THE ENDOGENEITY OF THE NATURAL RATE OF GROWTH

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Abstract

The aim of this paper is to estimate the sensitivity of the natural rate of growth to the actual rate of growth for 15 OECD countries over the period 1961 to 1995, on the hypothesis that the natural rate of growth is not exogenously given. To do this we estimate the natural rate of growth and, then, how it changes when the actual growth rate is different from the natural rate. As a side test of the endogeneity hypothesis, we also test for the direction of causality between national output and factor inputs for the same set of countries. Our results support the idea that the natural rate of growth is responsive to the actual rate of growth and bring to the fore the importance of focusing on demand as well as supply for an understanding of growth rate differences between countries.

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1. Introduction

The main purpose of this paper is to estimate the sensitivity of the natural rate of growth to the actual rate of growth for a series of developed countries over the period 1961 to 1995, on the hypothesis that the natural rate of growth is not exogenously given, as it is assumed to be in orthodox growth theory (including "new" growth theory). To do this, we first estimate the natural growth rate as defined by Harrod (1939) for the various countries. We then see how the natural growth rate varies when the actual growth rate is different from the natural rate, and give reasons why this is to be expected. As a side test of the endogeneity hypothesis, we also test for the direction of causality between national output and factor inputs for the same countries.

The question of whether the natural growth rate is exogenous or endogenous to demand, and whether it is input growth that causes output growth or vice versa, lies at the heart of the debate between neo-classical growth economists on the one hand, who treat the rate of growth of the labour force and labour productivity as exogenous to the actual rate of growth, and economists in the Keynesian/post-Keynesian tradition who maintain that growth is primarily demand driven because labour force growth and productivity growth respond to demand growth, both foreign and domestic.

There is a relatively simple way to answer this question and to discriminate between these competing hypotheses. Following the work of Okun (1962), one of the present authors (Thirlwall, 1969) has shown an easy way to estimate the natural rate of growth. Since the natural rate of growth is the sum of the rate of growth of the labour force and the rate of growth of labour productivity (or what Harrod originally called the rate of growth of the labour force in efficiency units), if the actual growth rate falls below the natural rate, the unemployment rate will rise, and if it rises above, the unemployment rate will fall. Thus, the natural rate of growth is the actual rate of growth that keeps unemployment constant. Okun specifies the change in the percentage level of unemployment ($\Delta\%U$) as a linear function of the growth of output (*g*):

$$\Delta\%U = a - b(g) \tag{1}$$

From equation (1), when $\Delta\%U = 0$, the natural rate of growth is defined as *a/b*. It is possible, of course, that because of labour hoarding the estimate of *b* is biased downwards, leading to an overestimate of the natural rate. Equally, however, when there is no growth, there are likely to be drop-outs from the labour force biasing the estimate of *a* downwards. It is difficult to know, *a priori*, what the relative (offsetting) strengths of the biases are likely to be.

An alternative approach which overcomes these particular problems of bias is to reverse the dependent and independent variables of equation (1) giving:

$$g = a_1 - b_1(\Delta\%U) \tag{2}$$

where the constant term (a_1) in equation (2) now defines the natural rate of growth; that is, the growth rate consistent with no change in the percentage level of unemployment. Since $\Delta\%U$ is not exogenous, however, the coefficient estimates of equation (2) will be statistically biased, although to what extent is also difficult to know *a priori*. In Thirlwall (1969), estimates of the natural rate of growth for the United Kingdom and the United States were made using both approaches over the period 1950 to 1967 and the results were not significantly different. For the US, the OLS estimation of equation (1) gave an estimate of 3.60 percent, and equation (2), 3.63 percent. For the UK, equations (1) and (2) gave the same estimate of 2.90 percent.

Once the natural rate of growth has been estimated, deviations of the actual growth rate from the natural rate can be calculated, and equation (2) can be estimated introducing a dummy variable ($D = 1$) for periods when the actual rate of growth is above the natural rate and zero otherwise, as in equation (3).

$$g = a_2 + b_2 D - c_2 (\Delta\%U) \quad (3)$$

If the coefficient on the dummy (b_2) plus the constant (a_2) is significantly higher than the original constant (a_1) in equation (2), this means that the rate of growth to keep unemployment constant in booms must have risen.[1] In other words, the actual rate of growth must have pulled up the natural rate. This issue is of great theoretical and practical importance.

2. Theoretical Considerations

It was Harrod (1939) who first formally introduced the concept of the natural rate of growth into economic theory, although interestingly Keynes alluded to the idea two years previously in a lecture to the Eugenics Society in 1937 on the economic consequences of a declining population (Keynes, 1937). There, he expressed the view that if the growth of population fell to zero, the growth of demand for savings (with a given capital-output ratio) may not match the supply of savings (given the propensity to save), leading to demand deficiency. This is a clear anticipation of the idea in Harrod that the natural rate of growth may fall below what Harrod called the warranted growth rate, leading to secular stagnation.[2]

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[1] Note that the coefficient on D is non-negative by construction, though not necessarily significantly different from zero. If all the changes in the actual rate were being captured by changes in $\Delta\%U$, then b_2 would not be significantly different from zero and, therefore, the natural growth rate would not be different in slump and boom periods.

[2] For a fuller discussion, see Thirlwall (1987).

In Harrod, and in mainstream growth theory, the natural growth rate fulfils two important functions. Firstly, it sets the ceiling to the divergence between the actual and the warranted rate of growth, and turns cyclical booms into slumps. It is thus important for generating cyclical behaviour in trade cycle models that rely on first-order difference equations. Secondly, it gives the long run rate of growth to which economies will gravitate; what Harrod called the social optimum rate of growth, but without any discussion of its determinants. That is why Harrod's growth theory is not really a theory of growth at all, but a dynamic theory of the trade cycle around an unexplained trend (Besomi, 1998). The natural growth rate is treated as strictly exogenous, made up of the growth of the labour force and the growth of labour productivity, without any recognition that both may be endogenous to demand.

In Harrod's model, there was also no mechanism for bringing the warranted rate of growth into line with the natural rate. It was this (pessimistic) conclusion that started the neo-classical versus Keynesian growth debate in the 1950s that engaged some of the greatest minds in the economics profession for more that two decades (see Hacche 1979, and Jones 1975, for a summary). Cambridge, Massachusetts, USA, represented by Samuelson, Solow and Modigliani was pitched against Cambridge, England, represented by Kaldor, Joan Robinson, Khan and Pasinetti. Both camps, however, treated, by and large, the natural rate of growth as given. Virtually all the discussion centred on the various mechanisms by which the warranted rate might converge on the natural rate giving a long run equilibrium growth path. The Cambridge, Massachusetts neo-classical school, as is well known, concentrated on adjustments to the capital-output ratio through capital-labour substitution. The Cambridge, England Keynesian school concentrated on adjustments to the savings ratio through changes in the distribution of income between wages and profits.

