

Economic growth: What factors matter?

1. Introduction

The case study considers the 'drivers' of long-run economic growth. While growth rates vary from period to period, helping to define the business cycle, we are interested here in growth over a protracted period of time. As we shall see, statistical estimates put the UK's long-run growth rate at around 2½% per annum.

Mathematical techniques are used to compare growth rates across countries. But, their main application is in analysing the extent to which economic growth in the UK is mirrored by the growth in our labour and capital inputs.

2. Economic growth in the UK

In time series analysis we largely focus on constant price data since they reflect only changes in volumes.¹ Current price or nominal GDP data, for instance, capture changes both in the price and volume of output. The UK's GDP in 2006 at *constant 2003 prices* is estimated at £1,209,387 million (£1.21 trillion). This is 4¼ times greater than the 1948 estimate of £284,961 million.

Consider what these numbers infer for the statistical long-run growth rate of the UK economy. To do so, we apply the compound growth rate formula

$$(1) \quad g = \left(\frac{V}{A} \right)^{\frac{1}{n}} - 1$$

where V is the constant price estimate of GDP in 2006 and A in 1948. The n th root of the factor increase, V/A , is taken with n being 58, the number of years after 1948. This gives us a long-run growth rate for the UK economy of 2.52% per annum.

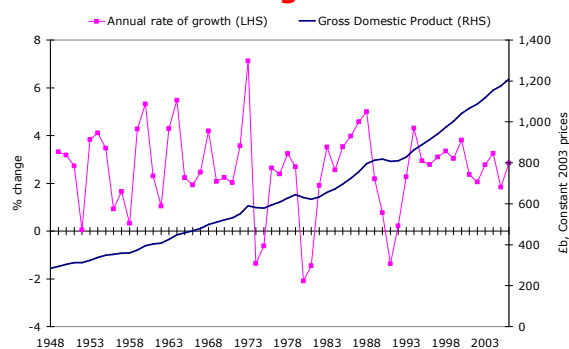
$$(2) \quad g = \left(\frac{£1,209,387m}{£284,961m} \right)^{\frac{1}{58}} - 1 = 0.0252$$

Another way of measuring our long-run growth rate is to calculate the actual

¹ The process of chain-linking which is used to derive constant price GDP estimates is explained in the case study 'Deriving constant price estimates of GDP: An illustration of chain-linking'.

year-to-year changes in constant price GDP and take its average value. By calculating the actual yearly changes we can simultaneously assess the smoothness of economic growth. Hence, while the average growth rate gives a sense of growth over the whole period, the yearly changes enable us to identify specific times when economic growth was strong and times when it was weak.

Chart 1: Level and growth of real GDP



Source: *Economic and Labour Market Review (ELMR)*, National Statistics

In Chart 1 we see the *level* of constant price GDP in the UK since 1948 and the actual *rate of growth* from year to year. The *mean* annual percentage change is 2.54% which is very close to our compound growth rate measure of the UK's long run growth rate. However, there is clear volatility in GDP with annual growth rates varying from as low as -2.09% in 1980 to as high as 7.13% in 1973.

3. Comparing long-run growth rates

A small change in a country's long-run growth rate can have a sizable impact on living standards. To demonstrate this, consider how long it takes for an economy to double in size if its long-run growth rate is 3% p.a. rather than 2½% p.a.

The problem can be formulated as follows

$$(3) \quad Y(1 + g)^n = 2Y$$

Y is constant price GDP, g the long-run annual growth rate of constant price GDP and n the number of years.

If we divide both sides by Y this becomes

$$(4) (1+g)^n = 2$$

We have a power function, with $(1+g)$ the known base and n the unknown power. Logarithms can be used to solve such an equation². If we take the log of both sides of (4) we get

$$(5) \log_b(1+g)^n = \log_b 2$$

By applying the *power rule* of logs we can "reclaim the exponent", such that

$$(6) \log_b m^n = n \log_b m$$

Applying this rule to (5)

$$(7) n \log_b(1+g) = \log_b 2$$

Finally, making n the subject of the equation we find

$$(8) n = \frac{\log_b 2}{\log_b(1+g)}$$

We can solve (8) for g values of 0.025 and 0.03. This can be done readily on a calculator. On our calculators *log* is the *common logarithm* where the base b is 10. If the economy's long-run growth rate is 2.5% p.a. it takes roughly 28 years for the economy to double in size.³ If the growth rate was 3% p.a. it would take just under 23½ years for it to double in size.⁴

Using UN constant price estimates of GDP in 1970 and 2006 (millions of each country's national currency) we undertake a statistical comparison of long-run growth rates across 9 countries. In Table 1 we show the results of applying the compound growth rate formula (1) to these countries, including the UK.

