Productivity Briefing Note

(final version, 6th October 2015)

Key Points

- Productivity, and its rate of growth, is a key measure of economic success
- It is best measured in terms of labour productivity per hour
- Within the overall measure, multi-factor productivity (MFP) is a key element as it picks up the role of innovation and new practices in improving output
- Many 'advanced' economies have been worried about a slowing in underlying productivity in recent decades
- This concern has been exacerbated post 2007 as productivity has fallen or stood still
- The UK has been one of the worst performers post 2007 in terms of poor productivity performance
- Unusually, such a poor productivity performance has been seen across almost all sectors of the economy
- There are a variety of possible causes of this, including:
  - decline of specific industries (e.g. North Sea oil and Finance)
  - a shift from capital to, cheaper, labour inputs as well as labour 'hoarding'
  - impaired access to funding, less investment and less competition from fewer new start ups
  - mis-measurement of the data
- Scotland has suffered less than the UK but has still performed poorly vs its pre 2007 record
- One of the key drivers of MFP in recent decades has been the on-going impact and roll out of new ICT developments and this is likely to continue
- Scotland's record on R&D spending and on innovation, which are key to improving MFP, remains relatively poor.
- While there is a crucial role to be played by invention and innovation as sources of productivity growth, there is an even greater role played by assimilation and 'catching up' by companies who are not at the forefront of technological progress.

Purpose

The key objective of this paper is to briefly provide a common understanding of our current knowledge base with regards to: different measures of productivity; its key components; how and why it has shifted over time; and potential policy recommendations to improve it.

Introduction

It has long been recognised by economists that the rate of growth of productivity is one of, if not the, key measure by which to judge the absolute and relative performance of an economy.

While overall **growth in GDP** is a useful top line measure of economic growth, over time it is productivity that is the most crucial measure.

For example, fast GDP growth can occur simply due to a rising population, without the **standard of living (GDP per capita)** necessarily rising alongside.

Equally a rising GDP per capita may be caused by demographic shifts, for example, due to more of the population being of working age, or by people working longer hours. Again, this may not necessarily mean that the economy, or individuals, are doing better, just that more time is being spent on work, regardless of whether this is a desirable outcome or not.

Labour productivity, as measured by GDP per worker or, preferably, by **GDP per hour**, adjusts for some of these potentially misleading elements to reach a more accurate judgement of the underlying improvement over time of the productive potential of an economy.

It is also possible to dis-aggregate changes in overall labour productivity into component elements, including - labour composition (which measures the level of workforce skills in terms of experience and education), capital deepening (which measures the capital stock available per unit of labour input) and multi-factor productivity.

This latter element, **multi-factor productivity (MFP)**, is often highlighted and analysed by researchers as it is considered to be the most important element, capturing the dynamism of an economy, whereby the benefits of finding new ways of doing things are harnessed through improving efficiency and spreading the benefits of innovation.

However, MFP can also be thought of as a measure of our ignorance over what drives productivity growth as it is essentially the unknown, or residual, element of labour productivity that is left after the impact of what can be measured is adjusted for. (1) As such it has the potential to cover a variety of impacts, including vital elements like innovation, imitation and management structures, although it also includes unwanted elements like mis-measurement of the data. In order to give it an easier to grasp title, the term MFP could also be referred to as **Innovation and Organisational Efficiency (IOE)**.

Throughout history IOE will have been affected by the economy wide exploiting of the benefits of new inventions, such as automation, steam trains and electricity. It is usually the case that the indirect effects of these inventions far outweighs the direct effects, as their positive impact disperses out across the whole economy.

The latest wave of such invention relates to **Information and Communications Technology (ICT)** which has followed on from the development of computers in the 1950's. As is often the case it takes some years, even decades, for such an original invention to be further developed and adapted to allow for more widespread use. As time has passed the ubiquity and usefulness of computers has expanded and further waves of related invention have occurred, for example, around digitalisation and the internet.

To highlight the impact that the different definitions of growth can have, Table 1 shows estimates over the period 1980 to 2007.

Table 1: Contributions to Real Output Growth in the Market Economy (2), European Union and the United states, 1980-2007 (annual average growth rates, in percentage points)

	European Union		United States	
Measure	**1980-1995**	**1995-2007**	**1980-1995**	**1995-2007**
GDP (real)	2.1	2.5	3.3	3.5
Hours worked	-0.5	0.8	1.3	0.9
Labour productivity	2.5	1.6	2.0	2.6
Multi factor productivity	1.1	0.6	0.7	1.2

Source: Timmer et al (2011), 'Productivity and Economic Growth in Europe: A Comparative Industry Perspective', International Productivity Monitor, Number 21, Spring 2011.

