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The Endogeneity of the Natural Rate of Growth for a Selection of Asian Countries

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Abstract

The paper questions the assumption in all of mainstream growth theory that the Harrod natural rate of growth is exogenously determined and independent of the pressure of demand in an economy. First a simple statistical technique is presented for estimating the natural rate of growth, and then it is shown how it is possible to test for its endogeneity. The model is applied to ten Asian countries, and the results support the conclusions from previous studies of OECD and Latin American countries that the natural rate of growth is elastic to the actual rate of growth working through induced labour supply and productivity growth. Demand matters for economic growth.

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KEYWORDS: Demand-led growth ; endogenous labour supply and productivity growth ; Asia

The Endogeneity of the Natural Rate of Growth for a Selection of Asian Countries[1]

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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 selection of ten Asian countries over the period 1982 to 2005, on the hypothesis that the natural rate of growth is not exogenously given as it is assumed to be in orthodox growth theory; as it was in Harrod's (1939) original growth model ; as it was in Solow's (1956) neoclassical response to Harrod, and as it still is in so-called 'endogenous' growth theory where growth is endogenous in the sense that investment matters for long run growth not in the sense that the determinants of the natural rate respond to demand. To do this we first use a particular statistical technique to estimate the natural rate of growth as defined by Harrod for the ten Asian countries: China, Hong Kong, Indonesia, Japan, Philippines, Singapore, South Korea, Sri Lanka, Taiwan and Thailand. We then estimate the sensitivity of the natural rate of growth when the actual rate of growth differs from the natural rate, and give reasons why the endogeneity of the natural rate is to be expected. We compare our results for Asia with recent studies of the endogeneity of the natural rate of growth for a selection of OECD countries (León-Ledesma and Thirlwall, 2002); for Latin American countries (Libanio, 2009; Vogel, 2009): for NAFTA countries (Perrotini and Tlatelpa, 2003), and for regions of Italy (Lanzafame, 2010). There are no previous studies for Asia. The overwhelming evidence from all studies, including the study presented here, is that the natural rate

of growth is not exogenously given, and it is therefore a mistake to treat it so in growth theory. It varies with the actual rate of growth or the pressure of demand. Demand matters for the long run growth of output (GDP).

This is an important topic because 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 neoclassical growth economists on the one hand, who treat the rate of growth of the labour force and labour productivity growth as exogenous to the actual rate, and economists in the Keynesian / post-Keynesian tradition who argue that growth is primarily demand-driven because labour force growth and labour productivity growth respond to the pressure of demand, both domestic and foreign. The latter view does not mean, of course, that demand growth determines supply growth without limit ; rather that there is not one single full employment growth path, and that in many countries demand constraints (related to excessive inflation and balance of payments difficulties) tend to bite long before supply constraints are ever reached.

There is a relatively simple way to discriminate between the competing growth hypotheses, and to estimate whether the natural rate of growth is endogenous or not. Following the work of Okun (1962), one of the present authors (Thirlwall, 1969) has shown a simple statistical technique to estimate the natural rate of growth, and León-Ledesma and Thirlwall (2002) have shown rigorously how to test for its endogeneity.

Estimating the Natural Rate of Growth and its Endogeneity

Since the natural rate of growth is (by definition) the sum of the growth of the labour force and the 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 it, the unemployment rate will fall. Thus the natural rate of growth must be the rate of growth that keeps the rate of unemployment constant. Okun specifies the change in the percentage rate of unemployment ($\Delta\%U$) as a linear function of the growth of output (g):

$$\Delta\%U = a - b(g) \qquad (1)$$

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.

