Increasingly weightless economies

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This article is one of an occasional series provided by academics working outside the Bank of England. The views expressed reflect those of the author rather than those of the Bank of England.

In this article Danny T Quah examines how, when an economy grows, its patterns of production and consumption systematically change. He describes one such large-scale evolution, namely, the increasing weightlessness of aggregate output across advanced economies. In all fast-growing successful countries, growth in information technology has contributed positively both to increasing weightlessness and to economic growth. In the sample of countries studied here, the richer the country the higher the contribution to growth of information technology and services; in no country has manufacturing, as traditionally construed, continued to be as important.

Introduction

What happens to the mix of economic activity as developed economies continue to grow? This article presents empirical evidence that shows such economies become increasingly *weightless* over time. By this I mean that greater value, as a fraction of GDP, resides in economic commodities that have little or no physical manifestation. Another description of such structural change is progressive *dematerialisation*.

Examples of weightlessness and dematerialisation are diverse: they range from economic activities such as stocking supermarket shelves and styling haircuts, all the way through financial services and up to telecommunications and providing software products on CD-ROM. Within the diversity of dematerialisation different activities might also have widely differing implications for the ability to sustain economic growth. For example, dematerialisation includes high technology but also low technology activities such as making hotel beds or providing gardening services. The latter might well carry a society through hard times but are unlikely to forge nations into enduring economic powerhouses.

One prominent form of dematerialisation is concentration of activity in information technology (IT). Economists are not all agreed that this matters, or that such change differs from any other kind of macroeconomic transformation. Those who suspect it might be important and different have just begun to study its implications for a range of issues: whether economic growth can be sustained in advanced economies; what might happen to the distribution of income across and within societies; and how trade patterns and macroeconomic policy must adjust as dematerialisation proceeds.

In assessing the evidence on sectoral change and aggregate growth, this article examines whether dematerialisation and IT will matter increasingly for economic performance and wealth creation.

Such an exercise can refine our understanding of the nature of economic growth. And the analysis has an immediate policy implication. Statistical agencies divide their research resources across a range of activities to build up a composite picture of the economy. Knowing that some sectors are likely to become more important than others can help improve the allocation of those resources. For instance, as the manufacturing sector shrinks as a percentage of GDP and shows behaviour different from those sectors that grow faster (ie, services), the performance of manufacturing will reveal progressively less about the macroeconomy.[2]

The economic issues

Two aspects suggest that dematerialisation might be macroeconomically important. The first is simply increasing weightlessness deriving from the growth of services—as opposed to, say, manufacturing in particular, or industry in general. The second is dematerialisation deriving from the increasing importance of IT.

These two aspects differ in their economic implications.[3] But they are both controversial. Some economists doubt if the basis of a strong, growing economy can be provided by services in general or IT in particular. Some have argued

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(2) For studying aggregate business cycles, this point has been emphasised in Lee (1996).
(3) Quah (May and October 1996) discusses some of those in greater detail.

that weightlessness might be regarded as being without substance and, consequently, without value. Two versions of this view can be distinguished. To the extent that increasing weightlessness means further development of multimedia in entertainment and video games, some consider it to be frivolous at best but actually harmful at worst. Others view increasing weightlessness as irrelevant.

It is useful to say explicitly what I mean by dematerialisation in economic growth, and to consider services and IT separately. I ask below, where in advanced economies does growth in GDP occur?

Nominal GDP—like any other measure of aggregate output that macroeconomists study—represents both value created and that willingly paid for by consumers. If something is valued and marketed then it shows up as part of GDP. Among economists at least, there should be no controversy over whether IT is what people want or whether multimedia entertainment adds economic value. These should simply be evaluated at market prices and sized up relative to everything else that enters GDP. Weight is irrelevant for economic value; what matters is how large that economic value is.

Examining output through GDP gives a measure of domestic value added. But detail on—for instance—UK spending on US imports has to be obtained from the expenditure measure of GDP. If the typical UK resident had come to depend on IT products—for example, through banking by computer or shopping over the internet—but all those were *imported* IT products from the United States, then little of what really mattered in economic life would show up in UK GDP. Analysing the GDP output measure alone would then underestimate IT's true importance in the UK economy. It is useful, therefore, to look also at the spending side; I will do so below.