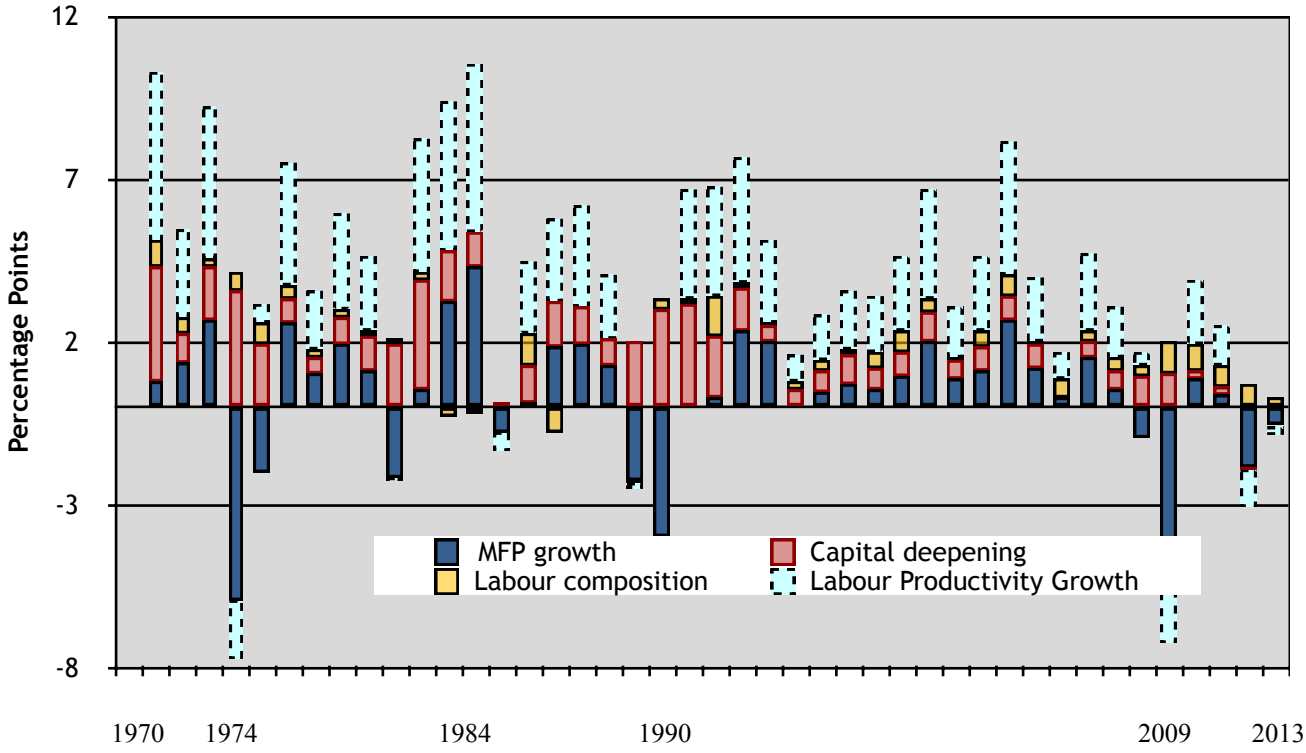
As can be seen, while the US continued to outgrow the EU post 1980, in fact the EU had a better productivity record over the period to 1995 and it was differences in work patterns that raised the US growth rate. However, post 1995, changes to work patterns have been similar and higher labour productivity growth, including higher MFP growth, has led to the US's better performance.

1. Scottish and UK productivity

Worries over the UK's decline in labour productivity have existed for some time, but these concerns have heightened in more recent years.

Figure 1 illustrates the overall productivity slowdown including the contribution of slower growth in both capital deepening and MFP to this. Capital deepening, while still generally positive, contributes much less now than in the 1970s or 1980s. MFP has always been susceptible to recessions but usually sees a positive bounce back soon after, although not this time.

Figure 1: Decomposition of UK labour productivity growth, 1970-2013, Whole Economy, with the main years of negative growth highlighted



Source: ONS, 'Multi-factor Productivity (experimental), Estimates to 2013', January 2015
Note: dashed lines illustrate cumulative effect of all solid line contributions.

For Scotland, official SNAP (Scottish National Accounts Project) estimates of labour productivity have only been published since 2014. They do not yet have National Statistics designation from the UK Statistics Authority, only go back to 1998 and exclude any North Sea activity. (See Table 2.)