To overcome these particular biases, an alternative approach is to reverse the dependent and independent variables of equation (1) giving:

$$g = a_1 - b_1(\Delta\%U) \qquad (2)$$

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 rate 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.*

Once the natural rate of growth has been estimated by either method, deviations of the actual growth rate from the estimated natural rate can be

calculated, and equation (2) can be re-estimated introducing a dummy variable (D=1) for periods when the actual rate of growth is above the natural rate of growth and zero otherwise, as in equation (3):

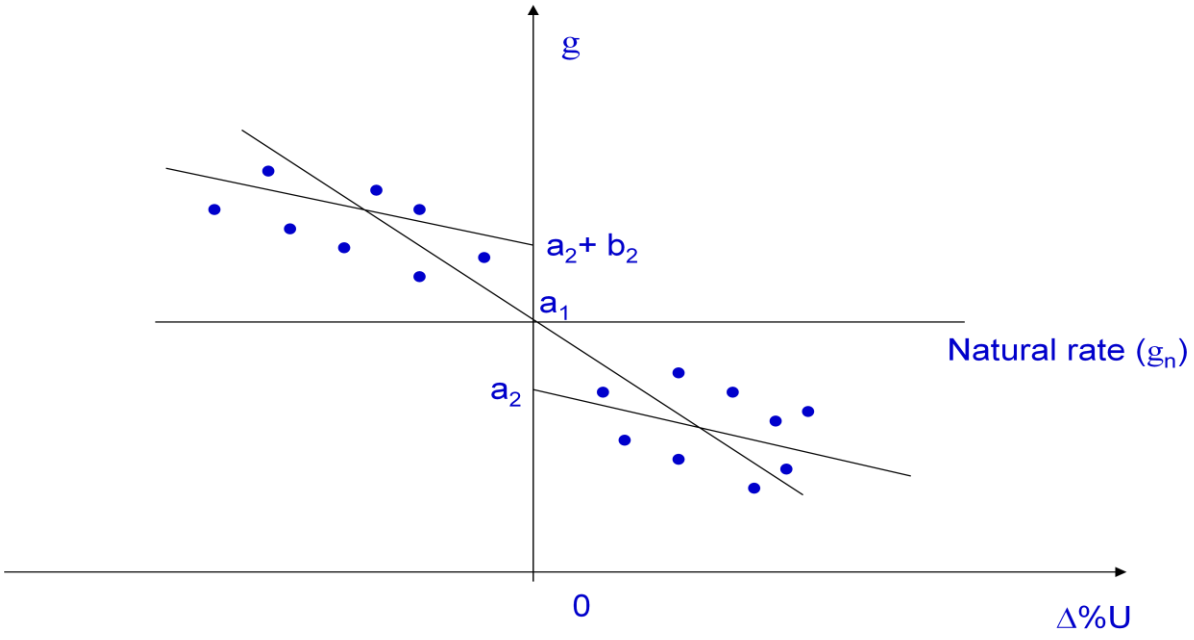
$$g = a_2 + b_2(D) - c_2(\Delta\%U) \qquad (3)$$

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 the unemployment rate constant must have risen. In other words, the actual rate of growth must have pulled up the natural rate. This is not a purely cyclical effect because the cycle is controlled for by the variable $\Delta\%U$ in equation (3).

To illustrate the point, consider Figure 1. The growth of output is measured on the vertical axis, and the change in the percentage rate of unemployment is measured on the horizontal axis.

Figure 1

Relation between Growth and the Change in Unemployment



Fitting equation (2) to time series observations of g and Δ%U defines the natural rate of growth (g_n) at a_1 where Δ%U = 0. Theoretically, if $g > g_n$, Δ%U < 0 ; and if $g < g_n$, Δ%U > 0, and all observations should lie in the top left-hand and bottom right-hand quadrants as depicted in Figure 1. The question is : is the intercept (a_1) the same for both samples of $g > g_n$ and $g < g_n$, or does a spline relationship fit the data more accurately, so that the natural rate of growth (a_2+ b_2) when $g > g_n$ is significantly greater than the natural rate of growth (a_2) when $g < g_n$?[2] We will look at the empirical evidence later, but first let us consider the theoretical and empirical implications if the natural rate is endogenous, and the mechanisms by which in might respond to the actual growth rate.

The Theoretical and Empirical Significance of the Endogeneity of the Natural Rate of Growth

If the natural rate of growth is not exogenously given, but is endogenous to demand, or to the actual rate of growth, it has two main implications. First at the theoretical level, it has implications for the efficiency and speed of the adjustment process between the warranted and natural rates of growth in the Harrod growth model. Second, it has implications for the way the growth process should be viewed, and for understanding 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 begin to operate.

