

Is the natural rate of growth exogenous? *

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Introduction

It was Sir Roy Harrod who first formally introduced the concept of the natural rate of growth into economic theory in his famous paper “An essay in dynamic theory” (Harrod 1939). The paper was essentially a dynamisation of Keynes’s *General Theory* and asked the question: if the condition for a static equilibrium is that plans to invest equal plans to save, what must be the growth of income in a growing economy for plans to invest to equal plans to save to give a moving equilibrium through time? Moreover, is there any guarantee that this required rate of growth (which Harrod called the warranted growth rate) will prevail, and, if not, what will happen? The answer was that there is no guarantee, and if the two growth rates diverge there will be dynamic instability. If the actual growth rate exceeds the warranted rate, there would be overcapacity utilisation and producers will feel they have done too little investment for steady growth. They will invest more, pushing the actual growth rate further above the warranted rate. Contrawise, if the actual growth rate is below the warranted rate, there will be excess capacity. Producers will revise their investment plans downwards, pushing the actual growth rate further below the warranted rate.

Within this framework, Harrod’s natural rate of growth fulfilled two functions. First, it set a ceiling to explosive growth, turning

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cyclical booms into slumps. Secondly, it was supposed to give a measure of the long run growth rate to which economies will gravitate, what Harrod called the “social optimum” growth rate made up of the growth of the labour force and the growth of labour productivity (or the growth of the labour force in efficiency units). The rates of growth of the labour force and labour productivity, however, were treated as *exogenously* given, as if immutable to actual conditions prevailing in the economy – boom or slump.

Ever since, virtually the whole of mainstream growth theory has treated the natural rate of growth as exogenous, independent of the actual rate of growth. It was treated as exogenous in the neoclassical response to Harrod, as, for example, in the original work of Solow (1956) and Swan (1956) which is still highly influential in the way economists view the growth process. It was treated as exogenous (by and large) in the original Keynesian response to the neoclassicals, represented by the work of Kaldor (1957) and Joan Robinson (1956). Paradoxically, it is even treated as exogenous in ‘new’ *endogenous* growth theory. Growth, in this apparently ‘new’ theory, is only endogenous in the sense that investment matters for growth, because the neoclassical assumption of diminishing returns to capital is relaxed, not in the sense that the determinants of the long run (natural) growth rate – labour force growth and productivity growth – respond to the growth rate itself. New, endogenous, growth theory does not model the demand side of the economy. Indeed, the main aim of many of the economists who do empirical work in the field, such as Barro (1991), seems to be to rehabilitate neoclassical growth theory by saying that the neoclassical growth model would hold, and particularly its prediction of convergence of per capita incomes across regions and countries, *if only* levels of education, research and development expenditure, and other factors that affect the productivity of capital, were the same across countries. In other words, the basic aggregate production function exhibits diminishing returns to capital, but the marginal product of capital does not fall as countries get richer, and the capital-labour ratio rises, because of various externalities.

It is also the case that the assumption of *exogeneity* of factor supplies and productivity growth permeates the whole of the mainstream growth accounting literature on the sources of growth that uses the aggregate production function, such as the pioneer studies of

Abramovitz (1956), Solow (1957), Maddison (1970) and Denison (1967), and the recent work of Alwyn Young (1995) on South East Asia and Hu and Khan (1997) on China. Young claims that there has been no growth miracle in the East Asian 'tiger' economies of Hong Kong, Taiwan, Singapore and South Korea because most of the rapid growth can be explained by the growth of factor inputs and not by technical progress or total factor productivity growth. But the question is never asked, let alone answered, of *why* the growth of factor inputs – labour and capital accumulation – was so fast? The use of factor inputs is not in general exogenously determined. Rather, the growth of factor inputs is endogenous to demand, and in the case of the Asian 'tigers' the driving force was undoubtedly the growth of export demand. There is no way that these countries could have grown at the rate that they did without the rapid growth of exports to pay for the import requirements for growth. In this sense, their growth was miraculous.