Table 2: Labour Productivity Growth (per hour), 1998 to 2013, real terms

Annual average, real terms, percentage points	Scotland	UK
1998-2007	1.7%	2.3%
2007-2013	0.6%	-0.2%
Change	-1.1%	-2.5%

Sources: Scottish government, 'Labour Productivity Statistics, 1998-2013', June 2015; ONS, 'Labour Productivity, Q1 2015' database, July 2015.

While Scotland's productivity performance pre 2007 was much better than its post 2007 performance, in relative (to the UK) terms it has improved post 2007. Some of this differential will be due to the rapid decline in North Sea production levels (Note: in the official published data 'extra regio', i.e. North Sea related, output is included at the UK level but not at the Scottish level) seen in recent years. However, even adjusting for this the Scottish performance, post recession, would be relatively better.

Sectoral breakdown

A breakdown by industrial sector allows us to differentiate between productivity performances across the economy at the UK level and Table 3 illustrates some of the key differences.

Table 3: UK Labour Productivity Growth (per hour) by Industrial Sector, 1998 to 2013, real terms changes in percentage points

	Whole economy	Manuf'g	Const'n	Services	Market economy	Gov't services
1998-2007 annual average	2.3	4.7	0.6	2.2	2.2	0.2
2007-2013 annual average	-0.2	0.5	-0.3	0.0	-0.8	-0.6
Change	-2.5	-4.2	-0.9	-2.2	-3.0	-0.8

Source: ONS, 'Labour Productivity, Q1 2015' database, July 2015.

- Manufacturing has experienced the fastest pace of productivity growth, pre and post recession. However, it also experienced the biggest slowdown in productivity growth.
- Public sector services tends to have a slow rate of productivity growth but have also seen the smallest slowdown in productivity growth between the two periods.

Within general sectors, like Manufacturing or Services, there have been a variety of productivity performances, although only Transport equipment (mainly cars) and the Admin & Support sector, have seen a similar or faster pace of productivity growth since 2009.

Table 4 illustrates the performance for ICT related and high productivity (level) sectors, where the fastest growing sub-sectors have, post-recession, slowed dramatically.

Table 4: UK Labour Productivity Growth (per hour) by Industrial Sub-sector, 1998 to 2013, real terms annual changes in percentage points

	Manufacturing		Services	
Time period	**Chemicals & Pharm's**	**Computers etc**	**Inform'n & Comm'ns**	**Financ'l Services**
1998-2009 annual average	6.5	4.4	5.7*	5.2**
2009-2013 annual average	-3.6	-1.2	-1.1*	-1.0**
Change	-10.1	-5.6	-6.8	-6.2

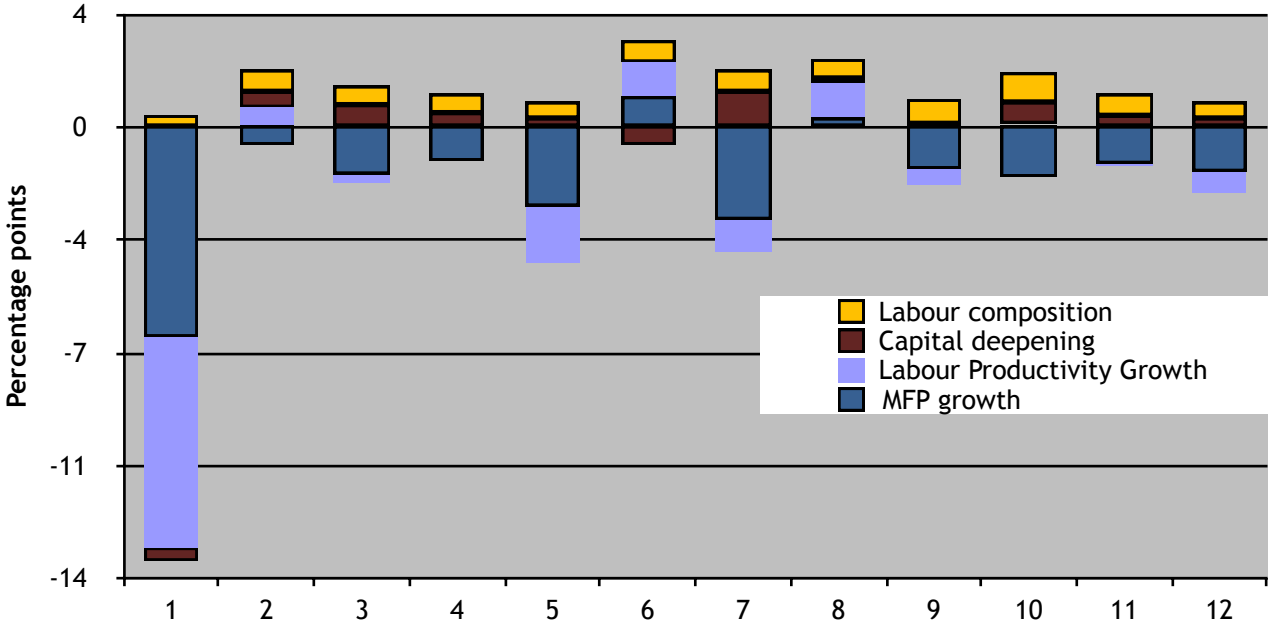
Source: ONS, 'Labour Productivity, Q1 2015' database, July 2015.