In Harrod's model of growth, and in mainstream growth theory, the natural rate of growth fulfils two important functions. First it sets the ceiling to the divergence

between the actual growth rate and warranted growth rate[3], 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. Second, it gives the maximum long-run rate of growth which is attainable – what Harrod called the social optimal rate of growth, but without discussion of its determinants. 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 recognition that both may be endogenous to demand. [4]

In Harrod's model, there was also no mechanism for bringing the warranted rate of growth into line with the natural rate of growth. It was this (pessimistic) conclusion that sparked the great neoclassical versus Keynesian growth debate in the mid-1950s that engaged some of the greatest minds in the economics profession for over two decades. There was Cambridge, Massachusetts, USA, represented by Samuelson, Solow and Modigliani, pitched against Cambridge, England, represented by Kaldor, Joan Robinson, Pasinetti and Kahn. Both camps, however, by and large, treated the natural rate of growth as given. Virtually all the focus of the debate centred on mechanisms by which the warranted growth rate might converge on the natural rate, giving a long-run equilibrium growth path. The Cambridge, Massachusetts, neoclassical school concentrated on adjustments to the capital-output ratio through capital-labour substitution if capital and labour were growing at different rates. The Cambridge, England, Keynesian school concentrated on adjustments to the savings ratio through changes in the distribution of income between wages and profits on the assumption that the propensity to save out of profits is higher than out of wages.

If the natural rate of growth is not exogenously given, however, but is endogenous to economic conditions, both approaches are considerably weakened. 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 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 difficulties before the natural rate is ever reached. The boom generates its own supply, but supply is never fully utilised because various demand constraints bite, perhaps associated with bottlenecks in particular sectors of the economy.

Secondly, consider the secular problem of divergence between the warranted and 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 neoclassical adjustment mechanism is the substitution of capital for labour, increasing the capital-output ratio and reducing the warranted growth rate. The Keynesian adjustment mechanism is a fall in the savings ratio through a redistribution of income from profits to wages, also reducing the warranted rate. But in conditions of over-saving, or depression, the natural rate of growth is likely to be affected adversely, 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 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.

Likewise, as far as the empirical analysis of growth is concerned, the possibility that long-run growth may endogenous to demand has serious implications

for the interpretation of production function studies of the sources of growth (or 'growth accounting' exercises) which treat factor inputs as exogenous, and also for 'new' growth theory modelling (e.g. Barro, 1991) which bears a very strong resemblance to traditional neoclassical production function studies, except for the inclusion in the equations of the initial level of per capita income of countries to test for convergence /divergence of per capita incomes (Thirlwall, 2003).[5]

Let us now discuss some of the mechanisms by which the determinants of the natural growth rate may be endogenous.

Mechanisms by which the Natural Growth Rate may be 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 participation rates of the young, of retired people and of married women are particularly flexible. 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. Historical examples abound : immigration into the United States in the 19th and 20th centuries ; Australia in the 1950s and 1960s ; Britain in the 1950s, and perhaps the most striking of all, the migration of labour from Portugal, Spain, Greece and Turkey into Germany, France, Switzerland and northern Italy during the so-called 'golden age' of European

growth from 1950 to 1973 (see Kindleberger, 1967 ; Cornwall, 1977). This was not an exogenous movement of labour; it was fuelled by an excess demand for labour in the receiving countries because the growth of demand for output was so strong. Significant transfers of labour also take place continually between regions of a country from depressed to prosperous regions. With the free mobility of labour, regional growth can never be supply-constrained in the neoclassical sense (Thirlwall, 1980).

Now consider the growth of labour productivity. There are several mechanisms through which labour productivity growth is endogenous to demand. First there are static and dynamic returns to scale associated with increases in the volume of output and the technical progress embodied in capital accumulation. 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 a further expansion of demand) but it will also reduce the price of machinery if there are economies of scale 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 the learning process related to cumulative output. The more output produced, the more adept labour becomes at producing it.