Table 1: Comparison of growth rates

Country	GDP at constant 1990 prices, millions of local currency		% p.a.
	1970	2006	
Australia	228,366	712,256	3.21
Canada	346,316	1,060,451	3.16
France	571,845	1,381,081	2.48
Italy	387,710	862,336	2.25
Japan	191,859,430	545,023,829	2.94
Netherlands	147,871	362,714	2.52
New Zealand	51,329	117,388	2.32
USA	3,037,076	9,276,652	3.15
UK	356,535	822,296	2.35

Source: United Nations⁵

Over the period from 1970 to 2006, the UK's long-run growth is a little lower at 2.35% p.a. This puts the UK ahead only of Italy and New Zealand. In comparison the US, Australia and Canada have long-run growth rates around 3.2% p.a.

4. Capital

Economic production is carried out using inputs of labour, capital and goods and services. In the National Accounts capital relates to non-financial *fixed assets*. Goods and services transformed or used up in the course of production results in *intermediate consumption*.

The UK's stock of fixed assets can be valued at its replacement cost, regardless of its age. This is its *gross value*. It can also be valued at its written-down value known as its *net value*. The net value takes into account the *consumption of capital* which is wear and tear, natural obsolescence and accidental damage.⁶

Table 2 shows the estimated *net* capital stock for the UK for 2006 is £2,834.6 billion (£2.83 trillion).⁷ This is equivalent to 2.18 times GDP.

There are 5 broad categories of fixed assets. The largest of these by value is

² The logarithm of a number y with respect to a base b is the exponent to which we have to raise b to obtain y . Therefore, $\log_b y = x$ means $b^x = y$.

³ Using the common logarithm, n approximately equals $0.30103/0.010724=28.07$.

⁴ Using the common logarithm, n approximately equals $0.30103/0.012837=23.45$

⁵ The UN National Accounts Main Aggregate Database can be accessed at

<http://unstats.un.org/unsd/snaama/Introduction.asp>

⁶ For more details on capital stock definition see the Office for National Statistics publication *National Accounts, Concepts, Sources and Methods*, Chapter 15.

⁷ The gross value of the capital stock in 2006 was £4.65 trillion or 3.58 times GDP.

dwellings, which includes houses, bungalows and flats. Its inclusion recognises that residential housing yields rental incomes. Since owner-occupation increasingly dominates the tenure type of households in the UK⁸, its inclusion is necessary to facilitate *historical* comparisons of the capital stock. Similarly, it is needed to make *international* comparisons. Dwellings accounted for 42.6%⁹ of fixed assets by value in 2006.

Table 2: UK Net Capital Stock, 2006

Type	£b	%
Dwellings	1,202.6	42.4
Other buildings and works	1,099.5	38.8
Plant, machinery, cultivated assets	403.5	14.2
Vehicles	80.1	2.8
Intangible assets	48.9	1.7
All fixed assets	2,834.6	100

Source: *Capital stocks tables for publication, National Statistics*

The second largest component by value is *other buildings and structures*. This includes buildings, other than dwellings, and most civil engineering and construction work. It will include structures such as factories, schools and hospitals and the country's railway track. This component accounted for 38.8% of fixed assets in 2006.

The third largest component by value is *plant, machinery and cultivated assets*. It accounted for 14.2% of fixed assets in 2006. Included are electricity and telephone lines as well as tractors and fork lift trucks. Cultivated assets include livestock and trees which are used repeatedly and continuously for more than 1 year.

The next smallest component by value is *vehicles*. This includes lorries for haulage, buses and railway rolling stock for transportation and all civil aircraft. Vehicles accounted for 2.8% of fixed

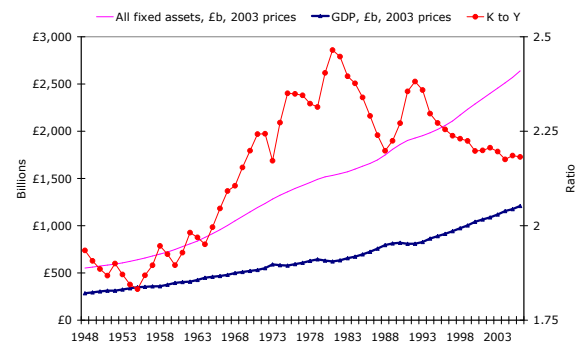
⁸ Figures from the Department of Communities and Local Government show that 70% of British households were owner-occupiers in 2006 compared with 29.6% in 1951.

⁹ $(£1,202.6b / £2,834.6b) * 100$.

assets in 2006. But, the smallest component of all is *intangible assets*. This includes computer software, original works of literature or art and mineral exploration. The stock of intangible assets in 2006 is estimated at £48.9 billion or 1.7% of fixed assets.

