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Effect of the Rate of Interest and Productivity Growth on the Output Growth

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ABSTRACT

This paper studies the effect of the real rate of interest and productivity growth on output growth. It contrasts the views of mainstream economists and post-Keynesian economists on the problem. A survey of literature related to these two schools of thought is provided. A concept of the fair (natural) rate of interest is discussed as well as its relationship with productivity growth. The notion of total productivity growth, which arises from growth accounting as a residual, has serious flaws because of questionable theoretical foundations of aggregate production functions. It is demonstrated that the real rate of interest does have impact on income distribution. The size of this impact depends on the relationship between the real rate of interest and productivity growth. The higher real rate of interest, as compared to productivity growth, causes income distribution to shift in favour of the holders of interest-bearing securities [rentiers], the value of which depends on the interest rate. The measure (r – g), where r=real interest rate and g=total productivity growth, was used to characterise the impact of the real interest rate—productivity growth nexus on income distribution and output growth. The empirical study conducted in this paper on the sample of seven countries showed what appears to be a consistent evidence of negative relationship between the differential of the real interest rate and growth productivity, on the one hand, and GDP growth, on the other.

This paper considers some concepts as they are being treated in post-classical economics. In particularly, it analyzed what is the "fair" or proper rate of interest, its relationship with productivity growth, and how it affects economic growth.

Section I provides an overall view of the problem and its treatment in the literature. Section II pinpoints different approaches of the two main schools of economic thought with regards to some specific problems. A review of Pasinetti's theory of the interest rate, which introduces the notion of the "fair (or natural) rate of interest", is given in Section III. Section IV illustrates some practical examples of the concepts of the real interest rate and productivity growth. Section V provides a further real-life application of the real interest rate to the problem of income distribution. Section VI refers to the empirical study of the relationship between the real interest rate and productivity growth, and how it affects output growth.

The Appendix contains SHAZAM computer printouts of the econometric program.

I. Background

Traditionally, in mainstream economics, such variables as the money supply and the government sector (government expenditure and taxes) are treated as being exogenous, and variables like consumption demand, investment, labour and capital, as well as market interest rates and the price level are determined endogenously. The interest rate is determined through the interaction of demand (liquidity preference) for and supply (marginal productivity of capital) of money and near-money, i. e., what the market can bear.

Unlike mainstream economists who regard the interest rate as a variable that brings into equilibrium the investment and saving flows in the financial markets, post-classical economists view the interest rate as a monetary convention agreed upon by the banks when they have to determine whether the borrower would be able to bring back the principal plus the interest.

The rate of profit, defined as $\rho=(P/K)$, where P=profits, K=value of capital stock, is fairly constant in the long run, according to Kaldor's stylized fact, although it can exhibit cyclical fluctuations. According to mainstream economics, in the state of equilibrium the rate of profit equals the marginal productivity of capital.

Mainstream economists tend to look at these two rates, the profit rate and the interest rate, as being the same in the state of equilibrium, as was pointed out by Pasinetti (1981). This "natural" rate of interest corresponds to the natural rate of unemployment of the Philips curve in the sense that both these rates are observed in the economy in the state of full employment (disregarding frictional unemployment), and can only fluctuate around its equilibrium value. This concept presupposes the existence of an aggregate production function for the purposes of using the marginal analysis for aggregate variables (like aggregate investment and aggregate capital) in the aggregate economy. But this is a very shaky assumption requiring stringent conditions.

A few words must be added here with regards to the production function and, based on it, total factor productivity. Mainstream economists, who use production functions, arrive at the equilibrium state by equating marginal products of inputs to their real prices. As Felipe and Fisher (2002) put it: "Following Samuelson they claim that even in the case of heterogeneous capital goods it is possible to provide rational ground for the existence of a single homogenous factor called capital with marginal product equal to the interest rate."

While interpreting total productivity growth and the results that depend on the existence and specification of aggregate production functions, one must be aware that aggregation is a serious problem affecting the concept of total factor productivity growth. We must also be aware "… that the use of the aggregate production function gives reasonably good estimates of factor productivity is due mainly to the narrow range of movement of aggregate data rather than the solid foundation of the function." (Nadire, (1970, p. 1146))

Felipe and Fisher (2002), in particularly, have shown that the aggregate production function lacks a solid theoretical foundation because the conditions necessary to derive a well-behaved aggregate production function, with two firms or thousands of them, from micro production functions at the firm level, are so stringent that they seem to be implausible in reality. When we use a production function for the economy as a whole, to associate aggregate inputs with aggregate output, as a consequence, we come up with a measure of total factor productivity growth

(Solow's residual). But because the meaning of such aggregates as output, labour and capital raises serious questions (e.g., Fisher (1993)), the notion of total productivity growth based on growth accounting, even when correctly measured, becomes objectionable. "Without proper aggregation we cannot interpret the properties of an aggregate production function which rules the behavior of (aggregate) total factor productivity." (Felipe and Fisher (2002), p. 250) But since the notion of total factor productivity is still widely used in the profession, the concept of total productivity is used in the empirical study of this paper.

II. The Treatment of the Interest Rate in Mainstream economics and post-Keynesian economics

The market (equilibrium) rate of interest of mainstream economists is contrasted with the fair rate of interest of post-classical economists. In mainstream economics, the (real) interest rate is treated as a real variable, and prices are driven by an exogenously determined money supply. Whereas mainstream economists believe that interest rates are based on the interaction of the demand for and the supply of loanable funds, for the post-classical economists, these rates are subject to conventions (Lavoie, 1997). This is because the monetary authorities have the power to set any bank rate they want, at least in the short run. The article of faith for mainstream economists is the disbelief that the monetary authorities (Central Banks) are able to set a rate of interest which is different from the natural (in the sense of mainstream economics) rate over the long run. But according to post-Keynesian economists (Smithin, 1996; Lavoie, 1997) the control of short-term rates of interest in the economy gives the Central Bank the ability to set long term interest rates as well.

What really matters is the real short term rate because, in Keynes' words, "In the long run we are all dead."

The ability of commercial banks to lend at a given interest rate is usually said to be directly related to their reserves. In some modern economies (e. g., Canada) there are no mandatory reserve requirements for commercial banks, and the claim of post-classical economists that the bank rate is subject to conventions is especially evident.

Post-Keynesian economists believe that from the supply side of the economy the proper measure of profitability is a normal rate of profit (*ex ante* profit rate). It corresponds to the target rate of return of firms provided they are operating at the standard rates of capacity utilization (Lavoie, 1997). Accordingly, post-classical economists believe that the normal rate of profit is determined by long term interest rates, the bargaining power of labour (unionization), and the realized rate of profit (*ex post* profit rate).

There is, as Lavoie (1997, p.127) points out, a disagreement between post-Keynesian economists as to what constitutes the core of the relationship between interest rates and profit rates. Some of them believe that the long term, trend, interest rate is determined by the profit rate on investment. Others, on the other hand, argue that the causality goes the other way round, and that the monetary policies of the Central Bank determine real variables, including the real interest rate.

Apart from these concepts of the rate of return, namely, the natural interest rate, the normal rate of profit, and the realized rate of profit, there is a concept of *the fair rate of interest*: "...the rate of interest that will leave unchanged the distribution of income between interest and non-interest income regardless of lending and borrowing activities." (Lavoie, 1997, p. 128) This concept of the fair rate of interest corresponds to the *natural rate of interest* in Pasinetti (1981). When a person is indifferent as to whether to borrow or not, then we have a fair rate of interest.

To preserve the balance in the distribution of income between lenders and borrowers, the fair rate of interest must be equal to the rate of growth of total factor productivity correctly measured. In other words, the fair rate would be equal to the growth rate in real wages (real purchasing power). In the inflationary economy, the fair rate of interest would equal total productivity growth plus the inflation rate. It follows that in an economic environment with negligible price inflation and technical change, there is no reason, in terms of social order and justice, for the interest rate to be different from zero.

III. Review of Pasinetti's Theory of Interest Rate

Consider a hypothetical 'pure labour' economy which uses labour as the only input (Pasinetti, 1981). In a closed economy, because of effective demand equilibrium, i. e., under conditions of full employment and full utilization of productive capacities, there are no savings for such an economy as a whole. But there are possibilities of savings and dissavings for individuals, although all personal lending and borrowing must cancel out. The people with excess purchasing power may decide to lend part of it to those who fall short of their consumption needs.

The emerging of lending and borrowing relations gives rise to the financial assets, on the part of lenders, and financial liabilities, on the part of borrowers. Financial obligations carried through time represent claims on future consumption (or labour efforts) of some individuals against the others, even though no physical goods are carried through time.

In this simplified economy we have (n – 1) commodity production sectors, the labour sector being the n-th sector, with a price system in which any commodity can serve as a numeraire. When we introduce intertemporal debt/credit relations, the value of these financial obligations at any point in time will depend on the choice of the numeraire for the price system. In terms of numeraire all debts/credits remain constant through time while 'natural' (relative) prices may change in terms of that numeraire.

Consider the following growth rates in our (n – 1) sectors of economy: $\rho_1, \rho_2, \ldots, \rho_{n-1}$. Chose commodity h as a numeraire. Then, in terms of this numeraire the value of all debts and credits will remain constant through time, but in terms of commodity 1 the value of all debts and credits will change at rate $(\rho_1 - \rho_h)$, in terms of commodity 2 at the rate $(\rho_2 - \rho_h)$ etc. Thus, the value of debts and credits would change if we changed the numeraire of the price system. This means that if we change the numeraire and want to preserve debt/credit relations "we must introduce a correction in the form of a rate of interest, even if no rate of interest had originally been stipulated on the debts and credits in terms of commodity h." (Pasinetti, 1981, p.159) If we change the numeraire from commodity h to, say, commodity 1, we have to apply an interest rate $(\rho_1 - \rho_h)$ on all debts and credits for them to remain unchanged in terms of the new numeraire, commodity 1. The magnitude of the interest rate would depend on the relative values of productivities in sectors 1 and h.

Remarkably, in this economy there will be not a single interest rate but a whole series of interest rates corresponding to each commodity sector. If we choose labour as a numeraire through time, i. e., the wage rate w(t)=1, and assume a zero interest rate on loans, then the amount of purchasing power in terms of labour which the lender receives at the end of the lending period will be the same as at the beginning, though natural prices of all commodities will be falling at the rate equal to the productivity growth in each sector ρ_j, j=1, 2, …, n-1. Hence, the value of the loan, although unchanged in terms of labour, would be increasing in terms of a specific commodity j at the compound rate ρ_j, which Pasinetti calls *the own-rate of interest for commodity j.*

If an interest rate i_w in terms of labour time was applied to loans, then the series of own-rates of interest in each commodity sector would be:

$(i_w + \rho_1), (i_w + \rho_2), \dots , (i_w + \rho_{n-1})$.

In the same fashion, if an arbitrary commodity h is chosen as numeraire for the loan transactions with interest rate i_h, then a series of own-rates of interest in terms of each specific commodity would be:

$(i_h + \rho_1 - \rho_h), (i_h + \rho_2 - \rho_h), \dots , i_h, \dots , (i_h + \rho_{n-1} - \rho_h)$.

The own-rate of interest in terms of labour will be: $i_h - \rho_h$, which means that if the interest rate i_h in terms of commodity h is not high enough, as compared with productivity growth in sector h, then the lenders who stipulate their loans in terms of labour, would actually suffer losses.

The rate of change of commodity prices $\sigma_1, \sigma_2, \dots , \sigma_{n-1}$, is positively related to the rate of change of the wage rate σ_w, and negatively related to a commodity productivity growth ρ_j:

$\sigma_j = \sigma_w + \rho_j, \qquad j=1, 2, \dots, n-1.$

If a physical commodity (e. g., gold) is used as numeraire, then its price equals unity by definition, and the rate of change of its price is zero, i. e., in this case two degrees of freedom of the price system are reduced to one. If prices are expressed not in terms of a physical commodity but in nominal values, in terms of (paper) money, then the number of degrees of freedom of the price system remains two, and we need another equation to solve the system. For this purpose Pasinetti introduces the notion of 'the dynamic standard commodity' for which productivity is changing at the rate ρ^*, equal to the weighted average of all specific productivities in the economic system.

