Investment and growth in the long run

Kevin Hjortshøj O'Rourke
All Souls College Oxford

Ricardo's theory of economic growth was all about capital accumulation, but nowadays most economists and economic historians agree that the key to long run economic growth is technological change, with investment playing a supporting role.

There are various reasons to believe this, both theoretical and empirical.

Theoretically, constructing more and more factories doing the same thing is bound to eventually give rise to diminishing returns. Technological change, on the other hand, allows us to produce more with a given amount of resources, and there is no reason to think that there are diminishing returns to adding to the stock of human knowledge –indeed, there are good reasons to think that there are *increasing* returns to pushing back the technological frontier, with discoveries in various fields feeding off each other.

Empirically, growth in total factor productivity ("TFP", or the amount of output that an economy can squeeze out of a given amount of inputs) typically explains a bigger share of growth in income per capita than increases in the capital labour ratio. This is particularly true during periods of rapid growth (Table 1). Furthermore, international income differences seem to be due more to differences in TFP than to differences in the amount of capital per worker, although differences in efficiency matter as much as differences in technology per se.

More tellingly perhaps, increases in growth rates from the mid-18th century onwards have been associated with successive waves of technological innovation. TFP growth during the British Industrial Revolution may have been slow until 1830 or so, but it was still much faster than anything that had gone before. It was driven by the innovations of the Industrial Revolution, particularly those associated with textiles, metallurgy, transportation, and the gradual diffusion of steam power more generally. (Before the Industrial Revolution growth per capita had averaged a mere 0.2% per annum in England, and was due more to people working harder, and to Smithian growth associated with commercialization and specialization, than to technological innovation per se.)

The acceleration in growth in the late 19th century evident in Table 1 was associated with an acceleration of TFP growth. In the leading economies (which increasingly meant the United States, and in some sectors Germany) TFP growth was driven by developments in the chemical industry, the spread of electrification, further improvements in metallurgy and transportation, the development of large corporations and more efficient ways of organising production. The period also saw several inventions whose full impact was only seen in the 20th century: the internal combustion engine, radio, telephones, movies, and various improvements in sanitation (Gordon 2012). And the spread of information and communications technology (ICT) since the 1980s has increased labour productivity, though by much more in the United States than in Europe.

Economic growth depends on technological change, but that does not mean that investment is irrelevant. First, investment in research and development is obviously important nowadays in determining the rate of technological change (and indeed once you recognise this, the share of growth that can be attributed to investment goes up, and the share that is

left to be explained by TFP growth declines). Investment in education presumably helps as well in this regard. Second, many of the technologies that have been developed since 1750 were designed to substitute relatively cheap capital (and energy) for relatively expensive labour. Third, not just in these cases, but also more generally, new technologies were typically embodied in machines, and investment was thus required in order to realize the potential growth which invention implied.

It is common to distinguish between growth in the frontier economy –which since 1870 or so has been the United States – and growth in the rest of the world. In the former, growth involves pushing back the technological frontier (though in the late 19th century US there was also a land frontier whose extension contributed powerfully to aggregate growth), and it has been remarkably constant over time. US output per capita has grown at roughly 2% per annum ever since the Civil War, abstracting from the Great Depression and subsequent recovery. Both private and public investment played a important role in the United States, for example in building up the world's leading university system, funding extensive R&D, and more recently in spreading ICT throughout the economy.

For economic drama one needs to look to countries inside the technological frontier. Here one finds striking examples of both growth miracles and growth disasters. The economic miracles of the late 20th century typically occurred because countries that had accumulated enormous technological deficits *vis-à-vis* the technological leader, the United States, started to close this gap. In all cases this involved massive investment. In such situations, the more savings you could mobilize, the more you could invest, the more you imported best practice technology, and the more rapidly you grew. There was a strong, positive correlation across European countries during the *Trentes glorieuses* between investment rates and growth, and investment in East Asian countries like Korea and Taiwan was as much as 35% of GDP during those countries' economic miracles.

In times where there is a large stock of unimplemented technologies, there will be a large stock of investment opportunities, and the binding constraint on growth will be the extent to which you can finance such opportunities. Here, increasing savings rates will have a big growth payoff. At other times, savings may be more than sufficient, and the binding constraint on growth may instead be finding profitable investment opportunities. Investing more and more in the same type of capital may run into diminishing returns, and savings may be used for less productive uses instead.

