at the 1% level of significance[2] this does not happen for the 1-step Chow test which shows instability for 1984. Instability for this year is also indicated by the 1-step recursive residuals. The latter shows instability for 1971 as well. If we increase the critical level of significance to 5% then the 1-step Chow test shows instability for 1971, 1991 in addition to 1984. Though we tried dummy variables to solve this problem they proved insignificant and thus we decided to leave the model as it is.

Regarding the forecasting accuracy of the model, this was examined by re-estimating the model without the five last observations that were kept for 1-step

[2]However, regarding the N↓ - step, it is clear that if we increase just a bit the level of significance it will become significant for 1984.

ahead forecasts. The forecast Chi-square statistic shows that the forecasts are not the best since, though the corresponding null hypothesis is not rejected at the 1% level, it does so at the 5% level (p-value = 0.0271). Diagram UK.5 below, presents the actual and the forecasted values. As it can be seen, the main problem of the model was for the period 1991-1992.

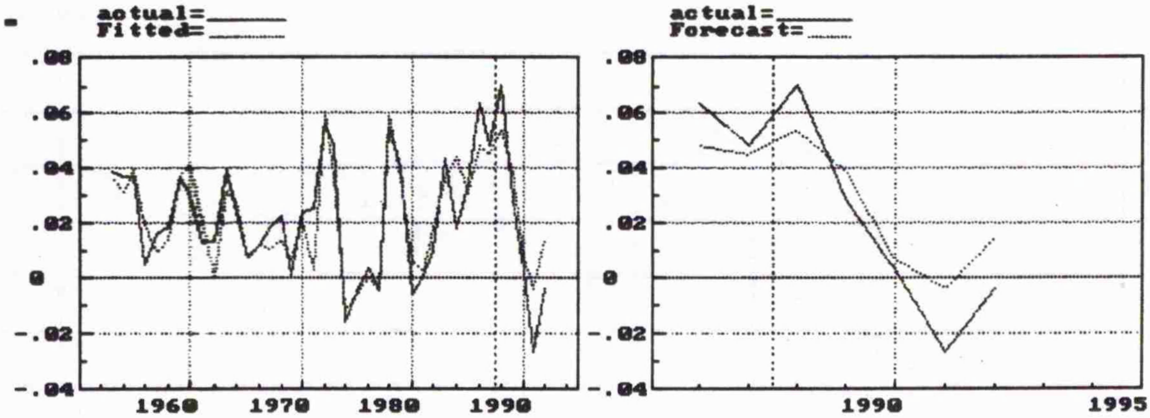


Diagram UK.4

Generally, one could say that the model was not the best that we have estimated in terms of stability and forecasting accuracy, though it performed very well in other aspects.

10.5 The ex-post and the ex-ante inflation corrected Current Account Balance (CAB)

10.5.1 A look at the paths of the main variables of the analysis.

Having estimated the short run and the long run degree of income correction, we can now use this estimates to estimate the short run and the long run ex-ante inflation corrected Current Account Balance (CAB). Nevertheless, it would be good before doing so to have a look at the paths that the main variables of the analysis followed, during the years of our sample. For this purpose, diagram UK.5 below presents the plots of the main variables of the analysis while table T.UK.7 shows some descriptive statistics for these variables. Regarding the diagram, the plots of the following variables are presented (from the top left to the right): net financial liabilities, gross interest payments, net saving, net lending, gross foreign debt and inflation rate. The first four variables are expressed as ratios to GDP and refer to the general government, while the fifth one is expressed as a ratio to the net financial liabilities and refers to the central government.