If we are to choose the wage rate in terms of money, assumed to change at the rate ρ^*, i. e.,

$\sigma_w=\rho^*$,

then the prices in the system would remain, on average, constant, although the prices of some commodities (those with $\rho_j>\rho^*$) would be falling, and the others would be rising (those with $\rho<\rho^*$).

Thus, $\sigma_w=\rho^*$ is a situation of average price stability (zero inflation).

When the money wage rate σ_w exceeds the 'standard' rate of growth ρ^*, the overall price level is increasing, i. e., we have a situation of price inflation: $\sigma_w>\rho^*$.

When $\sigma_w<\rho^*$, we are facing a situation of price deflation. Thus, relative strength of productivity versus the rate of growth of wages, $\sigma_A=\sigma_w-\rho^*$, determines the price dynamics of this pure labour economy.

After simple manipulations we can write:

$\sigma_j=\sigma_w-\rho_j$

$\sigma_j=(\sigma_w-\rho^*)+(\rho^*-\rho_j)$,

which shows that the rate of change of the price of a specific commodity can be decomposed into a general component, $\sigma_w-\rho^*$, which is characteristic of the overall price level, and a particular component, $\rho^*-\rho_j$, which is specific to the price of each commodity.

The following question then arises: what are the 'real' (in terms of a specific commodity) rates of interest in a monetary economy, i. e., an economy which uses a conventional monetary unit of account? We have n 'real' own-rates of interest for each of (n – 1) commodity sectors plus the labour sector related to the actual nominal interest rate i_M and to the rate of increase σ_w of the wage rate, all in terms of money. Then the own rate of interest for labour will be:

$$(i_M - \sigma_w)$$

$$= (i_M - \sigma_A - \rho^*).$$

The own rate of interest for each commodity j will be:

$$(i_M - \sigma_j)$$

$$= i_M - (\sigma_w - \rho_j)$$

$$= i_M - \sigma_A - (\rho^* - \rho_j), \qquad j=1, 2, \ldots, n-1.$$

Again, if we consider a composite commodity, the dynamic standard commodity, then for this particular commodity its own-rate of interest is:

$$i_M - (\sigma_w - \rho^*)$$

$$= i_M - \sigma_A,$$

which represents an average 'real' interest rate, the 'standard' real rate of interest for the economic system taken as whole.

It can be seen that unlike the case of real (commodity numeraire) if we choose a nominal (money) numeraire, then the own rate of interest in the economy depends not only on the actual money rate of interest, in terms of the chosen numeraire, and on the rates of productivity growth but also on the rate of change of the purchasing power of money, i. e., the inflation rate. Hence, the nominal rate of interest is only meaningful in relationship to the rate of change of the overall price level.

Pasinetti then reiterates that in the economic system with technical progress and, as a consequence, with structural price dynamics, there will be a whole structure of own-rates of interest, even if the nominal rate of interest is set to zero. The problem is to choose the interest rate which we should apply to all debt/credit relations on the basis of some criterion.

Pasinetti proposes that, in the economic system where all contributions to and benefits from production processes are regulated on the basis of quantities of labour, the interest rate in terms of labor must be zero. As it has already been indicated, if labour is chosen as numeraire, then such an interest rate – the *natural interest rate* i^*_w – is zero:

$$i^*_w = 0.$$

But in terms of any other commodity numeraire, this implies that the natural interest rate equals productivity growth:

$$i^*_j = \rho_j, \quad j=1, 2, \ldots, n-1.$$

When the composite commodity – what Pasinetti calls the 'dynamic standard commodity' – is chosen as numeraire and is applied to all debt/credit relations, then the natural interest rate is equal to the 'standard' productivity growth of the economy:

$$i^*_A = \rho^*.$$

And in case of the money numeraire, in order to obtain the natural rate of interest i^*_M, we must add up the rate of inflation to the standard rate of productivity growth:

$$i^*_M = \rho^* + \sigma_A$$

After taking into account that

$$\rho^* + \sigma_A = \rho^* + \sigma_w - \rho^* = \sigma_w,$$

we can write

$$i^*_M = \sigma_w$$

In a similar way, by measuring the rate of change of the wage rate in corresponding numeraire, we can write natural interest rates as follows:

$i^*_A = \sigma_w$

$i^*_j = \sigma_w$

$i^*_w = \sigma_w$

Keeping in mind that the wage rate is expressed in the corresponding numeraire we can drop the subscripts and just write:

$i^* = \sigma_w$ - the natural rate of interest which keeps constant the purchasing power of loans carried through time in terms of labour time.

How can the notion of the natural interest rate be applied to income distribution? According to Pasinetti, the income distribution process can be viewed as being made up of two components: first, income is distributed at any point of time in proportion to the quantity of labour contributed to the production process; second, a process of debt/credit relations is formed in accordance with the need of individuals to distribute their consumption over time.

If the chosen numeraire is the wage rate, then all debt/credit relations will be reckoned in terms of labour, and the natural rate of interest should be zero. The purchasing power of financial obligations in terms of labour will remain intact through time if the chosen numeraire is some commodity h. Then the natural rate of interest preserving debt/credit relations in terms of that commodity is $i_h^* = \rho_h$.

In our labour-based economy in which income is distributed in proportion to the labour contribution to the production process, the loans agreed upon in terms of commodity h will be devaluing at the rate ρ_h unless a compensating natural rate of interest $i_h^* = \rho_h$ is paid on loans, thus correcting for the devaluation of loans in terms of labour.

When we use conventional money as numeraire in which all debt/credit relations are stipulated, all financial assets/liabilities will be devaluing in terms of labour at the rate

$$i_M^* = \sigma_A + \rho^* = \sigma_w$$

Therefore the natural rate of interest $i_M^* = \sigma_w$ must be paid on loans to correct for this devaluation.

Thus whatever numeraire is chosen for the debt/credit relations, the natural rate of interest is just the rate which exactly compensates for the devaluation of loans in terms of labour. Any other level of interest rate will cause deviations from what Pasinetti calls the 'labour principle of income distribution'. A higher than natural rate of interest will distort the income distribution in favor of lenders, and the lower – in favor of borrowers. Only the natural rate of interest will ensure that the intertemporal distribution of income takes place in proportion to the quantity of labour supplied to the production process.

Now consider the more general case of production with labour and capital goods. In the state of equilibrium total savings are equal to total investments. In an economy with natural prices and the natural rate of profit, the amount of profits will be equal to the corresponding investments in each sector. Total consumption in the economy will be represented by total income minus investments, and cannot be transferred through time. With the introduction of capital goods the approach to the determination of the appropriate interest rate for debt/credit relations remains basically the same as was the case of the pure labour economy. Only now instead of productivity growth ρ_j in each sector, Pasinetti introduces the rate of productivity growth ρ_j' in the vertically hyper-integrated sector (including the sector that produces capital goods for sector j) for consumption good j. Then the 'natural' own-rates of interest for each consumption good would be:

$\rho_1', \rho_2', \ldots, \rho_{n-1}'$.

The basic definition of the natural rate interest, $i^*=\sigma_w$, is generalized: regardless of the nature of the chosen numeraire, the natural rate of interest is equal to the rate of percentage change of the wage rate.

Pasinetti points out that the 'natural' rate of profit in any sector defined as

$\pi_j^* = g + r_j$

(g = labour force growth rate

r_j = per capita rate of growth of the vertically hyper-integrated production in sector j)

is conceptually different from its 'natural' own-rates of interest

$\rho_j', j = 1, 2, \ldots, n-1$.

These two notions, the natural rate of profit and the natural rate of interest, though emerging from the same natural economic system can exist independently of one another because they apply to different spheres of economic activity. The rate of profit applies to the sphere of production in the natural economic system in which total new investments are equal to total profits, thus achieving self-sustainable growth. The rate of interest applies to the spheres of consumption and debt/credit relations, which allow individuals to distribute optimally their consumption over time, and for the system as a whole all financial transactions cancel each other.

As Pasinetti indicates, the confusion of these two independent, different, economic concepts comes from the institutionalized organization of the capitalist economic system. On the one hand, under free-market competition, there necessarily is a tendency to equalize the rate of profit (adjusted for risk) for the firms in all sectors of the production process. On the other hand, the financial transactions of individuals and those of the firms are not separated from each other and tend to take place in the same financial markets. These tendencies of the capitalist set-up lead to the distortions and deviations from the features of a natural economic system and to the equalization of the two rates: the rate of profit and the rate of interest.

IV. Some practical applications

The concept of the fair rate of interest allows us to see the redistribution effects between the lenders and borrowers of capital in terms of labour time or workweeks. Lavoie (1997) gives an example of how this concept of fair interest rate works by considering 15-year mortgage payments on an average house in Ottawa. He shows that in 1961 borrowing payments, relative to cash payments, were equivalent to 4 weeks in terms of labor time whereas in 1986 these additional payments were 136 weeks in terms of labour time. In 1986, the real interest rate (mortgage rate) and total productivity growth rates were 6% and 0.1% per annum respectively, which shows that when the real rate of interest is not equal to total productivity growth we witness income redistribution from borrowers to lenders (or vice versa) through increased labour time expropriation.

Here is a slight modification of the example above. Suppose a consumer wants to buy a house for $50,000 and takes a loan (mortgage) for that amount at an annual rate $r = 6\%$ to be repaid in 15 years. Further suppose that the weekly wage of this consumer is $300 and his total productivity growth (the wage rate growth) is $k = 0.012 = 1.2\%$.

Consider a typical amortized repayment schedule:

$\$50,000 = (\$C/1.06^1) + (C/1.06^2) + \ldots + (C/1.06^{15})$

where C=fixed annual payment

$\$50,000 = \$C \text{ x } \{[1 - (1/1.06^{15})]/0.06\}$

$\$50,000 = C \text{ x } 9.7122$

$C = \$\ 5,148.14$

The cost of the loan in terms of workweeks can be found through the summation (with regards to the annual wage growth):

$C/300\text{x}(1 + k) + C/300\text{x}(1 + k)^2 + \ldots + C/300\text{x}(1 + k)^{15}$

$= (C/300)\text{x}\{[1 - (1/(1 + k)^{15})]/k\}$

$= (5,148.14/300)\text{x}\{[1 - (1/(1 + 0.012)^{15})]/0.012\}$

$= 17.16 \text{ x } 13.652$

= 234.28 workweeks

Thus the cost of the house, with regards to interest rate and productivity growth as specified above, in terms of workweeks is 234.28

The cost of the house in terms of workweeks without going into debt is:

50,000/300 = 166.66 workweeks

Only when the interest rate is equal to productivity growth, in our case $r = 1.2\%$, does the purchasing power of labour remain unaltered through time.

The amortization schedule in this case is as follows:

$\$50,000 = (\$C/1.012^1) + (C/1.012^2) + \ldots + (C/1.012^{15})$

where C=fixed annual payment

$\$50,000 = \$C \text{ x } \{[1 - (1/1.012^{15})]/0.012\}$

$\$50,000 = C \text{ x } 13.6528$

$C = \$\ 3,662.23$

The cost of the loan in terms of workweeks is found through the summation (with regards to the annual wage growth):

$C/300x(1 + k) + C/300x(1 + k)^2 + \ldots + C/300x(1 + k)^{15}$

$= (C/300)x\{[1 - (1/(1 + k)^{15})]/k\}$

$= (3{,}662.23/300)x\{[1 - (1/(1 + 0.012)^{15})]/0.012\}$

$= 12.21 \times 13.6528$

= 166.66 workweeks

Thus, under the regime of a fair interest rate the consumer is indifferent, in term of workweeks, whether to go into debt or not.

The higher interest rate negatively affects economic growth as firms rank investment projects by their net present value (NPV). The higher interest rate increases the cost of capital for the firms, thus affecting investment. The higher interest rates (which are used to discount future cash flows) lower the NPV of a project and even make it negative, which means that the firm has to abandon it. To illustrate, consider a simplified case of the 5-year investment with a cost = $9,000. The expected cash flows are $2,000 per year for 5 years.