Decomposing the United Kingdom's GDP growth: dematerialisation and IT

According to the IMF *Balance of Payments Statistics Yearbook*, in all OECD economies exports of services accounted for more than 10% of total gross exports of goods and services over the period 1990–94. The OECD economies can be split into two groups: first, exporters primarily of goods, for example Canada, Germany and Japan; and second, more diversified exporters, including the United Kingdom, where services amounted to close to 25% or more of total gross exports of goods and services. And for the United Kingdom, of the value added from exports, services accounted for 43% in 1990 (the latest data available).

To begin, consider how GDP in the United Kingdom has evolved: what has contributed how much to the growth of GDP here?

Traditional macroeconomic accounting divides GDP into three principal categories: agriculture, industry, and services.

- *Agriculture* includes agricultural and livestock production and services; fishing; hunting; and logging and forestry.

- *Industry* includes mining and quarrying; manufacturing; construction; and electricity, gas, and water.

- Finally, *services* includes transport, storage, and communications; wholesale and retail trade; banking, insurance, and real estate; ownership of dwellings; public administration and defence; other services; and statistical discrepancies.

The natural step is to identify *services* as the sector where increasing weightlessness matters, and to take *agriculture* and *industry* as being the opposite.

But, for studying the issues of interest here, this partitioning is not ideal. IT does not show up neatly on only one side of either manufacturing or services. It comprises semiconductors, computers, software, telecommunications, and IT services (see, eg, OECD). Thus, IT straddles, among other things, manufacturing under *industry*, and transport, storage, and communications under *services*.

Production of semiconductors *is* manufacturing. But, semiconductors are also prime examples of dematerialisation. The location of their manufacture is unimportant because transportation costs are trivial (see, eg, the anecdotal evidence in Quah, May and October 1996). Semiconductor value derives from a logic configuration that sits on top of an ultra-thin wafer of silicon; the physical material, to all intents and purposes, is worthless. Yet, semiconductor production is recorded as manufacturing—just as are making steel cranes and railway sleepers.

For analysing dematerialisation, difficulties remain even at more micro levels of disaggregation. The International Standard Industrial Classification (ISIC) scheme partitions all economic activity into categories—the greater the number of digits in the ISIC code, the finer the disaggregation. At the four-digit level, the category ISIC 3825—office, computing, and accounting equipment manufacture—includes not only computers and peripherals, but also typewriters, cash registers, and simple accounting machines. Electronic components—a key IT ingredient—is placed not with computers, but elsewhere in ISIC 3832 (radio, TV, and communication equipment manufacture) instead, which then includes many other things unrelated to IT.

Thus, the *agriculture*, *industry* and *services* split provides little sharp insight on GDP dematerialisation and IT. Nevertheless, such a division is the only one available for a wide range of countries at differing levels of development. Therefore, it is the one I use. Such a division, while crude, shows general tendencies reasonably well. And, the methodology I describe will readily apply as more apposite data become available: I use this fact below when I combine IT and GDP data from different sources.

Let $Y(t)$ denote the time t flow of GDP. Index by j an arbitrary partitioning of the economy—say into the three categories *agriculture*, *industry* and *services*—so that:

$$Y = \sum_j Y_j \qquad \textbf{(1)}$$

where Y_j denotes GDP in category j. Differentiate both sides of equation **(1)** with respect to time t, and use dots to denote time derivatives. Then, normalising by Y, equation **(1)** becomes:

$$\dot{Y}/Y = \sum_j \dot{Y}_j / Y = \sum_j \left(\dot{Y}_j / Y_j \right) \quad \text{x} \quad \left(Y_j / Y \right) \qquad \textbf{(2)}$$

Define g to be the proportional growth rate of Y and g_j that of Y_j. Let s_j be sector share Y_j/Y. Then equation **(2)** can be rewritten as

$$g = \sum_j g_j \, s_j = \sum_j \gamma_j \qquad \text{with } \gamma_j = g_j \text{ x } s_j \qquad \textbf{(3)}$$

Equation **(3)** decomposes GDP growth into contributions due to the different sectors. Provided that g is not zero, equation **(3)** then says $\bullet_j \, \gamma_j/g = 1$, so that γ_j/g is sector j's relative contribution to total GDP growth.(1)

Each γ_j is the product of the sector's share in total GDP with that sector's proportional growth rate. Thus, in general, sector j will show a high contribution to growth only when both its share s_j and its growth rate g_j are high. Growth rates and sector shares g, g_j, and s_j will typically all change through time; but, at each moment in time, equation **(3)** will hold.