Suppose the natural rate of growth is not exogenously given. Suppose it is *endogenous* to demand, or the actual rate of growth, as we are suggesting above. What implications does this have? It has two major implications. First, at the theoretical level, it has implications for the efficiency and speed of the adjustment process between the warranted and natural growth rates in the Harrod growth model. Second, it has implications for the way the growth process should be viewed, and why growth rates differ between countries: whether growth is viewed as *supply determined*, or whether growth is viewed as *demand determined* or determined by *constraints on demand* before supply constraints bite. The view we take here is that it is a mistake to think of a natural rate of growth exogenously determined. In other words, there is nothing 'natural' about the natural rate of growth (just as there is nothing 'natural' about the natural rate of unemployment)! Both the growth of the labour force and labour productivity growth are positively related to demand or the actual rate of growth. Later, we will test this hypothesis and show this is empirically the case for a sample of 15 OECD countries over the period 1961 to 1995.

First, however, we will formally define the natural rate of growth and discuss the theoretical consequences of the natural rate being endogenous. Secondly, we will give reasons why the natural rate is likely to be endogenous. Thirdly, we will suggest a simple technique for estimating empirically the natural rate of growth and testing for

its endogeneity. Finally, we will present results for 15 OECD countries of the elasticity of the natural rate during periods of boom when the actual rate has exceeded the natural rate.

The natural rate of growth and theoretical consequences if it is not exogenous

Although it was Harrod in 1939 who first coined the term “the natural rate of growth”, as a matter of historical interest, Keynes had effectively anticipated Harrod’s ideas two years earlier in his Galton Lecture to the Eugenics Society in 1937 on “Some economic consequences of a declining population” (Keynes 1937), where he expressed the worry that because of a falling population there would not be enough demand to absorb full employment saving. Consider, he says, an economy with a savings ratio of 8-15% of national income, and a capital-output ratio of 4 giving a rate of capital accumulation which will absorb saving of approximately 2-4%. With a constant capital-output ratio, this is the required growth rate, but can this growth rate be guaranteed? Historically, it appeared to Keynes that one-half of the increase in capital accumulation could be attributed to increased population, the other half to increased living standards (productivity growth). Now suppose population growth falls to zero. Since the standard of life cannot be expected to grow by more than 1% per annum, this means that the demand for capital will only grow at 1% while the supply grows at between 2-4%, a clear and worrying imbalance which would have to be rectified either by reducing saving or reducing the rate of interest to lengthen the average period of production (i.e., to raise the capital-output ratio). This discussion is exactly analogous to Harrod’s discussion of divergences between the warranted and natural rates of growth. The required rate of growth to absorb saving is the warranted rate of growth and the long run growth rate determined by population (labour force) growth and rising living standards (productivity growth through technical progress) is the natural rate of growth. Harrod’s dynamic theory is precisely anticipated by Keynes, and Keynes, like Harrod, treats the natural growth rate as exogenous.

Given the definition of the natural rate of growth as the sum of the rate of growth of the labour force and the rate of growth of labour productivity, it follows that the measured natural rate must be that rate of growth that keeps the unemployment rate constant. Otherwise, if the actual growth rate is above the natural rate, unemployment will fall; and if the actual growth is below the natural rate, unemployment will rise. Throughout the rest of the article we define and measure the natural growth rate of countries as the rate which keeps unemployment constant.

As all students of economic growth will know already, there was no mechanism in the original Harrod model for bringing the warranted and natural rates of growth into line with one another, with the implication that economies might experience perpetual secular stagnation (if the warranted rate exceeds the natural rate) or permanent inflation and structural unemployment (if the natural rate exceeds the warranted rate, as in most developing countries). But mechanisms that achieve equilibrium were soon invented. The Cambridge, Massachusetts school, represented by Robert Solow, Paul Samuelson and Franco Modigliani used the neoclassical production function and variations in the capital-output ratio to show that the warranted growth rate would adjust to the natural rate (assuming appropriate factor price adjustment and a spectrum of production techniques to choose from). The Cambridge, England school, represented by Nicholas Kaldor, Joan Robinson, Richard Kahn and Luigi Pasinetti used variations in the savings ratio brought about by changes in the functional distribution of income between wages and profits as the mechanism to bring about equilibrium. But both schools, which hotly debated this issue for over twenty years, have equilibrium growth proceeding at the *exogenously* given natural rate.