If the natural rate of growth is not exogenously given, however, but is endogenous to economic conditions, both approaches are considerably weakened. Likewise, the endogeneity of the natural rate has serious implications for neo-classical growth theory that views the long run growth rate (the natural rate) as determined by exogenously given factor inputs and technical progress.

First consider the short run cyclical problem of divergence between the actual and warranted growth rates. If the natural rate increases as the actual growth rate diverges further from the warranted rate in the upward direction, this will perpetuate the cyclical upturn which is then eventually brought to an end not necessarily by reaching a full employment ceiling but by inflationary conditions and/or balance of payments problems before the natural rate is ever reached. This, indeed, may be one explanation why cyclical peaks of activity are very often accompanied in many countries by continued under-utilisation of labour and capacity. The boom has generated its own supply, but the supply cannot be utilised before various demand constraints bite.

Secondly, consider the secular problem of divergence between the warranted and the natural growth rates. If the warranted rate exceeds the natural rate, it means that the growth of the capital stock exceeds the growth of the labour force in efficiency units. The neo-classical adjustment mechanism is the substitution of capital for labour, increasing the capital-output ratio. The Keynesian adjustment mechanism is a fall in the savings ratio through a redistribution of income from profits to wages. But in conditions of depression, the natural rate of growth is likely to be adversely affected so that the natural rate falls as the warranted rate falls, making adjustment more difficult. Conversely, if the natural rate exceeds the warranted rate, the growth of the labour force in efficiency units exceeds the growth of capital. The warranted rate must rise to the natural rate, but if boom conditions raise the natural rate, the adjustment of the two rates is again made more difficult.

There are a number of mechanisms through which the natural rate of growth may be endogenous to the actual growth rate. First, there are a variety of ways, well documented, by which the growth of labour inputs increases when output growth is buoyant. Hours worked increase; participation rates increase, particularly among females; reallocation of labour from low to high productivity sectors takes place, which is a very important factor in the early stages of industrialisation (see Cornwall, 1977), and immigration may also occur (as in Germany in the 1950s and 1960s). Secondly, there are a whole host of ways in which labour productivity growth may be enhanced as output growth increases: micro (static) economies of scale; macro-economies of scale (in the Allyn Young (1928) sense), and dynamic economies of scale associated with induced capital accumulation, embodied technical progress, and learning-by-doing. All these mechanisms play a part in the determination of the Verdoorn relation (Verdoorn, 1949), resurrected by Kaldor (1966), which shows a strong positive relation between the growth of output in manufacturing as the independent variable and the growth of labour productivity. This relationship can, in turn, be derived (see Dixon and Thirlwall, 1975) from Kaldor's technical progress function (Kaldor, 1957) which postulates a relation between the rate of growth of output per head and the rate of growth of capital per head. If the extent of the market, and not relative factor prices, is the fundamental variable determining different production techniques and the introduction of new inventions and production processes, the actual growth of output becomes the major determinant of labour productivity growth.

If labour force growth and productivity growth are endogenous to output growth, then the natural growth rate will be endogenous to output growth and this has serious implications for the neo-classical theory of growth which attempts to understand the growth process in terms of the growth of factor inputs and technical progress, the growth of which are determined outside the model. With an exogenously determined production frontier it is always possible to assume that the economy will work towards the full employment of resources. If it can be shown, however, that the buoyancy of demand affects positively the natural rate of growth, and that output growth induces input growth, the notion of a full employment production frontier is no longer tenable. There needs to be much more focus on the components of demand, and constraints on demand, for an understanding of the growth process. It should be noted at this point that so-called “new” growth theory, or endogenous growth theory, provides no help in this regard, since the long run steady state growth rate is still determined by the exogenous growth of the labour force in efficiency units. Indeed, the main purpose of “new” growth theory seems to be to rehabilitate the neo-classical growth model by explaining growth rate divergences between countries in terms of various forms of externalities to investment (see Barro 1991, Lucas 1988 and Romer 1986, 1987 and 1991). Growth is only endogenous in the sense that the ratio of investment to output matters for growth because the capital-output ratio does not fall as the capital-labour ratio rises. This is attributed to external effects associated with investment in education and research and development, and with foreign direct investment. Thus, by investing in these inputs a country is able to sustain its growth rate independently of the exogenous rate of technical progress. However, the natural rate of growth is still independent of the actual rate of growth and, in this regard, is exogenously given by the parameters of the production function. There is no room for demand, or demand constraints, in the model. All saving is invested; supply creates its own demand, and there are no constraints on demand associated with inflation or the balance of payments. In relation to the latter, which would be a representative modern neo-classical view, Krugman (1989, p.1037) has summed up the position very well when he says,

> “*...we all know* (our italics) that differences in growth rates among countries are primarily determined by the rate of growth of total factor productivity (...) it is hard to see what channel links balance of payments (...) to total factor productivity growth.”

In other words, he does not see that constraints on demand imposed by poor balance of payments performance (or other factors for that matter) could impact unfavourably on productivity growth. Long run growth is *exogenously* determined.

Given this brief theoretical background to the importance of the question of the endogeneity of the natural growth rate, we now turn to empirical estimation of (i) the natural growth rate, (ii) the endogeneity of the natural growth rate, and (iii) the direction of causality between inputs and output, for our sample of countries.

3. Estimation of the Natural Rate of Growth

In order to test the hypothesis of the endogeneity of the natural rate of growth we will first obtain estimates of the natural rate as given by equations (1) and (2) and compare the results of both procedures. The analysis is carried out with a set of 15 OECD developed countries: Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Italy, Japan, The Netherlands, Norway, Spain, United Kingdom and United States. This selection of countries has the advantage of embracing different economic contexts, i.e. European and non-European, big and small economies, northern and southern development experiences, fast and slow growth, high and low unemployment levels, etc. The period over which the estimates are made is 1961 to 1995 and the data base used is *OECD Statistical Compendium, 1960-1995* provided by the OECD. The homogeneity of this data base allows us to compare with some confidence the results obtained for the different countries considered.