Since the split of the economy into categories in **(1)** is arbitrary, a sector's contribution to GDP growth can always be estimated by g_j x s_j, regardless of whether complete data exist on all remaining sectors. When the data are exhaustive, then the sector contributions sum to 1, but that is the only additional insight from having the entirety of sectors.

Using the World Bank's 1996 *World Tables*, I calculated the decomposition **(3)** for UK GDP measured in nominal US dollars at prevailing exchange rates. Use of nominal GDP data does mean that the results are subject to a couple of caveats. When considering the contribution of each sector it might be more informative to look at the real contribution—excluding the effect of different inflation rates (or even industry specific purchasing power parity exchange rates) between sectors. But this breakdown is difficult to achieve accurately if price measures do not adequately account for changes in quality: this may be important for computers where prices are measured per computer rather than per unit of computing power. The importance of this is uncertain and it is left to further research to consider these issues.

Table A shows the nominal GDP decomposition for five-year intervals from 1972 for the *agriculture/industry/services* split, but then also peels out the *manufacturing* component in industry.

Table A
Decompositions of UK GDP growth over five-year intervals

Per cent per year

Time span		γ/g				
	g	Agr.	Ind.	(Mnf.)	Svc.	IT (a)
1972–77	9.8	2.2	39.7	(25.5)	58.1	
1977–82	13.1	2.0	42.1	(20.7)	55.8	
1982–87	7.2	1.0	26.9	(22.6)	72.1	
1987–92	9.0	1.4	21.3	(15.6)	77.3	1.1

(a) The IT figure is for 1987–94.

In each row, the figures under Agr., Ind. and Svc. sum to 100, subject to rounding error.

Next, I used data from the OECD 1995 *Information Technology Outlook* to calculate the contribution of IT to GDP growth, although only from 1987. Unlike the value-added calculation given in the *agriculture/industry/services* split, IT contribution means spending on IT, not production. Therefore, division **(1)** is used now with Y as total spending, rather than total production. Nevertheless, the same principle applies.

Table A shows that *services'* contribution to UK growth rose from twice *manufacturing*'s in 1972–77 to more than five times the latter by 1987–92. Over the same period, *services*' growth contribution rose from one and a half times *industry*'s to almost four times the latter. This increase seems dramatic, but even by the 1970s, UK growth was already more than half due to *services* alone. Regardless of whether historical overall growth is considered strong or weak, it is unambiguous that the *services* sector has contributed substantially and increasingly to UK wealth creation.

The IT figure of only 1.1% for 1987–92 is, by comparison, tiny—smaller even than *agriculture*.

Can *services'* γ/g—contribution to GDP growth—continue to be so much larger than all the other sectors'? If the economy undergoes *balanced growth*—when all sectors grow at the same rate and thus sector shares are constant—then γ_j/g ratios simply reflect those different (constant) shares.(2)

Thus, in balanced growth, our observations on the relative contributions in Table A apply not just to growth dynamics, but to level shares as well. Using Table A then as a prediction on long-run, steady-state growth, the overwhelming importance of *services* is obvious.

Of course, most economies need not be undergoing balanced growth just yet. Some sectors might grow much faster than others and will thus be increasing their share of total GDP. What then can we learn from the calculations underlying

(1) Even if g is negative with some γ_j positive, so that $\gamma_j/g < 0$, the interpretation still goes through: sector j restrained the economy from wherever it would have otherwise gone.
(2) To see this, notice that equation **(3)** with $g_j = g$ for all j gives $\gamma_j = g_j \, s_j = g s_j \Rightarrow \gamma_j/g = s_j$.