1) In the first case the annual interest rate is 3%.

The net present value of this project is

$NPV = -\$9{,}000 + \$2{,}000/1.03 + \$2{,}000/1.03^2 + \ldots + \$2{,}000/1.03^5$

$= -\$9{,}000 + \$2{,}000x(1 - 1/1.03^5)/0.03$

$= -\$9{,}000 + \$2{,}000x4.5797$

$= -\$9{,}000 + \$9159.4$

$= \$159.4 > 0$

The firm will take on this project because NPV > 0.

Now consider the same project except for the interest rate being 5%.

$$
\begin{aligned}
\text{NPV} &= -\$9{,}000 + \$2{,}000/1.05 + \$2{,}000/1.05^2 + \ldots + \$2{,}000/1.03^5 \\
&= -\$9{,}000 + \$2{,}000\text{x}(1 - 1/1.05^5)/0.05 \\
&= -\$9{,}000 + \$2{,}000\text{x}4.3295 \\
&= -\$9{,}000 + \$8{,}659 \\
&= -\$341 < 0
\end{aligned}
$$

In this case the firm will scrap the project because its NPV < 0.

One can view the fair rates of interest as an "anchor" in the social economy which "preserve the intertemporal distribution of income, measured in labour time, between borrowers and lenders." (Lavoie, 1997, p. 135) On the other hand, at the Canadian macro-level, it was demonstrated that a high real interest rate, as compared to total productivity growth, is a definite suspect to blame for the economic recessions during the period 1946-1983 (Lavoie and Seccareccia, 1988).

The interest rate can be also viewed as a psychological problem of behavioral idiosyncrasy in a sense that an individual decides how much of its current consumption to forego today in return for more consumption tomorrow. In general, the behavior of rentiers in the capital markets gives rise to the science of behavioral finance which provides us with many insights into the workings of financial markets.

Interest rates are interrelated with economic performance. Generally post-Keynesian economists are opposed to high interest rates both on economic and social grounds. Today higher interest rates are recommended by mainstream economists as means to curb inflation. But according to post-Classical economists, inflation caused by excess demand is a minor problem compared with the escalation of rental and wage costs of inputs (Lavoie and Seccareccia, 1988). Unlike interest rates, inflation is not believed to be a monetary phenomenon as assumed by the quantity theory of money. Therefore raising interest rates to combat inflation would lead to economic recession as firms cut back on the employment of labour and on their investment projects.

The correct discount rate is tied to the interest rate set by the monetary authorities. This riskless interest rate (for example, on government bonds) is a bottom line for the interest rate structure in the financial markets. As long as firms are using financial markets to raise funds for their financing needs, the higher interest rate would increase the minimum required rate of return on investment, thus raising the cost of capital for the firm, and reducing, through this process, output and employment.

Instead, following Keynes, post-Keynesian economists would suggest a progressive income tax and price controls as the means to bring down inflation and excess demand. Higher interest rates depress financial markets and the market value of the firms. The wave of mergers and takeovers in Canada during the 1980s and in the US during the 1990s could have been the result of higher interest rates, thus making the replacement cost of the capital stock of a firm less than its market value (Tobin's $q < 1$), raising barriers to the entry into the industry, and increasing monopoly power within the industry.

Post-Keynesian economists differ from mainstream economists in their treatment of the problem of income distribution. In mainstream economics based on marginal productivity theory, the wage rate (the reward to labour) equals the marginal productivity of labour, and the rate of return on a dollar of capital, that is, the rate of profit (the reward to capital) is equal to the marginal productivity of capital, and hence, the marginal products of the factors of production determine income distribution.

V. Interest Rate and Income Distribution

In post-Keynesian economics the problem of the interest rate is closely related to the public policy of income distribution.

First, higher interest rates cause a direct income transfer from the productive sector to the holders of interest-bearing securities in the form of increased interest payments. Second, through its impact on production and employment, the increase in interest rates negatively affects the whole structure of wage-profit relationships (Lavoie and Seccareccia, 1988). Higher interest rates depress consumption and investment expenditures, causing redistribution of income shares of input factors from the "active earning class" in favor of the rentier class.

One might draw an analogy between interest rates and gravitational pull. Interest rates act on the valuation of financial assets much in the same way as gravity acts on matter. The higher the interest rate, the greater is the downward pull in the financial markets. This is because the rates of return that rentiers require from any kind of investment are directly linked to the risk-free rate they obtain from government securities. Therefore, if the government rate (or the Bank rate as set by the monetary authorities) goes up, the prices of all other investments must adjust downward, so that their expected rates of return are brought into line with that of government bonds. If, on the other hand, government interest rates go down, this pushes the prices of all financial investment of rentiers upward. In short, what a rentier pays today for a dollar to be received tomorrow is determined by the risk-free interest rate of government bonds. This means that every time the risk-free rate of monetary authorities moves, the value of all rentier investments changes.

The situation is especially transparent in case of bonds, the value of which is determined only by interest rates. But this is also true in the case of the stock market (although other important variables, mainly after-tax corporate profits also play a role) and in the case of capital stock (like real estate), but the effect of interest rate is usually obscured; nonetheless, sooner or later it will work through.

To illustrate how it works and how rentiers extract profits, consider long term U.S. government bonds at selected points of time. At the end of 1964, the interest rate was 4% and by late 1981 it was 14% (all data here and elsewhere is taken from www.finance.yahoo.com and *Report of the President*, various issues). If a rentier put $1 million into the 14% 30-year U.S. government bond issued at the end of 1981, and reinvested all coupons, then at the end of 1998, with long term government bonds yielding then 5%, he would have had $1 million x $(1 - 1.(1.05)^{13})/0.05$ = $9,393,600 and would have extracted an annual rate of return of more than 14% $((9.3936)^{1/17} = 1.1408)$.

The interest rate has the same effect on the stock market. In a similar fashion, if a rentier had put $1 million in a market index, say, Dow Jones Industrial Average (DJIA), at the end of 1981 and reinvested all dividends, at the end of 1998 he would have had $10,493,062 and his annual return would have been 14.83%.

We can make a comparison for selected periods between the performance of the U.S. businesses as measured by GDP, and the performance of financial markets governed by the interest rate.

(Nominal) Growth in GDP :

1964-1981: 373%

1981-1998: 177%

Stock market, as measured by DJIA:

Year-end 1964: 874.12
1981: 875.00
1998: 9181.43

Bond market, interest rates of long term U.S. government bonds:

Year-end 1964: 4.20%
1981: 13.65%
1998: 5.09%

These figures illustrate the power of compound interest rates. During the period 1964-1981, the GDP of the U.S. economy has risen by 373% in nominal terms while the stock market, as measured by DJIA, moved nowhere. On the other hand, during the period 1981-1998, the economy grew more than twice as slowly as it did in the previous 17-year period. And still, rentiers reaped record returns in the financial markets. This shows that the performance of the economy is very much independent of the performance of the market for interest-bearing securities which rentiers hold. Moreover, the performance of financial assets is almost exclusively determined by the interest rate (the other determining factor is the market mass-psychology of rentiers). The scissors of the interest rate roller coaster allow the rentiers to extract a rate of return in excess of the normal rate of profit.

Creating money out of nothing (more exactly, out of debt), which costs monetary authorities nothing, and charging interest on it, generates the most unfair tax – inflation. This is supposedly one of the reasons for the central bank to fight inflation.

Seccareccia and Lavoie (1996) offered a critique of the monetary policies of the Bank of Canada, which, while fighting inflation, pursued a policy of high real interest rates since 1990. This policy of the Bank of Canada was based on the necessity of achieving price stability. The primacy of price stability over all other economic indicators was originally based on findings by Jarret and Selody (1982), who claimed that "a one percentage point increase in inflation will significantly reduce average labour productivity growth on the order of three-tenth of a percentage point" and that "inflation is the single and most important explanatory variable in explaining slow (or negative) productivity growth."''(Seccareccia and Lavoie, 1996) But as was pointed out by these two authors, the empirical evidence of a negative relationship between inflation and productivity growth may have a different causation. As is well known among post-Keynesian economists, it is productivity growth which negatively affects inflation, and not vice versa. The policy of low inflation accompanied by a high unemployment rate is both unfair towards households and is disruptive by causing uncertainty. The presumed effect of inflation on productivity, via investment, should be interpreted as an increase in the cost of borrowing the capital, through a higher real interest rate. As Seccareccia and Lavoie (1996) put it: "... the problem of long-term financing of investment is a problem of higher interest costs relative to expected net revenues and not, stricto sensu, a problem arising from inflation or its variance."

One-sided policy to prioritize inflation reductions at the cost of higher interest rates leads, via the decrease in new investments, to lower productivity growth, and as a result to the slowdown of the economy. As Seccareccia and Lavoie (1996) remark, the strong negative relationship between inflation and productivity growth, as evidenced by empirical studies of Jarret & Selody (1982) and Cozier & Selody (1992), was observed only during the 1970s and early 1980s, and is mainly due to the oil price shocks of 1973 and 1979, which at the same time depressed productivity growth and increased inflation. The lack of a strong negative correlation between price inflation and productivity growth was also supported by evidence from outside Canada (Stanners, 1993). Thus, this case study casts doubts on the appropriateness of a monetary policy of artificially low inflation as pursued by the Bank of Canada during the 1980s and 1990s, a policy that gave rise to high rates of unemployment and real interest rates and is questionable in its ability to boost productivity growth.

Interest rates that are too low may cause high inflation and public dissatisfaction. Rentiers might want the central bank to set the interest rate at an optimal level, a "moderate" rate, say, 4-5% per annum – but it is 4-5% forever – that generates high revenues for the rentiers without causing public alarm.

VI. Empirical Study

Many researchers have been looking into various aspects of the interest rate-productivity growth-output growth nexus. For example, in the case of the US, Roberts (2000) estimated productivity growth in the late 1990s. He found that in the second quarter of 2000 the productivity growth rate picked up to about 2-2/3 percent at an annual rate. If the model explicitly accounts for the impact of capital accumulation on labour productivity, then productivity growth picks up to 3 percent. In this framework the trend in productivity is allowed to follow a random walk with drift and both the level and growth rate of the trend component in productivity are subject to random shocks. In this model, he decomposes aggregate output into its hours and productivity components, (which is defined as output per hour). The model confirms the well known result that productivity correlates positively ("procyclical") with output, that is, productivity increases when output increases, but productivity falls back to trend much more quickly than does output. The results show that the increase in labor productivity in the US in the late 1990s accounts for most of the rise in trend productivity.

For mainstream economics, the "natural" rate of interest is the rate that equates potential output with actual one, and which is assumed to be constant. According to the Taylor rule, it is approximately 2% for the US. Both the natural rate of interest and potential output are not directly observed. Naturally, the natural rate of interest would vary as aggregate demand and supply shift, as was the case in the US during the 1980s (the fiscal expansion), and late 1990s (the productivity acceleration). Laubach and Williams (2001) investigated the relationship between potential output and the natural rate of interest over the past four decades in the US by using the econometric technique of the Kalman filter. Their findings confirmed the view that there were structural changes in the American economy that had a significant impact on the natural rate of interest. The estimated relationship was most significant during the mid-sixties and the late 1990s, periods of high rates of potential output growth, and declined during the 1970s, the period of the productivity slow down. They also found that the fiscal expansion of the 1980s was associated with a high natural rate of interest. The estimated value for the natural rate of interest in the American economy at the end of 2000 was found to be 4%.

Galor and Tsiddon (1992) analysed the impact of changes in labor productivity on the long-run level of output. That analysis was conducted within the framework of dynamic general equilibrium model. Even one-time transitory changes in productivity can have an adverse effect on the output in the long run. This is because the fall in productivity reduces the output and as a result, savings. The reduction in savings supposedly increases the real interest rate and thus decreases investments during the period of adverse shock to the productivity. If the productivity shock is severe enough, the stationary long-run output will converge to a lower level with reduced output growth. This also may result in a higher long run unemployment level. Here there is the case for the government to step in to restore the initial long-run equilibrium output by transferring income from consumers to savers.