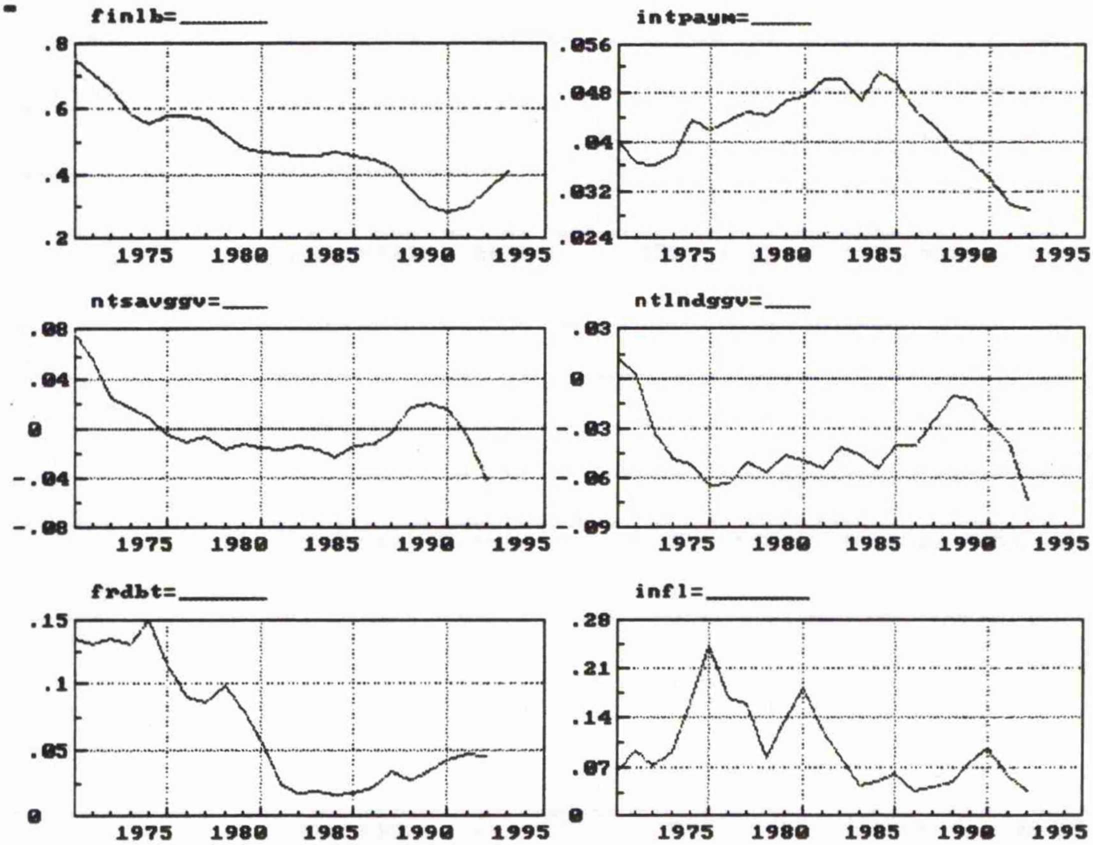


Diagram UK.5

Table T.UK.7

Variable	Minimum (Year)	Maximum (Year)	Average
Net Fin. Liabil. (% GDP)	28.4 (1990)	75.3 (1970)	48.7
Interest Payments (% GDP)	2.89 (1992)	5.126 (1984)	4.19
Net Saving (% GDP)	-4.148 (1992)	7.55 (1970)	0.1528
Net Lending (% GDP)	-7.325 (1992)	1.376 (1970)	-3.91
Foreign Debt (% Tot. Debt)	1.7 (1984)	14.865 (1974)	6.76
Inflation (%)	3.512 (1986)	24.224 (1975)	9.56

Starting from the net financial liabilities, it can be seen that the corresponding percentage followed a falling path during almost all the period of our sample. Also, it can be seen that it was always positive and, in the first years of the sample, pretty high. Actually, it was in the first year of the sample where this variable got its highest value (75.3% of GDP). The average value of this variable was 48.7% of GDP.

Although the net financial liabilities followed a falling path, this isn't true for the gross interest payments but only after 1984, year at which this variable got its highest value: 5.126% of GDP. This is not strange if we remember that this variable is *gross* while the financial liabilities are *net.*

Regarding the percentage of the conventional CAB, though it was strongly positive in the first five years of the sample, after that it turned and stayed negative for a long period. Yet, it cannot be said that it was too negative. Actually, although the conventional CAB was positive in only 8 out of the 23 years of the sample, the average value that it got was positive and equal to 0.1528% of the GDP. On the other hand, the net lending was negative in all the years of the sample except for the first year where it got its only positive value. The average value of this variable was -3.91% of GDP.

Finally, regarding the inflation rate it was rather high and in many cases above 10%, in the first 12 years of the sample. Yet, it didn't exceed that level after 1981. The average value of this variable was higher than in other developed countries (9.56%).

Generally, from the above discussion it can be said that the inflation correction will be rather quantitatively significant since both the inflation rate and the net financial liabilities of the government were rather high. However, the validity of this argument is decreased for the ex-ante measures because of the low degrees of income correction that we found.

10.5.2 Estimates of the ex-ante inflation corrected CAB

It is now time to use the estimates of the degree of income correction obtained previously to derive estimates of the ex-ante inflation corrected CAB. It is reminded that we obtained a long run degree of income correction equal to 0.222 while the short run one was found equal to 0.094. The formula that will be applied to estimate the ex-ante inflation corrected balance is the usual one:

$$CORCAB = CCAB + \delta\pi^{e}_{t}DB \qquad \text{E.UK.4}$$

where the notation is as in the previous case studies.

Depending on whether the short run or the long run degree of income correction is used, we can get respective estimates of the ex-ante inflation corrected CAB. Such estimates are presented at table T.UK.8 and they are also reproduced in diagram UK.6 below.