Table A? By definition, sector *j*'s share is

$$s_j = Y_j/Y$$

Taking proportional growth rates on both sides gives

$$\begin{aligned}\dot{s}/s_j &= g_j - g \\ &= (\gamma_j/s_j) - g \\ &= [\gamma_j/g - s_j] \times (g/s_j) \qquad \textbf{(4)}\end{aligned}$$

Equation **(4)** says that the sector share's proportional growth rate depends on how large that sector share already is compared to the overall growth rate. Of course, since sector shares have to lie between 0 and 1, this growth cannot continue indefinitely, but away from those boundaries, equation **(4)** gives a rough guide as to how sector shares will evolve.

In Table B I present growth dynamics for the *services*, *manufacturing*, and IT sector shares. Within each bloc, column *s* shows percentage share; column γ/g shows contribution to total growth; and column $\dot{s}/s$ shows how fast the sector share is growing. I emphasised above that these figures can show no more than rough tendencies; nevertheless, it is useful to provide an interpretation for them. Thus, take the row for 1987–92: *services'* sector share is growing at 2% per year. If this continues, then *services*' current 60% share will become 90% in 20 years.(1) By contrast, the manufacturing share continues to decline: with a rate of change of -3% the 20% share will decline to 15% in ten years.

Table B
Changes in UK sector shares: services, manufacturing, and IT

Per cent per year

	Svc.			Mnf.			IT (a)		
	s	γ/g	$\dot{s}/s$	*s*	γ/g	$\dot{s}/s$	*s*	γ/g	$\dot{s}/s$
1972–77	54.7	58.1	0.6	30.4	25.5	-1.6			
1977–82	54.9	55.8	0.2	27.8	20.7	-3.4			
1982–87	57.5	72.0	1.8	25.0	22.7	-0.7			
1987–92	62.8	77.3	2.1	23.6	15.6	-3.1	2.5	1.1	-5.2

A sector is expanding when its growth contribution γ/g exceeds its share *s*. The sector growth rate $\dot{s}/s = [\gamma/g - s](g/s)$ is given per cent per year; ratios (*s*, γ/g) are in percentage points.

(a) The IT figures are for 1987–94.

Interestingly, although in absolute figures IT spending is increasing, its share of the total is *declining*: the growth contribution γ/g is less than *s*. Moreover, this low growth contribution comes from IT's relatively low growth rate, not a low sector share. The 2.5% share in the United Kingdom is high compared with many other countries. The United States has about the same share, but one that is rising rather than falling. Two interpretations are possible: first, IT is just not an important part of the burgeoning dematerialised economic activity in the United Kingdom. I think this implausible. Second, the United Kingdom is not yet saturated with IT, and much more room remains for continued expansion. Given the results for the United States below, this possibility needs to be investigated further. More finely disaggregated and timely data would help here.

I now turn to the growth experiences of other economies, but it is useful to summarise the lessons thus far. Tables A and B have provided a picture of the UK economy where the performance of the weightless *services* sector has been the outstanding characteristic in aggregate economic growth. The sector is not only large, but continues to outpace all others. If the current trend were to continue, within a decade *manufacturing* would contribute no more than one tenth of the total value generated in the economy.

Decomposing economic growth across countries

Tables C.1, C.2, C.3, C.4 and C.5 provide results for a range of countries with differing growth experiences—the United States, Singapore, Korea, Pakistan, and the Philippines, respectively: they present the same growth decompositions as given for the United Kingdom in Table A. Similarly, Tables D.1, D.2, D.3, D.4 and D.5 present sector share dynamics for the different countries, analogous to Table B. (For Pakistan and the Philippines, I have been unable to obtain IT numbers.)

On Table C.1 we see that the United States is an economy where the *services* sector growth contribution has risen, continually, from under 60% in 1972–77 to over 80% in 1987–92. These contributions exceed their UK counterparts. At the estimated 2% annual rate of decrease (Table D.1, 1987–92) *manufacturing*'s share of 20% would decline to 15% in ten years. In the United States the IT share was only 2.4% of GDP by the end of the 1980s, marginally lower than in the United Kingdom. But, unlike the United Kingdom, the IT sector share is estimated to be growing at over 2% per year. This figure though seems quite small: if maintained, it implies only a doubling in 30 years.