Sometimes surplus savings can be profitably invested abroad, increasing GNP if not GDP. Most of Europe's investment in the New World and other resource-rich economies in the late 19th century was infrastructural in nature. It facilitated a steady increase in export earnings from the economies concerned, ensuring that the investments were on average profitable, the occasional default notwithstanding. By contrast, excess Asian savings in the 2000s were largely invested in financing Western consumption booms and housing bubbles, intermediated by under-regulated financial institutions. It is perhaps not surprising that the world economy subsequently faced a major financial crisis, and that in its aftermath we are now worried about the prospect of secular stagnation. On the other hand, we should also remember that such worries were also common in the 1930s. This turned out to be an exceptionally technologically progressive decade, which unleashed a wave of profitable investment and growth after the war. These things can be hard to predict.

The Eurozone economy now needs a massive investment stimulus – for short run business cycle reasons, certainly, but also to improve our currently dismal growth prospects. In order

to boost longer-term growth these investments should be genuinely needed (that is to say, not duplicate infrastructure that may already be excessive in certain "priority" regions). What these might be others here are better placed to say than I, but in the long run we will certainly need a more efficient energy sector in Europe, for economic, environmental, and strategic reasons. We are a long way behind the US in terms of ICT investment, as already noted. There are, amazingly enough given recent history, serious housing shortages in both the UK and Ireland. A lot of the infrastructure in the old West Germany is surprisingly dilapidated. There are many potential investment opportunities out there, both private and public. By encouraging and financing investment, the European Union could become part of the solution to Europe's economic problems, rather than one of its major causes.

Table 1. Contributions to per capita growth

	(1) Capital Deepening Contribution	(2) TFP Growth	(1)+(2) Total Per Capita Growth
		Panel A. British Industrial Revolution	
Britain			
1760-1801	0.1	0.3	0.3
1801-1831	0.1	0.2	0.3
1831-1873	0.4	0.7	1.1
		Panel B. Late 19th century	
Austria			
1870-1890	0.64	0.26	0.9
1890-1910	0.66	1.03	1.69
Germany			
1871-1891	0.39	0.71	1.1
1891-1911	0.58	1.18	1.76
Netherlands			
1850-1870	0.5	0.52	1.02
1870-1890	0.61	0.33	0.94
1890-1913	0.46	0.89	1.35
Spain			
1850-1883	1	0.2	1.2
1884-1920	0.7	0.3	1
Sweden			
1850-1890	1.12	0.06	1.18
1890-1913	0.94	1.83	2.77
United Kingdom			
1873-1899	0.4	0.8	1.2
1899-1913	0.4	0.1	0.5
United States			
1855-1890	0.7	0.4	1.1
1890-1905	0.5	1.4	1.9
1905-1927	0.5	1.3	2
		Panel C. Late 20th century	
Industrial Countries			
1960-70	1.7	2.3	4
1970-80	1.5	0.4	1.9
1980-90	0.8	0.9	1.7
1990-2003	1	0.6	1.6
East Asia			
1960-70	2.1	1.6	3.7
1970-80	3.3	1	4.3
1980-90	3.1	1.3	4.4
1990-2003	2.5	0.6	3.1
Latin America			
1960-70	1.1	1.7	2.8
1970-80	1.6	1.1	2.7
1980-90	0.5	-2.3	-1.8
1990-2000	0.4	-0.1	0.3
Sub-Saharan Africa			
1960-70	1	1.9	2.9
1970-80	1.4	-0.4	1
1980-90	0.3	-1.5	-1.2

Source: Crafts and O'Rourke (2014). This lists the sources behind the table, and contains references for most of the statements made in the text. The capital accumulation figures for the late 20th century include human capital accumulation.

References

Nicholas Crafts and Kevin Hjortshøj O'Rourke, "Twentieth Century Growth", in *Handbook of Economic Growth* Volume 2A, edited by Philippe Aghion and Steven N. Durlauf, Elsevier 2014.

Gordon, Robert J. (2012). "Is U. S. Economic Growth Over? Faltering Innovation Confronts the Six Headwinds," NBER Working Paper 18315, August.