Are Intangibles Running out of Steam?

Is the Rise in Intangible Investment Intensity and Productivity Growth Getting Disconnected?

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Abstract

This paper investigates whether the post-crisis slowdown in productivity growth in advanced economies can at least partially be attributed to a weaker performance of intangibles as a contributor to productivity growth. We establish the relationships between different types of tangibles and intangibles assets, as well as their separate and combined impact on productivity at aggregate and industry level for the period before and after the Global Financial Crisis (1998-2006 versus 2011-2019).

Analysing the evidence at aggregate and industry levels for Germany, France, Spain, Italy, the US, and the UK, we find that despite weak productivity growth since the GFC, the contribution of intangibles to productivity growth has strengthened in absolute terms in the four EU economies. But that is not the case in the UK and the US, where the productivity slowdown has been relatively large. In relative terms (which means as a share of - slower - productivity growth), the contribution of intangibles to productivity growth has mostly strengthened (except for UK) even though the degree of strengthening varies across countries, types of intangible assets and industries.

We find evidence (albeit rather weak) that the increased ratio of intangible to tangible capital intensity has not been conducive to strengthening productivity growth during the post-GFC period. There is stronger evidence that industries that are relatively intangible-intensive have contributed more to the slowdown in productivity growth than those that are less intangible capital intensive.

Given the rapid slowdown in total factor productivity growth during the post-GFC period, we argue that our results so far point to a suboptimal distribution of intangibles across industries and a lack of spillovers effects and complementarities translating into better TFP performance. Intangible investment may not have run out of steam. But in terms of spreading the benefits across the economy there are reasons for concern about its long-term impact on productivity.

1. Introduction

In recent decades the "intangibilisation" of advanced economies has rapidly increased. There is widespread evidence that investment in intangible assets, as originally conceptualised by Corrado, Hulten and Sichel (2005) and subsequently implemented empirically in a wide range of countries (e.g. Van Ark et al, 2009; Corrado et al., 2016), has outpaced tangible investment by a wide margin. There is also ample evidence that intangible capital contributes positively to productivity growth (Corrado et al., 2021; Corrado et al., 2022).

At the same time, there has been much concern about the widespread slowdown in productivity growth amongst advanced economies since the middle of the past decade. Many potential explanations for the slowdown have been investigated. These include an exhaustion of technological change and innovation, the drag from the Global Financial Crisis (GFC) because of low demand, weak investment and resource misallocation, an erosion in catch-up growth in emerging markets affecting advanced economies too, and potential mismeasurement regarding outputs and inputs in an increasingly digital and intangible economy (Syverson, 2016; Fernald et al., 2017; Cette et al., 2016; Crafts, 2018; Bauer et al., 2020; Dieppe, 2020).

In our earlier work, we have stressed the importance of time lags in the adoption of new technologies and, in particular, the complexity in generating productivity growth from the latest round of new digital technologies since the early 2010s. These include the transition toward mobile, ubiquitous access to broadband, the rise of cloud storage and advances in artificial intelligence (AI) and robotics (van Ark, 2016; van Ark et al., 2019).

Based on the above, the question arises ***whether the recent slowdown in productivity growth can at least in part be attributed to a weaker performance of intangible capital as a contributor to productivity***. One possibility is that the growth in intangible investment might have begun to level off, reducing the contribution of intangibles to productivity growth compared to previous decades (Westlake and Haskel, 2022). Another possibility is that the potential for intangibles to create spillover effects has run out of steam, perhaps related to the "ideas are getting harder to find" hypothesis (Bloom et al., 2020). Or it could be that complementarities between different types of intangible and tangible capital assets are more difficult to realize. The latter two possibilities would also translate into a slower growth in total factor productivity.

In this paper, we aim to establish the relationships between different types of tangible and intangible assets, as well as their separate and combined impact on productivity growth at the aggregate and industry level. In particular, we distinguish between the performance of intangibles before and after the GFC, that is 1998 (or 1999) to 2006 and 2011 to 2018 (or 2019).[1] We document the latest trends in intangible investment at industry-level across four major EU countries (Germany, France, Spain and Italy), the UK and the US.

[1] Due to data availability, we use two different periodizations, consistent with our broader distinction of pre- and post-GFC periods. In section 2, our pre-crisis period is 1998-2006 and the post-crisis period is 2011-2018 because of a lack of data for 2019 for Germany, Italy, and Spain. In section 3, the respective periods are 1998-2006 and 2011-2019 because we have the 2019 data for US and UK. In our regression analysis, we use the periods 1999-2006 and 2011-2018, due to constraints on some of the capital level data for the UK.

Our analysis in this paper benefited from the latest update of the EUKLEMS industry-level database and the UK growth accounts and intangibles by Goodridge and Haskel (2022). The original EUKLEMS data on growth accounts have now been merged with data on intangibles investment by the Luiss Lab of European Economics in the EUKLEMS & INTANProd – Release 2021 (https://euklems-intanprod-llee.luiss.it/).

Overall, the evidence suggests that the contribution of intangibles to productivity growth has increased in **absolute terms** in the four EU economies. But it dropped in the US and especially in the UK in line with their overall slowdown in productivity growth since the GFC. However, in **relative terms** (i.e., as a share of productivity growth), the contribution of intangibles to productivity growth has mostly strengthened modestly even though the picture is mixed amongst different types of intangible assets and industries. We also find evidence (albeit rather weak) suggesting that the increased **ratio of intangible to tangible capital intensity** was not conducive to productivity growth during the post-GFC period. There is stronger evidence though that **industries which are relatively intangible-intensive** have contributed more to the slowdown in productivity growth than those that are less intangible capital intensive. Given the rapid slowdown in **total factor productivity growth** during the post-GFC period, we argue this evidence points to a less than optimal distribution of intangibles across industries and a lack of spillovers and complementarities translating into greater TFP performance.

The paper proceeds as follows. In **Section 2** we review the latest evidence on the growth in intangible investment for the six countries in question before and after the GFC. We make four main observations:

- We do not find much evidence of a slowing of investment in intangible investment in the six countries we study, with the notable exception of the UK. Together with Italy and Spain, there is a rather late recovery of intangibles investment following the GFC, starting only as of 2015.
- Most countries show a sustained growth rate of intangible investment in different asset types before and after the financial crisis. However, we see a clear pulling ahead in software and databases, while investment in design has generally weakened. Overall, training is one of the weakest asset categories in terms of investment growth.
- In applying two different types of industry taxonomies, we find that industries which are relatively digital-intensive and/or relatively intangible-intensive, explain most of the productivity growth over the entire period.
- However, intangible-intensive industries are also responsible for a disproportionally large part of the productivity slowdown in the past decade. The latter is especially visible in the UK and the US while less so in the four EU nations.

In **Section 3,** we zoom in on a decomposition of the slowdown in labour productivity growth in three major intangible-intensive industries in the UK and the US. These industries, which have shown the largest slowdown in the contribution of intangibles to productivity growth since the GFC, are: 1) Computer, Electronic, Optical Products; Electrical Equipment (C26-C27); 2) Information & Communication (J); and 3) Financial & Insurance activities (K). For these industries we find that:

- The slowdown in **tangible capital intensity** accounts for a large portion of the productivity slowdown, especially for tangible ICT assets (computing and communication equipment) in the Information & Communication industry.
- Slower growth in **intangible capital intensity** in either country makes fairly small contributions to the productivity slowdown but with some notable exceptions, such as innovative property for Information & Communication in the US and economic competencies in Finance & Insurance in the UK.
- The **TFP slowdown** accounts for the bulk of the slowdown of labour productivity growth in those industries. This points to the possibility that in those industries the weakening of spillover effects from investment in tangibles and intangibles or the failure to realize complementarities between different types of assets are amongst the main explanations for slower productivity growth.

In **Section 4** of the paper, we econometrically investigate whether there has been a role for the change in the relative importance of intangibles relative to tangible capital intensities in the productivity slowdown. On the basis of this analysis we find the following:

- Despite the rise in intangible capital intensity, there is no strong evidence of a large **substitution of intangible capital for tangible capital** in the most recent period. Generally, we find rather positive albeit less strong correlations between tangible and intangible capital intensities and only a modest weakening of those coefficients in a limited number of cases.
- The rise in **intangible capital intensity** contributes positively to productivity growth over the entire period, but generally more so (and in a statistically significant way) during the post-GFC period. In particular, **R&D and brand intensities** have significantly stronger effects on labour productivity growth in the later period than in the earlier period. **Organisational capital intensity** is stronger during the pre-GFC period but during the post-GFC period there is a stronger interaction between levels of organisational capital and growth rates of ICT capital intensity in delivering productivity growth (see also Bontadini et al., 2022).
- However, when related to the rapid decline in the level of **tangible capital intensity**, the role of the increase in **intangible capital intensity** becomes less prominent. In other words, the positive contribution of intangible capital to productivity growth has not been sufficient to make up for the significant decline in the contribution of intangible relative to tangible capital.
- There is no evidence that **intangible-intensive industries** have come to the rescue in terms of improving their productivity performance. This is confirmed by the regression analysis in this section, even though the distinction between more and less intangible- intensive industries does not seem to make a significantly distinctive difference in terms of explaining productivity.

In conclusion, this paper finds that intangibles haven't run out of steam in terms of their continued accumulation during the post-GFC period. We also find that intangibles have mostly strengthened their relative contribution to productivity growth. However, as productivity growth itself has been weakening since the GFC, we suggest that the increase in the relative importance of intangibles over tangibles has played some role in the slower growth of productivity. Productivity growth has not increased as rapidly as it did when

tangible capital intensity was the main driver of growth (albeit with the help of intangibles). The slowdown in TFP growth suggests that the effects of spillovers from particular investments and complementarities between those investments have weakened.

Section 5 concludes with a few suggestions for further research to corroborate these observations and identify paths that may help in strengthening the role of intangibles for productivity growth.

2. Pre- and post-crisis growth in intangibles and productivity

The increasing role of intangible investment in the economy over the past half century has been well established in the literature. However, there have been concerns that the pace of intangible capital accumulation has been slowing since the GFC. For example, in their latest book, Haskel and Westlake (2022) argue that the share of intangible investment in GDP has recently begun to grow more slowly. Comparing intangible investment data up to 2017 against a pre-2007 trend, Haskel and Westlake find that "(T)he slowdown for Continental Europe and the United States is clear, with the United Kingdom a bit noisier". They also see "a decline in the growth of 'intangible' capital services, including and excluding software. The pace of growth slowed in the 2010s onwards, particularly excluding software." (Haskel and Westlake, 2022, p. 51-52).