Singapore is widely regarded as a successful, fast-growing economy. The *services* sector has, throughout the sample, accounted for over 60% of GDP growth. However, that contribution has remained roughly constant, unlike the United States and the United Kingdom where it has risen sharply. In Singapore, *manufacturing*'s growth contribution has consistently remained more than one quarter; and its share in GDP began to decline only towards the end of the sample. Singapore's recent massive IT push (eg, Slavin 1996) has not yet manifested in these data: the IT share actually declined over 1987–94.

Korea resembles Singapore in that *manufacturing* remains important for growth, but the share declines towards the end of the sample. On the other hand, Korea has increased its IT share, but the figure of only 0.7% in 1987 is surprisingly small—as is IT's growth contribution of only 0.8% over 1987–92. Although *services*' growth contribution in Korea

(1) The ratio of 90 to 60 is 1.5, whose natural log is 0.4; dividing this by the growth rate gives time in years needed to make the transition.

Table C.1
Decompositions of US GDP growth over five-year intervals

Per cent per year

Time span	g	γ/g Agr.	Ind.	(Mnf.)	Svc.	IT (a)
1972–77	10.3	-5.0	48.3	(29.4)	56.8	
1977–82	9.8	2.1	30.3	(15.6)	67.6	
1982–87	7.4	0.8	22.1	(17.2)	77.1	
1987–92	5.9	1.8	17.3	(13.0)	81.0	3.3

In each row, the figures under Agr., Ind., and Svc. sum to 100 (subject to rounding error).

(a) The IT figure is for 1987–94.

Table C.2
Decompositions of Singapore GDP growth over five-year intervals

Per cent per year

Time span	g	γ/g Agr.	Ind.	(Mnf.)	Svc.	IT (a)
1972–77	17.7	1.6	35.0	(27.9)	63.4	
1977–82	18.4	0.5	39.4	(27.0)	60.1	
1982–87	5.8	-1.1	40.0	(37.4)	61.1	
1987–92	19.6	-0.0	35.0	(26.2)	65.0	1.7

In each row, the figures under Agr., Ind., and Svc. sum to 100 (subject to rounding error).

(a) The IT figure is for 1987–94.

Table C.3
Decomposition of Korea GDP growth over five-year intervals

Per cent per year

Time span	g	γ/g Agr.	Ind.	(Mnf.)	Svc.	IT (a)
1972–77	28.1	20.3	39.4	(30.8)	40.4	
1977–82	15.3	6.7	43.7	(29.1)	49.6	
1982–87	12.5	5.0	47.3	(35.6)	47.8	
1987–92	17.7	5.3	45.4	(25.2)	49.2	0.8

In each row, the figures under Agr., Ind., and Svc. sum to 100 (subject to rounding error).

(a) The IT figure is for 1987–94.

Table C.4
Decompositions of Pakistan GDP growth over five-year intervals

Per cent per year

Time span	g	γ/g Agr.	Ind.	(Mnf.)	Svc.	IT (a)
1972–77	10.2	25.0	25.4	(14.1)	49.6	
1977–82	15.0	29.9	22.2	(15.5)	47.9	
1982–87	1.6	-35.3	43.8	(34.4)	91.5	
1987–92	7.7	26.0	28.8	(18.9)	45.2	n.a.

In each row, the figures under Agr., Ind., and Svc. sum to 100 (subject to rounding error).

(a) No IT data were available.

Table C.5
Decompositions of Philippines GDP growth over five-year intervals

Per cent per year

Time span	g	γ/g Agr.	Ind.	(Mnf.)	Svc.	IT (a)
1972–77	19.6	29.0	38.4	(24.7)	32.6	
1977–82	13.6	17.4	41.9	(24.9)	40.7	
1982–87	-2.2	18.0	75.5	(27.1)	6.4	
1987–92	9.8	17.6	30.6	(23.4)	51.7	n.a.

In each row, the figures under Agr., Ind., and Svc. sum to 100 (subject to rounding error).

(a) No IT data were available.