* periods 1998-2010 and 2010-2013

** periods 1998-2006 and 2006-2013

For the UK the ONS have published a disaggregated, by industry sector, analysis of labour productivity which helps to disentangle the reasons for its poor performance post 2007. (3) This confirms the strong, negative role of MFP post 2007, with annual average MFP growth (2008-2013) negative in every sector bar 'Information and Communications' and 'Business Services', where it was positive but very low. (See Figure 2.)

Figure 2: Decomposition of annual average labour productivity growth, 2008-2013
By industry



Bar No.	Industry SIC 2007	Industry Description
1	ABDE	Agriculture; Forestry & fishing; Mining & quarrying; Utilities
2	C	Manufacturing
3	F	Construction
4	GI	Wholesale & retail trade; Accommodation & food services
5	H	Transportation & Storage
6	J	Information & communication
7	K	Financial & insurance activities
8	LMN	Real estate activities; Professional & scientific activities; Administrative
9	OPQ	Public administration & defence; Education; Health & social work
10	RSTU	Arts & entertainment; Other services
11	**WE**	**Whole economy**
12	MS	Market sector

Source: ONS, 'Multi-factor Productivity (experimental), Estimates to 2013', January 2015

Disaggregated labour productivity (in per hour terms) data is not published for **Scotland** but can be estimated, on a GDP per worker basis, using sectoral data for GDP and for workforce job numbers.

Table 5 highlights these sectoral productivity figures for both Scotland and the UK and compares the pre-recession period (back to 1998) with the post-recession period, up to 2014.

Table 5: Scottish and UK Labour Productivity Growth (per workforce job) by Industrial Sub-sector, 1998 to 2014, real terms, average annual changes in percentage points,

	Scotland			UK		
	98 - 07	**07-14**	**Change**	**98 - 07**	**07 - 14**	**Change**
Total (exc NSO)	**1.3**	**0.5**	**-0.8**	**2.2**	**0.2**	**-2.0**
(inc NSO)	**n/a**	**n/a**	**n/a**	**1.9**	**-0.1**	**-2.0**
of which:						
Production	4.3	1.4	-2.9	3.9	-0.6	-4.5
Construction	0.1	2.4	+2.3	0.1	0.4	+0.3
Services	1.2	0.3	-0.9	1.9	0.2	-1.7
of which:						
Hotels & Catering	-0.1	-1.5	-1.4	2.0	-1.0	-3.0
Education	-2.7	-1.0	+1.7	-1.4	-1.2	+0.2
Health & Social Work	-0.8	0.7	+1.5	1.8	0.6	-1.2

Sources: Fiscal Affairs Scotland, Monthly Bulletin, June 2015

Note: the averages shown for total labour productivity are slightly different to those shown in Table 2 as Table 5 looks at productivity per worker rather than per hour.

The principal points of interest that emerge for Scotland are:

- Productivity in the Scottish **Construction** industry appears to have risen dramatically in the post-recession period, with a rise in output of almost 20% in the last year alone.
- The data for **Hotels & Catering** suggests that there has been no output growth in this sector since 2003, leading to Scotland's long term relative underperformance, vs the UK. This suggests that tourism has had little impact on growth in the Scottish economy.
- The poor productivity performance of Scottish **Education** in the period to 2007 is partly due to a data glitch in the published tables. However, even when adjusted for both Scotland and the UK are seeing falling productivity over the full period shown.
- Scotland's **Health & Social Work** productivity performance was negative, and much worse than the UK's, in the earlier time period. In the post-recession period it has been positive and similar to the UK's. The 5 year plan for the English NHS incorporates considerable efficiency savings which are geared towards improving future productivity. At present, no such plan exists for the NHS in Scotland at present.
- **Overall**, it would appear that Scotland faces similar issues as the UK, in terms of declining productivity gains, post-recession. However, some of the sectoral patterns seen in Table 5 are difficult to understand and bring into question the reliability of the official, published, data which is used in this analysis.