Looking at the most recent data, we do not see much of a slowdown in the growth rate of intangibles nor of a slowing in the rise of its share in GDP, with the notable exception of the UK. Using the latest update of the EUKLEMS industry-level database, which has now been merged with data on intangibles investment by the Luiss Lab of European Economics in the EUKLEMS & INTANProd – Release 2021 for France, Germany, Italy, Spain and the US, we establish a pattern of continued trend growth for those countries since the GFC. For the UK, we replaced the EUKLEMS with the latest updates on UK growth accounts and intangibles by Goodridge and Haskel (2022), which shows quite a different trend.[2]

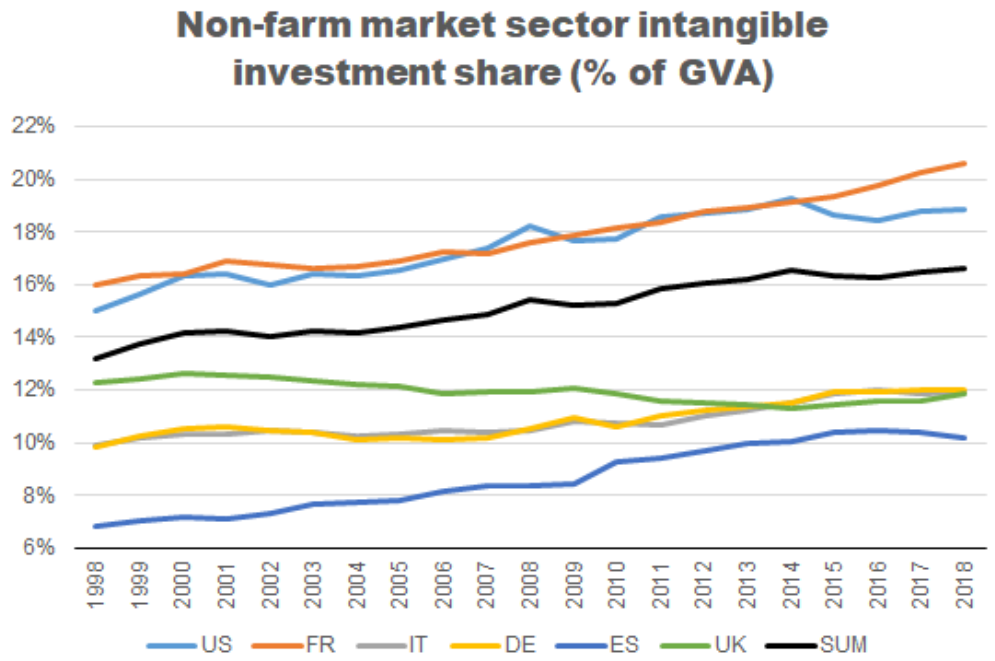
Chart 2.1 shows that intangibles as a share of gross value added (GVA) has continued to increase more or less at trend growth, with no clear break visible following the GFC. For some countries (e.g., the US, Italy and Spain) there is some moderation visible since 2015 which may be related to the improvements in GDP growth in those countries during the last few years. The main exception is the UK which has shown an ongoing decline in the share of intangibles in GDP, with some improvement since 2014 (see also Appendix A).

When looking at the growth in intangible investments in real terms (Chart 2.2), we see that growth rates improved after the GFC with some delay in Italy, Spain and the UK. The growth rate of real intangibles was fastest in the US, followed by France and Germany as close runner ups. Spain's growth of intangibles slowed relative to the rapid growth during pre-2007, while Italy's growth has been slow along. Nevertheless, both countries have shown some recovery as of 2015. The UK's intangible growth is weakened caused, by measures of design, brand and organisational capital.

Chart 2.3 shows that, when looking at an average of all six countries, real intangible investment in software & databases shows the clearest sign of strong growth. In contrast, industrial design shows some weakening in the post-GFC period, whereas investment in business training has remained flat both pre- and post-GFC. The reason for the decline in entertainment, artistic & literary originals & mineral explorations is unclear, but may be related to the fall in oil prices in the middle of the decade.

[2] For this paper we have replaced the EUKLEMS & INTANProd data for the UK by more recent data from Goodridge and Haskel (2022), which are based on substantial revision to GDP and experimental data on intangibles by the Office of National Statistics in the UK. For a detailed analysis of the difference between EUKLEMS and Goodridge and Haskel, see Appendix A.

Chart 2.1



Note: aggregation for six countries based on GDP PPPs to convert investment and value added into a common currency.

Chart 2.2

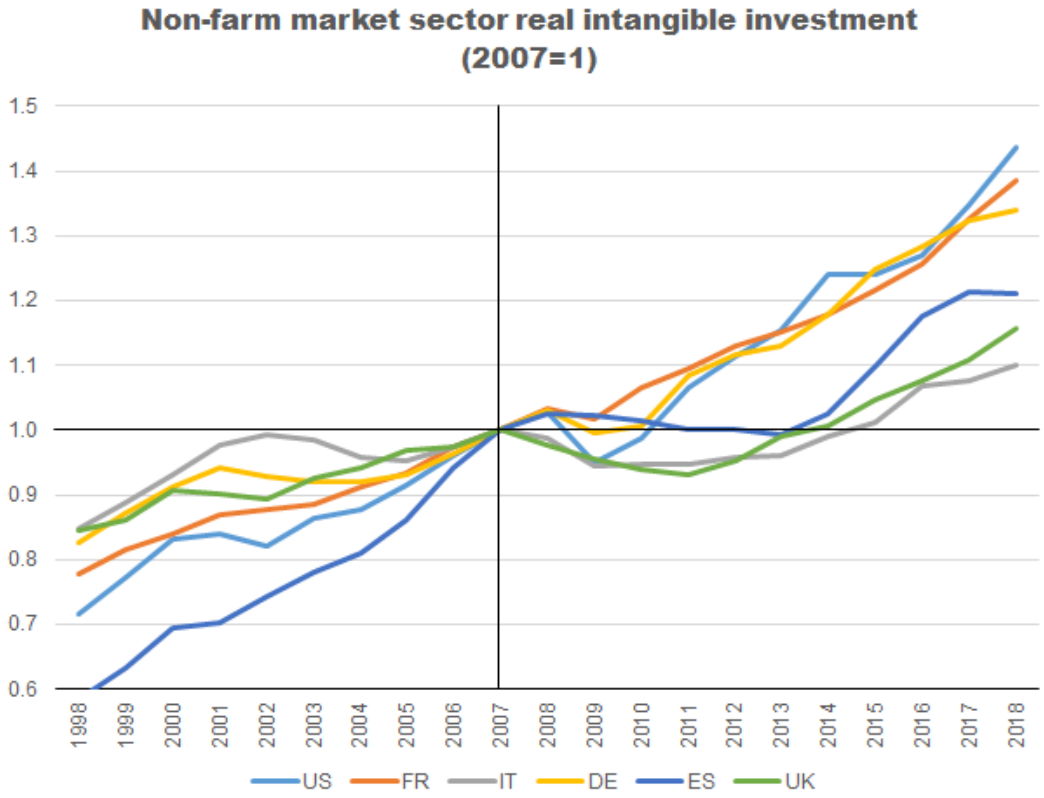
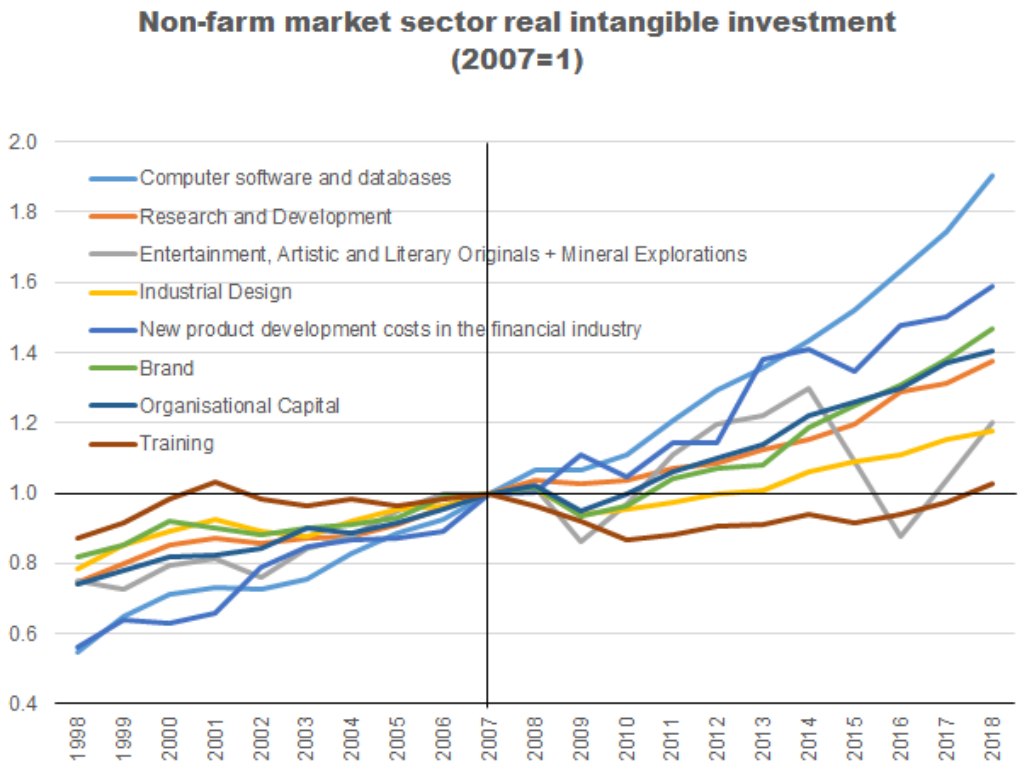


Chart 2.3



Note: Weighted aggregate across all six countries based on nominal investment converted into a common currency based on GDP PPPs.

Taking an industry perspective, we find a more mixed picture regarding the change in real intangible investment (Table 2.1). The US shows an increase in intangible assets across most industries, with some signs of weakness in the growth of intangible investment in Information & Communication and Finance & Insurance activities. Spain and Italy exhibit considerable weakness in traditional sectors, including Construction, Wholesale and Retail Trade, Transport and Storage, but also in Information & Communication. The weakness in the growth rate of intangible investment in the UK is most visible in Finance & Insurance, Professional, Scientific & Technical Services, and Arts, Entertainment & Recreation. A statistical test (t-test with unequal variance) suggests that most of the slowdown in intangibles was not statistically significant, with the most notable exceptions for Construction in Spain and for Professional, Scientific & Technical Services in the UK.[3]

The slowdown in labour productivity from 2011-2018 relative to 1998-2006 is clearly visible for four of the six countries studied in this paper (Chart 2.4). Spain and Italy showed a modest improvement in productivity growth compared to their very weak performance during the pre-GFC period, while Germany more or less unchanged throughout both periods.