Table D.1
Changes in US sector shares: services, manufacturing, and IT

Per cent per year

	Svc.			Mnf.			IT (a)		
	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$
1972–77	62.8	56.8	-1.0	24.3	29.4	2.2			
1977–82	63.7	67.6	0.6	22.5	15.6	-3.0			
1982–87	66.8	77.1	1.1	20.2	17.2	-1.1			
1987–92	69.5	81.0	1.0	19.2	13.0	-1.9	2.4	3.3	2.2

A sector is expanding when its growth contribution γ/g exceeds its share s. The sector growth rate $\dot{s}/s = [\gamma/g - s](g/s)$ is given per cent per year; ratios (s, γ/g) are in percentage points.

(a) The IT figures are for 1987–94.

Table D.2
Changes in Singapore sector shares: services, manufacturing and IT

Per cent per year

	Svc.			Mnf.			IT (a)		
	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$
1972–77	64.2	63.4	-0.2	24.0	27.0	2.2			
1977–82	62.4	60.1	-0.7	26.8	27.0	0.1			
1982–87	61.6	61.1	-0.0	25.4	37.4	2.7			
1987–92	61.0	65.0	1.3	28.0	26.2	-1.3	1.9	1.7	-2.1

A sector is expanding when its growth contribution γ/g exceeds its share s. The sector growth rate $\dot{s}/s = [\gamma/g - s](g/s)$ is given per cent per year; ratios (s, γ/g) are in percentage points.

(a) The IT figures are for 1987–94.

Table D.3
Changes in Korea sector shares: services, manufacturing, and IT

Per cent per year

	Svc.			Mnf.			IT (a)		
	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$
1972–77	43.3	40.4	-1.9	25.7	30.8	5.6			
1977–82	43.7	49.6	2.1	29.9	35.6	2.4			
1982–87	46.3	47.8	0.4	29.9	35.6	2.4			
1987–92	47.5	49.2	0.7	30.0	25.2	-2.8	0.74	0.75	0.4

A sector is expanding when its growth contribution γ/g exceeds its share s. The sector growth rate $\dot{s}/s = [\gamma/g - s](g/s)$ is given per cent per year; ratios (s, γ/g) are in percentage points.

(a) The IT figures are for 1987–94.

Table D.4
Changes in Pakistan sector shares: services, manufacturing and IT

Per cent per year

	Svc.			Mnf.			IT (a)		
	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$
1972–77	43.4	49.6	1.4	15.3	15.5	0.2			
1977–82	45.8	47.6	0.7	15.2	15.5	0.2			
1982–87	48.5	91.5	1.4	15.9	34.4	1.9			
1987–92	49.0	45.2	-0.6	17.0	19.0	0.9	n.a.		

A sector is expanding when its growth contribution γ/g exceeds its share s. The sector growth rate $\dot{s}/s = [\gamma/g - s](g/s)$ is given per cent per year ratios (s, γ/g) are in percentage points.

(a) No IT data were available.

Table D.5
Changes in Philippines sector shares: services, manufacturing and IT

Per cent per year

	Svc.			Mnf.			IT (a)		
	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$	s	γ/g	$\dot{s}/s$
1972–77	35.4	32.6	-1.6	25.9	24.7	-0.9			
1977–82	36.0	40.7	1.8	25.5	24.9	-0.3			
1982–87	39.5	6.4	1.9	24.8	27.1	-0.2			
1987–92	43.3	51.7	1.9	25.0	23.4	-0.6	n.a.		

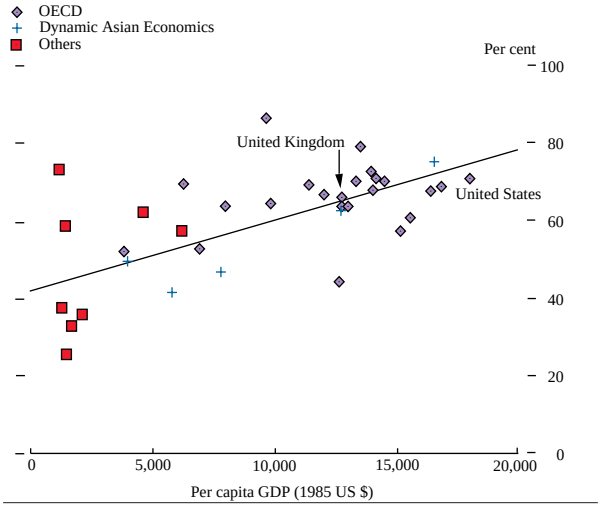
A sector is expanding when its growth contribution γ/g exceeds its share s. The sector growth rate $\dot{s}/s = [\gamma/g - s](g/s)$ is given per cent per year ratios (s, γ/g) are in percentage points.