The results of the ordinary least squares (OLS) estimation of Okun's equation (1) are reported in Table 1. For many of the countries correction for autocorrelation of the errors was necessary; thus, the Cochrane-Orcutt iterative method of generalised least squares is reported. The results show, in general, low values of R^2, but, except for the case of two countries, the model is jointly significant at the 95% confidence level, and most of the parameters are significantly different from zero. The natural rate of growth is obtained as *a/b* from equation (1), and is reported together with a Wald test for testing the significance of the value obtained. The estimate of the natural growth rate is significant in all but two countries and its value (for those significantly different from zero) ranges from 7.25 for Japan to 2.99 for the United States. In one of the two remaining cases (France) the results obtained indicate a very low sensitivity of changes in unemployment to the growth of GDP (and is even positive) making the results unreliable.

Though the results obtained seem to be reasonable given what we know of the growth experience of these countries, we also use the Thirlwall (1969) method of estimating the natural rate of growth given in equation (2). The estimates are reported in Table 2 and, in general, give more reliable results for the natural rate of growth. All the estimates except for Austria are jointly significant and most of the variables are significant at the 95% confidence level. Correction for autocorrelation was also necessary in several cases. Regarding the estimates of the natural rate of growth obtained, these are significantly different from zero in all cases and, again, the values obtained seem reasonable on the basis of the growth performance of the different countries considered. The natural growth rate now ranges from 4.57 for Japan to 2.54 for the United Kingdom. Except for the cases of Austria, Canada and France, the estimate of the natural rate of growth (i.e. a_1) is lower than that obtained using equation (1), and it is important to note that, for those countries that gave unreliable estimates of the natural growth rate in Okun's equation, the values obtained from the reversal test are positive and make economic sense.

As mentioned earlier, since we are hypothesising the endogeneity of input growth to output growth, the change in the percentage level of unemployment should be regarded as an endogenous variable which will bias the coefficient estimates in equation (2). However, when performing an instrumental variables estimation of equation (2), using the lags of the variables as instruments, the values obtained for the intercept term (i.e. the natural growth rate) were not different from those obtained using simple OLS and, in some cases, the lags of the variables did not seem to be appropriate instruments.[3] The bias that could arise from this sort of problem, therefore, does not seem to be important. We also tried a dynamic specification of equation (2) including lags of the variables[4] in order to test the robustness of the static OLS estimates presented in Table 2. The results of these dynamic specifications did not change the estimates of the natural rate obtained from the static equation. Only in the cases of Belgium and Italy some differences were detected but they were never more than one percentage point higher. The estimates of the natural rate of growth in Table 2 are therefore taken as reliable enough to use this specification for testing the endogeneity of the natural rate to the actual rate of growth. This is done in the next section.

<<Tables 1 and 2 here>>

4. Testing for the Endogeneity of the Natural Rate of Growth

The procedure used to test for the endogeneity of the natural growth rate consists of introducing a dummy variable for the periods of growth buoyancy when the actual rate is above the natural rate. If the coefficient of the dummy variable plus the new constant exceeds the constant in the equation without the dummy, this means that the natural rate of growth experiences an upward shift. In other words, the higher growth of output has induced a higher

[3] The results are not reported here but are available from the authors on request.
[4] Selected using the Schwarz Bayesian Criterion and the Akaike Information Criterion.

growth of the labour force in efficiency units due to increases in labour supply and productivity growth.

Two alternative procedures are used to identify the booming periods of each economy for which the dummy variable takes the value of one: (i) those years for which the actual rate of growth is higher than the natural rate of growth as estimated in equation (2); and (ii) those years in which a three to five years moving average of the growth of output is above the average growth, since the first procedure may not capture longer run effects associated with increasing returns. This second procedure is also independent of the estimation obtained in equation (2).

Tables 3 and 4 report the results of introducing the dummy variable in equation (2) using both procedures. All the estimates are jointly significant at the 95% confidence level. The dummy variable is significantly positive in all cases, and the sum of the constant and the dummy show that for some countries the natural rate of growth in boom periods is nearly twice as high as the average natural rate in Table 2. The extreme cases are Japan, Greece and Italy, while in other countries, such as USA, France, Germany and the UK, the natural rate is less sensitive. Table 5 gives the difference between the natural growth rate in high growth periods and that for the period overall (given in Table 2). For the 15 countries as a whole, the average difference between the natural rate in boom periods and the average natural rate is 1.83 and 1.42 percentage points, using the alternative methods proposed. This represents an average elasticity of 51.7 percent and 40.1 percent, respectively. The fact that Greece, Italy and Japan have a higher elasticity than the USA, UK, Germany and France is not surprising. The former countries have a lower participation of the labour force, especially among females, and higher reserves of labour in general. Also, the relationship between productivity growth and output growth, as represented by the Verdoorn relationship, is likely to be stronger in countries undergoing more rapid structural change which are not already industrially "mature".[5]

These results strongly support the hypothesis of the endogeneity of the natural growth rate to the actual growth rate. Growth creates its own resources in the form of increased labour force availability and a higher productivity of the labour force. If this is so, the orthodox theory of growth, that assumes that it is factor input growth that *causes* output, needs to be replaced by a demand oriented approach to economic growth. The evidence here shows that there is no such thing as an exogenously determined production frontier. The production frontier moves with each movement of the actual growth rate. In the next section we focus directly on the causal relationship between inputs and outputs for the same set of countries, complementing the empirical results already obtained.

<<Tables 3, 4 and 5 here>>

5. Granger-causality analysis between inputs and output

The causal relationship between factor inputs and output will be carried out using Granger's (1969) procedure for testing the temporal causality between two economic time series. Despite the fact that causality between economic variables cannot be completely identified using this technique, it gives a first hint of what the direction of causation is between the two variables considered. Our two variables will be the log of GDP ($LGDP_t$) and the log of total factor inputs ($LTFI_t$). Total factor inputs is taken, instead of labour and capital separately, in order

[5] See Setterfield (1997) for a similar argument based on the concept of lock-in specialisation.

to simplify the analysis that otherwise would require the use of vector error correction models for the causality tests. The $LTFI_t$ is obtained as

$$LTFI_t = wL_t + (1-w)K_t , \qquad (4)$$

where L_t and K_t are the logarithms of the levels of labour and the capital stock, and w is the weight of employees compensation in the national accounts. Given the fact that most of the human capital and new inventions are introduced in the production process through labour and capital inputs, and their respective returns, the $LTFI$ variable is capturing most of the inputs used to obtain the aggregate output. Note that the procedure used to weight the inputs does not imply assuming a constant returns to scale production function. What the procedure does is to use the share of labour and capital returns in the national accounts to weight the inputs (not to assume that output is exhausted by the marginal productivity times the levels of labour and capital used). This variable thus gives an accurate measure of the combined inputs used in the production process at each moment of time without making any *a priori* assumption about the technical characteristics of the production process.