What happens, however, if the natural rate of growth is not exogenous? This has interesting consequences both for the short-run trade cycle model of Harrod, as well as the long-run equilibrium growth model. Remember that in the trade cycle model, if the actual growth rate diverges from the warranted growth rate in either direction, forces come into play which widen the divergence – but divergence is bounded by ceilings and floors. The ceiling is the natural rate of growth because the level of output cannot exceed the full employment ceiling. But suppose that the natural rate increases with the actual rate of growth (because labour force growth and productivity

growth are induced), this will perpetuate the cyclical upturn. We conjecture that this increases the possibility that the cyclical upturn is not brought to an end by an absolute ceiling, but by demand constraints associated with inflation and balance of payments problems due to bottlenecks in the system. This may explain why cyclical peaks are often accompanied by excess capacity. In any case, the endogeneity of the natural rate will surely lengthen the cycle.

In the long period model of divergence between the warranted and natural growth rate, the endogeneity of the natural rate will impede adjustment to equilibrium. If the warranted rate exceeds the natural rate, it means that the growth of capital exceeds the growth of the labour force in efficiency units and the warranted rate must fall for equilibrium. In conditions of recession, however, the natural rate is also likely to fall as workers leave the labour force and productivity growth slows, impeding adjustment. Similarly, if the natural rate exceeds the warranted rate, this implies that the growth of the effective labour force exceeds the growth of capital and the warranted rate must rise for equilibrium. In booms, however, the natural rate is also likely to rise as workers are attracted into the labour force and productivity growth accelerates, also impeding adjustment.

In general, the endogeneity of the natural rate of growth has serious implications for the notion of a *given* full employment production frontier which economies will gravitate towards. In practice, this frontier will continually shift with the actual growth rate.

In what ways is the natural rate endogenous?

There are many mechanisms through which the natural rate of growth is likely to be endogenous to the actual rate of growth. Consider first the growth of the labour force or labour supply. Labour supply is extremely elastic to demand. When the demand for labour is strong, labour input responds in a number of ways. Firstly, participation rates rise. Workers previously out of the labour force decide to join the labour force. The participation rates of the young, the old and married women are particularly flexible and vary with the trade cycle. Secondly, hours worked increase. Part-time workers become full-time workers, and overtime work increases. Thirdly, and

significantly for many countries across the world, labour migration takes place in response to booming labour markets. If countries are short of labour, they import it. Cornwall (1977) and Kindleberger (1967) document the important role that immigrant labour played in Europe during the 'golden age' of economic growth between 1950 and 1973. The migration of labour from Portugal, Spain, Greece and Turkey into Germany, France, Switzerland and northern Italy was not an exogenous movement but fuelled by an excess demand for labour in the receiving countries because the growth of demand for output was so high. Similar stories could be told for other parts of the world.

Now consider the growth of labour productivity. There are several mechanisms through which labour productivity growth is endogenous to demand, and well documented. First, there are static and dynamic returns to scale associated with increases in the volume of output and the technical progress incorporated in capital accumulation. With a constant ratio of capital to output, all technical progress is labour-augmenting. Some technical progress is autonomous, but a great deal is demand-driven, particularly process innovation. Secondly, there are macro increasing returns in the Allyn Young (1928) sense associated with the interrelated expansion of all activities. Suppose the market for a good expands which makes it profitable to use more sophisticated machinery, which cuts costs. This not only reduces the price of the good (leading to further expansion of demand) but will also reduce the price of machinery if there are scale economies in its production, which makes it profitable to use machinery in other activities. The initial demand expansion leads to a series of changes which propagate themselves in a cumulative way causing labour productivity to rise. Thirdly, there is the well-known phenomenon of learning by doing whereby the efficiency or productivity of labour is an increasing function of a learning process related to cumulative output. The more widgets produced, the more adept labour becomes at producing them. Clearly the impact of learning will gradually diminish with cumulative output, but as long as product ranges change over time, the effect of learning on productivity growth will be a continuous process related to the expansion of output.