Chart 2.5 shows the contribution of tangible capital (including structures, machinery and ICT and non-ICT equipment) to productivity growth. It shows a drop off to near-zero or negative

[3] One possible reason for the large slowdown in Professional, Scientific & Technical Services could be the large dropff in in R&D investment in the R&D industry (division 72) from 2011, which might be related to a reclassification of large R&D performing business out of this sector.

in all six countries. However, the contribution of intangible capital to labour productivity in absolute terms is more mixed. It strengthened in the four EU countries, whereas it weakened substantially in the UK and the US where the productivity slowdown was also the largest (Chart 2.6).

Table 2.1

Non-farm market economy real investment in intangible assets
2011-2018 minus 1998-2006 annual average

	US	FR	IT	DE	ES	UK-GH
Non-agricultural market economy (Market economy less industry A)	+	+/-	+/-	+	-	+
B-Mining and quarrying	+	+	+	+	+	-
C-Manufacturing	+	+	+	+	-	+
D-E-Electricity, gas, steam; water supply, sewerage, waste management	+	+	+	-	-	+
F-Construction	+	-	-	+	-	+/-
G-Wholesale and retail trade; repair of motor vehicles and motorcycles	+	+/-	-	+	-	+/-
H-Transportation and storage	+	+/-	-	-	-	+
I-Accommodation and food service activities	+	-	-	+/-	+	+
J-Information and communication	+/-	-	-	+	-	+/-
K-Financial and insurance activities	+/-	+	+	-	+/-	-
M-Professional, scientific and technical activities	+/-	+/-	-	+/-	-	-
N-Administrative and support service activities	+	-	+/-	-	+	+
R-Arts, entertainment and recreation	+	-	-	+	-	-
S-Other service activities	+	+/-	+/-	+/-	+	+

Note: The table shows the difference between average annual growth of the 2011-2018 period versus the 1998-2006 period (1999-2006 for UK-ONS). A + sign indicates a ppt difference of above 0.5, a - sign a ppt difference of below -0.5 and +/- anything in between.

Chart 2.4

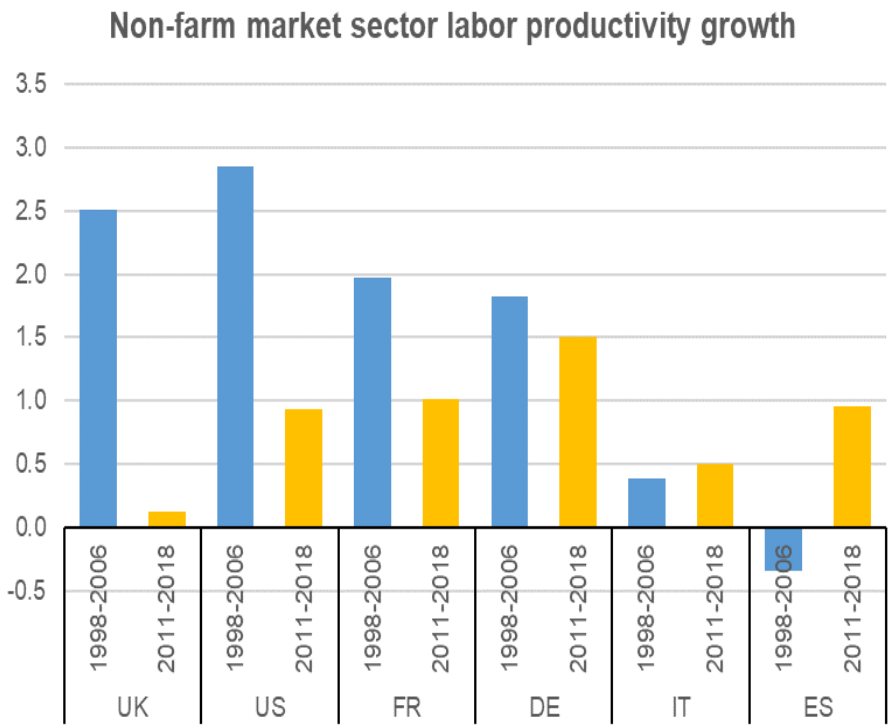


Chart 2.5

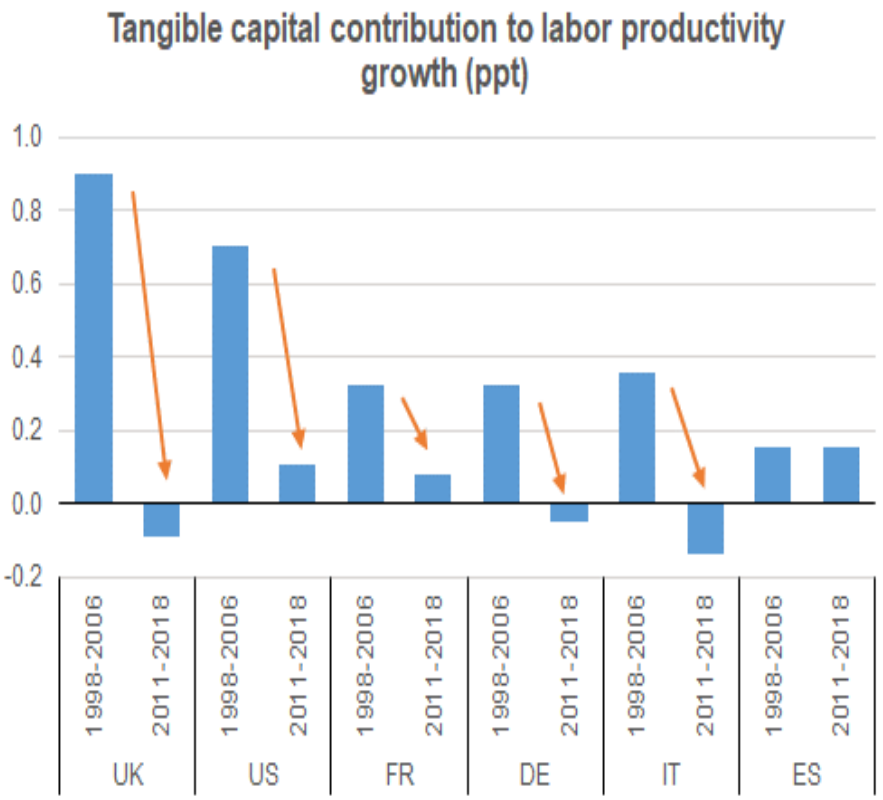
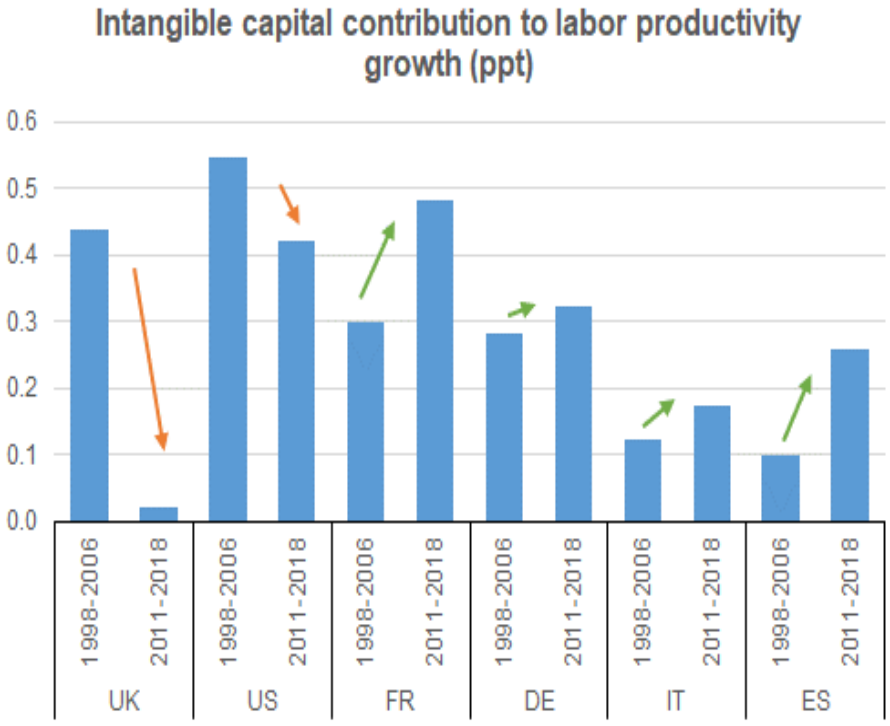


Chart 2.6



Moving to the industry level we find quite a diverse performance on the role of intangibles in relation to productivity. Table 2.2 points to quite a bit of weakening in productivity growth in industries that are big users of intangibles capital. Notably, in four of the six countries, Computers & Electronics was among the five industries showing the largest slowdown in their contribution to the aggregate slowdown on productivity growth. The UK saw a large contribution to the slowdown from Information & Communication and Finance & Insurance. Indeed, the declining contribution from Finance & Insurance was also notable in the US and Spain.

Of course, there were also intangible-intensive industries showing some sizeable improvements in the contribution of intangibles to productivity growth. For example, Germany and Spain saw improvements in Professional, Scientific and Technical Services.