Table T.UK.8: The conventional and the ex-ante inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Short Run Ex-Ante Inflation Erosion	Short Run Ex-ante Inflation Corrected CAB	Long Run Ex-ante Inflation Erosion	Long Run Ex-ante Inflation Corrected CAB
1970	0.075	0.004	0.079	0.009	0.085
1971	0.057	0.005	0.062	0.011	0.069
1972	0.024	0.005	0.029	0.011	0.036
1973	0.018	0.004	0.022	0.010	0.028
1974	0.010	0.006	0.016	0.014	0.025
1975	-0.004	0.009	0.005	0.023	0.018
1976	-0.010	0.010	-0.0004	0.023	0.013
1977	-0.005	0.008	0.002	0.019	0.013
1978	-0.016	0.005	-0.010	0.013	-0.0001
1979	-0.010	0.004	-0.006	0.011	0.0002
1980	-0.015	0.006	-0.009	0.015	-0.0005
1981	-0.016	0.006	-0.009	0.014	-0.0012
1982	-0.013	0.004	-0.009	0.009	-0.0033
1983	-0.015	0.002	-0.013	0.006	-0.0093
1984	-0.022	0.002	-0.020	0.004	-0.0177
1985	-0.012	0.002	-0.010	0.005	-0.0070
1986	-0.011	0.001	-0.010	0.004	-0.0073
1987	-0.003	0.001	-0.001	0.003	0.0004
1988	0.017	0.001	0.018	0.003	0.020
1989	0.021	0.001	0.023	0.004	0.025
1990	0.015	0.002	0.018	0.005	0.021
1991	-0.005	0.002	-0.003	0.004	-0.0007
1992	-0.041	0.001	-0.040	0.003	-0.0381

(all figures are ratios to GDP)

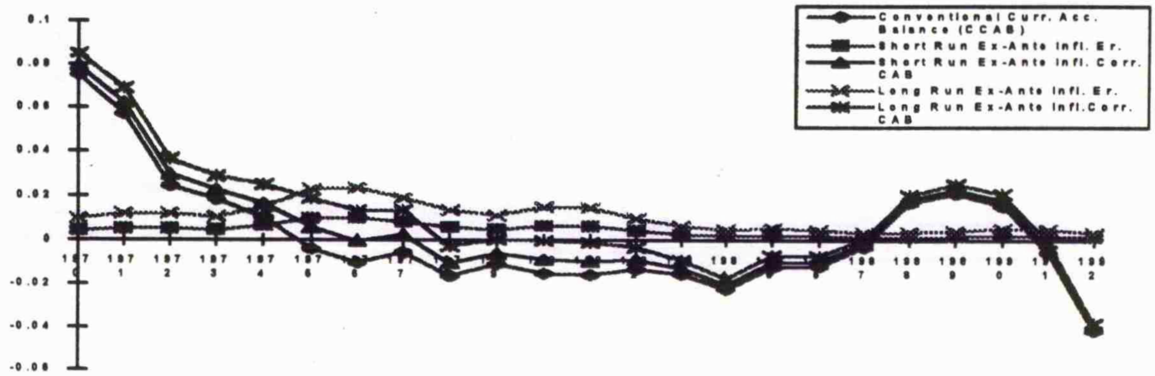


Diagram UK.6

As it can be seen from the table and from the diagram, the ex-ante inflation correction seems to be of minor importance. The reason is because the short run and the long run degree of income correction are very small thus rendering the second term of the right hand side of E.UK.4 quantitatively unimportant. Thus, one could say that for the UK the conventional CAB was not a much distorted proxy of the CAB as it is perceived by people.

10.5.3 Estimates of the ex-post inflation corrected CAB

The second set of inflation corrected balances that will be derived in this study are ex-post ones. Similarly to the previous case studies, to derive estimates of the ex-post inflation corrected CAB we applied the next two formulas:

$$CORDEF2 = DEF + \pi DB \qquad \text{E.UK.5}$$

$$CORDEF3 = DEF + \pi DB_i + (\pi_t - e_t)DB_e \qquad \text{E.UK.6}$$

where the notation and the differences in reliability between E.UK.5 and E.UK.6 have already been explained in the first case study.

The first formula does not account for the effects that changes in the exchange rate have on the real value of the external debt. In contrast, the second formula takes such effects into account. Table T.UK.9 below presents estimates of the ex-post inflation corrected CAB as it is computed by the above two formulas. Then, diagram UK.7 contrasts the conventional balance with the ex-post and the ex-ante inflation corrected ones.