2. Analysis of post recession UK productivity puzzle

The post recession slowdown illustrated in Section 1 has been the cause of much debate amongst economists as to its cause. A variety of factors have been put forward, some of which are more observable and measurable than others.

The following is a list of possible contributing factors to slowing UK productivity, along with relevant observations over the role and scale of each. In reality, many, or even all, of them are likely to have contributed, to some degree, to the overall fall seen.

Sectoral decline or adjustment

- Rapid decline of North Sea output, which is now half the level it was in 2007.
- Decline of the Finance sector, due to both a diminution of its size (and hence the weight attached to this high productivity level sector) and to restrictions in practice affecting its profitability.

Labour retention or expansion during a period of weak demand

- Labour 'hoarding', in order to retain experienced workforce and in expectation of an upturn in output in the near future. This seems a less plausible explanation as time progresses, and we are now into the 8th year of low productivity growth.
- Substitution of labour for capital as their relative prices change, with labour becoming cheaper.

Higher firm survival rates

- Due to impaired access to funding for new and/or expanding companies. This can emerge through (i) less lending in general due to balance sheet rebalancing (ii) support of existing 'zombie' companies (i.e. forbearance of old loans rather than new ones) resulting in misallocation of constrained financial resources.
- Also encouraged by other forms of 'forbearance' including 'Time to Pay' scheme and by exceptionally low level of interest rates.

Lack of investment in tangible and intangible working capital

- Due to (i) impaired access to funding (ii) over investment in earlier capital purchases (iii) substitution of capital inputs with cheaper labour inputs.

Mis-measurement of the data.

- On the output side, history shows that GDP is usually revised upwards over time.
- On the employment side, there has been a large rise in self-employment and jobs with zero hour contracts. If the number of hours worked is accurately measured this should not be a problem but the rise in self-employment and in zero hour contracts may mean that the number of hours is not being recorded accurately.

Lack of competitive pressure

- This could emerge as a result of low cost pressures due to: low wage inflation, in turn brought about by low inflation in general: an expanding workforce (including a rise in elderly workers); and a lack of emerging new firms.

Analysing the potential causes

A number of attempts have been made to judge the relative importance of some of these causes. (4) In summary, it can be said that while the role of some factors is well understood (e.g. (i) the declining (but with high productivity levels) North Sea and Finance sectors of the economy and (ii) low levels of investment) the role and scale of others factors is still a matter of conjecture. In some cases this will be because accurately measuring such impacts is not possible given the data sources available.

The above analysis of the productivity puzzle applies equally to both the UK and to Scotland, although there has been much less analysis of the Scottish situation. In many instances it can be assumed that a similar impact will have occurred at the Scottish level as is seen at the UK level e.g. impaired access to funding. However, in other cases the Scottish impact may have been different e.g. the impact of declining North Sea activity on related onshore activities, which are likely to be stronger in Scotland.

As well as the reasons discussed above, there may also be an important role being played by longer term factors in falling productivity, particularly in relation to MFP, as the next section discusses.

3. Analysis of long term international (US, EU and UK) productivity data, including 'growth accounting' disaggregation

As the rate of growth of productivity has been long known to be an important factor in driving economic growth it has been the source of much study by economists over recent decades. One of the original 'productivity puzzles' related to the slowdown in productivity seen in the US post the early 70s. This anomaly, given the fairly constant rate of productivity growth prior to that, was thought to have been resolved in the mid 90s when productivity growth in the US returned, but that has turned out to be less true than was originally thought to be the case.

The position for EU countries has been very different, with on-going productivity gains post 1980, probably still associated with the 'catch up' seen since WWII. However, since the mid 1990s the EU has again fallen behind the US performance. See Table 6. (5)

Table 6: Level of Labour Productivity Growth (per hour), 1950 to 2015, (US=100 in each year)

	1950	1980	1995	2007	2015
France	45	92	108	101	96
Germany	35	84	106	101	96
Italy	40	98	102	82	77
UK	60	70	81	80	75

Source: Conference Board Database, accessed July 2015. See Annex 1, Table B1, for the growth rates over the years shown.

Growth accounting breakdown

Economists use the technique of 'growth accounting' (6) to disaggregate the impact of key component elements of the overall labour productivity performance.

Due to the perceived importance of ICT to productivity growth it is often separately identified in academic analysis. However, to measure its full impact we need to estimate (i) the (direct) impact from capital investment in ICT related industries, (ii) the (indirect) impact from non ICT capital investment, which will include ICT related improvements, and (iii) the indirect impact via MFP.