Table 2.2

Change in the sectoral contribution to aggregate market economy labour productivity growth, 2011-2018 versus 1998-2006

	US	FR	IT	DE	ES	UK
Non-farm market economy	**-1.87**	**-1.10**	**0.14**	**-0.16**	**1.12**	**-2.38**
B-Mining and quarrying	0.07	0.00	0.05	0.00	0.02	-0.09
C10-C12-Food products; beverages and tobacco products	-0.05	-0.05	-0.01	0.02	**-0.10**	-0.07
C13-C15-Textiles, wearing apparel, leather and related products	-0.02	-0.04	0.01	-0.01	**-0.07**	-0.04
C16-C18-Wood, paper, printing and reproduction	-0.04	-0.01	0.02	-0.04	-0.01	-0.03
C19-Manufacture of coke and refined petroleum products	-0.05	-0.01	0.03	-0.02	0.04	0.00
C20-C21-Chemicals; basic pharmaceutical products	**-0.16**	-0.07	-0.01	**-0.15**	-0.02	**-0.19**
C22-C23-Rubber and plastic products and other non-metallic mineral products	-0.03	-0.06	**-0.02**	-0.04	0.00	-0.06
C24-C25-**Manufacture of b**asic metals and fabricated metal products, except machinery and equipment	-0.02	-0.02	0.03	-0.03	0.06	-0.09
C26-C27-Computer, electronic, optical products; electrical equipment	**-0.49**	**-0.13**	**-0.06**	**-0.19**	-0.01	-0.05
C28-Machinery and equipment n.e.c.	-0.06	-0.07	0.00	**-0.08**	-0.03	-0.08
C29-C30-Motor vehicles, trailers, semi-trailers and of other transport equipment	**-0.14**	-0.04	0.07	0.06	-0.04	-0.03
C31-C33-Furniture; jewellery, musical instruments, toys; repair and installation of machinery and equipment	-0.05	-0.07	0.01	-0.07	-0.04	-0.02
D-Electricity, gas, steam and air conditioning supply	-0.03	**-0.14**	**-0.07**	-0.02	**-0.13**	**-0.13**
E-Water supply; sewerage, waste management and remediation activities		-0.02	0.00	0.05	-0.01	-0.06
F-Construction	0.07	-0.04	0.04	0.02	0.59	-0.01
G-Wholesale and retail trade; repair of motor vehicles and motorcycles	**-0.32**	0.05	0.27	**-0.21**	0.28	0.01
H-Transportation and storage	-0.10	**-0.12**	**-0.24**	**-0.22**	0.16	**-0.15**
I-Accommodation and food service activities	-0.04	0.01	0.00	0.06	0.39	-0.09
J-Information and communication	-0.10	**-0.18**	**-0.17**	0.02	0.05	**-0.46**
K-Financial and insurance activities	**-0.35**	0.01	0.06	0.28	**-0.49**	**-0.66**
M-N-Professional, scientific and technical activities; administrative and support service activities	0.03	-0.01	0.14	0.37	0.48	-0.02
R-Arts, entertainment and recreation	0.00	-0.02	0.00	0.04	**-0.04**	-0.04
S-Other service activities	0.02	**-0.08**	-0.01	0.01	0.05	-0.02

Note: Showing the difference in sectoral contribution to average annual market economy productivity growth in 2011-2018 minus the 1998-2006 period, in other words the difference between the two bars in chart 2.4. The bottom-5 industries are marked in red.

The observed weakening in the growth of intangible assets and their contribution to productivity growth in sectors such as Computers & Electronics, Information and Communication and Finance & Insurance raises the question whether industries which are big users of digital technologies and intangible assets are more generally responsible for the slowdown in productivity growth since the GFC. In earlier work, we investigated the possibility that industries characterised as early adopters of digital technologies show time lags in realising improvements in productivity growth from it (van Ark, 2016; van Ark, de Vries and Erumban, 2019, 2021).

As time has passed, it is useful to test the time lag hypothesis on the latest data used in this paper. In our earlier work we used an industry taxonomy for digital intensity by industry from the OECD (Calvino et al., 2019). Here we extend our analysis to a second taxonomy based on the intensity of intangible investment to see if our time-lag hypothesis also applies here. We developed the industry taxonomy on the basis of the share of intangible investment in gross value added (GVA) by industry, where the industries in the lowest two quartiles are called "least intangible intensive" and those in the highest two quartiles the "most intangible intensive".

Table 2.3 shows our industry taxonomy based on intangible investment. Although this new taxonomy is largely comparable to our original digital intensity taxonomy, there are notable differences as well. In particular, in manufacturing we find several industries which are intangible intensive but not digital intensive, such as Petroleum Products, Chemicals & Pharmaceuticals, Rubber & Plastic Products. In contrast, Retail and Wholesale Trade, Arts, Entertainment & Recreation and Other Service Activities were classified as digital intensive industries, but do not belong to the most intangible intensive industries.

Chart 2.7 shows the contribution of the two top quartiles (most intangible-intensive) and two bottom quartiles (least intangible-intensive industries) to the slowdown in labour productivity growth the our six countries. The chart confirms the picture established in Table 2.2 that intangible-intensive industries contributed most to the productivity slowdown in the UK and the US, but also in France. In Chart 2.8 we repeat the same exercise for the slowdown in total factor productivity (TFP) growth which shows an even stronger role for the intangible-intensive industries in explaining the productivity slowdown, particularly in the UK.

All in all, we find little evidence of intangible investment running out of steam, neither in terms of its own growth nor in terms of the contribution to productivity growth, although there is some variation between countries, industries and different types of intangible assets. Notably, we find little improvement in the UK's share of intangibles in GVA across the period, and we also find a fairly late recovery in Spain. While software and data investment pulled ahead, other intangibles have kept growing at about the same pace. Investment in business training remained among the weakest asset categories in terms of growth.

However, we also find that while intangible and digital intensive industries explain most of the productivity growth, the relatively large role of intangible-intensive sectors explaining the productivity slowdown is concerning. This is, therefore, the focus of the next section, which zooms in on the performance of three intangible-intensive industries which have seen a significant slowdown in the contribution of digital assets to productivity growth.

Table 2.3 Intangible Intensive and Digital Intensive Industry Taxonomies.

	Intangible intensity	Digital intensity
B-Mining and quarrying	1	2
C10-C12-Manufacture of food products; beverages and tobacco p	1	2
C13-C15-Manufacture of textiles, wearing apparel, leather and re	2	2
C16-C18-Manufacture of wood, paper, printing and reproduction	2	1
C19-Manufacture of coke and refined petroleum products	1	2
C20-C21-Chemicals; basic pharmaceutical products	1	2
C22-C23-Manufacture of rubber and plastic products and other n	1	2
C24-C25-Manufacture of basic metals and fabricated metal produ	2	2
C26-C27-Computer, electronic, optical products; electrical equipm	1	3
C28-Manufacture of machinery and equipment n.e.c.	1	1
C29-C30-Manufacture of motor vehicles, trailers, semi-trailers an	1	1
C31-C33-Manufacture of furniture; jewellery, musical instrument	1	1
D-Electricity, gas, steam and air conditioning supply	2	2
E-Water supply; sewerage, waste management and remediation	2	2
F-Construction	2	2
G-Wholesale and retail trade; repair of motor vehicles and motor	2	1
H-Transportation and storage	2	2
I-Accommodation and food service activities	2	2
J-Information and communication	1	3
K-Financial and insurance activities	1	1
M-N-Professional, scientific and technical activities; administrative	1	1
R-Arts, entertainment and recreation	2	1
S-Other service activities	2	1

Note: 1 – most intensive (two lowest quartile values); 2 – least intensive (two highest quartile values); 3 – digital producing. Intangible intensity taxonomy is based on intangible investment share in GVA. Average based on simple average of intangible investment shares across all countries; Distribution is +/- 50-50% in terms of value added. Digital intensity taxonomy based on OECD taxonomy used by Van Ark, Erumban and de Vries (2019) with digital producing sectors separated out.

Chart 2.7

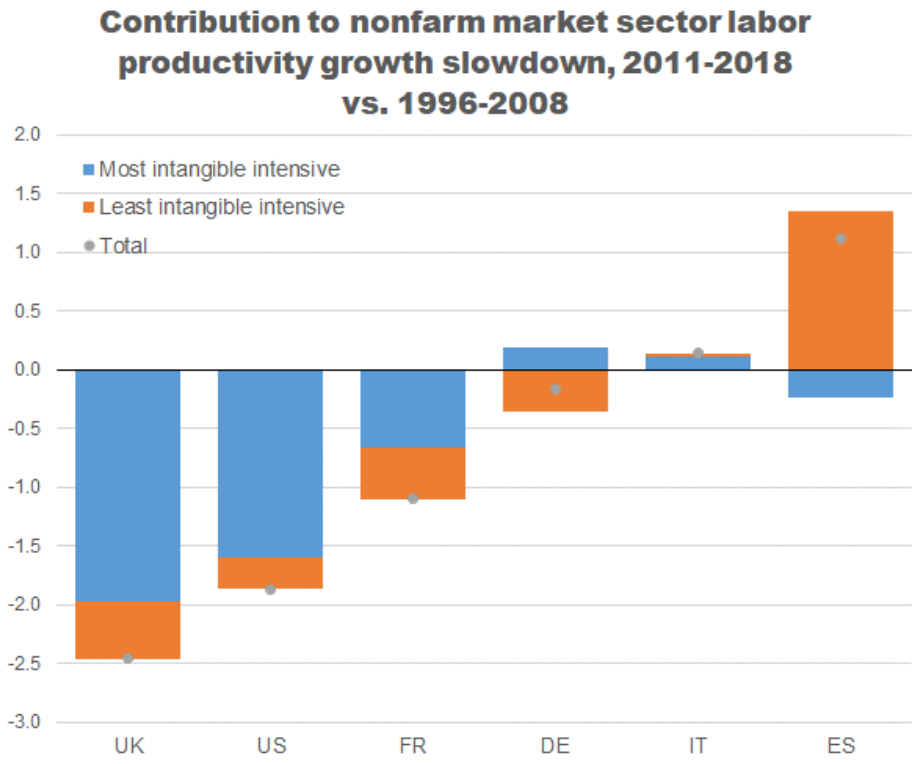
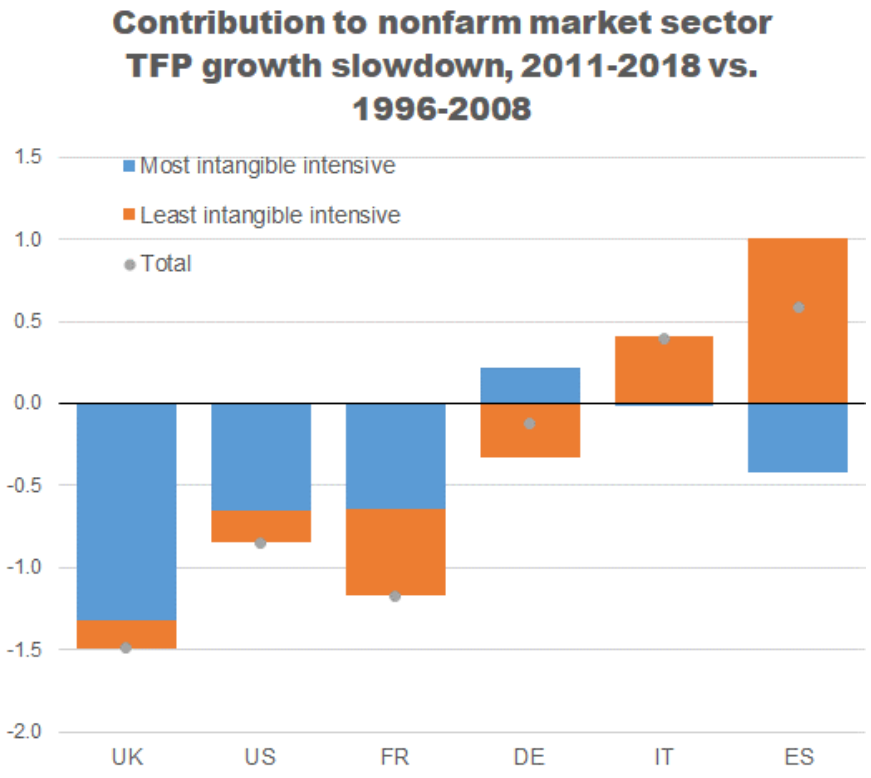


Chart 2.8



3. The contribution of intangibles to the productivity slowdown in three intangible-intensive industries

In this section the focus is on three sectors that are identified as large contributors to the productivity growth slowdown in the US and the UK, namely computer, electronic, optical products; electrical equipment (C26-C27), Information and communication (J) and Financial and insurance activities (K). The slowdown refers to the post-crisis period of 2011-2019 relative to the pre-crisis period of 1998-2006.