The data base used in the estimations is the same as that used in estimating the natural rate of growth, namely the *OECD Statistical Compendium*. However, for some countries, the capital stock series are not available from this source or are incomplete, while for other countries the data on capital stock only correspond to a limited set of manufacturing industries. For this reason, when the OECD data on the capital stock are not available we have used the estimates provided by Nehru and Dhareshwar (1993) that range from 1960 to 1990. The causality tests are not run, therefore, for the same period in all the countries. These estimates are based on the perpetual inventory method of accumulated investment and, since they are not obtained as a residual, they avoid accounting identity problems in our econometric test.

The standard Granger causality tests between two economic time series, x_t and y_t, are based on the following regression:

$$x_t = a_0 + \sum_{i=1}^{p} a_{xi} x_{t-i} + \sum_{i=1}^{p} a_{yi} y_{t-i} + e_t \qquad (5)$$

If the joint *F*-test of significance of the lagged values of y_t rejects the null hypothesis of zero coefficients, we reject the hypothesis that y_t does not Granger cause x_t. Replacing x_t by y_t on the left-hand side of the equation we would obtain the Granger causality relation from x_t to y_t. However, as pointed out by Granger (1988), based on the developments of the co-integration and error correction theory, the causality tests carried out with equation (5) do not take into account the problems arising when I(1) variables are being used. If two I(1) variables are co-integrated, there must exist a causality relation at least in one direction, independently of the significance of the values of the parameters of the lagged variables in equation (5). Two co-integrated variables are generated by the error correction model

$$\Delta x_t = a_0 + \sum_{i=1}^{p} a_{xi} \Delta x_{t-i} + \sum_{i=1}^{p} a_{yi} \Delta y_{t-i} + b_1 \mu_{t-1} + e_t , \qquad (6)$$

where μ_{t-1} is the lagged value of the error term of the co-integration equation of x_t on y_t, b_1 is the velocity of adjustment of x_t to its equilibrium relationship with y_t and Δx_t and Δy_t are the first differences of the I(1) variables x_t and y_t. The introduction of μ_{t-1} (the error correction term) in equation (5) provides another channel through which causality can be tested. In the error-correction model (6), Granger causality from y_t to x_t will emerge not only if the lagged values of y_t are jointly significant, but also if μ_{t-1} is significant. Reversing the left- and right-hand side variables, and using the error term of the co-integration vector of y_t on x_t, we would test for causality from x_t to y_t. If both the error-correction term and the lagged values of the independent variable are significant, the variable considered is *strongly exogenous*, while if the error-correction term is not significant but the lagged values are significant, the variable is *weakly exogenous*.

On the hypothesis that the natural rate of growth is endogenous to the actual rate of growth, we would not expect factor inputs to unidirectionally cause output as is the case in the neo-classical and "new" neo-classical growth theories. If output growth creates its own inputs, and the economy does not reach the full employment of its resources because of demand constraints, demand growth would lead output growth. Output growth does not meet supply constraints and, thus, it is output growth that leads input growth. However, we cannot discard the possibility of bi-directional causality between inputs and output for two reasons. First, though demand growth may lead output growth, in order to increase production it is clearly necessary to hire capital and labour. Depending on the time lag structure of the process of demand growth / hiring factors of production / output growth sequence, we would also presume that some temporal causality from inputs to output will arise. Secondly, the introduction of new capital embodies technical progress that will increase the productivity of the economy, leading to increased price and non-price competitiveness. Thus, increased capital inputs can lead to increased demand through the effects on export performance and, in turn, to increased output.[6] In this case, causality from inputs to output is also a plausible result, although through a very different channel from that proposed by the orthodox neo-classical growth theory. Summarising, although bi-directional causality is consistent with the demand-led approach to economic growth, the finding of causality from output to inputs

[6] This is the mechanism of cumulative growth proposed by Kaldor (1970) and later formalised by Dixon and Thirlwall (1975). See also Targetti and Foti (1997) for an empirical illustration of this kind of model.

would be enough to reject the neo-classical view that the growth of output is always constrained by supply and is a consequence of the growth of inputs.

The Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests for the order of integration of the variables are presented in Table A.1 in the Appendix.[7] Most of the time series for the different countries analysed are I(1), i.e. first-difference stationary, and we carry out the co-integration analysis assuming I(1) variables since at least in one of the tests this hypothesis is not rejected.

The co-integration vectors are obtained using an autoregressive distributed lags (ARDL) model, to take into account the dynamic nature of the relationship between inputs and output.[8] The ARDL procedure consists of the OLS estimation of a dynamic model that includes the lagged values of the dependent and independent variables. Once this estimation is obtained selecting an appropriate number of lags,[9] the long-run co-integration relationship is obtained solving the dynamic model for its static solution. In order to test for co-integration, DF and ADF tests of the residuals of the dynamic models were carried out. Note that, since this estimation accounts for the dynamic nature of the data, it is not pushing the dynamic terms into the residuals as would be the case in the static Engle-Granger procedure.[10] For this reason, also, the DF tests for the residuals are more reliable since the autocorrelation of the

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[7] Both tests are carried out for the levels and the first differences of the variables. In many cases the technique proposed by Perron (1989 and 1990), allowing for structural breaks in the time series, was used. Following Granger (1997), when I(2) variables were found, we tested for structural breaks and, if this is confirmed by the data, Perron's procedure was applied.

[8] The ARDL procedure proposed by Pesaran and Shin (1995) also allows for testing long-run relationships between variables with different order of integration. We have not included this step in our procedure since all the variables seem to be I(1).

[9] The number of lags chosen in our estimations was based on the information provided by the Schwarz Bayesian Criterion (SBC) and Akaike Information Criterion (AIC).