All the mechanisms mentioned above are captured by the Verdoorn relation, or Verdoorn's Law, which posits a positive relation between the growth of manufacturing 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; across regions within countries for both developed and developing countries, and across industries (see McCombie, Pugno and Soro, 2003 for a survey of evidence). All the studies find the relation robust with a central estimate of the Verdoorn coefficient of approximately 0.5.[6] That is, an expansion of industrial output of one percent leads to a 0.5 percent increase in labour productivity, induced by scale economies; embodied technical progress; macro-externalities, and learning by doing, and a 0.5 percent increase in employment.

Empirical Studies of the Endogeneity of the Natural Rate of Growth

The first study of the endogeneity of the natural rate of growth, using the techniques described earlier, was that by León-Ledesma and Thirlwall (2002) for 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 and reasonableness of results. The estimates of the natural rate were significant for all countries ranging from 2.5 percent per annum (p.a.) in the UK (the lowest) to 4.6 percent p.a. in Japan (the highest). The full results are shown in column one of Table 1.

When a dummy variable was added to equation (2) for years when the actual rate of growth exceeded the natural rate of growth (equation 3), it was found to be significant in all 15 countries The natural rate in boom periods is shown in column 2

of Table 1. Taking the countries as a whole the average increase in the natural rate is 1.8 percentage points which represents just over a 50 percent increase in the average natural rate for all countries of 3.5 percent. But it can be seen that the elasticity is higher in some countries than others. In Greece and Italy, where surplus labour is known to exist, the elasticity of the natural rate is over 70 percent, and in Japan it is 90 percent, where output growth has induced impressive technical progress and productivity growth through learning and sectoral rationalisation.

Table 1

Estimates of the Natural Rate of Growth and Its Endogeneity for 15 OECD Countries 1961-1995

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: León-Ledesma and Thirlwall (2002)

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In general, the results show substantial elasticity of the labour force and productivity growth, certainly significant enough to suggest that the natural rate of growth is not exogenous,, but is vry responsive to demand conditions in the economy.

Two interesting studies, using the same methodology as above, have been done to estimate the endogeneity of the natural rate of growth for a selection of Latin American countries. Vogel (2009) conducts a study of 11 countries over the period 1986 to 2003, and Libanio (2009) takes 10 countries over the longer period 1980 to 2004. Equations (2) and (3) are used to estimate the average natural rate of growth, and to test for endogeneity. Eight of the countries in the two studies are the same. The results are shown in Table 2.

In the Vogel study, all estimates of the natural rate of growth are significant ranging from 1.78 percent in Venezuela to 6.12 percent for Chile. The average rate for the sample as a whole is 3.52 percent. Estimating the endogeneity of the natural rate using equation (3), the dummy variable (b_2) is significant in all cases. The elasticity of the natural rate is the highest in Venezuela (160 percent) and Argentina (137 percent) and lowest in Chile (29 percent). The average elasticity for all countries is 62 percent which is similar, although slightly higher, to that for the OECD countries.

In the Libanio study, the time period is different. but estimates of the average natural rate, using equation (2), range from 1.81 percent for Uruguay to 4.42 percent for Chile. The average natural rate for all countries is 2.73 percent. This is lower than in Vogel's study because Libanio's estimates include the years of the severe debt crisis in Latin America in the first half of the 1980s. Estimating the endogeneity of the natural rate produces a range of elasticity estimates from 145 percent in Brazil (and 144 percent in Argentina to 24 percent in Chile (also the lowest estimate in the Vogel study). The average elasticity for all countries is 66 percent, which is very close to

the Vogel estimate of 62 percent. Both studies confirm that when the actual growth rate exceeds the average natural rate, the growth rate to stop the unemployment rate from rising increases because a faster actual growth induces increases in the labour supply and productivity – although the split between the two components of the natural rate are not identified.

Table 2.