Kahn and Rich (2003) looked into long-term productivity, trying to identify the trend and cyclical variations in productivity. The data set, which was used to estimate trend productivity growth, included consumption, labour compensation and detrended hours. In their empirical work they used the regime switching dynamic factor model (Kim and Murray, 2002). A strong evidence was found for the switching of both economy and productivity from a low growth to high growth regime in the mid 1990s, with the annualised difference between growth rates in the two regimes of approximately 1.5%. They point out that during the 1970s the government didn't recognise the slowdown in productivity growth, which led to overestimating potential GDP and to supposedly setting too low an interest rate by the Central Bank. This, in turn resulted in two-digit inflation.

The mainstream viewpoint, which considers the interest rate as an endogenous phenomenon, faces many contradictions. For example, the simultaneous rise in both interest rates and current investments during the early 1980s in the US cannot be easily explained within a standard general equilibrium dynamic model. To explain this phenomenon Olivei (1999) had to introduce nominal rigidities in his model, which interprets a favourable shift in expected profitability as an increase in expected productivity. The classical view leads to an implausibly large value for the intertemporal elasticity of substitution in consumption, which is necessary to explain the paradox of high values of both real interest rates and current investments.

Following Pasinetti (1981), as well as Lavoie and Seccareccia (1988), a measure of such income transfer, from the productive sector of workers and entrepreneurs towards the unproductive sector of holders of interest-bearing securities, has been identified. This measure is $(r - g)$, where r = real interest rate and g = rate of growth of (labour or total) productivity. It is presumed that whenever this differential in rates is positive there is an income transfer from the productive sector of the economy to the rentier class associated with periods of recession and depression, and vice versa (Lavoie and Seccareccia, 1988). In fact, using Canadian postwar data Lavoie and Seccareccia (1988) demonstrated that each time the difference $(r - g)$ was positive, the Canadian economy was experiencing a recession with the corresponding drop in output growth.

The working hypothesis to be tested in the empirical part of the paper is as follows: whenever the real rate of interest exceeds total productivity growth, there is a slowdown or recession in the economy, that is, when the real interest rate is high as compared to productivity growth, GDP growth tends to slow down.

To investigate this relationship, a sample of 7 countries (the US, Belgium Netherlands, Denmark, France, Italy, and Sweden) has been identified from the AMECO annual macroeconomic database. The country sample was chosen on the basis of data availability. The annual time series of the real interest rate (both long-run and short-run), total productivity growth rate, and real GDP growth rate for each country covering the period 1960-2004 have been selected for the estimation.

Prior to the estimation, the selected time series have been subjected to diagnostic tests, including unit root testing (Dickey-Fuller tests, Ljung-Box-Pierce statistics, and the correlogram), Chow test and Goldfeld-Quand statistic of the structural stability of time series, and Granger causality tests. SHAZAM output is enclosed in Appendix. Tests for the stationarity and cointegration revealed mixed evidence, i. e., some of the time series were stationary and some were not. The Chow test (at 5% level of significance) showed structural breaks in the following years:

USA: 1970-71, 1973-1974, 1982, 1983-84
Belgium: 1970-71, 1971, 1972, 1973-74
Denmark: 1974, 1975, 1976-77
France: 1969, 1970, 1971, 1972, 1973, 1974-75
Italy: 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974-75
Netherlands: 1972, 1973-74, 1975-76, 1999, 2000-01
Sweden: no structural breaks.

The Chow test revealed that almost all series (except for Sweden's series) experienced structural breaks around the 1971 and 1973-1974 years, which may be explained by the abandonment in 1971 of the "gold standard" in the US, and the oil price shocks in 1973-1974, which is in agreement with the findings of Laubach and Williams (2001) with regards to structural changes in the US economy. Goldfeld-Quandt statistics (measure of homoskedasticity of the error variance between two subsets of observations) also provided evidence for the structural breaks.

Granger causality tests (with H0: no Granger causality) did not reveal any consistency in the direction of Granger causality at a 5% level of significance. Denote

GROWTH=GDP Growth, and

DIFF= differential between real interest rate and total productivity growth,

then for our sample of countries the results were as follows:

Table 1.

	DIFF	GROWTH
USA	0	1
Belgium	0	1
Denmark	1	1
France	0	0
Italy	0	0
Netherlands	0	0
Sweden	1	0

The second column (DIFF) in Table 1 shows the direction of the causality from DIFF (toward GROWTH). The third column (GROWTH) shows the direction of the causality from GROWTH (toward DIFF). "1" indicates the presence of Granger causality, and "0" – its absence, in either direction.

In the econometric distributed-lag model involving the regression of GDP growth on the differential between the real interest rate and total productivity growth, lagged values were used to supposedly account for cumulative influences of the lagged values of the explanatory variable.

In order to reduce collinearity in lagged regressors and other potential problems, the Almon polynomial lag scheme of second degree was used. Assume that GDP growth rate [GROWTH_t] depends of the difference between the real interest rate and total productivity growth [DIFF_t] in the current year and in the three preceding years as follows:

$$\mathrm{GROWTH}_t=\alpha + \beta_0\mathrm{DIFF}_t + \beta_1\,\mathrm{DIFF}_{t-1} + \beta_2\mathrm{DIFF}_{t-2} + \beta_3\mathrm{DIFF}_{t-3} + u_t\,,$$

where β_i coefficients are approximated by a second-degree polynomial as follows:

$$\beta_i = a_0 + a_1 i + a_2 i^2$$

The results of the regressions are given in the following two tables.

Table 2. Estimated regression coefficients β_i using long-term real interest rates

	Estimated coefficients of lagged variables, DIFFs				
	0	1	2	3	Sum of coefs
US	-0.66	--	0.34	--	--
Belgium	-0.49	--	--	--	-0.33
Denmark	-0.67	--	--	--	-0.53
France	-0.38	--	--	--	-0.46
Italy	-0.41	--	0.16	--	-0.24
Netherlands	-0.54	--	0.21	--	-0.29
Sweden	-0.64	--	0.32	--	--

Table 3. Estimated regression coefficients β_i using short-term real interest rates

	Estimated coefficients of lagged variables, DIFFs				
	0	1	2	3	Sum of coefs
US	--	--	--	--	-0.44
Belgium	-0.27	--	--	--	-0.32
Denmark	-0.47	--	--	--	-0.32

France	--	-0.15	--	--	-0.37
Italy	-0.53	--	0.20	--	-0.30
Netherlands	-0.30	--	--	--	-0.27

Note: "--" denotes statistically insignificant (at 5% level of significance) values.

A look at the regression coefficients in these tables reveals that the differential value between real interest rates and total productivity growth rates do have a negative effect on output growth. Also note that in all cases the influence of the differential on output growth becomes negligible after the second period (regression coefficients are statistically zero at lag=3).

In all countries of our sample (except for the US and Sweden, the long-term case) the sum of the regression coefficients (which gives the cumulative effect) is negative, the largest one being for Denmark: a 100 basis points increase in the real interest rate relative to the productivity growth rate leads to a 53 basis points drop in GDP growth. Predominantly, the effect of the differential on output growth occurs during the current period.

VII. Conclusion

The assertion of mainstream economists about the endogeneity of the interest rate has shaky foundations in view of the ability of monetary authorities to set the interest rate at a predetermined level in the short-run (and in the long-run as well). Besides, the equalization of the rate of interest with the rate of profit is not the outcome of the natural economic system but rather a consequence of the institutional set-up of current society. In an economy with technical change, the fair (or "natural") rate of debt/credit relations should preserve unchanged the purchasing power of all loans in terms of the wage rate (labour time).

The ability on the part of the central bank to set the level of the rate of interest has consequences for income distribution and output growth. The empirical study based on the sample of seven countries has nearly consistently found a cumulative negative effect of the differential between the real interest rate and total productivity growth on GDP growth. The results of diagnostic test indicate that the results could be improved if a more desegregate data were available.

REFERENCES

Cozier, Barry, and Jack Selody. *Inflation and Macroeconomic Performance: Some Cross-Country Evidence.* Working Paper 92-6. Ottawa: Bank of Canada, 1992.

Felipe, J. and Fisher F. M. "Aggregation in Production Functions: What Applied Economists Should Know." *Metroeconomica* 54:2 & 3, pp. 208–262, 2003.

Fisher F. M. *Aggregation. Aggregate Production Functions and Related Topic*s. MIT Press, Cambridge, MA., 1993.

Galor O. and Tsiddon D. "Transitory Productivity Shocks and Long-Run Output." *International Economic Review*, vol.33, No. 4, 1992.

Jarret, Peter, and Jack G. Selody. "The Productivity-Inflation Nexus in Canada, 1963-1979." *Review of Economics and Statistics* 64: 361-67 (August 1982).

Kahn J. A. and Rich R. "Tracking the New Economy: Using Growth Theory to Detect Changes in Trend Productivity." Federal Reserve Bank of New York Staff Report, 2003.

Kim, Chang-Jin and Christian Murray. "Permanent and Transitory Components of Recessions." *Empirical Economics* 27, 2002.

Laubach, Thomas, and John C. Williams. "Measuring the Natural Rate of Interest."*Computing in Economics and Finance*, no. 35, 2001.

Lavoie, Marc. "Fair Rates of Interest in Post-Keynesian Political Economy." *Issues in Modern Political Economy* (ed. J. K. Teixeira), University of Brasilia Press, 1997.

Lavoie, M. and Seccareccia M. "Money, Interest and Rentiers: the Twilight of Rentier Capitalism in Keynes's *General Theory*." In *Keynes and Public Policy After Fifty Years. Volume 2: Theories and Method.* By Hamouda O. F. and Smithin J. N. (eds). Edward Elgar, 1988.

Nadiri M. I. "Some Approaches to the Theory and Measurement of Factor Productivity: a Survey." *Journal of Economic Literature*, 8, pp. 1137–77, December 1970.

Olivei G. "Productivity Shocks, Investment, and the Real Interest Rate." Research Department, Federal Reserve Bank of Boston, 1999.

Pasinetti L. *Structural Change and Economic Growth: A Theoretical Essay on the Dynamics of the Wealth of Nations.* Ch. 8. Cambridge University Press, Cambridge, 1981.

Roberts, John M. "Estimates of the Productivity Trend Using Time-Varying Parameter Techniques." Board of Governors of the Federal Reserve System, Working Paper, November 2000.

Seccareccia, Mario, and Marc Lavoie. "Central Bank Austerity Policy, Zero-Inflation Targets, and Productivity Growth in Canada." *Journal of Economic Issues*. Vol. XXX, No. 2, June 1996.

Stanners, W. "Is Low Inflation an Important Condition for High Growth?" *Cambridge Journal of Economics* 17: 79-107, March 1993.