Table T.UK.9: The conventional and the ex-post inflation corrected CAB

Year	Conventional Current Account Balance (CCAB)	Inflation Erosion according to E.UK.5	CORDEF2	Inflation Erosion according to E.UK.6	CORDEF3
1970	0.075	0.047	0.122	0.047	0.122
1971	0.057	0.064	0.122	0.063	0.120
1972	0.024	0.046	0.071	0.044	0.069
1973	0.018	0.052	0.071	0.054	0.072
1974	0.010	0.085	0.095	0.088	0.099
1975	-0.004	0.125	0.121	0.128	0.124
1976	-0.010	0.086	0.075	0.096	0.085
1977	-0.005	0.084	0.078	0.086	0.080
1978	-0.016	0.042	0.025	0.037	0.020
1979	-0.010	0.062	0.051	0.057	0.046
1980	-0.015	0.077	0.062	0.074	0.059
1981	-0.016	0.052	0.036	0.055	0.039
1982	-0.013	0.037	0.024	0.039	0.025
1983	-0.015	0.019	0.004	0.020	0.005
1984	-0.022	0.022	-2.74945E-05	0.023	0.0009
1985	-0.012	0.026	0.014	0.027	0.014
1986	-0.011	0.015	0.003	0.014	0.002
1987	-0.003	0.016	0.013	0.015	0.012
1988	0.0170	0.017	0.034	0.016	0.034
1989	0.0213	0.024	0.045	0.025	0.046
1990	0.0158	0.026	0.042	0.025	0.041
1991	-0.005	0.016	0.011	0.016	0.011
1992	-0.041	0.011	-0.029	0.011	-0.029

(all figures are ratios to GDP)

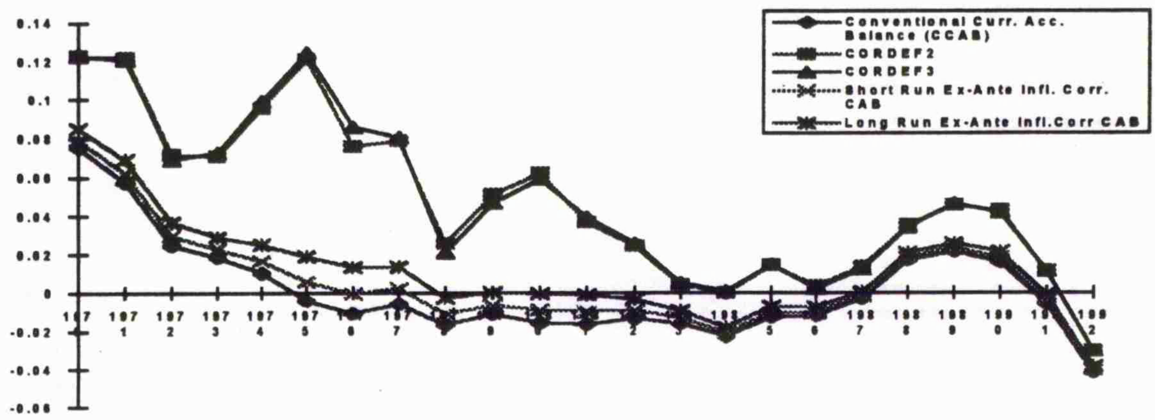


Diagram UK.7

As it can be seen from the table and from the diagram, in contrast to the ex-ante inflation corrected measures, the ex-post ones are really different from the conventional CAB. Thus, though the conventional CAB was negative in fifteen out of the twenty three years of the sample the CORDEF2 was so in only two years. The big difference observed between the ex-ante and the ex-post inflation corrected estimates is due to the fact that the low degree of income correction, is not taken into account in the ex-post estimates.

To conclude one could say that the inflation correction matters only when it is computed ex-post. When it is computed ex-ante it is of rather minor importance and this because of the small estimated degrees of income correction.

11.6 Summary of the results

In this section the case of the UK was examined. The main results of the analysis are as follows:

i) All the variables of the analysis were I(1), except for the real interest rate and the unemployment rate that were stationary, as it is theoretically expected.

ii) The Johansen cointegration procedure showed that there are three statistically significant cointegrating vectors. Thus for one more time, more than one cointegrating vectors were found.

iii) According to the chosen cointegrating vector, the long run elasticity of consumption with respect to income is 0.73267, while the corresponding elasticity with respect to wealth is 0.27715. Inference in the cointegrating space shows that the wealth variable is statistically significant which gives bonus to the validity of the life cycle model of consumption.

iv) Regarding the long run degree of income correction, it is only 0.222.

v) To formulate the short run consumption function an ECM was estimated. However, the final equation was non-linear and it was thus estimated using non-linear least squares. The Hausman-Wu exogeneity test verified the weak exogeneity of the independent variable. The fitness of the equation was very good, and the equation passed successfully all the statistical tests to which it was subjected. However, the model was rather weak regarding its stability and forecasting accuracy properties.

vi) The short run degree of income correction was 0.094125 which is again very low.

vii) Finally, we derived estimates of the ex-post and the ex-ante inflation corrected CAB. Comparing the relative figures with the conventional ones, it can be seen that the ex-ante ones are hardly different from the later. The reason is the low estimates of the degree of income correction. On the other hand, the ex-post inflation correction was much more significant and actually it turned the conventional CAB from deficit to surplus in 13 out of the 15 cases. The reasons for the significance of the ex-post inflation correction are the rather high inflation rate and the high net financial liabilities of the government.