As similar (post 2007) productivity slowdowns have been seen in many developed economies, although few to the same degree as seen in the UK, use of data across countries allows for a wider analysis of the potential causes of such a slowdown.

Table 7 shows a breakdown, using growth accounting, of the overall labour productivity performance since 1980 for the EU and the US.

Table 7: Contributions to Real Output Growth in the (market economy), European Union and the United States, 1980-2007 (annual average growth rates, in percentage points)

	European Union		United States	
Measure	**1980-1995**	**1995-2007**	**1980-1995**	**1995-2007**
Labour productivity	2.5	1.6	2.0	2.6
contributions from:				
- Labour composition	0.3	0.2	0.2	0.3
- ICT capital services per hour	0.4	0.5	0.7	0.9
- Non ICT capital services per hour	0.8	0.4	0.3	0.3
- Multi factor productivity	1.1	0.6	0.7	1.2

Source: Timmer et al (2011), 'Productivity and Economic Growth in Europe: A Comparative Industry Perspective', International Productivity Monitor, Number 21, Spring 2011.

- In both time periods, in terms of both contribution to overall growth and in terms of differential performance over time, the most important element was MFP, being higher in the EU in the earlier period but in the US in the later period
- While capital deepening was higher in the EU in the earlier period, this was down to much higher non ICT related capital investment, while ICT related capital investment grew at about half the rate seen in the US
- In the later period, ICT related capital investment in the EU again grew at about half the rate seen in the US, while non ICT capital investment contributions were similar.
- Labour composition (which is the transformation of the labour force to higher skills) had neither little impact on growth nor was the cause of much of the differential.

Of course the EU region is heterogeneous in terms of the economic performance of its constituent parts and so some of these contributions to change will differ county by country, as Table 8 shows. It also breaks down the post 1990 productivity experience into three time periods.

- Over the pre recession time period (1990-2007) UK labour productivity growth is relatively high, above that of the US.
- This good performance was driven by relatively high contributions from labour composition, ICT capital and MFP.
- Finland was the outstanding performer in labour productivity and MFP terms, linked no doubt to the emergence of Nokia in the mobile phone industry.
- Denmark had the highest contribution from ICT capital but this did not follow through into labour productivity or MFP growth.
- The greatest degree of dispersion of growth rates is associated with MFP and the highest contributions to growth relate to either MFP or ICT capital, with the sole exception of Italy.

Table 8: Contributions to Real Output Growth (all economy), EU economies and the United States, 1990-2013 (annual average growth rates, in percentage points)

1990-2000	Denmark	Finland	France	Germany	Italy	UK	US
Labour productivity	**1.1**	**2.8**	**1.7**	**1.5**	**1.4**	**2.7**	**2.1**
- Labour composition	0.3	0.4	0.4	0.0	0.2	0.6	0.2
- ICT capital services per hour	0.8	0.7	0.3	-0.1	0.2	0.6	0.7
- Non ICT capital services per hour	0.4	0.0	0.7	0.5	0.5	0.5	0.6
- Multi factor productivity	-0.4	1.7	0.3	1.1	0.5	1.0	0.6
2000-2007	**Denmark**	**Finland**	**France**	**Germany**	**Italy**	**UK**	**US**
Labour productivity	**1.3**	**2.3**	**1.4**	**1.5**	**0.5**	**2.2**	**1.8**
- Labour composition	0.1	0.2	0.2	0.1	0.2	0.4	0.2
- ICT capital services per hour	0.7	0.6	0.2	0.3	0.2	0.5	0.5
- Non ICT capital services per hour	0.4	0.3	0.7	0.2	0.6	0.6	0.6
- Multi factor productivity	0.1	1.2	0.3	0.9	-0.5	0.7	0.5
2007-2013	**Denmark**	**Finland**	**France**	**Germany**	**Italy**	**UK**	**US**
Labour productivity	**-0.1**	**-0.6**	**0.2**	**0.6**	**-0.5**	**-0.4**	**1**
- Labour composition	0.0	0.2	0.1	0.1	0.0	0.1	0.1
- ICT capital services per hour	0.6	0.5	0.2	0.5	0.2	0.2	0.4
- Non ICT capital services per hour	0.0	0.2	0.5	0.2	0.0	0.5	0.2
- Multi factor productivity	-0.7	-1.5	-0.6	-0.2	-0.7	-1.2	0.3

Source: OECD, 'The Future of Productivity', (2015)

This analysis tends to confirm the view that the UK's performance in recent times, up to 2007, was relatively good and more in line with that seen in the US than in the large economies of mainland Europe.