Lines 1-3 in Table 3.1 show a decomposition of output growth into the contribution of growth in hours worked and labour productivity growth. The output growth slowdown in these three sectors is almost exclusively driven by a **labour productivity slowdown**. In fact, employment growth generally improved in those three industries during the post-GFC period:

- In the Computer & Electronics sector, growth in total hours worked was strongly negative in the pre-crisis period and was more or less stagnant in the post-crisis period.
- Employment in the Information & Communications sector increased in both periods in the US and the UK and accelerated in the post-crisis period.
- Employment growth in Finance & Insurance was more or less unchanged in both periods, though almost stagnant in the UK and positive in the US.

Lines 3-6 in Table 3.1 show a decomposition of labour productivity growth into the contributions of capital deepening, labour composition and total factor productivity. The breakdown is reproduced in Table 3.2 in terms of the percentage contribution to labour productivity growth:

- The labour productivity slowdown is largely driven by a **TFP slowdown** (line 4), particularly in Computers & Electronics (88% of the overall labour productivity slowdown in the US and 76% in the UK) and in Finance & Insurance for the UK (88% of the slowdown).
- **Labour composition** (line 5) contributed relatively little to the slowdown with the exception of a weakening of human capital intensity in Information & Communication in the US)
- The exception is Information & Communication in the US, where a **slowdown in capital deepening growth** (line 6) accounted for 77% of the labour productivity slowdown, with TFP growth being roughly equal in both periods.

Lines 7-11 in Tables 3.1 and 3.2 show a decomposition of capital deepening into ICT and non-ICT tangible capital deepening and intangible capital deepening:

- The capital deepening slowdown is mostly a result of weaker growth in **tangible capital deepening**, both in ICT and non-ICT tangible capital. The exception is Finance & Insurance in the UK, where tangible capital deepening improved but intangible capital deepening weakened substantially.
- There were relatively large contributions to the productivity slowdown from the weakening in the **intensity of ICT tangible capital** (computing and communication

equipment) in Information & Communication in both the US (31% of the slowdown) and the UK (27%).

- The contribution of weaker **intangible capital intensity** to the productivity slowdown has been relatively small compared to tangible capital intensity, with some notables exceptions:
    - Capital intensity of **innovative property** accounted for 29% of the productivity slowdown in Information & Communication in the US.
    - Capital intensity of **economic competencies** accounted for 14% of the productivity slowdown in UK Finance & Insurance with another 9% of the slowdown accounted for by **digitized information**.

Table 3.1: Output and productivity growth decomposition, select industries in the US and UK (period averages)

	Computer, electronic, optical products; electrical equipment				Information and communication				Financial and insurance activities			
	US		UK		US		UK		US		UK	
	1998-2006	2011-2019	1998-2006	2011-2019	1998-2006	2011-2019	1998-2006	2011-2019	1998-2006	2011-2019	1998-2006	2011-2019
Real GVA growth (1)	13.0	3.7	5.7	2.2	6.5	6.1	12.5	7.7	5.1	1.8	3.7	-0.1
Total hours growth (2)	-4.1	0.0	-5.8	-0.5	0.8	1.9	1.4	2.3	1.4	1.0	0.2	0.1
Labor productivity growth (3)	17.2	3.7	11.4	2.8	5.7	4.3	11.2	5.4	3.7	0.7	3.5	-0.2
TFP (4)	14.2	2.3	9.6	3.0	2.4	2.3	8.4	5.4	1.2	-0.5	2.2	-1.0
Labor composition (5)	0.7	0.8	0.7	0.0	0.5	0.2	0.2	0.2	0.6	0.3	0.6	0.6
Capital Deepening (6)	2.3	0.6	1.1	-0.3	2.8	1.7	2.5	-0.2	1.9	1.0	0.7	0.3
Tangible – non-ICT (7)	0.4	0.0	0.4	-0.4	0.0	-0.1	-0.1	-0.2	0.5	0.1	0.0	0.2
Tangible – ICT (8)	0.3	0.1	0.1	0.0	1.4	0.9	1.5	0.0	0.6	0.1	-0.1	0.0
Economic Comp (9	0.2	0.2	0.2	0.0	0.4	0.4	0.3	0.0	0.3	0.4	0.4	-0.1
Innovative Prop (10)	1.0	0.5	0.4	0.1	0.6	0.2	0.3	0.1	0.0	0.0	0.1	0.1
Digitized info (11)	0.3	-0.1	0.1	0.0	0.4	0.3	0.5	0.1	0.3	0.3	0.4	0.0

Table 3.2: Decomposition of labour productivity slowdown, in %-point and %, select industries in the US and UK (period averages)

	Computer, electronic, optical products; electrical equipment				Information and communication				Financial and insurance activities			
	US		UK		US		UK		US		UK	
	11-19 minus 98-06	%-contri-bution	11-19 minus 98-06	%-contri-bution	11-19 minus 98-06	%-contri-bution	11-19 minus 98-06	%-contri-bution	11-19 minus 98-06	%-contri-bution	11-19 minus 98-06	%-contri-bution
Labor productivity growth (3)	-13,5	100%	-8,6	100%	-1,5	100%	-5,8	100%	-3,0	100%	-3,7	100%
TFP (4)	-12,0	88%	-6,6	76%	-0,1	4%	-3,0	52%	-1,7	57%	-3,2	88%
Labor composition (5)	0,1	-1%	-0,7	8%	-0,3	18%	-0,1	1%	-0,3	11%	0,0	0%
Capital Deepening (6)	-1,6	12%	-1,4	16%	-1,1	77%	-2,7	46%	-0,9	31%	-0,4	12%
Tangible – non-ICT (7)	-0,5	3%	-0,8	9%	-0,2	11%	-0,1	2%	-0,4	12%	0,2	-5%
Tangible – ICT (8)	-0,3	2%	-0,2	2%	-0,5	31%	-1,5	27%	-0,6	19%	0,2	-4%
Economic Comp (9	0,0	0%	-0,2	2%	-0,1	4%	-0,3	5%	0,0	-1%	-0,5	14%
Innovative Prop (10)	-0,5	4%	-0,2	3%	-0,4	29%	-0,3	5%	0,0	-1%	0,1	-2%
Digitized info (11)	-0,4	3%	0,0	0%	0,0	2%	-0,4	7%	0,0	1%	-0,3	9%

4. The relationship between tangibles and intangibles pre- and post-GFC

In this section we adopt an econometric approach to analysing whether there is any indication of a role for intangibles in explaining part of the productivity slowdown because of its increased importance relative to tangible capital intensities. The capital intensity of any given asset in this section is defined as the ratio of capital stock in the asset divided by the total number of hours worked.

We first look at the correlation between the growth in tangible and intangible capital intensities. Although this is not a perfect indicator of any complementarity or substitution between these asset types, it can provide insights into whether the two types of assets are moving in the same or opposite directions. More importantly, it will help us understand whether those correlations are changing in the post-crisis period compared to the pre-crisis period. Subsequently, we also look at the correlations among different intangible asset intensities.

Table 4.1 shows the results based on six countries (UK, US, Germany, Spain, Italy and France) and 22 industries. Prima facia, there is no evidence of any substitution of tangible versus intangibles as the correlation between the growth rates of the tangible and intangible capital intensities are generally positive, albeit not very strong. Faster growth in tangible capital intensity happens along with improving growth in the intangible intensities both in the pre-crisis and post-crisis periods. One exception to this general trend is the correlation between ICT capital intensity and training capital intensity. That correlation was negative in the pre-crisis period but turned positive in the post-crisis period.

Interestingly when we consider only the United States (Table 4.2), the correlation between tangible and intangible was relatively stronger than the six-country sample in the pre-crisis period. Although it remained so in the post-crisis period, especially for the ICT assets, we see a notable weakening in the correlation between economic competency and its components with both ICT and non-ICT tangibles. In contrast, the correlation between tangibles and innovative property assets has improved.

In the UK (Table 4.3), the story is more mixed. In most cases, the correlation was weaker than for the 6-country sample in the pre-crisis period, but the correlation between intangibles and ICT tangibles has improved across the board, with high increases in the association between innovation and ICT and software and ICT. With the non-ICT tangibles, the correlation did not change massively.

Overall, these correlations do not suggest any indication of a decline in the growth rates of one type of asset (tangible or intangible) when the other is growing.

Appendix B presents correlations between different types of capital intensities also showing positive correlation though at different magnitudes.