CONCLUSION

1. A review of the thesis and the results

Though it is not unusual today to see inflation corrected estimates of the government balance, these estimates are almost always ex-post. Consequently, they have little significance for policy analysis since what the latter needs is ex-ante estimates. This thesis aimed to fill this gap by deriving an ex-ante measure of the inflation corrected current account government balance which was then estimated for 10 OECD countries.

The idea upon which this thesis is based is very simple: to estimate the ex-ante inflation corrected balance, it is necessary to know the degree by which people correct their nominal incomes for the effects of inflation on the real value of their net monetary assets. Then, by adjusting the inflation erosion of the government debt by this degree we can have an ex-ante measure of the inflation corrected government balance. For ease of reference we reproduce below the ex-ante measure that we derived in this study:

$$CCAB'' = G - T + nL_g - \delta\pi^e L_g \qquad \text{E.1.21}$$

As it was seen in the first chapter of this thesis and as it can also be seen from the above relationship, both the conventional balance and the ex-post inflation corrected one, are special cases of E.1.21. Indeed, the conventional balance corresponds to a zero degree of income correction ($\delta = 0$), which in turn means that the people base their decisions on the nominal interest payments that they receive. On the other hand, the traditional inflation corrected measure corresponds to the case where the people fully correct their income for the effects of inflation[1] ($\delta = 1$). Both these two cases suffer from the fact that in order to have any behavioural meaning they require extreme assumptions about the degree of income correction.

To derive estimates of E.1.21, it is obvious that we need to have an estimate of the degree of income correction. To estimate this degree, we utilised a consumption function where the degree of income correction was treated as an additional parameter for estimation.

Chapter 2 reviewed the existing attempts for the estimation of the degree of income correction. As we saw there, these attempts are very few relative to the voluminous literature on the consumption function. Also, we saw that when there were more than one studies about the same country their results contradicted each other. This manifests serious methodological inefficiencies of the existing studies.

The solution to these problems was the subject of chapter 3. In that chapter, we utilised the newly developed concepts of unit roots, cointegration and error correction model to construct a different framework for the estimation of the degree of income correction. Our model does not suffer from any of the problems of the existing models and the modelling strategy that is used is what today is considered to be the best way of econometric modelling.

Before the empirical application of what was said in chapters 2 and 3, we felt that it is needed to confront the problem of lack of data about the stock of dwellings that together with the financial wealth makes up the total wealth of the households. To solve this problem we utilised a method based on capital-output ratios to derive a benchmark estimate. Then, by using the Perpetual Inventory Method we derived estimates of the stock of dwelling for 16 OECD countries. To evaluate the reliability of our estimates we compared them with the official estimates for 8 OECD countries for which such estimates were available. This

[1]In this case it is also required to have equality of the realised inflation rate with the expected one.

comparison confirmed the reliability of our estimates since with the exception of Belgium, for all the other countries the average absolute difference was less than 20% of the official estimates and for 4 out of the 8 countries less than 7%.

Having solved the problem of the lack of data about the stock of dwellings, we estimated the short run and the long run degree of income correction for 10 OECD countries. The corresponding estimates are presented below at table T.1 together with the existing estimates, where such estimates were available.

Table T.1

Country	δ_L	δ_S	**Other estimates**	**Study**
Belgium	0.86	0	1	Nicolleti (1988)
France	0.8262	0.8262	0.75	Nicolleti (1988)
Germany	0.278	0.1533	0 1.16	Nicolleti (1988) U-S (1981)
Japan	0.3797	0.23	0.5	Nicolleti (1988)
Italy	0.77	0	1 0.1 0.2	Nicolleti (1988) Rossi et al. (1983) Rossi and Schiantarelli (1982)
UK	0.222	0.094	0 0.5 0.85	Nicoletti (1988) HUS (1980) U-S (1981)
Greece	0.495	0.413		
Netherlands	0.153	0.153		
Norway	1	0		
Spain	0.652	0.189		

One of the many innovations of our work was that the discrimination between the long run and the short run degree of income correction. This discrimination was confirmed by the data since in 8 out of 10 cases the point estimate of the short run degree of income correction was smaller than the long run one exactly as it is theoretically expected. In the two cases where it was larger than the long run one, it couldn't be rejected that it is statistically equal to the long run one.

A comparison of our results with those obtained by Nicolleti (1988) - his study is the latest one and the only one that refers to a more than two countries sample - shows that his estimates are similar to the ones obtained here for the long run.

Generally from the above results, it is confirmed what was said in chapter two i.e. that there is a great diversity in the estimates of the degree of income correction among countries. As it can be seen, for countries with a large government debt as Belgium and Italy, the long run degree of income correction was also large and in both cases we couldn't reject that it was equal to 1. On the other hand, for some countries that experienced a small inflation rate the degree of income correction was rather moderate. This happened for Netherlands, Japan and Germany all of which had a long run degree of income correction less than 0.4.

Regarding the short run degree of income correction, in 9 out of 10 cases it was less than 0.5. In fact, in 7 out of 10 cases we were unable to reject the null hypothesis that this degree is equal to 0. These results show the existence of extensive money illusion in the short run and justify our discrimination between the short run and the long run.