However, post 2007 the story has been very different.

- Over the post 2007 time period the UK's relatively good performance has been replaced by a relatively bad one. Part of this will be due to the UK's high presence in Financial Services and the decline in North Sea oil.
- It is particularly noticeable from Table 8 that MFP performance collapses across all countries post 2007, with only the US remaining, marginally, positive. Previous MFP leaders like Finland and the UK have fared the worst.
- There has also been a considerable decline in the role of ICT capital services per hour for the UK (and, to a lesser degree, the US) from the earlier time period's relatively high contribution to growth.

This analysis tends to confirm the view that the UK's post 2007 performance, was one of the worst amongst nations with developed economies. (7)

Firm based breakdown

The most recent OECD analysis of the worldwide slowdown in productivity (8) focussed on the role of different types of firms in the productivity slowdown. It found that:

- Productivity growth of the globally most productive firms has remained robust…
- …but the gap between these and the rest has widened.
- There is evidence of a breakdown of the 'diffusion machine' that spreads innovations out across the economy
- This diffusion machine depends on 'national frontier firms', who are the first to pick up on the global leaders (which tend to be large and multi national firms), adapting innovations to national circumstances, after which 'laggard' firms can start to adopt them
- The observed rise in inequality may, in part, reflect the increasing dispersion in productivity across firms, which means that raising the productivity of 'laggard' firms could promote an improvement in wage equality.

Perhaps the most noteworthy aspect of this research is the widespread heterogeneity of performance within industries, which makes it important to consider productivity beyond the 'average' firm or industry performance.

A Scottish analysis at company level (9) highlights the finding that new plant start ups and foreign owned (i.e. non UK) plants contributed negatively to MFP growth in Scotland post 1997. (10) This counter intuitive, and counter to UK and international experience, finding highlights the need to discover non standard routes to promoting more investment and entrepreneurship, in order to achieve higher productivity.

4. Potential policy recommendations

A number of policy recommendations have emerged from past analysis of productivity performances at the international, UK and Scottish levels.

International

The recent, firm based, OECD report (discussed above) highlighted that, in general, key policies to sustain productivity growth include:

A. pro-competition reforms to product markets, especially in services, to incentivise and facilitate diffusion of new technologies and managerial performance

B. closer collaboration between firms (of all sizes) and universities in order to benefit from access to the global knowledge frontier

C. a level playing field that does not favour incumbents over entrants

D. greater labour mobility in order to reduce skill mismatch

E. public investment in basic research

UK

The relevance of the above OECD recommendations will vary country by country. In the case of the UK, it is seen as being at or near the forefront already in areas like A, C and D. As a result the Secretary General of the OECD recently commented that "*The UK is a textbook case of best practice on how good labour and product markets can support growth and job creation.*"

Instead the OECD's recommendations with regards to the UK emphasise improvements in areas like the education sector and investment in public infrastructure.

Scotland

The economic historian Nick Crafts has analysed the Scottish position (11) and highlighted the lack of diffusion and low share of 'innovation active' businesses, which he sees as a key shortfall.

Crafts finds that it is much better to incentivise innovation than to provide investment subsidies and that diffusion of innovation matters more than original invention, which can be imitated from elsewhere. Absorptive capacity also plays an important role.

The Wholesale & Retail industry is a good example of the potential of a non-ICT leading industry, as it does not do much original research but is a big user of new technology.

Crafts general view is supported by the work of Harris on Scottish Productivity. (12) Harris finds that Scotland has relatively low levels of R&D which in turn is known to affect innovation (in terms of outputs and capacity) and internationalisation (i.e. exporting). These elements help determine MFP and so can be identified as a key weakness in the growth potential of the Scottish economy.

5. Conclusions

The OECD have highlighted that future economic growth is set to become increasingly dependent on improvements in MFP, with labour and capital adding little to, or even detracting from, overall growth. (13)

In particular, most 'developed' economies will suffer from: ageing populations; a slowdown in the number of hours worked through increased participation (as the previous rise of the female workforce comes to an end); a slowdown in the rise in quality of human capital (as education standards flatten off). At a worldwide level these negative effects could be offset by: rising populations; increased female participation rates; and increased education opportunities, at all levels. However, these positives will need to feed through to advanced economies, rather than being inherent in them.

As a result, the importance of innovation within MFP, through the increased use, diffusion of, and investment in, ICT, is likely to increase over time.