Table 4.1: Correlation between tangible and intangible capital intensity growth rates: Sample: 6 countries, 22 industries

		Tangible Assets								
		1999-2006			2011-2018			2011-2018 minus 1998-2006		
	Variables	Non-ICT	ICT	Total	Non-ICT	ICT	Total	Non-ICT	ICT	Total
Intangible Assets	Economic Competencies	0.232	0.125	0.234	0.336	0.183	0.358	0.104	0.058	0.124
	Brand	0.335	0.225	0.343	0.201	0.159	0.23	-0.134	-0.066	-0.113
	Organizational Capital	0.426	0.295	0.442	0.352	0.244	0.387	-0.074	-0.051	-0.055
	Training	0.062	-0.12	0.058	0.265	0.12	0.271	0.203	0.24	0.213
	Innovative Properties	0.587	0.172	0.556	0.525	0.203	0.541	-0.062	0.031	-0.015
	R&D	0.417	0.118	0.397	0.418	0.143	0.413	0.001	0.025	0.016
	Design	0.505	0.199	0.491	0.393	0.145	0.408	-0.112	-0.054	-0.083
	Software & Databases	0.273	0.201	0.293	0.275	0.32	0.32	0.002	0.119	0.027

Table 4.2: Correlation between tangible and intangible capital intensity growth rates: Sample: US, 22 industries

		Tangible Assets								
		1999-2006			2011-2018			2011-2018 minus 1998-2006		
	Variables	Non-ICT	ICT	Total	Non-ICT	ICT	Total	Non-ICT	ICT	Total
Intangible Assets	Economic Competencies	0.501	0.197	0.507	0.418	0.102	0.408	-0.083	-0.095	-0.099
	Brand	0.39	0.234	0.396	0.181	-0.05	0.184	-0.209	-0.284	-0.212
	Organizational Capital	0.526	0.221	0.528	0.391	0.113	0.373	-0.135	-0.108	-0.155
	Training	0.228	0.015	0.234	0.596	0.265	0.598	0.368	0.25	0.364
	Innovative Properties	0.643	0.306	0.644	0.737	0.364	0.735	0.094	0.058	0.091
	R&D	0.456	0.243	0.458	0.702	0.378	0.701	0.246	0.135	0.243
	Design	0.434	0.246	0.441	0.461	0.051	0.449	0.027	-0.195	0.008
	Software & Databases	0.21	0.539	0.234	0.128	0.552	0.157	-0.082	0.013	-0.077

Table 4.3: Correlation between tangible and intangible capital intensity growth rates:
Sample: UK, 22 industries

		Tangible Assets								
		1999-2006			2011-2018			2011-2018 minus 1998-2006		
	Variables	Non-ICT	ICT	Total	Non-ICT	ICT	Total	Non-ICT	ICT	Total
Intangible Assets	Economic Competencies	0.395	0.145	0.376	0.359	0.397	0.448	-0.036	0.252	0.072
	Brand	0.13	0.121	0.18	0.314	0.385	0.412	0.184	0.264	0.232
	Organizational Capital	0.314	0.15	0.327	0.267	0.376	0.367	-0.047	0.226	0.04
	Training	0.486	0.066	0.42	0.509	0.443	0.582	0.023	0.377	0.162
	Innovative Properties	0.53	-0.116	0.424	0.514	0.399	0.572	-0.016	0.515	0.148
	R&D	0.416	-0.13	0.326	0.555	0.296	0.557	0.139	0.426	0.231
	Design	0.424	-0.072	0.327	0.42	0.399	0.489	-0.004	0.471	0.162
	Software & Databases	0.209	0.033	0.16	0.234	0.493	0.398	0.025	0.46	0.238

To establish whether the contributions of tangible and intangible capital intensity to productivity growth have materially changed since the GFC, we regress the growth rates of labour productivity and TFP on growth rates of labour quality and the capital intensity (capital stock per hour) of different types of capital assets. The tangible assets are distinguished between non-ICT and ICT tangibles. The former includes non-ICT machinery, transport equipment, and structures. The latter consists of communication equipment and computing equipment. The intangible assets included in the regression are brand, organizational capital, research and development (R&D), design, and software and databases. As in Section 3 we focus the regression analysis only on the US and the UK (for 22 industries) as they exhibited the largest change in productivity growth before and after the GFC. Table C.1 is Appendix C shows t-test results for pre and post-crisis growth rates for all the individual capital intensity growth rates, labour productivity growth, and TFP growth rates.

In Tables 4.1 and 4.2, Models 1 to 4 are based on fixed effect panel data regression models with country-industry fixed effects. We first regress the growth rates of labour productivity (Model 1) and TFP (Model 2) on the growth rates of intensities of ICT and non-ICT tangibles, labour quality and five types of intangibles (Table 4.1). Models 3 and 4 include relative levels of intangible to tangible capital. These relative levels are measured as the ratio capital stock per hour of five types of intangible assets to that of total tangible assets in the previous year (Table 4.2). Models 3 and 4 help us understand whether a relatively higher level of capital stock in a particular type of intangible asset relative to total tangible assets affects productivity growth. These models also include an interaction between relative levels of organizational capital (in the previous year) and ICT intensity growth to capture any effect of organizational capital on the impact of ICT tangibles on productivity growth (Bontadini et al., 2022).

Models 5 to 8 are based on OLS regression, including a dummy for the most intangible-intensive industries, using the taxonomy provided in Section 2 (Table 2.3), helping to understand the difference in terms of labour productivity and TFP growth rates relative to less intensive industries. Models 5 and 6 (Table 4.3) are similar to Models 1 and 2 (Table 4.1), and Models 7 and 8 (Table 4.4) are similar to Models 3 and 4 (Table 4.2), but with the inclusion of the intangible intensity dummy. Appendix C provides the same analysis as Models 5-8 for the UK and the US separately, although with a lower number of observations.

All regressions are estimated with a period dummy to distinguish between pre-GFC (1999-2006) and post-GFCs (2011-2018) periods. To delineate the difference in the impact of each variable between the two time periods, an interaction between the period dummy and each independent variable is included in the regression. Since the period dummy takes the value 1 for the 2011-2018 period and 0 for 1999-2006, the reference coefficients are for the period 1999-2006. The coefficients of the interaction between the period dummy and capital intensities will indicate whether the effect of any given asset has increased or decreased in the 2011-2018 period and whether those coefficients are significantly different from the reference period. Therefore, this analysis helps to pinpoint whether the change in productivity growth since the GFC has been due to a significant change in the impact of a particular

variable. We also perform a Wald test to test the joint significance of the interaction and main effects. These results are provided in the adjacent columns to each Model.

Table 4.1: Fixed effects regression: productivity growth on capital intensity growth rates: US&UK 22 industries (Models 1 and 2)

	Labor productivity growth		TFP growth	
	Model 1	Joint significance (F test) with period interaction#	Model 2	Joint significance (F test) with period interaction#
d.Non-ICT capital	.505***		.24*	
	(.131)		(.142)	
d.ICT capital	.036		.019	
	(.048)		(.054)	
d.Brand	.056		.009	
	(.195)		(.175)	
d.Organizational K	.136**		-.008	
	(.065)		(.086)	
d.R&D	.038		.013	
	(.039)		(.039)	
d.Design	-.107		-.092	
	(.133)		(.114)	
d.Software & DB	-.015		-.012	
	(.074)		(.069)	
d.Labor Quality	.117		-.032	
	(.176)		(.154)	
Dummy 2011-2018=1	-3.479***		-3.452***	
	(.933)		(.847)	
Interactions with period Dummy				
d.Non-ICT capital	-.175	3.47*	-.046	2.02
	(.17)	(0.0696)	(.169)	(0.1627)
d.ICT capital	.142	1.95	.094	0.9
	(.125)	(0.1704)	(.119)	(0.349)
d.Brand	.466***	4.58**	.496***	4.44**
	(.121)	(0.0383)	(.125)	(0.0411)
d.Organizational K	-.243**	0.49	-.194**	2.1
	(.111)	(0.489)	(.084)	(0.1548)
d.R&D	.327***	17.73***	.272***	11.7***
	(.096)	(0.0001)	(.094)	(0.0014)
d.Design	.242	0.52	.17	0.25
	(.206)	(0.4742)	(.172)	(0.6199)
d.Software & DB	.097	0.35	.052	0.09
	(.149)	(0.5586)	(.156)	(0.77)
d.Labor Quality	.314	2.54	.516*	5.24**
	(.291)	(0.1184)	(.266)	(0.0271)
Constant	1.812***		1.717***	
	(.67)		(.63)	
Observations	688		688	
R-squared	.413		.286	
Adj R^2	.398		.268	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Table 4.2: Fixed effects regression: productivity growth on capital intensity growth rates and intangible to tangible ratios in year t-1 : US&UK 22 industries (Models 3 and 4)

	Labor productivity growth		TFP growth	
	Model 3	Joint significance (F test) with period interaction#	Model 4	Joint significance (F test) with period interaction#
d.Non-ICT capital	.486***		.243	
	(.136)		(.147)	
d.ICT capital	-.028		-.045	
	(.041)		(.043)	
d.Intangible capital	.161*		-.094	
	(.08)		(.086)	
Brand /Tangible	.089		.116	
	(.123)		(.117)	
Organizational K /Tangible	-.093***		-.088***	
	(.01)		(.01)	
R&D /Tangible	-.035		-.066	
	(.064)		(.068)	
Design /Tangible	-.089		-.104	
	(.08)		(.076)	
Software & DB /Tangible	.223		.183	
	(.195)		(.166)	
d.Labor Quality	.147		-.02	
	(.134)		(.136)	
d.ICT capital * Org. K /Tangible	.001***		.001***	
	(0)		(0)	
Dummy 2011-2011=1	-.73		-.118	
	(2.129)		(1.983)	
Interactions with period Dummy				
d.Non-ICT capital	-.154	4.05*	-.026	2.86*
	(.182)	(0.0507)	(.181)	(0.0984)
d.ICT capital	-.469***	14.43***	-.571***	27.17***
	(.135)	(0.0005)	(.126)	(0)
d.Intangible capital	.477	5.46**	.362	1.01
	(.296)	(0.0242)	(.288)	(0.3212)
Brand /Tangible	-.133	0.03	-.12	0
	(.221)	(0.8716)	(.215)	(0.9897)
Organizational K /Tangible	-.064	1.57	-.072	2.04
	(.126)	(0.2173)	(.112)	(0.1609)
R&D /Tangible	-.041	2.38	-.023	2.8
	(.028)	(0.1307)	(.029)	(0.1017)
Design /Tangible	.113	0.03	.06	0.12
	(.081)	(0.8584)	(.074)	(0.728)
Software & DB /Tangible	-.06	0.48	-.054	0.33
	(.221)	(0.4919)	(.215)	(0.5689)
d.Labor Quality	.071	2.95*	.179	1.84
	(.191)	(0.0935)	(.193)	(0.1821)
d.ICT capital * Org. K /Tangible	.041***	82.68***	.043***	116.97***
	(.005)	(0)	(.004)	(0)
Constant	3.637		4.125*	
	(2.6)		(2.43)	
Observations	688		688	
R-squared	.554		.441	
Adj R^2	.54		.423	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Table 4.3: OLS with dummy for intangible intensive industries: US&UK 22 industries (Models 5 and 6)