The estimation of the short run and the long run degrees of income correction permitted us to derive corresponding estimates of the ex-ante inflation corrected current account government balance. As we saw many times the ex-ante inflation correction managed to turn the conventional deficit to an ex-ante inflation corrected surplus. This happened[2] 9 times for Italy, 6 times for Belgium, 5 times for France, Spain and the UK and 1 time for Greece. The maximum of the

[2]The reference here is to the long run ex-ante inflation corrected CAB

percentage of the long run inflation correction to GDP fluctuated from a minimum of 0.25% (1982) for Germany to a maximum of 7.46% (1981) for Italy.

Apart from ex-ante inflation corrected estimates we also computed ex-post ones. These estimates were of two kinds. One discriminated between foreign and domestic debt, as it is theoretically correct, while the other didn't make a discrimination like this. However, the estimates that discriminated between foreign and domestic debt are not as reliable as the estimates that avoid this discrimination. The reason is that the data on the foreign debt were gross and referred to the central government only.

As in the case of the long run ex-ante inflation corrected balance so in the case of the ex-post inflation corrected balance, many times the inflation correction turned the conventional deficit to an ex-post inflation corrected surplus. However, the times that this happened as well as the corresponding percentage of the inflation correction were much higher than for the ex-ante inflation corrected CAB[3]. Thus, the current account government balance turned from a conventional deficit to an ex-post inflation corrected surplus[4] 18 times for Italy, 14 times for the UK, 9 times for Greece, 7 times for Belgium, 6 times for Spain, 5 times for France and 3 times for Netherlands. As it concerns the maximum percentage of the inflation correction to GDP it fluctuated from a minimum of 0.84% (1982) for Germany to a maximum of 17.55% (1991) for Greece.

All the above show the significance of the inflation correction. However the government balance is not the only measure that is distorted by inflation. Such statistics as the private savings, the balance of foreign payments and generally any measure that includes interest payments needs to be corrected for the effects of

[3]The reason is that in the ex-post computation, the degree of income correction, that because it takes values in the unit interval it decreases the quantitative importance of the inflation correction, is not taken into account.
[4]The discussion here refers to the measure that does not discriminate between domestic and foreign debt.

inflation. However, as we said, the inflation correction must not be seen as a simple accounting exercise since in a case like this the corresponding corrected estimates will not be but ex-post ones. The degrees of income correction that were estimated here can also be used for the derivation of similar ex-ante inflation corrected estimates of other statistics.

Potential improvements of the thesis and suggestions for further research[5]

After the above summary of the main contributions and results of this thesis, it is necessary to point out some things that could be improved by further research.

i) The first improvement regards the fact that the wealth variable is not all embracing. Indeed, apart from the fact that it does not explicitly include the human wealth, it also assumes that all the non-financial, non-human wealth is composed of a house. This assumption was necessary because of lack of data and though it has been extensively used in the literature it does have inefficiencies[6]. Also the liquid assets variable does not include the value of shares. Though again this was done because of lack of data, the inclusion of this item might be an important improvement since in many countries there was a movement in the last 15 years, from traditional forms of savings to shares. Also the financial liberalisation that took place in the last 20-25 years may have resulted in changes in the composition of the financial wealth of the households and probably in different propensities to consume out of different kinds of wealth. Therefore, further research may be needed that will try to construct and use a more complete wealth variable.

[5]I'm indebted to Prof. G. Hadjimatheou and Dr. C. Bourlakis for making these suggestions to me.
[6]For example this assumption ignores the fact that part of the wealth may be kept in the form of a simple piece of land.

ii) Another point that may need further research is the estimation of the housing stock. For this estimation it was assumed that the useful life of dwellings as it is given by OECD is accurate. However, this may not be entirely true. This is indicated for example by the fact that while for Norway the OECD assumption is that the useful life of a house is 90 years, for Finland, a country of very similar conditions, this estimate is no more than 55 years.

Apart from the above point, a comparison between the official estimates and the estimates obtained by our method shows that there is a systematic discrepancy between the two series. This discrepancy that is the result of the difference between the benchmark estimate and the corresponding official estimate, may cause a misspecification error. Further research may therefore be needed to show the extension of the problem and how it could be corrected.

iii) Another point that could be made is that in the case of Belgium, while the long run degree of income correction is not significally different from 1 the wealth variable is statistically insignificant. This is really a strange result since one would expect that if people corrected their incomes fully for the effects that inflation has on the real value of their monetary wealth they wouldn't be indifferent to the total value of this wealth. An explanation that could be given is that the degree of income correction counts the degree by which the people discount their net interest payments and not their total wealth. However, it is certain that further research may be needed for Belgium that will shed more light on this issue.

iv) Also, one of the assumptions of the thesis was that the degree of income correction is constant over time. Though we used various instability tests to test this assumption, one could go further and estimate the relative coefficients through time by using such a suitable technique as the Kalman Filter.

v) Finally, regarding the discrimination between the short and the long run we approached the subject from a macroeconomic point of view where the relative time constancy of the proportion of the population that suffer from some degree of money illusion provides both for a constant long run and short run degree of income correction and for the difference between them[7]. This was in accordance with our approach where we were interested to compute a macroeconomic degree of income correction that we would then apply to correct the public deficit. Of course significant changes may have taken place if we approached the subject from a microeconomic point of view, where the agent learns through time and therefore little difference should be expected in the microeconomic level between the short run and the long run. Therefore, further research may be needed that will examine the topic from a microeconomic point of view.