Appendix

*US

Using Long-Term Rates

```
R-SQUARE =    0.2292     R-SQUARE ADJUSTED =    0.1667
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.8491
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.9619
 SUM OF SQUARED ERRORS-SSE=   142.42
 MEAN OF DEPENDENT VARIABLE =    3.3510
 LOG OF THE LIKELIHOOD FUNCTION = -83.7026

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF1    -0.19968      0.142      -1.40     0.169 |  -4.029 |   3.67     0.021

 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF1     -0.66465    0.2057      -3.231     0.003-0.469    -0.7398    -0.3817
 DIFF1      0.12321    0.8678E-01   1.420     0.164 0.227     0.1393     0.0691
 DIFF1      0.34401    0.1378       2.496     0.017 0.380     0.3894     0.1919
 DIFF1     -0.22558E-02 0.1629E-01 -0.1385    0.891-0.023    -0.0025    -0.0012
 CONSTANT   3.7528     0.4155       9.032     0.000 0.829     0.0000     1.1199
```

Using Short-Term Rates

```
R-SQUARE =    0.1692     R-SQUARE ADJUSTED =    0.1018
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    4.1487
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    2.0368
 SUM OF SQUARED ERRORS-SSE=   153.50
 MEAN OF DEPENDENT VARIABLE =    3.3510
 LOG OF THE LIKELIHOOD FUNCTION = -85.2395

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF1SH  -0.44420      0.172      -2.58     0.014 |   0.442 |   2.51     0.074

 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF1SH  -0.28032     0.1561      -1.796     0.081-0.283    -0.2962    -0.0763
 DIFF1SH  -0.12974     0.8471E-01  -1.532     0.134-0.244    -0.1376    -0.0350
 DIFF1SH  -0.35760E-01 0.1085     -0.3296     0.744-0.054    -0.0377    -0.0098
 DIFF1SH   0.16141E-02 0.1704E-01  0.9472E-01 0.925 0.016     0.0017     0.0004
 CONSTANT   3.7604     0.3614       10.40     0.000 0.863     0.0000     1.1222
```

*Belgium

Using Long-Term Rates

```
R-SQUARE =    0.4019     R-SQUARE ADJUSTED =    0.3534
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.5941
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.6106
 SUM OF SQUARED ERRORS-SSE=   95.982
 MEAN OF DEPENDENT VARIABLE =    2.8652
 LOG OF THE LIKELIHOOD FUNCTION = -75.6135

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF2    -0.33449     0.861E-01  -3.89      0.000 |  -0.950 |   8.29     0.000

 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF2     -0.48919    0.1241      -3.941     0.000-0.544    -0.7841    -0.3405
 DIFF2     -0.58057E-02 0.5169E-01 -0.1123    0.911-0.018    -0.0093    -0.0040
 DIFF2      0.15807    0.8254E-01   1.915     0.063 0.300     0.2541     0.1061
 DIFF2      0.24348E-02 0.1336E-01  0.1822    0.856 0.030     0.0039     0.0015
 CONSTANT   3.5512     0.3082       11.52     0.000 0.884     0.0000     1.2394
```

Using Short-Term Rates

```
R-SQUARE =    0.3239     R-SQUARE ADJUSTED =    0.2691
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.9325
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.7124
 SUM OF SQUARED ERRORS-SSE=    108.50
 MEAN OF DEPENDENT VARIABLE =    2.8652
 LOG OF THE LIKELIHOOD FUNCTION = -78.1268

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF2SH  -0.32656      0.828E-01  -3.94      0.000 |   0.078 |   5.91     0.002


 VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF2SH  -0.27760     0.1168      -2.377     0.023-0.364    -0.4898    -0.1230
 DIFF2SH  -0.71413E-01 0.4923E-01  -1.450     0.155-0.232    -0.1266    -0.0309
 DIFF2SH   0.21456E-01 0.7745E-01  0.2770     0.783 0.045     0.0381     0.0090
 DIFF2SH   0.10030E-02 0.1433E-01  0.7000E-01 0.945 0.012     0.0018     0.0004
 CONSTANT   3.2823     0.2918       11.25     0.000 0.880     0.0000     1.1456
```

*Denmark

Using Long-Term Rates

```
R-SQUARE =    0.5004     R-SQUARE ADJUSTED =    0.4599
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.1274
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.7685
 SUM OF SQUARED ERRORS-SSE=    115.71
 MEAN OF DEPENDENT VARIABLE =    2.3021
 LOG OF THE LIKELIHOOD FUNCTION = -79.4464

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF3    -0.53565      0.110      -4.85      0.000 |  -0.664 |   12.4     0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF3    -0.67782     0.1390      -4.877     0.000-0.626    -0.7911    -0.9490
 DIFF3    -0.53575E-01 0.6425E-01 -0.8338     0.410-0.136    -0.0664    -0.0722
 DIFF3     0.17821     0.9353E-01  1.905      0.065 0.299     0.2277     0.2316
 DIFF3     0.17534E-01 0.1579E-01  1.111      0.274 0.180     0.0224     0.0223
 CONSTANT   4.1210     0.4530      9.098      0.000 0.831     0.0000     1.7901
```

Using Short-Term Rates

```
R-SQUARE =    0.3527     R-SQUARE ADJUSTED =    0.3002
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    4.0521
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    2.0130
 SUM OF SQUARED ERRORS-SSE=    149.93
 MEAN OF DEPENDENT VARIABLE =    2.3021
 LOG OF THE LIKELIHOOD FUNCTION = -84.7566

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF3SH  -0.32370      0.105      -3.09      0.004 |  -0.973 |   6.72     0.001


 VARIABLE   ESTIMATED  STANDARD   T-RATIO       PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF3SH  -0.47139     0.1194      -3.948     0.000-0.544    -0.6780    -0.2887
 DIFF3SH  -0.10694E-01 0.5864E-01 -0.1824     0.856-0.030    -0.0157    -0.0062
 DIFF3SH   0.14942     0.8211E-01  1.820      0.077 0.287     0.2218     0.0812
 DIFF3SH   0.89582E-02 0.1722E-01  0.5201     0.606 0.085     0.0133     0.0047
 CONSTANT   2.8101     0.3504      8.020      0.000 0.797     0.0000     1.2206
```

*France

Using Long-Term Rates

```
R-SQUARE =    0.4490     R-SQUARE ADJUSTED =    0.4043
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    1.9900
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.4107
 SUM OF SQUARED ERRORS-SSE=    73.630
 MEAN OF DEPENDENT VARIABLE =    3.0135
 LOG OF THE LIKELIHOOD FUNCTION = -70.1787

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF4    -0.45841      0.877E-01  -5.22     0.000 |   0.067 |   10.1     0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF4    -0.38784     0.1468      -2.642      0.012-0.398     -0.5865    -0.2035
 DIFF4    -0.10403     0.5271E-01  -1.974      0.056-0.309     -0.1673    -0.0480
 DIFF4     0.27306E-01 0.9044E-01  0.3019      0.764 0.050      0.0442     0.0116
 DIFF4     0.61605E-02 0.1296E-01  0.4753      0.637 0.078      0.0099     0.0025
 CONSTANT   3.7473     0.2700       13.88      0.000 0.916      0.0000     1.2435
```

Using Short-Term Rates

```
R-SQUARE =    0.4155     R-SQUARE ADJUSTED =    0.3681
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.1109
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.4529
 SUM OF SQUARED ERRORS-SSE=    78.104
 MEAN OF DEPENDENT VARIABLE =    3.0135
 LOG OF THE LIKELIHOOD FUNCTION = -71.3880

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF4SH  -0.37738      0.774E-01  -4.87     0.000 |   0.969 |   8.77     0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF4SH  -0.11890     0.1211     -0.9816      0.333-0.159     -0.2084    -0.0276
 DIFF4SH  -0.14992     0.4602E-01  -3.258      0.002-0.472     -0.2794    -0.0252
 DIFF4SH  -0.10986     0.7556E-01  -1.454      0.154-0.232     -0.2074    -0.0143
 DIFF4SH   0.12991E-02 0.1320E-01  0.9840E-01 0.922 0.016      0.0024     0.0001
 CONSTANT   3.2189     0.2403       13.39      0.000 0.910      0.0000     1.0682
```

*Italy

Using Long-Term Rates

```
R-SQUARE =    0.4314     R-SQUARE ADJUSTED =    0.3853
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.9496
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.7174
 SUM OF SQUARED ERRORS-SSE=    109.14
 MEAN OF DEPENDENT VARIABLE =    2.8978
 LOG OF THE LIKELIHOOD FUNCTION = -78.2464

                   TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF5    -0.24138      0.741E-01  -3.26     0.002 |  -1.336 |   9.36     0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR      37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF5    -0.41713     0.8996E-01  -4.637      0.000-0.606     -0.7906    -0.0699
 DIFF5     0.22623E-01 0.4022E-01  0.5624      0.577 0.092      0.0437     0.0025
 DIFF5     0.15953     0.5835E-01   2.734      0.010 0.410      0.3092     0.0088
 DIFF5    -0.64052E-02 0.1505E-01 -0.4256      0.673-0.070     -0.0124    -0.0002
 CONSTANT   3.0491     0.2763       11.04      0.000 0.876      0.0000     1.0522
```

Using Short-Term Rates

```
R-SQUARE =    0.5407     R-SQUARE ADJUSTED =    0.5035
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    2.3826
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.5436
 SUM OF SQUARED ERRORS-SSE=    88.157
 MEAN OF DEPENDENT VARIABLE =    2.8978
 LOG OF THE LIKELIHOOD FUNCTION = -73.8701

                   TESTS ON LAGGED COEFFICIENTS
```

```
VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
DIFF5SH  -0.29837      0.618E-01  -4.83     0.000 |  -1.523 |   14.5     0.000


VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
  NAME    COEFFICIENT   ERROR     37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
DIFF5SH  -0.53531     0.9823E-01  -5.449     0.000-0.667     -1.0440     0.0898
DIFF5SH   0.25309E-01 0.3752E-01  0.6745     0.504 0.110      0.0508    -0.0058
DIFF5SH   0.20572     0.6176E-01   3.331     0.002 0.480      0.4165    -0.0581
DIFF5SH   0.59164E-02 0.1417E-01  0.4175     0.679 0.068      0.0119    -0.0018
CONSTANT   2.8455     0.2486       11.44     0.000 0.883      0.0000     0.9819
```

*Netherlands

Using Long-Term Rates

```
R-SQUARE =    0.3881     R-SQUARE ADJUSTED =    0.3385
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.5003
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.8709
 SUM OF SQUARED ERRORS-SSE=    129.51
 MEAN OF DEPENDENT VARIABLE =    2.9140
 LOG OF THE LIKELIHOOD FUNCTION = -81.7554

                    TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF6    -0.29441      0.894E-01  -3.29     0.002 |  -1.583 |   7.82     0.000

 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR     37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF6    -0.53936     0.1269      -4.249     0.000-0.573     -0.8392    -0.2780
 DIFF6     0.29090E-01 0.5339E-01  0.5449     0.589 0.089      0.0454     0.0145
 DIFF6     0.21062     0.8460E-01   2.490     0.017 0.379      0.3287     0.1030
 DIFF6     0.52365E-02 0.1547E-01  0.3384     0.737 0.056      0.0082     0.0026
 CONSTANT   3.3900     0.3249       10.43     0.000 0.864      0.0000     1.1633
```

Using Short-Term Rates

```
R-SQUARE =    0.2599     R-SQUARE ADJUSTED =    0.1999
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    4.2334
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    2.0575
 SUM OF SQUARED ERRORS-SSE=    156.63
 MEAN OF DEPENDENT VARIABLE =    2.9140
 LOG OF THE LIKELIHOOD FUNCTION = -85.6535

                    TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF6SH  -0.27528      0.875E-01  -3.15     0.003 |  -0.337 |   4.33     0.010


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
   NAME    COEFFICIENT   ERROR     37 DF    P-VALUE CORR. COEFFICIENT  AT MEANS
 DIFF6SH  -0.30047     0.1185      -2.535     0.016-0.385     -0.5252    -0.0170
 DIFF6SH  -0.39460E-01 0.5138E-01 -0.7680     0.447-0.125     -0.0694    -0.0013
 DIFF6SH   0.61684E-01 0.7898E-01  0.7810     0.440 0.127      0.1086     0.0009
 DIFF6SH   0.29615E-02 0.1720E-01  0.1722     0.864 0.028      0.0052     0.0001
 CONSTANT   2.9734     0.3262       9.117     0.000 0.832      0.0000     1.0204
```

*Sweden

Using Long-Term Rates

```
R-SQUARE =    0.3905     R-SQUARE ADJUSTED =    0.3411
 VARIANCE OF THE ESTIMATE-SIGMA**2 =    3.6019
 STANDARD ERROR OF THE ESTIMATE-SIGMA =    1.8979
 SUM OF SQUARED ERRORS-SSE=    133.27
 MEAN OF DEPENDENT VARIABLE =    2.4876
 LOG OF THE LIKELIHOOD FUNCTION = -82.3419

                    TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 DIFF7    -0.22668      0.129      -1.76     0.087 |  -3.136 |   7.90     0.000


 VARIABLE   ESTIMATED  STANDARD   T-RATIO        PARTIAL STANDARDIZED ELASTICITY
```

```
  NAME    COEFFICIENT   ERROR      37 DF   P-VALUE CORR. COEFFICIENT  AT MEANS
DIFF7    -0.64480     0.1391      -4.635    0.000-0.606    -0.7492    -0.3875
DIFF7     0.11108     0.6690E-01   1.660    0.105 0.263     0.1307     0.0642
DIFF7     0.32127     0.9311E-01   3.451    0.001 0.493     0.3821     0.1750
DIFF7    -0.14231E-01 0.1596E-01 -0.8915    0.378-0.145    -0.0168    -0.0073
CONSTANT   2.8317     0.3580       7.909    0.000 0.793     0.0000     1.1383
```