[10] The ARDL procedure has two further advantages put forward by Pesaran (1997). First, it does not depend on which variable is assumed to be exogenous, whether inputs or output. Second, the *t*-tests have good size and power properties and, thus, it allows for making inferences over the parameters of the co-integration vector obtained.

residuals has already been accounted for. [11] The results in Table A.2 of the Appendix indicate that inputs and output are co-integrated in the long run for all the countries and show the long-run elasticities of the co-integration equations of $LGDP$ on $LTFI$ and $LTFI$ on $LGDP$. Except for the cases of Italy, Japan and the United States, the elasticity of output with respect to total factor inputs is greater than one. This indicates the existence of increasing returns to scale, one of the causes of the endogeneity of the natural rate of growth.[12] The values of the long-run co-integration equations therefore support the Kaldorian hypothesis of increasing returns to scale as a source of the endogeneity of the natural rate of growth found in the preceding section.

Once the co-integration vectors have been obtained, we estimated equation (6) for each country assuming, first, that $\Delta LGDP$ is the dependent variable - with the causal relation running from $LTFI$ to $LGDP$ ($LTFI \rightarrow LGDP$) - and, second, that $\Delta LTFI$ is the dependent variable, i.e. $LGDP \rightarrow LTFI$. The *F*-tests for the joint significance of the lagged values of the first differences of the independent variable and the *t*-test of significance of the error-correction terms are reported in Table 6. Out of the 15 countries, 13 show bi-directional causality between output and total factor inputs, two of them (Australia and Denmark) show causality running only from output to inputs and none of them show causality running *only* from inputs to output. This result can be derived by analysing the significance of the lagged values, the error-correction term or both. In most of the cases the error-correction term is significant, showing that both inputs and output adapt endogenously to their long run relationship.

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[11] In all these cases, the SBC and AIC criteria for the selection of the appropriate number of lags in the DF and ADF tests indicates that the preferred test is the DF.

[12] Analysing the reverse estimation, we can see that this hypothesis is confirmed in most of the cases.

<<Table 6 here>>

6. Conclusions

In mainstream growth theory the natural rate of growth is treated as exogenously determined. We have shown in this paper that for a sample of 15 developed countries over the post-war period, it is a mistake to regard the natural rate of growth as exogenously given. The rate of growth necessary to keep the percentage level of unemployment constant rises in boom periods and falls in recession because the labour force and productivity growth are elastic to demand and output growth.

This is also confirmed using causality tests between input and output growth. The orthodox and "new" growth theories that assume that it is input growth that *unidirectionally* causes output growth finds no support from the evidence presented here. The implication for growth theory and policy is that it does not make economic sense to think of growth as supply constrained if demand creates its own supply. If factor inputs (including productivity growth) react endogenously, the process of growth, and growth rates differences between countries, can only be properly understood in terms of differences in the strength of demand, and constraints on demand. This is not to say, of course, that input growth is not important for output growth, but it is not *causal* in the neo-classical sense. Demand constraints are also likely to be related to supply bottlenecks which cause inflation and balance of payments difficulties for countries. It is this aspect of supply, and not the growth of inputs in a production function, that should be the main focus of enquiry in any supply-orientated theory of economic growth.

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Table 1

Estimation of the Natural Rate of Growth using Okun's Equation: 1961-1995

Country	Constant	Coefficient on GDP growth	R^2	DW	Natural Rate[1]
Australia	0.8205	-0.1514	0.118*	1.939	5.42
	(2.524)*	(-2.064)*			(16.195)*
Austria[2]	0.0850	-0.0433	0.265*	-	1.97
	(0.385)	(-0.8737)			(0.302)
Belgium[2]	0.8613	-0.1538	0.605*	-	5.60
	(2.640)*	(-3.488)*			(6.660)*
Canada[2]	1.3263	-0.3435	0.689*	-	3.861
	(3.693)*	(-7.789)*			(16.381)*
Denmark	0.9508	-0.2864	0.262*	1.743	3.32
	(3.102)*	(-3.423)*			(22.265)*
France[2]	0.0341	0.0877	0.145	-	-0.39
	(0.150)	(1.167)			(0.014)
Germany[2,3]	0.8769	-0.2192	0.664*	-	3.99
	(5.329)*	(-6.047)*			(4.635)*
Greece	0.5059	-0.0930	0.224*	1.278	5.43
	(3.022)*	(-3.085)*			(19.716)*
Italy	0.3822	-0.0567	0.061	1.755	6.74
	(2.352)*	(1.469)			(5.986)*
Japan	0.1849	-0.0255	0.266*	1.445	7.25
	(3.728)*	(-3.461)*			(37.255)*
Netherlands[2]	0.7591	-0.1656	0.408*	-	4.58
	(2.384)*	(-2.669)*			(9.039)*
Norway	0.7191	-0.1622	0.296*	1.733	4.43
	(3.980)*	(-3.726)*			(80.441)*
Spain[2]	1.8654	-0.3539	0.611*	-	5.27
	(4.371)*	(-4.566)*			(28.532)*
United Kingdom[2]	0.8197	-0.2681	0.468*	-	3.05
	(2.584)*	(-3.137)*			(9.737)*
USA	1.1735	-0.3919	0.748*	1.563	2.99
	(8.089)*	(-9.892)*			(194.542)*

Notes:

* Denotes significant at the 95% confidence level, while ** denotes significant at the 90% confidence level. The significance of the model reported together with the R^2 is based on an *F*-test of joint significance.

[1] The number in parentheses is a Wald test for the significance of the natural rate of growth, distributed as a $\chi^2(1)$. The natural rate is obtained as a/b.

[2] Estimated using Cochrane-Orcutt AR(1) iterative method since evidence of autocorrelation was found. For Austria AR(2) errors were used. In the case of Greece, though evidence of autocorrelation was found, estimation converged after 6 iterations and the results obtained gave implausible values for the parameters; the OLS estimates therefore are given in the table and the results must be interpreted with caution.

[3] For Germany a dummy variable for the re-unification in the period 1990-91 was included and is significantly positive at the 95% confidence level.