(a) No IT data were available.

increased sharply from 1977 to 1982 (40% to 50%), that figure has since remained roughly constant.

Finally, turn to Pakistan and the Philippines.(1) The patterns of change here are less clear-cut. In Pakistan, services have always contributed more than 40% to GDP growth, but manufacturing continues to increase its share of GDP. Growth patterns show little stability in the Philippines, but manufacturing has consistently declined.

Chart 1
Contribution of services to GDP growth plotted against 1992 per capita GDP



I now expand the sample to include all the other OECD economies, all Dynamic Asian Economies (DAEs), and a selection of others. For these countries, Charts 1 and 2 plot the growth contributions of *services* and IT against per capita incomes. For completeness Chart 3 also gives the analogous plot for *manufacturing*'s growth contribution.(2)

The figures yield a number of interesting conclusions. First, for all the relations depicted here, the distinction between OECD and non-OECD membership does not seem to matter. Once one allows for per capita GDP, the respective scatters of OECD and non-OECD points are not out of line with each other. Although in 1994, 93% of the IT market of US $431 billion was concentrated in the OECD area (with 80% in just the United States, Japan, Germany, France, and the United Kingdom), that concentration might reflect only the pattern of income distribution across countries.(3)

Second, the slope of the scatter of points in Chart 1 and Chart 2 is positive, while that in Chart 3 is negative. Across the sample, richer countries are those that have higher contributions to economic growth from *services* and from

Chart 2
Contribution of IT to GDP growth plotted against 1992 per capita GDP

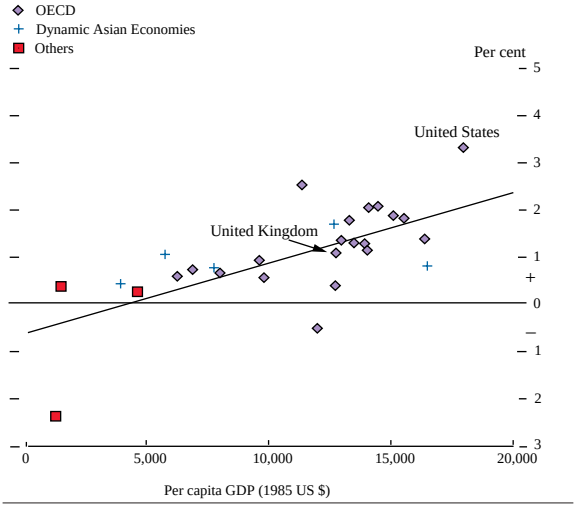
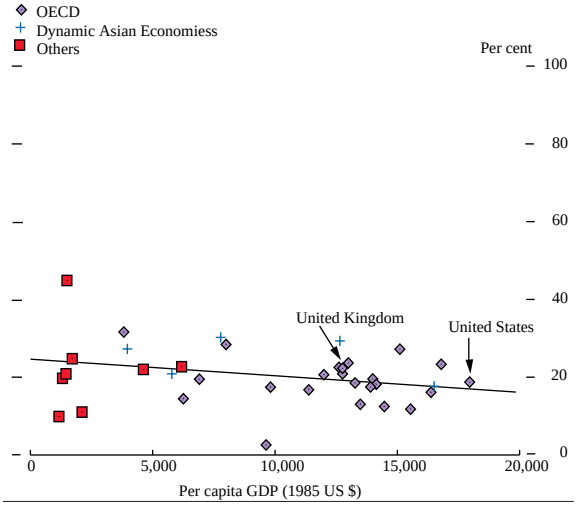


Chart 3
Contribution of manufacturing to GDP growth plotted against 1992 per capita GDP



IT; only the relatively poorer economies continue to see significant contributions from *manufacturing*.