[7]The reason is because though a specific person may learn through time the effects of inflation on his monetary wealth and therefore will no more have money illusion, other people will enter the economy that will haven't learned these effects yet. Thus in an aggregate level there is space for both a short run and a long run degree of income correction and for a difference between them.

DATA APPENDIX

SOURCES AND DEFINITIONS

The purpose of this appendix is to give the specific sources and definitions of the variables that were used in the analysis.

1. **Consumption:** it was defined as the private final consumption expenditure. Data source: OECD, National Accounts.
2. **Disposable income:** it was defined as the disposable income of households and private unincorporated enterprises. Data Source: OECD, National Accounts.
3. **Total wealth:** it was defined as the sum of the financial wealth and the stock of dwellings of the households. For the computation of the financial wealth see later in this appendix. For the stock of dwellings we used OECD data when they were available. When they were not, we used the estimates derived in chapter 4.
4. **Inflation rate:** It was defined as the change relative to the previous year of the consumer price index of the IMF Financial Statistics (line 64)
5. **Conventional current account balance:** It was defined as the item "net saving" of the general government accounts: OECD, National Accounts
6. **Net lending of the general government:** It was defined as the item "net lending" of the general government accounts: OECD, National Accounts. When there wasn't an official estimate, we used the information about: the consumption of fixed capital of the general government, the capital transfers of the government, and the gross government investment to derive an estimate.
7. **Unemployment rate**: It was computed as the ratio of the difference of the total labour force from the total employment to the total labour force. The data source was OECD, Labour statistics.

8. **Interest rate**: For all countries except for Belgium and Japan it was defined as the government bond yield (line 61 of IMF Financial Statistics). For Belgium and Japan, because we didn't have data on the government bond yield we used the treasury bill rate (line 60c) and the money market rate (line 60b) respectively.

9. **Net financial liabilities of the general government.** It was taken from P. Muller and R. Price: "Structural budget deficits and fiscal stance", OECD, Economics and Statistics Department, Working Paper No.15, 1984, as well as OECD, Economic Outlook, various issues

10. **Gross interest payments of the general government.** It was taken from the "accounts for general government", OECD, National Accounts

11. **Foreign debt:** It corresponds to "foreign debt", line 89a, IMF Financial Statistics

12. **Gross Domestic Product**: It was taken from OECD, National Accounts.

The financial/monetary wealth variable

The financial wealth variable is actually a monetary wealth one, since it does not include the shares holdings for the reason that information was not available. Though the ideal situation for the computation of the monetary erosion variable would be to have data on the net monetary assets of the household sector such data are simply unavailable, at least on a comparable basis and for a long enough time period. Thus, we had to compute this variable indirectly. For this purpose we used the information given by the IMF Financial Statistics plus some logical assumptions about the distribution of the financial assets within the private sector.

The sectorisation that is followed by IMF, Financial Statistics discriminates four sectors: the monetary/financial sector, the government sector, the foreign sector and the private sector. However the private sector except for the households comprises all the non-financial corporate enterprises as well. We have therefore to find a way to separate the households from the private corporate enterprises since while the households are usually net lenders the private corporate enterprises are usually heavy debtors. Therefore, mixing these two sectors together would give a distorted picture of the item that we want to compute. Fortunately, there is a solution to this problem. This solution is based on some observations that can be made by taking a look at the balance sheet data of the few countries that publish such data. The first observation is that the financial assets of the enterprises are small in magnitude relative to the financial assets of the household sector. Indeed, most of the assets of the private non-financial enterprises are non-financial (cars, factories, land etc.). The second observation is that the deposits of the government sector are in most cases very small relative to the total deposits. From these two observations we could says that a large part of the total deposits (excluding the deposits of foreigners) plus M0 belong to the households sector. Moreover, since we have information of the internal debt that is possessed by the financial sector (IMF, Financial Statistics) we can residually compute the part of the debt that is possessed by the private sector. Then, assuming that the amount of the government debt that is possessed by the non-financial private corporate enterprises is negligible, we can compute the amount of the government debt that is possessed by the household sector as the difference of the total internal debt and the debt possessed by the financial sector. Adding to this variable, the total deposits with the financial sector plus the M0 we can derive an indirect measure of the gross monetary assets of the households. Unfortunately information about the net monetary assets was impossible to be derived since there were no comparable data on the liabilities of the household sector. However, a look at the balance sheet data[1] shows that the liabilities of the household sector are generally small relative

[1]For example see: Table 33B/12 "Outstanding Financial Assets and Liabilities of sectors N.E.I", OECD,

to the assets. Besides that, the exclusion of the bonds of the private corporations that are possessed by the household sector as well as the exclusion of other minor items could compensate the anyway small difference.