The Endogeneity of the Natural Rate of Growth in Latin America

Country	Lena Vogel 1986-2003			G. Libanio 1981-2003		
	Natural Rate	Natural Rate in Booms	Elasticity of the Natural Rate (%)	Natural Rate	Natural Rate in Booms	Elasticity of the Natural Rate (%)
Argentina	3.03	7.20	137	2.25	5.51	144
Bolivia	3.03	4.42	46	-	-	-
Chile	6.12	7.91	29	4.42	5.47	24
Colombia	3.82	5.21	36	3.34	4.31	29
Costa Rica	4.77	6.81	43	3.76	4.86	29
Mexico	2.64	4.66	77	2.57	4.38	70
Nicaragua	2.64	5.00	89	-	-	-
Paraguay	2.64	4.54	72	-	-	-
Peru	5.13	7.96	55	2.13	4.67	119
Venezuela	1.78	4.62	160	2.36	3.11	32
Brazil	3.03	4.42	46	2.25	5.51	145
Ecuador	-	-	-	2.38	3.80	60
Uruguay	-	-	-	1.81	3.80	110
Average	3.52	5.70	62	2.73	4.54	66

Perrotini and Tlatelpa (2003) have tested the endogeneity hypothesis for the three NAFTA countries of Mexico (very similar to the estimates of Vogel and Libanio), Canada and the USA over the period 1970 to 2000. They estimate an elasticity of the natural rate in boom periods of 75 percent for Mexico; 17 percent for Canada, and 31 percent for the USA.

Finally, the methodology has been applied at the regional level by Lanzafame (2010) to the twenty regions of Italy over the period 1977 to 2003 using panel and seemingly unrelated regression (SUR) estimating techniques. With panel data, using equation (2), the average natural growth rate for all regions is 3.6 percent, with a high of 4.0 percent (for the region of Veneto) and a low of 3.1 percent (for the region ofValle d'Aosta). Estimating the endogeneity of the natural rate, using equation (3), gives an average natural rate for all regions of 5.1 percent when the actual growth exceeds the natural rate, or an elasticity of 65 percent, which is approximately the same as the average rate for most of the country studies.[7] The elasticity of the natural rate of the southern regions of Italy is slightly higher than for the north, which is consistent with the greater availability of surplus labour in the south.

The Endogeneity of the Natural Rate of Growth in a Selection of Asian Countries

Having outlined the methodology for estimating the natural rate of growth and its endogeneity, and examined the empirical evidence for other countries (regions), we now turn to our own original study of ten countries of Asia over the period 1982 to 2005. While there has been a great deal of discussion of the rapid growth performance of many Asian countries over the last thirty years – and about whether it is the fast growth of factor supplies or technical progress that is responsible (e.g. Young, 1995) – this is the first study of its kind to estimate the responsiveness of labour supply and productivity growth to the growth of demand. Maybe it has been demand growth (particularly export growth) that has been driving the fast growth of these countries to which factor supplies and productivity growth have responded,

which is an entirely different interpretation of the growth process to the orthodox neoclassical explanation.

The data for GDP growth for the Asian countries taken come from the World Bank's *World Development Indicators* except for Taiwan where the data comes from the Reuters EcoWin economic database. The data on unemployment rates for countries are also obtained from this latter source. For China, only data on urban unemployment are available. In order to obtain the most robust results from fitting equations (1), (2) and (3), the longest time series available is taken. For most countries, this is 1982 to 2005, but for Sri Lanka it is 1991 to 2005, and for Japan it was possible to take the even longer time period 1961 to 2007. Since we are not estimating a dynamic behavioural model, the time series properties of the data are not explored. Equations (1) and (2) are simply used as a statistical device for estimating the natural rate of growth. The estimation technique used, as in other country studies, is ordinary least squares, using the Cochrane-Orcutt iterative technique to adjust for serial correlation of the residuals where necessary. Some of the Asian countries examined were severely hit by the financial crisis of 1997 and its aftermath, and in these cases the regressions include a dummy variable for 'outlying' years.

We first estimate the natural rate of growth using the Okun equation (equation 1) where the natural rate of growth is given by the ratio a/b. The results are given in Table 3.