Table 2

Estimation of the Natural Rate of Growth using Thirlwall's Reversal

Country	Constant	Coefficient on $\Delta\%U$	R^2	DW	Natural Rate
Australia	3.9985	-0.7763	0.118*	1.878	3.999
	(10.324)*	(-2.064)*			
Austria[1]	3.1358	-0.5482	0.136	-	3.136
	(6.653)*	(-1.163)			
Belgium	3.5239	-1.4702	0.328*	1.467	3.524
	(10.281)*	(-3.893)*			
Canada[1]	3.8352	-1.9982	0.705*	-	3.835
	(4.735)*	(-8.160)*			
Denmark	2.9424	-0.9149	0.262*	1.835	2.942
	(8.309)*	(-3.423)*			
France[1]	2.8270	0.4838	0.176*	-	2.827
	(7.891)*	(1.178)*			
Germany[2]	3.5054	-2.4150	0.738*	1.627	3.505
	(13.631)*	(-6.946)*			
Greece	4.5089	-2.4064	0.224*	1.785	4.509
	(8.103)*	(-3.085)*			
Italy[1]	3.3439	-0.4581	0.173**	-	3.344
	(5.412)*	(-0.604)			
Japan[1]	4.5671	-5.0503	0.582*	-	4.567
	(2.066)*	(-1.735)**			
Netherlands[1]	3.2817	-1.2423	0.523*	-	3.282
	(3.645)*	(-4.015)*			
Norway	3.9722	-1.8259	0.296*	1.709	3.972
	(15.472)*	(-3.726)*			
Spain[1]	4.0623	-1.0793	0.733*	-	4.062
	(4.995)*	(-4.365)*			
United Kingdom	2.5438	-1.1083	0.376*	1.577	2.544
	(9.119)*	(-4.457)*			
USA	2.9911	-1.9078	0.748*	1.407	2.991
	(16.114)*	(-9.892)*			

Notes:
* Denotes significant at the 95% confidence level, while ** denotes significant at the 90% confidence level. The significance of the model reported together with the R^2 is based on an *F*-test of joint significance.
[1] Estimated using Cochrane-Orcutt AR(1) iterative method since evidence of autocorrelation was found. For Austria AR(2) errors were used. In the case of Greece, though evidence of autocorrelation was found, estimation converged after 6 iterations and the results obtained gave implausible values for the parameters; the OLS estimates therefore are given in the table and the results must be interpreted with caution.
[2] For Germany a dummy variable for the re-unification in the period 1990-91 was included and is significantly positive at the 95% confidence level.

Table 3

Estimation of the Change in the Natural Rate of Growth using a Dummy for the Years when Actual Growth is above the Natural Rate of Growth

Country	Constant	Coefficient on Dummy	Coefficient on $\Delta\%U$	R^2	DW
Australia	2.1900	3.5231	-0.2345	0.648*	1.899
	(6.886)*	(7.492)*	(-1.928)**		
Austria	1.6837	3.2726	-0.3958	0.742*	1.833
	(6.895)*	(9.315)*	(-1.609)		
Belgium	1.3172	3.5930	-1.0653	0.707*	2.529
	(4.528)*	(8.615)*	(-1.917)**		
Canada	2.5349	2.7264	-1.0653	0.734*	1.529
	(7.301)*	(5.454)*	(-4.162)*		
Denmark	1.1907	3.5919	-0.1668	0.665*	1.831
	(3.199)*	(6.201)*	(-0.761)		
France	1.8228	2.1115	0.0265	0.684*	1.839
	(8.976)*	(8.235)*	(0.109)		
Germany[2]	2.2997	2.4094	-1.4790	0.871*	1.839
	(8.177)*	(5.654)*	(-4.959)*		
Greece	1.8101	5.8610	-0.7280	0.769*	1.966
	(4.146)*	(8.713)*	(-1.540)		
Italy	1.6954	4.2150	0.4783	0.684*	1.693
	(4.803)*	(7.937)*	(1.003)		
Japan[1]	3.6593	5.0606	-1.3917	0.802*	-
	(5.001)*	(6.256)*	(-0.713)		
Netherlands	2.0397	3.2754	-0.7109	0.732*	2.358
	(7.787)*	(8.077)*	(-3.122)*		
Norway	2.5662	2.4432	-1.0775	0.746*	1.444
	(10.541)*	(7.539)*	(-3.423)*		
Spain[1]	3.2446	2.8482	-0.8474	0.866*	-
	(7.126)*	(5.286)*	(-4.612)*		
United Kingdom	1.4503	2.3519	-0.6982	0.665*	1.703
	(4.940)*	(5.263)*	(-3.480)*		
USA	2.2738	1.3904	-1.4014	0.802*	1.776
	(7.739)*	(2.967)*	(-5.759)*		

Notes:

* Denotes significant at the 95% confidence level, while ** denotes significant at the 90% confidence level. The significance of the model reported together with the R^2 is based on an F-test of joint significance.

[1] Estimated using Cochrane-Orcutt iterative method because of residual autocorrelation. All the estimations were done using AR(1) errors.

[2] For Germany a dummy variable for the re-unification in the period 1990-91 was included and is significant at the 95% confidence level.

Table 4

Estimation of the Change in the Natural Rate of Growth using a Dummy for the Medium Run Cycles

Country	Constant	Coefficient on Dummy	Coefficient on $\Delta\%U$	R^2	DW
Australia	2.0023	2.8761	0.0037	0.386*	2.162
	(3.847)*	(4.299)*	(0.022)		
Austria	1.6699	2.9462	-0.4527	0.607*	2.162
	(5.224)*	(6.782)*	(-1.494)		
Belgium	1.9217	2.6782	-0.6258	0.581*	2.401
	(4.118)*	(4.252)*	(-1.726)**		
Canada	2.2318	2.6136	-1.2040	0.707*	1.712
	(5.204)*	(4.891)*	(-4.634)*		
Denmark	1.5393	2.3324	-0.4354	0.431*	2.273
	(2.775)*	(3.078)*	(-1.529)		
France	1.9313	1.9684	-0.0515	0.587*	1.815
	(8.386)*	(6.657)*	(-0.184)		
Germany[2]	2.5753	1.8967	-1.7615	0.828*	2.209
	(8.234)*	(4.037)*	(-5.359)*		
Greece	1.3060	5.4864	-0.3915	0.649*	2.050
	(2.040)*	(6.219)*	(-0.628)		
Italy[1]	1.3241	4.0784	0.2969	0.626*	-
	(2.386)*	(5.912)*	(0.561)		
Japan	3.5405	5.4377	-6.2043	0.730*	1.685
	(7.215)*	(7.423)*	(-3.178)*		
Netherlands	1.9699	2.8363	-0.6976	0.606*	2.116
	(5.704)*	(5.845)*	(-2.509)*		
Norway	2.1516	2.6207	-1.2575	0.642*	2.141
	(5.568)*	(8.574)*	(-3.407)*		
Spain[1]	2.8693	2.8428	-0.8356	0.805*	-
	(4.779)*	(3.619)*	(-3.649)*		
United Kingdom	0.7143	2.4791	-0.4874	0.591*	1.785
	(1.426)	(4.108)*	(-1.917)**		
USA	2.1341	1.3010	-1.4495	0.789*	1.606
	(5.577)*	(2.508)*	(-5.666)*		

Notes:
* Denotes significant at the 95% confidence level, while ** denotes significant at the 90% confidence level. The significance of the model reported together with the R^2 is based on an *F*-test of joint significance.
[1] Estimated using Cochrane-Orcutt iterative method because of residual autocorrelation. All the estimations were done using AR(1) errors.
[2] For Germany a dummy variable for the re-unification in the period 1990-91 was included and is significant at the 95% confidence level.