Chow test: Null Hypothesis: Structural stability

*US

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1   N2    SSE1         SSE2         CHOW      PVALUE    G-Q        DF1   DF2 PVALUE
     3   40 0.85878E-01  163.02       0.62029      0.543 0.2002E-01     1    38 0.112
     4   39 0.86482E-01  159.87        1.0166      0.371 0.1001E-01     2    37 0.010
     5   38 0.59015      153.38        1.8152      0.176 0.4617E-01     3    36 0.013
     6   37   1.2596     145.44        2.8703      0.069 0.7578E-01     4    35 0.011
     7   36   2.4614     145.07        2.7441      0.077 0.1154         5    34 0.012
     8   35   4.6123     143.87        2.6031      0.087 0.1763         6    33 0.019
     9   34   4.9564     143.77        2.5664      0.090 0.1576         7    32 0.008
    10   33   8.9389     134.50        3.3799      0.044 0.2575         8    31 0.025
    11   32   20.452     134.20        1.7211      0.192 0.5080         9    30 0.143
    12   31   20.453     131.25        2.1327      0.132 0.4519        10    29 0.093
    13   30   20.876     124.71        3.0414      0.059 0.4261        11    28 0.069
    14   29   33.470     110.77        3.2524      0.049 0.6799        12    27 0.245
    15   28   80.301     83.140       0.57944      0.565  1.932        13    26 0.074
    16   27   81.469     82.544       0.50944      0.605  1.762        14    25 0.105
    17   26   81.888     82.460       0.46875      0.629  1.589        15    24 0.151
    18   25   84.425     80.594       0.38744      0.681  1.506        16    23 0.181
    19   24   84.453     80.554       0.38889      0.680  1.357        17    22 0.248
    20   23   87.842     68.554        1.4839      0.239  1.495        18    21 0.188
    21   22   88.083     66.991        1.6628      0.203  1.384        19    20 0.238
    22   21   88.096     46.360        4.9081      0.013  1.805        20    19 0.102
    23   20   97.730     45.450        3.4209      0.043  1.843        21    18 0.097
    24   19   135.28     29.123       0.46223      0.633  3.589        22    17 0.005
    25   18   139.25     28.193       0.99725E-01 0.905  3.436        23    16 0.007
    26   17   139.86     28.030       0.47085E-01 0.954  3.119        24    15 0.013
    27   16   141.24     26.994       0.80196E-02 0.992  2.930        25    14 0.020
    28   15   143.62     23.907       0.89897E-01 0.914  3.004        26    13 0.021
    29   14   143.92     23.137       0.14530     0.865  2.764        27    12 0.034
    30   13   144.61     23.040       0.74845E-01 0.928  2.466        28    11 0.058
    31   12   152.37     14.782       0.13380     0.875  3.554        29    10 0.020
    32   11   152.37     14.782       0.13378     0.875  3.092        30     9 0.039
    33   10   152.42     14.466       0.16458     0.849  2.719        31     8 0.070
    34    9   153.85     13.910       0.62149E-01 0.940  2.420        32     7 0.113
    35    8   153.89     13.620       0.91424E-01 0.913  2.054        33     6 0.187
    36    7   154.42     13.455       0.49256E-01 0.952  1.688        34     5 0.294
    37    6   156.47     11.409       0.48795E-01 0.952  1.567        35     4 0.361
    38    5   157.27     9.6245       0.16395     0.849  1.362        36     3 0.462
    39    4   158.87     5.2972       0.49122     0.616  1.621        37     2 0.455
    40    3   159.13   0.83694E-01  1.1131      0.339  50.03        38     1 0.112

             CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND    NO.OBS =    43
 REGRESSAND : GROWTH1

  R-SQUARE = 0.1300          DURBIN-WATSON =  1.379

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  4    M =  2
                        TEST      ASY. CRITICAL
                      STATISTIC     VALUE 10%
 ---------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          T-TEST       -2.7271      -3.04
                                                AIC =      1.455
                                                 SC =      1.670
 ---------------------------------------------------------------------------

 COINTEGRATING REGRESSION - CONSTANT, TREND       NO.OBS =    43
 REGRESSAND : GROWTH1
```

```
 R-SQUARE = 0.1301          DURBIN-WATSON =  1.385

 DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  4   M =  2

                      TEST      ASY. CRITICAL
                    STATISTIC     VALUE 10%
--------------------------------------------------------------------------
 NO CONSTANT, NO TREND
        T-TEST       -2.7286     -3.50
                                           AIC =      1.457
                                            SC =      1.673
-------------------------------------------------------------------------------------
```

*Belgium

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1    N2    SSE1          SSE2         CHOW      PVALUE    G-Q        DF1   DF2 PVALUE
     3    40 0.11427        98.050      0.96982       0.388 0.4429E-01    1    38 0.166
     4    39  1.9073        95.189       1.1950       0.314 0.3707        2    37 0.307
     5    38  3.6431        95.170      0.83547       0.441 0.4594        3    36 0.288
     6    37  4.7316        95.152      0.61760       0.544 0.4351        4    35 0.218
     7    36  4.7548        94.806      0.68282       0.511 0.3410        5    34 0.116
     8    35  4.7830        93.932      0.85565       0.433 0.2801        6    33 0.058
     9    34  7.2802        86.446       1.9391       0.157 0.3850        7    32 0.096
    10    33  9.0959        78.342       3.4810       0.041 0.4499        8    31 0.119
    11    32  10.502        78.231       3.1456       0.054 0.4475        9    30 0.102
    12    31  11.186        76.648       3.3774       0.044 0.4232       10    29 0.076
    13    30  11.207        71.838       4.6967       0.015 0.3971       11    28 0.054
    14    29  15.040        71.476       3.7259       0.033 0.4734       12    27 0.087
    15    28  51.499        49.038      0.48669       0.618  2.100       13    26 0.052
    16    27  52.116        46.757      0.82312       0.447  1.990       14    25 0.065
    17    26  61.911        40.818      0.60154E-01 0.942  2.427       15    24 0.026
    18    25  61.918        40.812      0.60094E-01 0.942  2.181       16    23 0.043
    19    24  61.941        40.787      0.60636E-01 0.941  1.965       17    22 0.068
    20    23  65.354        36.319      0.26334       0.770  2.099       18    21 0.053
    21    22  66.670        35.297      0.20636       0.814  1.988       19    20 0.068
    22    21  69.897        31.836      0.25174       0.779  2.086       20    19 0.058
    23    20  71.376        28.867      0.54533       0.584  2.119       21    18 0.056
    24    19  72.076        28.646      0.45008       0.641  1.944       22    17 0.083
    25    18  72.195        28.630      0.42962       0.654  1.754       23    16 0.125
    26    17  72.201        28.516      0.45113       0.640  1.582       24    15 0.180
    27    16  73.058        28.240      0.33660       0.716  1.449       25    14 0.237
    28    15  77.619        22.655      0.53911       0.588  1.713       26    13 0.155
    29    14  77.680        21.909      0.67711       0.514  1.576       27    12 0.205
    30    13  80.609        19.418      0.58869       0.560  1.631       28    11 0.198
    31    12  80.828        18.897      0.64942       0.528  1.475       29    10 0.264
    32    11  81.358        18.832      0.55585       0.578  1.296       30     9 0.357
    33    10  85.670        15.445      0.37259       0.691  1.431       31     8 0.310
    34     9  87.509        11.930      0.70748       0.499  1.605       32     7 0.267
    35     8  88.538        10.659      0.75680       0.476  1.510       33     6 0.320
    36     7  89.219        10.659      0.61860       0.544  1.231       34     5 0.451
    37     6  89.449        8.8940      0.93257       0.402  1.149       35     4 0.508
    38     5  89.725        8.6914      0.91737       0.408 0.8603       36     3 0.337
    39     4  89.725        7.0096       1.2723       0.292 0.6919       37     2 0.249
    40     3  90.436       0.56678       2.5806       0.089  4.199       38     1 0.372

              CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND   NO.OBS =    43
 REGRESSAND : DIFF2

 R-SQUARE = 0.3907          DURBIN-WATSON = 0.5825

 DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                      TEST      ASY. CRITICAL
                    STATISTIC     VALUE 10%
--------------------------------------------------------------------------
 NO CONSTANT, NO TREND
        Z-TEST       -12.002     -17.1
        T-TEST       -2.5311     -3.04
```

```
                                                 AIC =      1.159
                                                  SC =      1.201
---------------------------------------------------------------------------

COINTEGRATING REGRESSION - CONSTANT, TREND      NO.OBS =   43
REGRESSAND : DIFF2

 R-SQUARE = 0.4982         DURBIN-WATSON = 0.5018

 DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  6   M =  2
                       TEST      ASY. CRITICAL
                     STATISTIC     VALUE 10%
---------------------------------------------------------------------------
 NO CONSTANT, NO TREND
         T-TEST       -1.4655     -3.50
                                                 AIC =      1.103
                                                  SC =      1.411
------------------------------------------------------------------------------------
```

*Denmark

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1   N2    SSE1        SSE2        CHOW     PVALUE    G-Q       DF1  DF2 PVALUE
     3   40  2.7043      125.02     0.67589     0.515 0.8219         1   38 0.630
     4   39  5.2309      114.94      1.9440     0.157 0.8419         2   37 0.561
     5   38  5.4248      114.78      1.9387     0.158 0.5672         3   36 0.360
     6   37  5.6018      114.42      1.9712     0.153 0.4284         4   35 0.213
     7   36  6.1447      114.40      1.8790     0.166 0.3653         5   34 0.131
     8   35  6.3416      114.37      1.8484     0.171 0.3050         6   33 0.070
     9   34  10.342      106.57      2.5430     0.092 0.4436         7   32 0.133
    10   33  12.083      106.57      2.2196     0.122 0.4394         8   31 0.112
    11   32  12.124      106.47      2.2294     0.121 0.3796         9   30 0.064
    12   31  12.177      105.77      2.3484     0.109 0.3338        10   29 0.036
    13   30  12.841      104.33      2.4941     0.096 0.3133        11   28 0.023
    14   29  14.733      91.948      4.6563     0.015 0.3605        12   27 0.033
    15   28  36.688      65.607      5.6921     0.007  1.118        13   26 0.388
    16   27  55.282      54.086      4.0631     0.025  1.825        14   25 0.092
    17   26  64.247      54.022      2.2896     0.115  1.903        15   24 0.077
    18   25  72.649      52.978      1.0133     0.372  1.971        16   23 0.067
    19   24  79.475      50.633     0.30687     0.738  2.031        17   22 0.060
    20   23  79.934      50.361     0.27845     0.758  1.852        18   21 0.088
    21   22  83.605      38.901      1.5359     0.228  2.262        19   20 0.039
    22   21  86.783      38.596      1.0539     0.358  2.136        20   19 0.052
    23   20  86.887      38.596      1.0369     0.364  1.930        21   18 0.082
    24   19  91.370      36.476     0.65730     0.524  1.936        22   17 0.084
    25   18  94.856      33.384     0.59536     0.556  1.977        23   16 0.082
    26   17  101.00      26.148     0.76842     0.471  2.414        24   15 0.040
    27   16  101.00      26.114     0.77364     0.468  2.166        25   14 0.067
    28   15  101.02      26.094     0.77385     0.468  1.936        26   13 0.106
    29   14  104.57      23.183     0.67165     0.517  2.005        27   12 0.103
    30   13  104.61      22.802     0.72634     0.490  1.802        28   11 0.152
    31   12  104.66      22.403     0.78185     0.465  1.611        29   10 0.216
    32   11  104.69      21.890     0.85894     0.431  1.435        30    9 0.294
    33   10  104.98      19.077      1.2724     0.292  1.420        31    8 0.314
    34    9  109.79      6.4806      2.6643     0.082  3.706        32    7 0.039
    35    8  112.41      6.4779      2.1766     0.127  3.155        33    6 0.077
    36    7  112.43      6.4676      2.1744     0.127  2.556        34    5 0.149
    37    6  112.48      5.6232      2.3206     0.112  2.286        35    4 0.219
    38    5  112.56      4.6524      2.4860     0.096  2.016        36    3 0.313
    39    4  112.85      2.4819      2.8445     0.070  2.458        37    2 0.331
    40    3  118.93      1.7172      1.8608     0.169  1.823        38    1 0.537

             CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND   NO.OBS =   43
 REGRESSAND : DIFF3

  R-SQUARE = 0.4864         DURBIN-WATSON = 0.7655

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  5   M =  2
```

```
                      TEST      ASY. CRITICAL
                    STATISTIC     VALUE 10%
---------------------------------------------------------------------------
 NO CONSTANT, NO TREND
        T-TEST       -1.3505     -3.04
                                             AIC =     1.231
                                              SC =     1.492
---------------------------------------------------------------------------

COINTEGRATING REGRESSION - CONSTANT, TREND      NO.OBS =   43
REGRESSAND : DIFF3

 R-SQUARE = 0.5217         DURBIN-WATSON = 0.7187

 DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  5   M =  2

                      TEST      ASY. CRITICAL
                    STATISTIC     VALUE 10%
---------------------------------------------------------------------------
 NO CONSTANT, NO TREND
        T-TEST       -1.0354     -3.50
                                             AIC =     1.119
                                              SC =     1.380
---------------------------------------------------------------------------
```

*France

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1    N2    SSE1         SSE2        CHOW      PVALUE     G-Q        DF1   DF2 PVALUE
     3    40 0.59417       74.324      0.71430      0.496 0.3038          1    38 0.415
     4    39 0.86492       71.586       1.4026      0.258 0.2235          2    37 0.199
     5    38   2.2006      70.639       1.2912      0.286 0.3738          3    36 0.228
     6    37   2.2010      67.507       2.2252      0.122 0.2853          4    35 0.114
     7    36   2.2916      65.333       2.8946      0.067 0.2385          5    34 0.057
     8    35   3.0641      64.851       2.7987      0.073 0.2599          6    33 0.048
     9    34   4.1021      59.158       4.4397      0.018 0.3170          7    32 0.059
    10    33   4.6546      52.358       7.0629      0.002 0.3445          8    31 0.059
    11    32   4.9879      50.343       7.8704      0.001 0.3303          9    30 0.042
    12    31   6.1349      49.438       7.7511      0.001 0.3599         10    29 0.046
    13    30   6.1518      45.149       10.020      0.000 0.3468         11    28 0.034
    14    29   10.475      45.119       7.7406      0.001 0.5224         12    27 0.119
    15    28   39.410      31.543       1.8438      0.172  2.499         13    26 0.023
    16    27   40.451      31.514       1.5437      0.226  2.292         14    25 0.034
    17    26   41.488      31.490       1.2517      0.297  2.108         15    24 0.050
    18    25   43.148      31.452      0.80052      0.456  1.972         16    23 0.067
    19    24   44.362      31.428      0.48175      0.621  1.827         17    22 0.092
    20    23   46.242      30.907      0.12995      0.879  1.746         18    21 0.111
    21    22   47.408      29.911      0.86729E-01 0.917  1.668         19    20 0.132
    22    21   47.577      29.748      0.85195E-01 0.919  1.519         20    19 0.183
    23    20   48.186      28.559      0.23311      0.793  1.446         21    18 0.216
    24    19   48.194      28.141      0.33892      0.715  1.323         22    17 0.280
    25    18   48.199      27.891      0.40293      0.671  1.202         23    16 0.358
    26    17   48.270      27.537      0.47728      0.624  1.096         24    15 0.438
    27    16   51.048      26.152      0.11686      0.890  1.093         25    14 0.444
    28    15   55.486      22.129      0.11958E-01 0.988  1.254         26    13 0.343
    29    14   58.522      18.234      0.23018      0.795  1.426         27    12 0.263
    30    13   59.763      15.121      0.72347      0.491  1.553         28    11 0.224
    31    12   60.235      15.015      0.62519      0.540  1.383         29    10 0.303
    32    11   60.235      13.734      0.97385      0.387  1.316         30     9 0.347
    33    10   66.102      11.082      0.12093      0.886  1.539         31     8 0.270
    34     9   66.197      11.082      0.96890E-01 0.908  1.307         32     7 0.380
    35     8   66.197      10.734      0.18541      0.831  1.121         33     6 0.488
    36     7   66.318      10.472      0.22160      0.802 0.9313         34     5 0.392
    37     6   66.395      10.467      0.20294      0.817 0.7249         35     4 0.261
    38     5   66.755      10.060      0.21492      0.808 0.5530         36     3 0.163
    39     4   68.340      1.7339       2.1118      0.135  2.130         37     2 0.371
    40     3   69.477      1.6619       1.7882      0.181  1.100         38     1 0.654

             CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND    NO.OBS =   43
 REGRESSAND : DIFF4
```

```
 R-SQUARE = 0.4929          DURBIN-WATSON = 0.6135

 DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                         TEST      ASY. CRITICAL
                       STATISTIC     VALUE 10%
---------------------------------------------------------------------------
 NO CONSTANT, NO TREND
         Z-TEST        -12.781     -17.1
         T-TEST        -2.6764     -3.04
                                               AIC =      0.854
                                                SC =      0.895
---------------------------------------------------------------------------

COINTEGRATING REGRESSION - CONSTANT, TREND      NO.OBS =   43
REGRESSAND : DIFF4

 R-SQUARE = 0.6572          DURBIN-WATSON = 0.7151

 DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                         TEST      ASY. CRITICAL
                       STATISTIC     VALUE 10%
---------------------------------------------------------------------------
 NO CONSTANT, NO TREND
         Z-TEST        -15.030     -23.4
         T-TEST        -2.8872     -3.50
                                               AIC =      0.592
                                                SC =      0.633
---------------------------------------------------------------------------
```

*Italy

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1   N2     SSE1          SSE2        CHOW      PVALUE     G-Q        DF1   DF2 PVALUE
     3   40 0.53383        115.56       2.6785       0.081 0.1755         1    38 0.322
     4   39  10.678        115.45      0.91440       0.409  1.711         2    37 0.195
     5   38  11.137        115.41      0.84580       0.437  1.158         3    36 0.339
     6   37  13.210        108.97       1.5741       0.220  1.061         4    35 0.390
     7   36  18.293        93.994       3.4305       0.042  1.323         5    34 0.278
     8   35  20.635        79.765       6.1454       0.005  1.423         6    33 0.236
     9   34  20.992        70.291       8.7069       0.001  1.365         7    32 0.254
    10   33  21.153        65.580       10.187       0.000  1.250         8    31 0.305
    11   32  28.950        65.418       7.7847       0.001  1.475         9    30 0.202
    12   31  31.543        65.217       7.1100       0.002  1.403        10    29 0.228
    13   30  32.841        62.909       7.3905       0.002  1.329        11    28 0.261
    14   29  38.534        62.332       6.0267       0.005  1.391        12    27 0.230
    15   28  82.128        38.258       1.8879       0.165  4.293        13    26 0.001
    16   27  82.293        36.738       2.1313       0.132  4.000        14    25 0.001
    17   26  88.911        34.540       1.3569       0.269  4.119        15    24 0.001
    18   25  89.475        34.473       1.2732       0.291  3.731        16    23 0.002
    19   24  90.029        30.800       1.8093       0.177  3.783        17    22 0.002
    20   23  92.643        30.800       1.3582       0.269  3.509        18    21 0.003
    21   22  104.12        25.649      0.34182       0.713  4.273        19    20 0.001
    22   21  107.17        24.131      0.10999       0.896  4.219        20    19 0.001
    23   20  108.24        23.529      0.39673E-01 0.961  3.943        21    18 0.002
    24   19  108.24        23.464      0.49346E-01 0.952  3.565        22    17 0.005
    25   18  108.86        22.452      0.10892       0.897  3.373        23    16 0.008
    26   17  108.96        22.451      0.92935E-01 0.911  3.033        24    15 0.015
    27   16  109.71        20.923      0.21056       0.811  2.936        25    14 0.020
    28   15  111.76        16.576      0.56301       0.574  3.371        26    13 0.013
    29   14  112.22        14.671      0.79146       0.460  3.400        27    12 0.015
    30   13  113.29        14.631      0.62831       0.539  3.042        28    11 0.028
    31   12  113.54        14.624      0.59010       0.559  2.677        29    10 0.052
    32   11  113.60        14.623      0.58015       0.565  2.331        30     9 0.091
    33   10  117.43        8.0732       1.0159       0.371  3.754        31     8 0.028
    34    9  117.61        8.0028      0.99854       0.378  3.215        32     7 0.056
    35    8  119.56        7.0891      0.83083       0.443  3.066        33     6 0.082
    36    7  120.02        6.9859      0.77345       0.468  2.526        34     5 0.152
    37    6  120.08        6.0314      0.91606       0.409  2.275        35     4 0.221
    38    5  121.26        6.0292      0.72729       0.490  1.676        36     3 0.379
    39    4  121.41        5.4767      0.79241       0.460  1.198        37     2 0.558
    40    3  121.52        2.0282       1.3406       0.273  1.577        38     1 0.569
```

```
               CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND   NO.OBS =   43
 REGRESSAND : DIFF5

  R-SQUARE = 0.4224         DURBIN-WATSON = 0.4538

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                       TEST      ASY. CRITICAL
                     STATISTIC     VALUE 10%
----------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          Z-TEST       -9.6552     -17.1
          T-TEST       -2.3123     -3.04
                                               AIC =     1.444
                                                SC =     1.486
----------------------------------------------------------------------------