Table 3: Estimation of the natural rate of growth using Okun's equation

Country	Constant	Coefficient on GDP Growth	R^2	DW	Natural Rate
China[a]	0.38 (2.45)**	-0.03 (-2.07)**	0.19*	1.24	12.67%
Hong Kong[b]	0.77 (3.05)***	-0.16 (-4.06)***	0.51***	1.90	4.81%
Indonesia	0.51 (1.6)	-0.04 (0.046)	0.04	2.07	12.75%(NS)
Japan[a,c]	0.11 (1.49)	-0.02 (-1.89)*	0.33***	-	5.50%(NS)
Philippines[a]	0.30 (1.57)	-0.06 (-1.27)	0.07	-	5.00%(NS)
Singapore	1.48 (3.96)***	-0.19 (-4.11)***	0.45***	1.90	7.79%
South Korea[a,d]	0.89 (2.73)**	-0.15 (-3.8)***	0.89***	-	6.67%
Sri Lanka	0.22 (0.38)	-0.12 (-1.07)	0.09	1.83	1.83%(NS)
Taiwan[a]	0.78 (4.45)***	-0.11 (-5.26)***	0.51***	-	7.10%
Thailand	0.70 (2.00)**	-0.11 (-2.45)**	0.21**	2.46	6.36%

Notes:
t-stats are in parentheses; * Denotes significance at the 90% confidence level; ** Denotes significance at the 95% confidence level; *** Denotes significance at the 99% confidence level.
The significance of the model reported with the R^2 is an F-test of joint significance; DW is Durbin-Watson d test for AR(1).
[a] Estimated using Cochrane-Orcutt iterative method to correct for AR(1) serial correlation.
[b] Includes a dummy for effects of the Asian financial crisis of '97 - '98, for the year '99, significant at the 90% C.L.
[c] Includes two dummies for effects of the Asian financial crisis, for the years '98 and '99, both significant at the 95% C.L.
[d] Includes a dummy for the effects of the Asian financial crisis for the year '98, significant at the 99% C.L.
NS – not significant

The most significant results are for Singapore, Hong Kong, South Korea, Taiwan and Thailand where the coefficients are significant at least at the 95 percent confidence level. For China the 'b' coefficient is only significant at the 90 percent confidence level; and for Indonesia, Japan, the Philippines and Sri Lanka there seems to be no relation between growth and the change in the percentage rate of unemployment. Where the coefficient estimates are significant, the estimates of the natural rate are close to the long run average growth rate of these countries, so we can have some confidence in them. [8]

Next we estimate the natural rate of growth using the Thirlwall 'reversal' method (equation 2) which in the other studies discussed previously has given more robust results. This is also the case for the Asian countries studied here. The results of fitting equation (2), where the natural rate is given by the constant term, are shown in Table 4.

Table 4: Estimation of the natural rate of growth using Thirlwall's Reversal

Country	Constant	Coefficient on Δ%U	R^2	DW	Natural Rate
China[a]	10.36 (8.11)***	-6.70 (-2.15)**	0.21**	1.01	10.36%
Hong Kong[b]	5.53 (9.62)***	-1.91 (-3.01)***	0.54***	2.07	5.53%
Indonesia[a,c]	6.07 (8.06)***	-0.12 (-0.49)	0.91***	-	6.07%
Japan[a]	3.94 (1.29)*	-4.34 (-2.79)***	0.15***	-	3.94%(NS)
Philippines[a]	2.85 (1.29)*	-0.40 (-0.82)	0.03	-	2.80%(NS)
Singapore[b]	7.66 (15.2)***	-2.10 (-4.36)***	0.62***	1.64	7.66%
South Korea[a]	6.82 (8.12)***	-3.07 (-10.36)***	0.83***	-	6.82%
Sri Lanka	4.43 (7.01)***	-0.78 (-1.07)	0.90	1.85	4.43%
Taiwan[a]	6.40 (7.07)***	-4.60 (-5.40)***	0.52***	-	6.40%
Thailand[a,d]	6.72 (3.95)***	-0.22 (-0.83)	0.82***	1.41	6.72%