	Labor Productivity growth		TFP growth	
	Model 5	Joint significance (F test) with period interaction#	Model 6	Joint significance (F test) with period interaction#
d.Non-ICT capital	.523***		.253**	
	(.119)		(.122)	
d.ICT capital	-.001		-.019	
	(.041)		(.043)	
d.Brand	.043		-.018	
	(.121)		(.121)	
d.Organizational K	.167		.05	
	(.157)		(.158)	
d.R&D	.011		-.009	
	(.031)		(.03)	
d.Design	-.001		.005	
	(.137)		(.131)	
d.Software & DB	-.001		-.004	
	(.064)		(.064)	
d.Labor Quality	.011		-.115	
	(.151)		(.148)	
Dummy (Int-intensive=1)	2.203***		2.29***	
	(.826)		(.813)	
Dummy 2011-2011=1	-2.841**		-2.795**	
	(1.242)		(1.201)	
Interactions with period Dummy				
d.Non-ICT capital	-.408**	0.77	-.261	0.0005
	(.177)	(0.3805)	(.172)	(0.948)
d.ICT capital	.18	2.95*	.131	1.25
	(.112)	(0.0862)	(.109)	(0.2637)
d.Brand	.458**	7.09***	.503**	7.32***
	(.224)	(0.0079)	(.216)	(0.007)
d.Organizational K	-.171	0.0001	-.15	0.37
	(.235)	(0.9834)	(.229)	(0.5451)
d.R&D	.443***	14.6***	.379***	11.47***
	(.123)	(0.0001)	(.114)	(0.0007)
d.Design	.048	0.07	-.006	0.0003
	(.22)	(0.7845)	(.204)	(0.9975)
d.Software & DB	.021	0.05	-.003	0.01
	(.115)	(0.829)	(.111)	(0.9369)
d.Labor Quality	.274	2.61	.469**	4.93**
	(.232)	(0.107)	(.218)	(0.0267)
Dummy (Int-intensive=1)	-1.342	1.19	-1.507	1.09
	(1.144)	(0.2764)	(1.107)	(0.2979)
Constant	.664		.549	
	(.724)		(.74)	
Observations	688		688	
R-squared	.39		.265	
Adj R^2	.373		.244	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Table 4.4: OLS with dummy for intangible intensive industries: US&UK 22 industries (Models 7 and 8)

	LP growth		TFP growth	
	Model 7	Joint significance (F test) with period interaction#	Model 8	Joint significance (F test) with period interaction#
d.Non-ICT capital	.516***		.284**	
	(.132)		(.139)	
d.ICT capital	-.056		-.082*	
	(.042)		(.044)	
d.Intangible capital	.261		.007	
	(.233)		(.224)	
Brand /Tangible	.061		.113	
	(.089)		(.089)	
Org. K /Tangible	-.045***		-.05***	
	(.016)		(.016)	
R&D /Tangible	.038*		.019	
	(.02)		(.021)	
Design /Tangible	-.056		-.056	
	(.041)		(.04)	
Software & DB /Tangible	.101		.054	
	(.079)		(.082)	
d.Labor Quality	.072		-.092	
	(.171)		(.169)	
d.ICT * Org. K /Tangible	.001		.002	
	(.001)		(.001)	
Dummy (Int-intensive=1)	2.449***		2.435***	
	(.682)		(.702)	
Dummy 2011-2011=1	-.266		.101	
	(1.439)		(1.412)	
Interactions with period Dummy				
d.Non-ICT capital	-.248	5.37**	-.143	1.84
	(.176)	(0.0207)	(.174)	(0.1755)
d.ICT capital	-.459**	8.52***	-.534***	16.12***
	(.181)	(0.0036)	(.16)	(0.0001)
d.Intangible capital	.275	8.94***	.191	1.44
	(.294)	(0.0029)	(.278)	(0.2299)
Brand /Tangible	-.517**	4.94**	-.518**	4.44**
	(.223)	(0.0265)	(.212)	(0.0355)
Org. K /Tangible	.032	0.02	.021	0.13
	(.094)	(0.8892)	(.083)	(0.7225)
R&D /Tangible	-.061***	5.06**	-.046**	8.01***
	(.023)	(0.0248)	(.023)	(0.0048)
Design /Tangible	.085	0.32	.06	0.01
	(.066)	(0.574)	(.061)	(0.9274)
Software & DB /Tangible	.397**	7.71***	.394**	7.12***
	(.196)	(0.0056)	(.187)	(0.0078)
d.Labor Quality	-.018	0.08	.107	0.01
	(.259)	(0.7816)	(.25)	(0.9339)
d.ICT * Org. K /Tangible	.041***	17.42***	.043***	28.15***
	(.01)	(0)	(.008)	(0)
Dummy (Int-intensive=1)	-2.159**	0.13	-2.128**	0.17
	(1.049)	(0.7155)	(1.024)	(0.6806)
Constant	.696		.876	
	(.757)		(.761)	
Observations	688		688	
R-squared	.505		.392	
Adj R^2	.487		.371	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Below we summarize the main observations from our regression results regarding each type of capital asset. Starting with Models 1 and 2 in Table 4.1, we observe that:

- The growth in **non-ICT capital intensity** positively impacted on both labour productivity and TFP growth rates in the pre-GFC (1999-2006) period. The interaction effects and the joint significance tests suggest that the pre-crisis positive effect of non-ICT capital intensity on labour productivity growth weakened significantly in the post-GFC period.
- **ICT capital intensity** growth was positive but not significant for either labour productivity or TFP growth both before and after the GFC.
- **Organizational capital intensity** growth had a positive and significant impact on labour productivity growth (but not on TFP growth) in the pre-GFC period. However, its positive impact has eroded substantially and reduced productivity in the post-crisis period (the interaction effect is negative, significant, and larger than the main effect, but the joint impact is insignificant).
- All other intangible asset intensities remained insignificant for labour or TFP growth during the pre-GFC period. However, there were positive impacts of brand intensity growth and **R&D intensity** growth on both labour productivity and TFP growth in the post-2011 period.
- The rise in **labour quality** was positive but insignificant during the pre-GFC period but it showed up as a significant contributor to TFP growth (but not to labour productivity growth) during the post-GFC period.

In Table 4.2 we present the results from Models 3 and 4, including the relative levels of intangible assets (relative to total tangible capital stock) to see if the change in the relative level of intangible to tangible intensity affects productivity growth:

- Table 4.2 confirms our findings from Table 4.1, regarding the positive role of **non-ICT capital intensity** in driving labour productivity growth in the pre-crisis period, and its weakening in the post-crisis period.
- Additionally, this regression shows a substantial erosion in the impact of **ICT capital intensity** growth on productivity growth in the post-2011 period.
- When considering **intangible capital intensity** growth as a single block, the coefficient shows a positive and significant impact on labour productivity growth (but not on TFP growth) in the pre-crisis period. The positive impact on labour productivity further improved during the post-crisis period.
- Among the intangible ratios relative to total tangible stock, only **organizational capital intensity** has a significant coefficient which is negative. This implies that while the impact of the rise in intangible capital intensity was positive for labour productivity growth in Model 1, when relating the level of intangible capital to that of tangible capital in Model 3 its positive effect on productivity disappears.
- On the positive side, we also included an **interaction between organizational capital levels and the rise in ICT capital intensity**, which showed a positive and significant impact in the 1999-2006 period. This suggests the supporting role of organizational capital on the relationship between ICT tangible growth and productivity growth, which shows a substantial improvement during the post-GFC period. Thus, better organizational capabilities show a substantial positive impact on the effectiveness of ICT investments to deliver productivity growth (see also Bontadini, 2022).

- The positive role of **brand and R&D intensities** during the post-GFC period in Models 1 and 2 have disappeared from Models 3 and 4 once we relate their intensity levels (capital per hour) to that of tangible capital. This implies that while the growth of these intangible assets exhibits a positive impact on labour productivity growth, once taking into account the significant decline in tangible capital investment, their positive contribution vanishes.

Table 4.3 provides our results from Models 5 and 6, including the intangible intensity taxonomy we introduced in Section 2:

- The regressions underscore the positive and significant impact of the **non-ICT capital intensity** growth rate on productivity in the 1999-2006 period and its weakening in the post-crisis period.
- The insignificant impact of **ICT capital intensity** is also evident in the Table, although it improved marginally during the post-crisis period.
- Third, Table 4.3 confirms the strengthening roles of **brand and R&D intensities** on labour productivity, as we observed before in Table 4.1, even though this seems primarily the case for the UK (Appendix Table C.3). In the US, we also see software and database intensity's positive and significant impact on productivity in the first period, being worn out in the post-crisis period (Appendix Table C.2).
- Most importantly, we observe that the **intangible-intensive industries dummy** made a large contribution to productivity during the pre-crisis period. Although their dominance has weakened in the post-crisis period, the difference is quite marginal, as suggested by insignificant interaction terms. The joint-significance test suggests that there is no further strengthening in the role of those industries contributing to labour productivity growth. Rather their role is not substantially different from that of less intensive intangible-using industries.

Finally, in Table 4.4, we replicate the exercise from Table 4.2 introducing the relative intangible to tangible capital ratios but also including intangible industry dummies:

- As in our previous results, we see a strong positive impact of **non-ICT capital intensity** in the pre-crisis period, which has rather dramatically eroded during the post-crisis period.
- In contrast to earlier results, we now find the coefficient of **ICT capital intensity** on productivity growth becoming significantly negative during the post-crisis period, indicating a productivity- reducing role of increased growth of ICT capital deepening compared to the first period. This resulted mainly from the severe negative impact of ICT intensity in the UK (Appendix Table C.5). Faster growth in ICT investment intensities did improve productivity in the US (Appendix Table C.4), but its effect was outweighed by a more substantial negative impact in the UK.
- We see a weakening effect of **brand intensity** and **R&D intensity** relative to tangible capital intensity in the post-crisis period.
- In contrast to previous regressions, we find that the **software & databases intensity** to tangible intensity suggests a substantial improvement in the post-GFC period. Industries with higher software/tangible ratio levels seem to have improved productivity faster in the post-crisis period.

- As before, the **interaction of ICT and organizational capital intensity** shows commendable improvement in the post-crisis period, evidenced by significant interaction terms and significant joint effects of main and interaction terms.
- Finally, the **intangible-intensive industry dummy** shows a positive effect on productivity during the pre-crisis period (as in Table 4.3) but a significant negative effect on productivity growth during post-GFC period. This result is in line with our observations in Charts 2.7 and 2.8 above.

Taken together, while the outcomes from our various regression specifications are not entirely consistent, there are some observations in the analysis that seem to be recurring:

- First, the significant drop in the contribution of the tangible capital intensity to productivity relative to the modest improvement in the contribution of intangible capital intensity during the post-GFC period plays a role in the slowdown of productivity in the UK and the US.
- Second, while intangible capital, notably organisational capital (especially during the pre-GFC period) and brand and R&D intensity (especially during the post-GFC period) contribute positively to productivity growth, when related to the rapid decline in the level of tangible capital, their role becomes less prominent. In other words, the positive contribution of intangible capital to productivity growth has not been sufficient to make up for the significant decline in the contribution of intangible relative to tangible capital. Despite a positive relationship between organizational capital and ICT tangible capital (i.e., computers), this effect does not seem to have been large enough to halt the overall productivity slowdown.
- Finally, there is no evidence that intangible-intensive industries have come to the rescue in terms of improving their productivity performance. As already seen in Section 2, the contribution of the most intangible-intensive industries to the productivity slowdown during the post-GFC period was even larger than for less intangible-intensive industries. This is confirmed by the regression analysis in this section, even though the distinction between more and less intangible-intensive industries does not seem to make a significantly distinctive difference.