With regards to the future role of ICT, and in particular digital services, there are a number of reasons to consider that this route can deliver further improvements to productivity performance:

- The impact of ICT on US performance continues to outstrip that seen in Europe, which suggests that there may still be scope for catch up. This improvement could come from ICT investment, management structures, skill levels or a combination of each. OECD analysis (14) suggests that the contribution of ICT-using sectors – such as Retail & Wholesale, Finance & Real estate and Other business services – to overall productivity growth rose significantly in the United States over the 1995-2009 period. This was much less evident in most European economies.
- Recent, very low, capital investment figures suggest that older capital is being retained for longer and that newer technological innovations will not have spread across industries and between leading and lagging technology using companies as rapidly as would normally be the case, again suggesting scope for improvement.
- The post recession collapse in the UK of MFP, both in absolute terms and relative to other countries, suggest that this is a key area to concentrate on. It is also the area most affected by the impact of innovation and re-organisation, both in terms of leading companies forging ahead and of the diffusion of new techniques to lagging companies.

Some of the key questions that this review of the productivity literature provoke include:

- Can more radical public policy initiatives, as seen in other countries, improve productivity?
- Is it better for the government to facilitate direct support to companies or to address economy wide issues?
- As well as raising productivity levels in existing firms can Scotland also increase its international presence in high productivity industrial activities?
- How can investment, at both government and company levels, be increased?
- How can ICT be used to improve Scotland's poor record in terms of business spend on R& D and innovation?

End-notes

1. **Measurement issues.** While it will be clear from the paper that a degree of uncertainty exists around estimating productivity and its components it is worth emphasising how much of a qualitative, as much as a quantitative, exercise this is. There are difficult issues in relation to measuring the changing 'quality' of labour and capital over time and of what might be included under the definition of ICT. Furthermore, data collection issues and data consistency issues, across time and across nations, add further degrees of uncertainty.As a result any findings and conclusions should be viewed as indicative as opposed to definitive. Despite these warnings, productivity remains one of, if not the, most important economic indicator and therefore gleaming whatever information we can about how it works remains a very useful exercise.
2. It is fairly common in the academic literature to separate out the market economy from the non-market, which typically, but not always, consist of public sector led areas of economic output like education and health. This is for two reasons. First, it is often much more difficult to measure changes in output (or productivity) in the latter e.g. school education or social care. Second, it is generally accepted that the scope for productivity growth in these more personal and labour intensive service sectors is more limited than in the market sector.
3. See ONS, 'Multi-factor Productivity (experimental), Estimates to 2013', January 2015.
4. See for example: (i) Barnett et al, 'The UK productivity puzzle', Bank of England Quarterly Bulletin 2014 Q2; (ii) Riley et al, 'The UK Productivity Puzzle 2008-2013: Evidence from British Businesses', NIESR Discussion Paper, May 2015; (iii) McCafferty, 'The UK productivity puzzle - a sectoral perspective', BoE speech, June 2015; (iv) IPPR, 'The missing pieces: Solving Britain's productivity puzzle', August 2015.
5. In interpreting these results it is important to take into account some factors that can lead to higher or lower productivity. For example:
   - Industry make-up - those countries with relatively large Manufacturing sectors, like the US and Germany, will benefit from the higher productivity seen in this sector over Services
   - Average weekly hours worked - where productivity is expected to fall as the number of hours worked rises. (Although the US appears to be an exception to this rule of thumb.)
   - Rate of employment - where productivity is expected to fall as employment rises.

   Adjusting for these factors could result in the productivity disadvantage seen for the UK, in comparison to countries like France and Germany, fall considerably.
6. Growth Accounting methodology involves the disaggregation of economic growth into key constituent factors, involving different measures of labour and capital as well as a residual element multi (or total) factor productivity.
7. See ONS, 'International Comparisons of Productivity - Final Estimates, 2013', Feb 2015, Tables 3 and 7 for more details. These show that, in terms of GDP per hour, only Italy has performed worse 2007-2013, although Germany was also on a par.
8. See OECD, 'The Future of Productivity', 2015.
9. See Harris & Moffat, 'Lower Productivity in Scotland, 1997-2012: Implications Post-2016', Durham University Working Paper, 2014.
10. In the case of foreign owned plants this was due to a high level of closures over the period studied, rather than low inherent productivity, which highlights a form of 'branch syndrome' problem.
11. See Crafts, 'What Kind of Supply-Side Policy for the UK? What Implications for Scotland', David Hume Institute (Power point Presentation), 2013
12. Harris, 'Growing the Value of R&D in Scotland: Final Report', for the National Centre for Universities and Business (NCUB), (forthcoming publication)
13. See OECD, 'Trends in Income Inequality and its Impact on Economic Growth', OECD Social, Employment and Migration Working Papers No. 163, 2014
14. As 10, see Box 1.