Notes:
t-stats are in parentheses; * Denotes significance at the 90% confidence level;
Denotes significance at the 95% confidence level; * Denotes significance at the 99% confidence level.
The significance of the model reported with the R^2 is an F-test of joint significance
[a] Estimated using Cochrane-Orcutt iterative method to correct for AR(1) serial correlation.
[b] Includes a dummy for effects of the Asian financial crisis '97 - '98, for year '98, significant at the 95% level.
[c] Includes two dummies for effects of the Asian financial crisis, for the years '98 & '99, both significant at the 99% level.
[d] Includes two dummies for effects of the Asian financial crisis, for the years '97 & '98, both significant at the 99% level.
NS – not significant

The constant term is highly significant in all cases except Japan and the Philippines. The range of the natural rate goes from a high of 10.36 percent for China to a low of 4.43 for Sri Lanka. For all the significant countries, the deviation of the estimate of the natural rate is less than one percentage point from the actual average growth rate, and for five of the countries it is less than 0.5 percentage points.

To estimate the endogeneity of the natural rate, using the estimates from equation (2), we fit equation (3) giving a dummy variable to years when the actual growth rate exceeded the average natural rate. The results are presented in Table 5.

Table 5: Testing the endogeneity of the natural rate of growth

Country	Constant	Dummy	Δ%U	R^2	DW
China[a]	8.89 (9.11)***	3.15 (3.21)***	-4.10 (-1.53)	0.50***	-
Hong Kong[b]	2.95 (4.57)***	4.56 (5.06)***	-0.77 (-1.56)	0.79***	1.68
Indonesia[c]	4.88 (17.07)***	2.90 (7.51)***	-0.03 (-0.18)	0.96***	1.90
Japan[a]	2.66 (3.76)***	3.89 (4.51)***	-2.31 (-1.52)	0.42***	-
Philippines[e]	-1.11 (-1.29)	5.86 (5.65)***	-0.31 (-0.73)	0.61***	1.53
Singapore[e]	5.57 (7.55)***	3.42 (3.4)***	-1.18 (-2.48)**	0.76***	1.20
South Korea[a]	5.81 (7.09)***	1.74 (3.05)***	-2.68 (-9.46)***	0.88***	-
Sri Lanka	2.96 (3.93)***	2.64 (2.67)**	-0.35 (-0.58)	0.47**	2.23
Taiwan	5.03 (10.59)***	3.19 (4.63)***	-2.82 (-3.68)***	0.67***	1.82
Thailand[d,e]	5.12 (12.29)***	4.43 (6.94)***	-0.34 (-1.16)	0.91***	1.34

Notes:
t-stats are in parentheses; * Denotes significance at the 90% confidence level;
** Denotes significance at the 95% confidence level; *** Denotes significance at the 99% confidence level.
The significance of the model reported with the R^2 is an F-test of joint significance.
[a] Estimated using Cochrane-Orcutt iterative method to correct for AR(1) serial correlation.
[b] Includes a dummy for effects of the Asian financial crisis '97 - '98, for year '98, both significant at the 95% level.
[c] Includes two dummies for effects of the Asian financial crisis, for the years '98 & '99, both significant at the 99% level.
[d] Includes two dummies for effects of the Asian financial crisis, for the years '97 & '98, both significant at the 99% level.
[e] The Durbin-Watson test statistics for serial correlation is inconclusive for these regressions.

The dummy variable and the constant term are statistically significant for all countries except the Philippines. The increase in the natural rate in 'boom' periods ranges from 1.74 percentage points in South Korea to 4.56 percentage points in Hong Kong.

Table 6 presents in summary form (excluding the Philippines)the estimates of the average natural rate of growth estimated; the estimates of the natural rate when $g > g_n$, and the percentage increase (or elasticity) of the natural rate. Overall, the elasticities are lower than those estimated by Leon-Ledesma and Thirlwall for the OECD countries, and by Vogel and Libanio for Latin America. The elasticities for the Asian countries range from only 10.7 percent for South Korea to 66.2 percent for Japan. The average elasticity is 30.1 percent, compared with roughly 50 percent for the OECD countries and 60 to 70 percent for Latin America. One possible explanation is that the faster the average growth rate, the less the possibility of an

increase in the natural rate because the scope for increases in the labour supply and productivity growth is *relatively* less.