All the phenomena mentioned above are captured by the Verdoorn relation, or Verdoorn's Law, which posits a positive relation between the growth of output as the independent variable and the

growth of labour productivity as the dependent variable (Verdoorn 1949). In recent years, this relation has been tested extensively across countries (Kaldor 1966, Michl 1985); across regions within countries for both developed and less developed countries (McCombie and de-Ridder 1983, Fingleton and McCombie 1998, Leon-Ledesma 2002, Hansen and Zhang 1996), and across industries (McCombie 1985), and all find the relationship robust with a central estimate of the Verdoorn coefficient of approximately 0.5. That is, an expansion of output demand by 1% leads to a 0,5% increase in employment and a 0,5% increase in labour productivity induced by scale economies, embodied technical progress and learning by doing. It is no accident, therefore, that when growth slows down, productivity growth also slows down. The productivity growth slow-down after the shocks to the world economy in the 1970s was regarded as a puzzle by some economists, but can be readily understood in the context of models in which productivity growth is endogenous.

Estimating the natural rate of growth and testing its endogeneity

Let us now turn to the question of how the natural growth rate of a country may be estimated, and to test whether it is endogenous. The technique for estimation relies on a modification of the equations used for testing Okun's Law (Okun 1962), a technique first suggested and applied by one of the present authors (Thirlwall 1969). We saw earlier that, by definition, the natural growth rate must be the growth rate that keeps unemployment constant. If we therefore relate changes in unemployment in a country to its growth rate, we can solve for the growth of output that keeps unemployment constant. In other words, let

$$(1) \quad \Delta\%u = a - b(g),$$

where $\%u$ is the percentage rate of unemployment and g is the growth rate. Solving for g when $\Delta\%u = 0$ gives an expression for the natural rate of growth of $g_n = a/b$. The technique is simple, but there are certain problems. The estimate of the coefficient b may be biased downwards because of labour hoarding which would exaggerate g_n .

Equally, however, the constant term a may be biased downwards through workers leaving the labour force when g is low. It is difficult to know *a priori* what the relative strengths of the (offsetting) biases are likely to be.

An alternative procedure is to reverse the variables in equation 1 to give:

$$(2) \quad g = a_1 - b_1 (\Delta\%u).$$

Solving for g when $\Delta\%u = 0$ now gives an estimate for the natural rate of growth of $g_n = a_1$. This has statistical problems since the change in unemployment is an endogenous variable (although it transpires empirically that this does not affect the results obtained from fitting equation 2).¹

If this simple technique for estimating the natural rate of growth is accepted, the obvious way to test for endogeneity is to include a dummy variable into (say) equation 2 in periods when the actual growth rate is above the estimated natural rate and test for its significance, i.e.

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

where D takes the value of 1 when actual growth is greater than the natural rate of growth and zero otherwise. If the dummy is significant, this must mean that the rate of growth in periods of boom to keep unemployment constant has risen. The actual growth rate must have been pulling more workers into the labour force and inducing productivity growth. The constant a_2 plus b_2 gives the natural rate of growth in boom periods. The interesting question is then how this estimate of the natural rate in boom periods compares with the estimate of the natural rate which does not distinguish between boom and slump. What is the elasticity of the natural rate in periods of boom?

¹ In Thirlwall (1969) both equations 1 and 2 were fitted to US and UK data over the period 1950 to 1967, and both procedures gave the same estimates of g_n : 2.9% per annum for the UK and 3.3% for the US – which seemed eminently reasonable.