Table 5

Sensitivity of the Natural Rate of Growth to the Actual Rate of Growth

Country	Natural rate	Natural rate in boom periods		Increase in Natural Rate in Boom Periods			
	(1) Table 2	(2) Table 3	(3) Table 4	Absolute difference (2) - (1)	% increase	Absolute difference (3) - (1)	% increase
Australia	3.9985	5.7131	4.8784	1.7146	42.9	0.8799	22.0
Austria	3.1358	4.9563	4.6161	1.8205	58.1	1.4803	47.2
Belgium	3.5239	4.9102	4.5999	1.3863	39.3	1.0760	30.5
Canada	3.8352	5.2613	4.8454	1.4261	37.2	1.0102	26.3
Denmark	2.9424	4.7826	3.8717	1.8402	62.5	0.9293	31.6
France	2.8270	3.9343	3.8997	1.1073	39.2	1.0727	38.0
Germany	3.5054	4.7091	4.4720	1.2037	34.3	0.9666	27.6
Greece	4.5089	7.6711	6.7924	3.1622	70.1	2.2835	50.6
Italy	3.3439	5.9104	5.4025	2.5665	76.8	2.0586	61.6
Japan	4.5671	8.7199	8.9782	4.1528	90.9	4.4111	96.6
Netherlands	3.2817	5.3151	4.8127	2.0334	62.0	1.5310	46.7
Norway	3.9722	5.0094	4.7723	1.0372	26.1	0.8001	20.1
Spain	4.0623	6.0928	5.7121	2.0305	50.0	1.6498	40.7
UK	2.5438	3.8022	3.1934	1.2584	49.5	0.6496	25.5
USA	2.9911	3.6642	3.4351	0.6731	22.5	0.4440	14.8
Average	3.5359	5.3634	4.9521	1.8275	51.7	1.4162	40.1

Table 6

Granger-causality Tests

Country	Causal relation	*F*-test of lagged differences	*t*-test of Error-Correction term
Australia	$LTFI \rightarrow LGDP$	0.294	1.307
	$LGDP \rightarrow LTFI$	6.100*	-2.148*
Austria	$LTFI \rightarrow LGDP$	3.271**	2.819*
	$LGDP \rightarrow LTFI$	0.420	-2.069*
Belgium	$LTFI \rightarrow LGDP$	6.506*	-1.788**
	$LGDP \rightarrow LTFI$	0.131	-2.156*
Canada	$LTFI \rightarrow LGDP$	8.383*	-3.895*
	$LGDP \rightarrow LTFI$	10.567*	-0.548
Denmark	$LTFI \rightarrow LGDP$	1.197	-1.332
	$LGDP \rightarrow LTFI$	3.722*	-5.149*
France	$LTFI \rightarrow LGDP$	1.327	-3.413*
	$LGDP \rightarrow LTFI$	2.368	-2.408*
Germany	$LTFI \rightarrow LGDP$	1.434	-3.136*
	$LGDP \rightarrow LTFI$	18.726*	1.767**
Greece	$LTFI \rightarrow LGDP$	0.713	-2.722*
	$LGDP \rightarrow LTFI$	0.385	-12.612*
Italy	$LTFI \rightarrow LGDP$	6.305*	-3.684*
	$LGDP \rightarrow LTFI$	6.584*	-2.222*
Japan	$LTFI \rightarrow LGDP$	10.070*	-4.732*
	$LGDP \rightarrow LTFI$	0.392	-3.647*
Netherlands	$LTFI \rightarrow LGDP$	2.259	-5.461*
	$LGDP \rightarrow LTFI$	1.858	-3.698*
Norway	$LTFI \rightarrow LGDP$	0.885	-4.010*
	$LGDP \rightarrow LTFI$	0.641	-2.615*
Spain	$LTFI \rightarrow LGDP$	9.179*	-3.723*
	$LGDP \rightarrow LTFI$	2.597**	-4.600*
UK	$LTFI \rightarrow LGDP$	0.025	5.756*
	$LGDP \rightarrow LTFI$	15.839*	-2.151*
USA	$LTFI \rightarrow LGDP$	8.484*	-0.226
	$LGDP \rightarrow LTFI$	13.581*	-1.639

Notes:
* Denotes that the joint test of the lagged values of the first differences of the independent variable in equation (5) or the error-correction terms are significant at the 95% confidence level. ** Denotes significance at the 90% confidence level.

APPENDIX

Table A.1

DF and ADF Tests for the Order of Integration

Country	Variable	DF	ADF
Australia (1966-1994)	*LGDP*	-2.958	-2.918
	LTFI	-2.074	-2.203
	Δ*LGDP*	-4.159*	-2.905**
	Δ*LTFI*	-3.580*	-3.686*
Austria (1960-1990)	*LGDP*	-1.297	-1.422
	LTFI	-1.836	-1.835
	Δ*LGDP*	-3.567*	-1.353
	Δ*LTFI*	-4.841*	-3.686*
Belgium (1960-1995)	*LGDP*[1]	-2.529	-2.401
	LTFI[1]	-4.066*	-2.055
	Δ*LGDP*[1]	-6.859*	-4.255*
	Δ*LTFI*[1]	-3.829*	-3.484*
Canada (1960-1995)	*LGDP*	-1.048	-1.156
	LTFI	-0.067	-0.708
	Δ*LGDP*	-3.961*	-2.742**
	Δ*LTFI*	-2.883**	-2.444
Denmark (1965-1992)	*LGDP*	-2.529	-2.753
	LTFI	-1.845	-2.475
	Δ*LGDP*	-3.961*	-3.704*
	Δ*LTFI*	-3.232*	-2.880**
France (1960-1990)	*LGDP*	-0.188	-0.346
	LTFI[1]	-2.460	-2.378
	Δ*LGDP*	-3.654*	-2.364
	Δ*LTFI*[1]	-5.145*	-4.836*
Germany (1960-1994)	*LGDP*	-1.990	-2.418
	LTFI	-1.625	-1.978
	Δ*LGDP*	-4.121*	-4.423*
	Δ*LTFI*	-5.004*	-3.907*