Table 6: Sensitivity of the natural rate of growth to the actual rate of growth

Country	Estimate of g_n from Thirlwall's Reversal (1)	Natural rate of growth in boom periods: Estimate of g_n from Endogeneity Test (2)	Absolute difference (2) - (1)	Percentage increase
China	10.36	12.04	1.68	16.20%
Hong Kong	5.53	7.51	1.98	35.80%
Indonesia	6.07	7.78	1.71	28.17%
Japan	3.94	6.55	2.61	66.24%
Singapore	7.67	9.00	1.33	17.34%
South Korea	6.82	7.55	0.73	10.70%
Sri Lanka	4.43	5.60	1.17	26.41%
Taiwan	6.40	8.22	1.82	28.44%
Thailand	6.72	9.55	2.83	42.11%

Source: From Tables 4 and 5.

Conclusion

The results of this study for a selection of Asian countries confirm the results of other country studies that it is a mistake to treat the natural rate of growth as exogenously determined independent of demand conditions in an economy. The overwhelming evidence is that the natural rate of growth is endogenous to demand and the actual growth rate. The question then arises, if the actual growth rate can be kept above the estimated natural rate, for how long can it raise the natural rate and by how much? This will first of all depend on the source of demand-led growth, and secondly on the elasticity of labour supply and productivity growth. If growth is consumption-led, financed by debt, difficulties are likely to arise quickly as the world has recently witnessed with the financial crash and subsequent recession starting in 2007 which everyone agrees is now likely to *reduce* the natural rate (or the future growth of

productive potential). Inflation and balance of payments difficulties for countries are also likely concomitants. If growth is investment- or export-led, however, there is much more scope for raising the natural rate if the investment is productive in reducing supply bottlenecks in the economy, and exports can pay for the import requirements for a faster rate of economic growth. Imports may also be more productive than domestic resources.

The implications for growth theory and policy of these results for Asian countries (and from the other studies reviewed) is that it makes little economic sense to think of growth as supply constrained if, within limits, demand can create its own supply. If factor inputs (including productivity growth) react endogenously, the process of growth, and growth rate differences between countries, can only be properly understood in terms of differences in the strength of demand, and constraints on demand. For most countries, and particularly developing countries, demand constraints come into play long before capacity is reached. Many of these countries have large reserves of labour and capital capacity is never fully utilised. There are not many developing countries in the world, for example, that could not grow faster given the greater availability of foreign exchange, which is the major reason why there is such a strong association across countries between growth performance and export performance, but that is another story well documented elsewhere (McCombie and Thirlwall, 2004).

Footnotes

1. Address for correspondence : A.P.Thirlwall, School of Economic Studies, Keynes College, University of Kent, Canterbury CT2 7NP. E-mail : at4@kent.ac.uk
2. In practice, of course, the relationship between g and Δ%U is a stochastic one, and observations of g and Δ%U in the top right and bottom left quadrants are possible which may bias the estimates of a_2 and b_2. We examine this issue later.

3 The warranted growth rate in Harrod is that rate which induces just enough investment to match planned full employment saving, so that there is no under- or over-capacity utilisation, and therefore no reason for entrepreneurs to revise their investment plans upwards or downwards.

4 This 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 (see Besomi, 1998).

5 In so-called 'new' growth theory, growth is endogenous in the sense that investment matters for long run growth, because the assumption of diminishing returns to capital is relaxed, not in the sense that factor supplies are endogenous to demand. Demand is absent from 'new' endogenous growth theory.

6 The coefficient seems to be somewhat higher in developing countries perhaps owing to greater scope for scale economies when production of many manufactured goods is initially limited.

7 Using SUR, the estimated average natural rate is 2.2 percent, rising to 3.34 percent when actual growth is above the average natural rate – giving an elasticity of 52 percent.

8 Except for China where the long-run growth rate is 9.8 percent per annum.

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