Chart 2 shows constant 2003 price estimates of net fixed assets and GDP. At constant 2003 prices the UK's net capital stock has increased from £551 billion in 1948 to £2,639 billion in 2006.

Chart 2: Net capital stock and GDP



Sources: (i) *Capital stocks tables for publication, National Statistics*; and (ii) *ELMR, National Statistics*

Putting the 1948 and 2006 figures into our compound growth rate formula, we find the UK has accumulated capital at a rate of 2.74% p.a. This is just above the economy's long-run growth rate of 2.52% p.a.

$$(9) \quad g = \left(\frac{£2,639b}{£551b} \right)^{\frac{1}{58}} - 1 = 0.0274$$

Estimates of capital consumption do not take into account wars or natural disasters. For some time after 1945 the UK was in the process of rebuilding and replenishing its capital stock. Chart 2 shows the *ratio* of capital to GDP increasing through much of the 1950s and 1960s. However, since the 1970s no systematic trend is observed in the capital-GDP ratio.

Consider the growth rate of net capital in the period from 1970 to 2006. The net value of the capital stock in 1970 at constant 2003 prices was £1,146 billion resulting in a growth rate of 2.34% p.a.

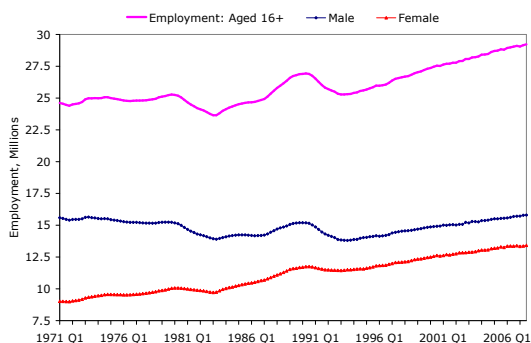
$$(10) \quad g = \left(\frac{£2,639b}{£1,146b} \right)^{\frac{1}{36}} - 1 = 0.0234$$

This is almost identical to the growth rate for the UK's GDP of 2.35% p.a. reported in Table 1.

5. Labour

We now consider the growth in the labour input. The Labour Force Survey (LFS), in accordance with the International Labour Organisation standard, categorises individuals of 16 or over as employed, unemployed or economically inactive.

Chart 3: UK Employment



Source: Labour Market Statistics, National Statistics

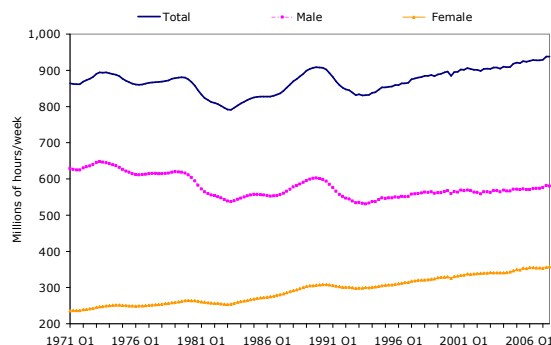
Chart 3 shows UK employment over the period from 1971Q1 to 2007Q3. Total employment has increased from 24.613 million (74.9% of working age) to 29.233 million (74.4% of working age). The increase comes from rising female employment which increased by 4.40 million or 48.8%. Male employment increased by just 212,000 or 1.4%. This has caused the male-female gender share to go from 63:37 to 54:46.

An alternative way of measuring the labour input is the number of labour hours worked in a given week. This is preferable because it controls for changes in the intensity to which labour is employed, such as changes in the amount of overtime, as well as for the observed rise in the number of part-time workers.

Chart 4 shows the number of labour hours supplied *per week* from 1971Q1 to 2007Q3. There are contrasting gender trends. Over the period, male hours supplied *fell* by 48.1 million, a decline of 8.3%, while female hours

increased by 121.8 million or 34.1%. Hence, the gender mix changed from 73:27 to 62:38.

Chart 4: Labour Hours



Source: Labour Market Statistics, National Statistics

While labour hours have increased since the mid 1990s, there is no clear systematic trend over the longer term. Any comparisons are sensitive to the periods chosen. This contrasts with our findings for capital where we observe the UK accumulating capital at a rate similar to the rate at which the economy is growing.

Tasks

- (i) Calculate the UK's fixed capital stock in 2006 if we exclude residential dwellings. Then calculate the percentage shares of the new total contributed by each of the remaining 4 components.
- (ii) Based on the United Nation's estimates of Chinese GDP in 1970 and 2006 constant prices, China's compound growth rate is 8.81% p.a. Calculate how long it would take an economy to double in size if it grows at this rate.