 COINTEGRATING REGRESSION - CONSTANT, TREND      NO.OBS =   43
 REGRESSAND : DIFF5

  R-SQUARE = 0.5140         DURBIN-WATSON = 0.5602

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                       TEST      ASY. CRITICAL
                     STATISTIC     VALUE 10%
----------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          Z-TEST       -11.885     -23.4
          T-TEST       -2.5677     -3.50
                                               AIC =     1.456
                                                SC =     1.497
----------------------------------------------------------------------------
```

*Netherlands

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1    N2      SSE1         SSE2         CHOW      PVALUE    G-Q        DF1   DF2 PVALUE
     3    40 0.48356E-01  145.84      0.15976E-01 0.984 0.1260E-01    1    38 0.089
     4    39 0.59270      141.88      0.48378       0.620 0.7728E-01    2    37 0.074
     5    38 0.65258      141.38      0.54650       0.583 0.5539E-01    3    36 0.017
     6    37  1.3478      140.67      0.54809       0.582 0.8383E-01    4    35 0.013
     7    36  3.2825      137.32      0.74983       0.479 0.1625         5    34 0.025
     8    35  5.8932      131.53       1.2185       0.307 0.2464         6    33 0.043
     9    34  7.4210      123.81       2.1955       0.125 0.2740         7    32 0.040
    10    33  8.1524      119.03       2.8875       0.068 0.2654         8    31 0.027
    11    32  11.448      118.95       2.3352       0.110 0.3208         9    30 0.038
    12    31  18.094      118.59       1.3312       0.276 0.4425        10    29 0.087
    13    30  18.283      115.32       1.8105       0.177 0.4035        11    28 0.057
    14    29  18.394      113.99       2.0076       0.148 0.3631        12    27 0.034
    15    28  42.417      97.016      0.91994       0.407 0.8744        13    26 0.413
    16    27  42.602      93.038       1.4909       0.238 0.8177        14    25 0.355
    17    26  42.717      93.033       1.4740       0.241 0.7347        15    24 0.271
    18    25  42.717      92.917       1.4919       0.238 0.6609        16    23 0.199
    19    24  48.110      91.843      0.84412       0.438 0.6779        17    22 0.209
    20    23  48.124      91.141      0.94460       0.398 0.6160        18    21 0.152
    21    22  49.739      80.213       2.4098       0.103 0.6527        19    20 0.179
    22    21  52.748      66.934       4.2898       0.021 0.7487        20    19 0.263
    23    20  54.787      66.900       3.8978       0.029 0.7019        21    18 0.217
    24    19  60.977      66.128       2.9005       0.067 0.7125        22    17 0.225
    25    18  61.020      64.529       3.1782       0.053 0.6578        23    16 0.175
    26    17  65.814      64.292       2.3837       0.106 0.6398        24    15 0.160
    27    16  72.594      64.176       1.3175       0.279 0.6334        25    14 0.155
    28    15  73.207      64.134       1.2309       0.303 0.5707        26    13 0.108
    29    14  80.516      57.050       1.1971       0.313 0.6272        27    12 0.153
    30    13  80.878      57.009       1.1491       0.327 0.5573        28    11 0.103
    31    12  81.747      56.491       1.0965       0.344 0.4990        29    10 0.070
    32    11  82.114      55.096       1.2508       0.298 0.4471        30     9 0.048
    33    10  82.643      53.574       1.4021       0.258 0.3981        31     8 0.031
    34     9  83.086      51.888       1.5946       0.216 0.3503        32     7 0.020
```

```
    35    8  84.894       50.069       1.5963      0.216 0.3083        33     6 0.013
    36    7  84.928       49.905       1.6166      0.212 0.2503        34     5 0.006
    37    6  87.739       37.687       3.2003      0.052 0.2661        35     4 0.012
    38    5  90.831       37.639       2.6625      0.082 0.2011        36     3 0.005
    39    4  98.159       7.2298       7.5164      0.002 0.7339        37     2 0.269
    40    3  98.161      0.24026       9.4347      0.000  10.75        38     1 0.238

            CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND   NO.OBS =   43
 REGRESSAND : DIFF6

  R-SQUARE = 0.3118         DURBIN-WATSON = 0.5170

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                       TEST      ASY. CRITICAL
                     STATISTIC     VALUE 10%
 --------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          Z-TEST       -10.502     -17.1
          T-TEST       -2.3289     -3.04
                                               AIC =     1.398
                                                SC =     1.440
 --------------------------------------------------------------------------

 COINTEGRATING REGRESSION - CONSTANT, TREND      NO.OBS =   43
 REGRESSAND : DIFF6
  R-SQUARE = 0.4316         DURBIN-WATSON = 0.5047

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                       TEST      ASY. CRITICAL
                     STATISTIC     VALUE 10%
 --------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          Z-TEST       -10.179     -23.4
          T-TEST       -2.2291     -3.50
                                               AIC =     1.193
                                                SC =     1.234
 --------------------------------------------------------------------------

 |_COINT DIFF6SH GROWTH6 / TYPE=RESD
 OBSERVATION      1 IS SKIPPED BECAUSE DIFF6SH  MISSING
 OBSERVATION     45 IS SKIPPED BECAUSE DIFF6SH  MISSING
 OBSERVATION      1 IS SKIPPED BECAUSE GROWTH6  MISSING
 ...NOTE..SAMPLE RANGE SET TO:     1,    45

 REQUIRED MEMORY IS PAR=      23 CURRENT PAR=    2000
 ...NOTE..TEST LAG ORDER AUTOMATICALLY SET

 COINTEGRATING REGRESSION - CONSTANT, NO TREND   NO.OBS =   43
 REGRESSAND : DIFF6SH

  R-SQUARE = 0.2429         DURBIN-WATSON = 0.5811

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  0   M =  2

                       TEST      ASY. CRITICAL
                     STATISTIC     VALUE 10%
 --------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          Z-TEST       -12.016     -17.1
          T-TEST       -2.5497     -3.04
                                               AIC =     1.829
                                                SC =     1.871
 --------------------------------------------------------------------------
```

*Sweden

```
SEQUENTIAL CHOW AND GOLDFELD-QUANDT TESTS
    N1    N2     SSE1          SSE2       CHOW      PVALUE     G-Q       DF1  DF2 PVALUE
```

```
   3   40 0.96861       168.53      0.66372      0.521 0.2184          1   38 0.357
   4   39  1.0055       161.59       1.5190      0.232 0.1151          2   37 0.108
   5   38  2.0789       161.37       1.4099      0.256 0.1546          3   36 0.074
   6   37  2.8274       160.78       1.3892      0.261 0.1539          4   35 0.040
   7   36  3.7427       160.78       1.2730      0.291 0.1583          5   34 0.024
   8   35  8.9861       158.31      0.92866      0.404 0.3122          6   33 0.074
   9   34  11.234       152.28       1.4013      0.258 0.3372          7   32 0.069
  10   33  13.939       140.61       2.6132      0.086 0.3841          8   31 0.079
  11   32  20.601       138.84       1.9350      0.158 0.4946          9   30 0.134
  12   31  23.137       138.73       1.6134      0.212 0.4836         10   29 0.113
  13   30  23.799       137.70       1.6614      0.203 0.4399         11   28 0.076
  14   29  26.842       137.70       1.2703      0.292 0.4386         12   27 0.067
  15   28  36.112       134.90      0.48465      0.620 0.5354         13   26 0.119
  16   27  45.817       126.15      0.37355      0.691 0.6485         14   25 0.201
  17   26  66.219       107.08      0.22109      0.803 0.9895         15   24 0.505
  18   25  68.123       102.11      0.57591      0.567 0.9590         16   23 0.475
  19   24  69.378       102.08      0.43222      0.652 0.8795         17   22 0.399
  20   23  72.379       93.053       1.1589      0.324 0.9075         18   21 0.421
  21   22  73.508       89.982       1.4042      0.258 0.8599         19   20 0.373
  22   21  73.813       86.893       1.7664      0.184 0.8070         20   19 0.319
  23   20  74.107       81.279       2.4944      0.096 0.7815         21   18 0.292
  24   19  79.899       80.893       1.7550      0.186 0.7632         22   17 0.272
  25   18  84.126       78.278       1.5440      0.226 0.7476         23   16 0.256
  26   17  86.178       78.227       1.2878      0.287 0.6885         24   15 0.201
  27   16  93.240       70.438       1.3802      0.264 0.7413         25   14 0.249
  28   15  94.051       68.987       1.4622      0.244 0.6817         26   13 0.196
  29   14  94.126       68.903       1.4633      0.244 0.6071         27   12 0.137
  30   13  95.294       68.757       1.3328      0.275 0.5445         28   11 0.095
  31   12  109.76       48.112       2.1484      0.130 0.7866         29   10 0.291
  32   11  113.90       47.477       1.6777      0.200 0.7197         30    9 0.237
  33   10  125.47       24.676       3.2628      0.049  1.312         31    8 0.362
  34    9  145.45       16.801       1.5633      0.222  1.894         32    7 0.193
  35    8  155.41       12.601      0.84114      0.439  2.242         33    6 0.157
  36    7  155.87       12.325      0.81943      0.448  1.860         34    5 0.254
  37    6  156.33       12.229      0.77558      0.467  1.461         35    4 0.392
  38    5  161.85       10.140      0.37123      0.692  1.330         36    3 0.471
  39    4  169.01       5.9908      0.29143E-01 0.971  1.525         37    2 0.475
  40    3  173.61      0.89051      0.84755E-01 0.919  5.131         38    1 0.339

             CHOW TEST - F DISTRIBUTION WITH DF1=   2 AND DF2=  39
```

Unit root test

```
COINTEGRATING REGRESSION - CONSTANT, NO TREND   NO.OBS =   43
 REGRESSAND : DIFF7

  R-SQUARE = 0.2419          DURBIN-WATSON = 0.7208

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  1   M =  2

                        TEST      ASY. CRITICAL
                      STATISTIC     VALUE 10%
 --------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          T-TEST       -1.8831     -3.04
                                                   AIC =      1.169
                                                    SC =      1.252
 --------------------------------------------------------------------------

 COINTEGRATING REGRESSION - CONSTANT, TREND      NO.OBS =   43
 REGRESSAND : DIFF7

  R-SQUARE = 0.5222          DURBIN-WATSON =  1.151

  DICKEY-FULLER TESTS ON RESIDUALS - NO.LAGS =  1   M =  2

                        TEST      ASY. CRITICAL
                      STATISTIC     VALUE 10%
 --------------------------------------------------------------------------
  NO CONSTANT, NO TREND
          T-TEST       -2.4055     -3.50
                                                   AIC =      1.137
                                                    SC =      1.220
 --------------------------------------------------------------------------
```

|_* Testing for Granger causality

```
 |_* Consider a VAR(3) model
|_SAMPLE 1 42
```

*US

```
|_*Test H0: DIFF1 does not Granger-cause GROWTH1
 |_*The test statistic is the JOINT-F on DIFF1

 |_ols GROWTH1 GROWTH1(1.3) DIFF1(1.3)
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH1  -0.17196       0.294     -0.584     0.563 |  4.002 |  0.979     0.415
 DIFF1    -0.80532E-01  0.165     -0.488     0.629 | -3.008 |  0.382     0.767
|_*Test H0: GROWTH1 does not Granger-cause DIFF1
 |_*The test statistic is the JOINT-F ON GROWTH1

 |_ols DIFF1 GROWTH1(1.3) DIFF1(1.3)
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH1   0.27988       0.182       1.54     0.133 |  0.702 |   4.21     0.013
 DIFF1     0.91864       0.102       9.02     0.000 |  1.058 |   28.2     0.000
```

*Belgium

```
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH2   0.21429       0.319      0.672     0.506 |  2.213 |  0.604     0.617
 DIFF2    -0.15300       0.146      -1.05     0.301 |  0.178 |  0.639     0.595

TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH2  -0.27259       0.288     -0.945     0.352 |  3.570 |   3.65     0.023
 DIFF2     0.73783       0.132       5.60     0.000 |  0.804 |   14.9     0.000
```

*Denmark

```
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH3  -0.28477       0.327     -0.872     0.390 |  0.868 |   1.01     0.403
 DIFF3    -0.57781       0.202      -2.86     0.007 |  1.114 |   3.88     0.018

TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH3   0.41374       0.253       1.63     0.112 |  0.514 |   5.97     0.002
 DIFF3      1.0614       0.157       6.77     0.000 |  1.439 |   20.5     0.000
```

*France

```
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH4   0.53315       0.205       2.60     0.014 |  1.452 |   2.33     0.093
 DIFF4    -0.13739       0.118      -1.16     0.253 |  0.178 |  0.812     0.497

TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH4  -0.18820E-02  0.210     -0.896E-02 0.993 | 263.494 |   2.07     0.123
 DIFF4     0.81235       0.121       6.73     0.000 |  1.123 |   17.4     0.000
```

*Italy

```
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH5   0.61019       0.249       2.45     0.020 |  1.188 |   3.25     0.034
 DIFF5     0.12670E-01  0.105      0.121     0.904 | -30.872 |   2.28     0.098

TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)   STD ERROR  T-RATIO   P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH5   0.45531E-02  0.376      0.121E-01 0.990 | -11.689 |  0.902     0.451
 DIFF5     0.77601       0.158       4.91     0.000 |  1.596 |   9.28     0.000
```

*Netherlands

```
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH6   0.21452      0.311      0.690    0.495  |  2.316  |  0.382    0.767
 DIFF6    -0.16594      0.134     -1.24     0.224  |  0.012  |  2.60     0.069

TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH6  -0.93444E-01  0.333     -0.280    0.781  |  5.452  |  1.07     0.374
 DIFF6     0.82103      0.143      5.72     0.000  |  1.056  |  15.3     0.000
```

*Sweden

```
TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH7   0.65304      0.210      3.10     0.004  |  1.210  |  5.05     0.006
 DIFF7     0.12074      0.143      0.847    0.403  | -0.704  |  2.97     0.046


TESTS ON LAGGED COEFFICIENTS
 VARIABLE  SUM(COEFS)  STD ERROR  T-RATIO  P-VALUE | MEAN LAG| JOINT-F  P-VALUE
 GROWTH7  -0.27446      0.231     -1.19     0.243  |  1.837  |  1.44     0.250
 DIFF7     0.67790      0.156      4.34     0.000  |  1.990  |  8.40     0.000
```