The third conclusion is that for growth, the *services* sector is the most important in all advanced economies. In economies with per capita GDP of at least US $5,000, the *services* sector accounted for more than 40% of that economy's growth performance. In 80% of economies having per capita GDP of at least US $10,000, the manufacturing sector contributes less than 20% of that economy's growth performance.

Finally, the United States is distinguished in having experienced the highest contribution from IT to aggregate growth.

(1) Fairly or unfairly, these are frequently singled out (by, among others, Lucas (1993) and the World Bank) for comparison with Korea and other successful fast-growing economies.
(2) Per capita incomes are taken as the 1992 values of per capita GDP, in 1985 US dollars, calculated using a chain index (Summers and Heston (1991) and updates).
(3) In Chart 2 the two highest points are the United States and New Zealand. The two points that show negative IT contribution are India (-2.4%) and Finland (-0.5%). From 1987 to 1994, India actually experienced *negative* GDP growth, while IT growth was 11%. In this case, how to interpret my measure of IT's contribution to growth is subtle, but I have decided to maintain the convention earlier described. Over this period, Finland showed a slight negative decline in IT spending measured in current exchange rates, as used throughout this paper. Using purchasing power parity corrections, this would have showed a slight increase instead. Either way, however, the magnitude of its contribution to growth is small.

What do these estimates tell us about the United Kingdom's specialisation in services? Advanced economies all have the *services* sector contributing the most to growth. The richer the economy, the more it relies on the *services* sector, and the less on *industry*, *manufacturing*, or *agriculture*.

Conclusion

This article has investigated growth facts on GDP's increasing weightlessness—through dematerialisation in general and IT in particular.

Although the picture varies across countries, several generalisations are apparent. First, the *services* sector is the most important in all advanced economies. In richer economies (those with per capita GDP of at least US $5,000), the *services* contribution to growth is always at least 40%. In almost all advanced economies it is *services* which figure most prominently in growth.

Second, while increasing dematerialisation matters, it is much less clear that a great deal of that has, thus far, arisen from IT. Successful economies like the United States and Korea do show a rising emphasis on IT, but other successful ones, like Singapore, do not—at least not dramatically.

Circumspection is called for in drawing implications from this last observation. The United States and Korea might be leading the way for all other economies, while Singapore might simply show the potential for greater future growth and IT concentration.

The United Kingdom is one economy that has had its *services* sector both contributing strongly to GDP growth and continuing to increase rapidly in share. But, here, the transition to an IT emphasis remains far from obvious. Again, this might just mean that the scope for high IT growth in the United Kingdom remains correspondingly large.

Third, increasing weightlessness and dematerialisation in economic growth take many different forms. To see whether IT has become more important in overall economic activity, it is far from ideal to look simply at the national income accounting distinction between *manufacturing* and *services*. IT involves elements of both, and looking at just the standard classification categories can mislead. While already-developed economies like the United Kingdom and the United States almost uniformly show continuing decline in *manufacturing*, the shift to the *services* account does not reveal whether IT is becoming more or less important as a fraction of GDP: revisions to the standard industrial classification categories might be called for, eventually. New data are critical for further investigation. For the United Kingdom, considerable additional insight might result if finer statistical details on this split were available.

One overarching conclusion from this analysis is that the term 'industrialised countries' no longer carries any resonance: now, no advanced and growing country is dependent on production industries. But, whether it is IT and only IT that will subsequently be the main engine of growth is not yet apparent from the numbers. The United States leads the way, but even there IT has made only a 3% contribution to GDP growth, while the increase in IT share in GDP is, for the time being, no more than 2% per year.

One goal of this article was to stimulate discussion on the issue of changing industrial structures in economic growth. The financial sector is a large part of the weightless economy, and this article has said little about it. Implications for financial and monetary policy, appropriate emphasis on the manufacturing sector, the importance of the exchange rate for the geographical location of economic activity—all might follow from better understanding and more precise measurement of the effects described above. My calculations above made simplifying assumptions, and left open a number of other empirical issues that will lead to a programme of further work.

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