Empirical results²

To test the model we take a sample of 15 OECD countries over the period 1961 to 1995. Both equations 1 and 2 were fitted to estimate the natural rate of growth over the whole period. In general, equation 2 gave the best results in terms of goodness of fit of the equations and the reasonableness of the results. In equation 2, the estimate of the natural rate of growth is given by the constant term (a_1), and this is reported for all countries in the first column of Table 1. The constant term was estimated as statistically significant in all 15 countries.³ The estimates of the natural rate of growth all look reasonable for the countries concerned, and range from 2.5% in the UK (the lowest) to 4.6% in Japan (the highest). The average natural growth rate for the 15 OECD countries as a whole is 3.5%.

When a dummy variable was added to equation 2 for years when the actual growth rate exceeded the estimated natural rate (equation 3) it was found to be significant in all 15 countries. The sum of the dummy plus the new constant (a_2) gives the natural rate of growth in boom periods, and is shown in column 2 of Table 1.

The natural rate is seen to increase considerably in all countries, but in some countries by more than others. Taking the countries as a whole the average increase is 1.8 percentage points, which is to say that the actual rate of growth in boom periods has induced labour force growth and productivity growth by that amount. The countries where the sensitivity of the natural rate seems to be greatest are those where the reserves of labour are known to be highest such as Greece and Italy (due to surplus labour in the south) and where output growth has induced impressive technical progress through learning and sectoral rationalisation, such as Japan. In general, the results show substantial elasticity of the labour force and productivity growth; certainly enough to suggest that the natural rate of growth is not exogenously given, but is very responsive to demand conditions in the economy. It is important to stress that these results are not measuring

² The full regression results from which the various estimates in this section (and Table 1) are derived are available on request and can also be found in Leon-Ledesma and Thirlwall (2002).

³ Allowing for the endogeneity of $\Delta\%u$ using instrumental variables does not alter the results.

simply the *cyclical* effect of demand on output growth because this is captured by the coefficient c_2 in equation 3. The results are capturing the longer lasting effects that sustained demand expansion has had on the growth of productive potential over the period under study.

TABLE 1

ESTIMATES OF THE NATURAL RATE OF GROWTH AND ITS ENDOGENEITY FOR 15 OECD COUNTRIES, 1961-95

Country	Natural rate from equation 2 (%)	Natural rate in boom periods (%)	Increase in natural rate in boom periods	% Increase in natural rate in boom periods
Australia	3.999	5.713	1.714	42.9
Austria	3.136	4.956	1.820	58.1
Belgium	3.524	4.910	1.386	39.3
Canada	3.835	5.261	1.426	37.2
Denmark	2.942	4.782	1.840	62.5
France	2.827	3.934	1.107	39.2
Germany	3.505	4.709	1.204	34.3
Greece	4.509	7.671	3.162	70.1
Italy	3.344	5.910	2.566	76.8
Japan	4.567	8.720	4.153	90.9
Netherlands	3.282	5.315	2.033	62.0
Norway	3.972	5.009	1.037	26.1
Spain	4.062	6.093	2.031	50.0
UK	2.544	3.802	1.258	49.5
USA	2.991	3.664	0.673	22.5
Average	3.536	5.363	1.827	51.7

Source: Leon-Ledesma and Thirlwall (2002).

Conclusion

If supply or output potential responds to demand, this raises the crucial question of what does it mean to say that output growth is supply determined, or constrained by supply, which is the prevailing orthodoxy? Of course, it is true in a trivial sense that capital and labour are required to produce output, and how much output is produced will also depend on the level of technical efficiency, but the really important question is why does the growth of capital, labour and technical progress differ so much between countries? The supply-oriented, neoclassical production function approach to the analysis of growth cannot answer this question, and for the most part never asks it!

In our view, demand should assume a central role in growth theory and must play a major part in the explanation of growth rate differences between countries. For most countries, and particularly developing countries, demand constraints bite long before capacity is reached, and as we have shown, supply capacity is elastic. In an open economy, the major long run constraint on demand is likely to be its balance of payments, but this is another story – fully articulated by one of the present authors (Thirlwall 1979) in this *Review* over twenty years ago! There is now substantial empirical support for this view, and interested readers are referred to McCombie and Thirlwall (1994 and 1997) and a recent “Symposium” in the *Journal of Post Keynesian Economics* (1997).

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