Below, we give for each country the way that the monetary wealth variable is computed and the specific data that were used.

BELGIUM

(in parenthesis is the corresponding line of the IMF Financial Statistics)

Financial/monetary wealth = Money (line 34) + Quasi Money (line 35) + General Savings Fund Deposits (45 i) + Domestic government debt (line 88a) - claims of financial institutions on government (line 32an + 42a.s)

FRANCE

Financial/monetary wealth = Liquid Liabilities (54) + Bills, Bonds Capital etc. (line 56a) + Post Office Checking Deposits (24...i) + Treasury: P.S. Deposits (24...r) + Government Debt in francs (88b) - Claims on the government (financial survey or Banking Survey, 52an)

GERMANY

Financial/monetary wealth = Money (34) + Quasi-Money (35) + Bonds (36ab) + Time and Saving Deposits in Non bank Financial Institutions (45i) + Domestic Debt (88a) - Claims on Central Government by Monetary Authorities (12a) - (Claims on Central Government by Deposit Money Banks (22a) - Net Claims on Laender Government (32an x)) - Claims on Central Government by Nonbank Financial Institutions (42a. i)

Financial Statistics, various issues

GREECE

Financial/Monetary wealth = Currency outside Banks (line 14a) + Total Private Deposits in all banks (it was take from: Long run statistical series of the Greek Economy, Bank of Greece, 1989, Table 24, p.70) + Bank bonds (IMF, OECD economic surveys) + Repos (OECD: economic surveys, Greece) + Private sector holdings of treasury bills (OECD: economic surveys, Greece)

ITALY

Households' Financial wealth: See Table 21, p.39 of P.Pagliano and N.Rossi, Banca D'Italia, Temi di discussione, Numero 169.

Households' Monetary wealth = Financial wealth - shares possessed by households (source: 1965-1981, Riati, 1985; 1982-1993, OECD Financial Statistics: Italy; for years earlier to 1965 we used personal estimations)

JAPAN

Financial/Monetary assets: Money (IMF: line 34) + Quasi Money (IMF: line 35) + bonds of deposit money banks (IMF: line 26a) + certificates of deposit (IMF: line 26aa) + Internal central government debt (United Nations) - claims on central government: monetary authorities (IMF: line 12a) - claims on central government: deposit money banks (IMF: line 22a) - claims on central government: other banking institutions (IMF: line 42a) - claims on central government: Non bank financial institutions (IMF: line 42a...s)

NETHERLANDS

Financial/Monetary assets: Money (IMF line: 34) + Quasi Money (IMF line: 35) + Bonds (IMF line: 36a) + Time and Saving deposits with Saving Banks (IMF line: 45..g) + Central government debt in guilders (IMF line: 88b) - claims on central government: central bank (IMF line: 12a) - claims on central government: deposit money banks (IMF line: 22a) - claims on central government: saving banks (IMF line: 42a.g) - claims on central government: Life Insurance and Pension Funds (IMF line: 42a.i)

NORWAY

Financial/Monetary assets: Money (IMF line: 34) + Quasi Money (IMF line: 35) + Bonds of other banking Institutions (IMF line: 46a) + Central government domestic debt (IMF line: 88b and after 1970: IMF Government Statistics) - claims on central government: central bank (IMF line: 12a) - claims on central government: commercial and savings banks (IMF line: 22a) - claims on central government: post office saving bank and postal giro (IMF line: 22a.i) - claims on central government: non bank financial institutions (IMF line: 42a.s)

SPAIN

Financial/Monetary assets: Money (IMF line: 34) + Quasi Money (IMF line: 35) + Bonds of commercial and saving banks (IMF line: 26a) + Time deposits with other banking institutions (45) + Bonds of other banking institutions (46ab) + Central government domestic debt (1955 - 1971: United Nations, 1972-1987: IMF line: 88a.h, 1988-1993: European Community) - claims on central government: central bank (IMF line: 12a) - claims on central government: commercial and savings banks (IMF line: 22a) - claims on central government: other banking institutions (42a)

UK

Financial/Monetary assets: Money (IMF line: 34) + Quasi Money (IMF line: 35) + Central government domestic debt (From 1950-1972 United Nations, Statistical Yearbook, Public Finance, Budget Accounts and Public debt; from 1973 onwards IMF Financial Accounts line 88a) - claims on central government: central bank (IMF line: 12a) - claims on central government: deposit money banks (IMF line: 22a)

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