Table A.1

(continued)

Country	Variable	DF	ADF
Greece (1960-1990)	*LGDP*	-1.494	-1.467
	LTFI[1]	0.867	0.883
	Δ*LGDP*	-3.083*	-2.276
	Δ*LTFI*[1]	-4.359*	-4.029*
Italy (1960-1990)	*LGDP*	-1.365	-1.364
	LTFI	-0.685	-0.760
	Δ*LGDP*	-4.147*	-3.325*
	Δ*LTFI*	-3.288*	-3.185*
Japan (1960-1994)	*LGDP*[1]	-2.704	-2.401
	LTFI[1]	-1.714	-2.282
	Δ*LGDP*[1]	-5.155*	-4.270*
	Δ*LTFI*[1]	-4.298*	-4.576*
Netherlands (1960-1990)	*LGDP*[1]	-2.435	-3.123
	LTFI[1]	-2.580	-2.527
	Δ*LGDP*[1]	-5.814*	-3.275**
	Δ*LTFI*[1]	-3.975*	-3.091**
Norway (1960-1990)	*LGDP*	0.116	-0.932
	LTFI[1]	-0.617	-1.279
	Δ*LGDP*	-3.229*	-2.993*
	Δ*LTFI*[1]	-3.740*	-3.174**
Spain (1960-1990)	*LGDP*[1]	-1.802	-1.608
	LTFI[1]	-1.625	-1.761
	Δ*LGDP*[1]	-4.508*	-3.037
	Δ*LTFI*[1]	-5.122*	-3.726**
United Kingdom (1960-1991)	*LGDP*	-2.196	-3.232
	LTFI	-1.821	-2.965*
	Δ*LGDP*	-3.118*	-3.574*
	Δ*LTFI*	-2.745**	-3.509*
USA (1960-1993)	*LGDP*	-3.023	-3.430
	LTFI	-0.134	-1.051
	Δ*LGDP*	-4.021*	-4.149*
	Δ*LTFI*	-3.270*	-3.582*

Notes:
[1] Unit root tests and critical values used are provided in Perron (1989, 1990), since a structural break was found in the series in the form of additive outliers.
* The null hypothesis of the existence of a unit root is rejected at the 95% confidence level. ** denotes rejection at the 90% confidence level.

Table A.2

Long-run Co-integration Elasticities of the Estimated ARDL Models

Country	Dependent variable	Constant	*LTFI*	*LGDP*	DF	ADF
Australia	*LGDP*	-0.698 (-0.812)	1.233 (16.318)*	-	-4.103*	-3.900**
	LTFI	1.228 (8.922)*	-	0.763 (81.19)*	-5.338*	-4.105
Austria	*LGDP*	-1.631 (-1.105)	1.441 (10.988)*	-	-5.258 n.a.	-4.029 n.a.
	LTFI	1.398 (1.168)	-	0.684 (8.059)*	-5.258*	-3.998
Belgium	*LGDP*	-1.842 (-3.594)*	1.978 (34.295)*	-	-5.016*	-3.100
	LTFI	1.175 (6.327)*	-	0.490 (41.51)*	-5.064*	-3.495*
Canada	*LGDP*	-0.630 (-0.102)	1.312 (2.188)*	-	-6.152*	-4.484
	LTFI	1.234 (0.719)	-	0.721 (5.163)*	-5.875*	-4.047
Denmark	*LGDP*	-2.826 (-0.857)	1.606 (5.036)*	-	-5.612*	-4.346
	LTFI	3.015 (13.24)*	-	0.532 (31.46)*	-6.215*	-3.903
France	*LGDP*	-0.396 (-0.216)	1.140 (8.165)*	-	-5.428*	-4.794*
	LTFI	2.937 (2.571)*	-	0.703 (8.740)*	-5.494*	-4.497**
Germany[1]	*LGDP*	-8.887 (-7.050)*	1.936 (18.62)*	-	-4.431 n.a.	-2.743 n.a.
	LTFI	5.910 (54.40)*	-	0.429 (56.63)*	-2.276	-4.159*
Greece	*LGDP*	0.431 (1.111)*	1.133 (41.64)*	-	-5.049*	-2.800
	LTFI	0.023 (0.073)*	-	0.859 (44.66)*	-4.286*	-2.782
Italy	*LGDP*	-3.655 (-0.349)	1.117 (1.743)**	-	-5.361*	-3.395
	LTFI	7.712 (30.65)*	-	0.592 (33.91)*	-4.850*	-6.569*

Table A.2

Continued

Country	Dependent variable	Constant	*LTFI*	*LGDP*	DF	ADF
Japan	*LGDP*	3.069	0.936	-	-5.377[n.a.]	-4.542[n.a.]
		(1.429)*	(4.797)*			
	LTFI	0.559	-	0.859	-4.721**	-5.690*
		(0.769)		(14.19)*		
Netherlands	*LGDP*	-5.664	1.768	-	-4.626*	-4.159
		(-0.886)	(2.847)*			
	LTFI	6.182	-	0.332	-6.167*	-4.959
		(8.904)*		(5.917)*		
Norway	*LGDP*	-1.202	1.381	-	-4.718*	-4.284*
		(-1.207)*	(15.24)*			
	LTFI	1.617	-	0.672	-4.986*	-3.328
		(8.537)*		(47.07)*		
Spain	*LGDP*	-7.464	1.299	-	-5.500*	-4.104
		(-20.48)*	(50.05)*			
	LTFI	5.824	-	0.763	-5.238*	-5.230*
		(44.04)*		(61.80)*		
UK	*LGDP*	-12.870	2.276	-	-5.193**	-3.899
		(-11.27)*	(22.77)*			
	LTFI	5.375	-	0.458	-4.788*	-3.062
		(25.30)*		(27.84)*		
USA	*LGDP*	2.009	1.037	-	-4.541**	-1.890
		(2.886)*	(19.42)*			
	LTFI	-1.371	-	0.930	-5.404*	-2.287
		(-2.542)*		(26.37)*		

Notes:

[1] For Germany a dummy variable to take account for the re-unification process was included.

* Denotes significant at the 95% confidence level. In the case of the DF and ADF tests it denotes that we can reject the hypothesis of the existence of a unit root in the residuals at the 95% confidence level. ** Denotes significance at the 90% confidence level.

[n.a.] Denotes that the DF and ADF tests' critical values for the number of regressors chosen in the ARDL model are not available.