5. Conclusions

In this paper we have focused on the question whether the increased importance of intangible assets in the economy has not only provided benefits for productivity growth, but could also be responsible for part of the slowdown in productivity since the Great Financial Crisis. We investigated various reasons why this may be the case. The evidence based on an analysis of six countries (France, Germany, Italy and Spain, and with a specific focus on UK and US) across 22 industries leads to the following conclusions:

- We do not find much evidence of slowing growth in intangibles either in real terms or as a share of GDP, with the UK as the main exception where intangibles as a share of GDP have been lower after the GFC than before.
- Since the GFC the contribution of intangibles to productivity has increased in most countries, even though it dropped in absolute terms in the UK and the US where the productivity slowdown has also been relatively intense.
- We find some evidence that there are no productivity benefits in cases where the ratio of intangible to tangible capital has increased relatively fast. In other words, the positive contribution of intangible capital to productivity growth has not been sufficient to make up for the significant decline in the contribution of intangible relative to tangible capital.
- There is clearer evidence that, for most countries, industries that make relatively intensive use of intangible assets have contributed more to the weakening in productivity than industries that were less intensive users. This observation could point at the time lag hypothesis for new investments in digital and intangibles to translate into productivity growth as laid out in some of our earlier work (van Ark, 2016; van Ark et al, 2019, 2021).

We stress that, despite the focus of this paper on intangible investment, it is the weakening of TFP growth which is the main culprit in explaining the productivity slowdown. This could point at a lack of spillover effects from investment in tangible and intangible capital as well as the weakening of positive effects from complementarities between them.

While the results discussed here are important pointers, we believe more analysis is needed to fully understand the implications of the decomposition and different econometric exercises employed in this paper. Importantly, we have not discussed the issue of increased measurement problems in intangibles- and digital-intensive economy. Such measurement issues can occur on both the input side of the productivity equation (for example, the measurement of own account intangibles, etc.) as well as on the output side (such as the production value of digital content and the measurement of prices for digital output). (See also Corrado et al, 2022; Coyle and Mei, 2022; Goodridge and Haskel, 2022)

Another line of fruitful research would be to analyse the differences between countries and industries in more detail (as done, for example, in Section 3 of this paper). Countries clearly have different economic structures which have impacted the pace of "intangibilisation" of their economies. For example, the large share of digital-producing industries in the US and a relatively large Finance & Insurance sector in the UK might have led to a faster pace in the adoption of intangible assets in those industries, and the possibility of "over-intangibilisation" during the pre-GFC period. In contrast, several European countries may still be in an earlier

stage of "intangibilisation" and the productivity effects of greater usage may still be in the waiting.

Finally, the recent work by Haskel and Westlake (2022) points to the need for greater attention for the institutional aspects of intangibles, such as the role of science, technology and innovation institutions, the design of financial markets and policies, and competition. Such institutional factors could interact strongly with the changing impact of intangibles on productivity.

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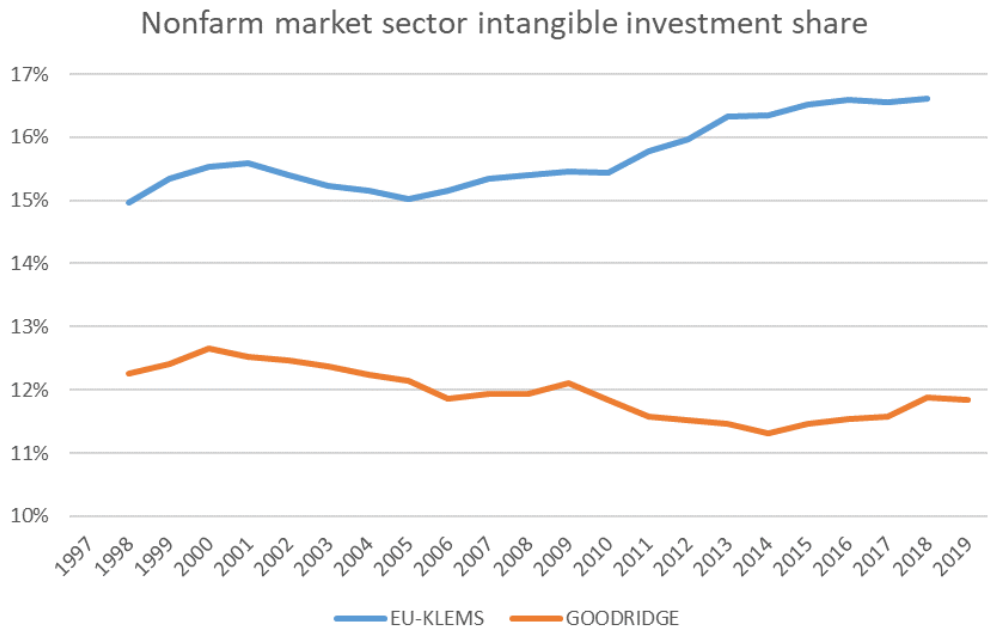
Appendix A – Differences between EUKLEMS & INTANProd – Release 2021 and Goodridge & Haskel (2022) for the UK

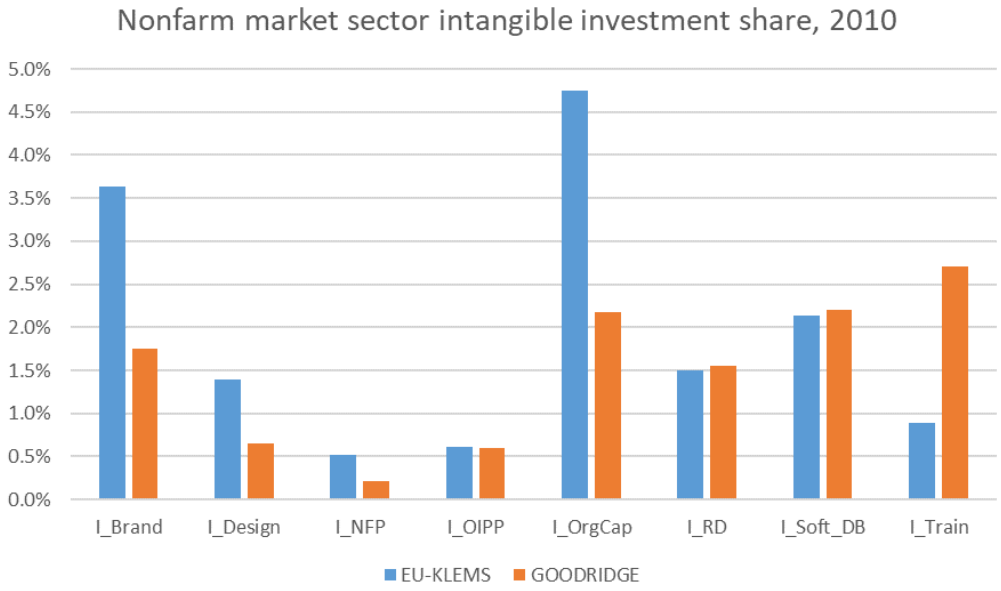
The two key differences between the source data (EUKLEMS & INTANProd – Release 2021 – hereafter referred to as EUKLEMS – and Goodridge & Haskel (2022)) used to construct these vintages of industry level national accounts and growth accounting data for the UK are as follows:

1. While both rely on the CHS framework to identify intangible assets, both use different sources. Goodridge relies on ONS experimental data, EU-KLEMS data are constructed by the KLEMS team themselves using a harmonized method used across countries and industries.
2. Goodridge and Haskel (2022) takes into account substantial Blue Book 2021 revisions (among others double deflation); KLEMS relies on Eurostat data which has not been updated to include these revisions (in fact I'm not sure when this was last updated, but the data only go up to 2018).

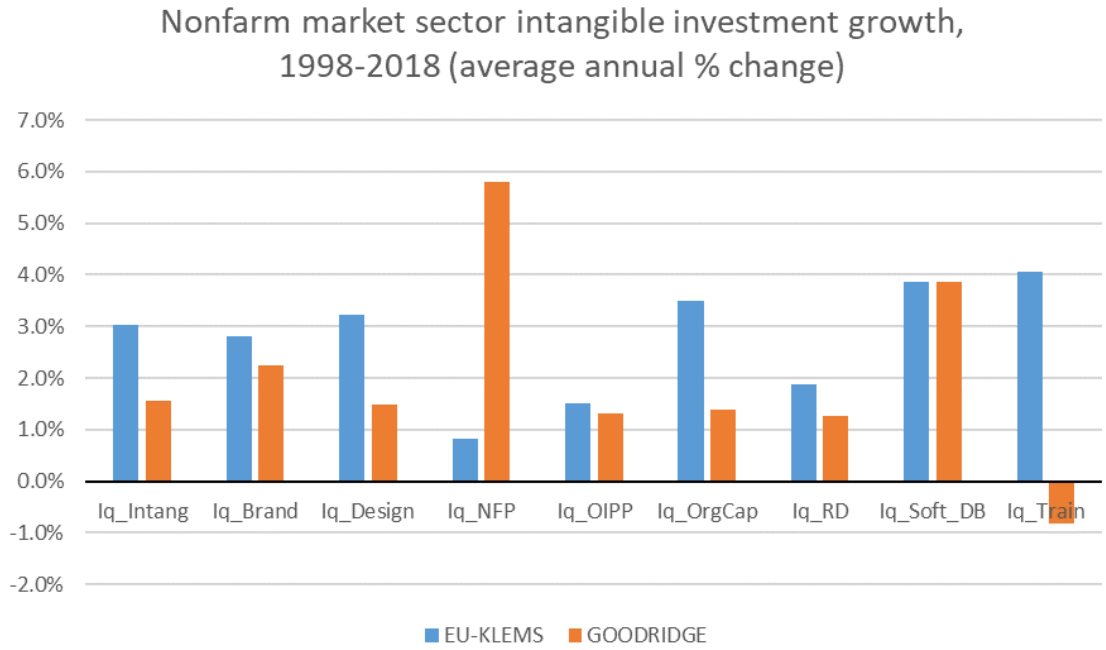
Intangible investment data differences

Nominal intangible investment level data are substantially higher in the KLEMS data, and the trend is also different. The difference in nominal output data are minimal between these two vintages of the data. Whereas in the Goodridge/Haskel vintage the intangible investment share (investment as a share of value added) has declined between 1998 and 2018, it has increased in the EU-KLEMS vintage. The EU-KLEMS vintage shows particularly higher levels of intangible investment for Brand, Design and Organizational capital. The Goodridge/Haskel vintage on the other hand shows higher levels of training investment data.



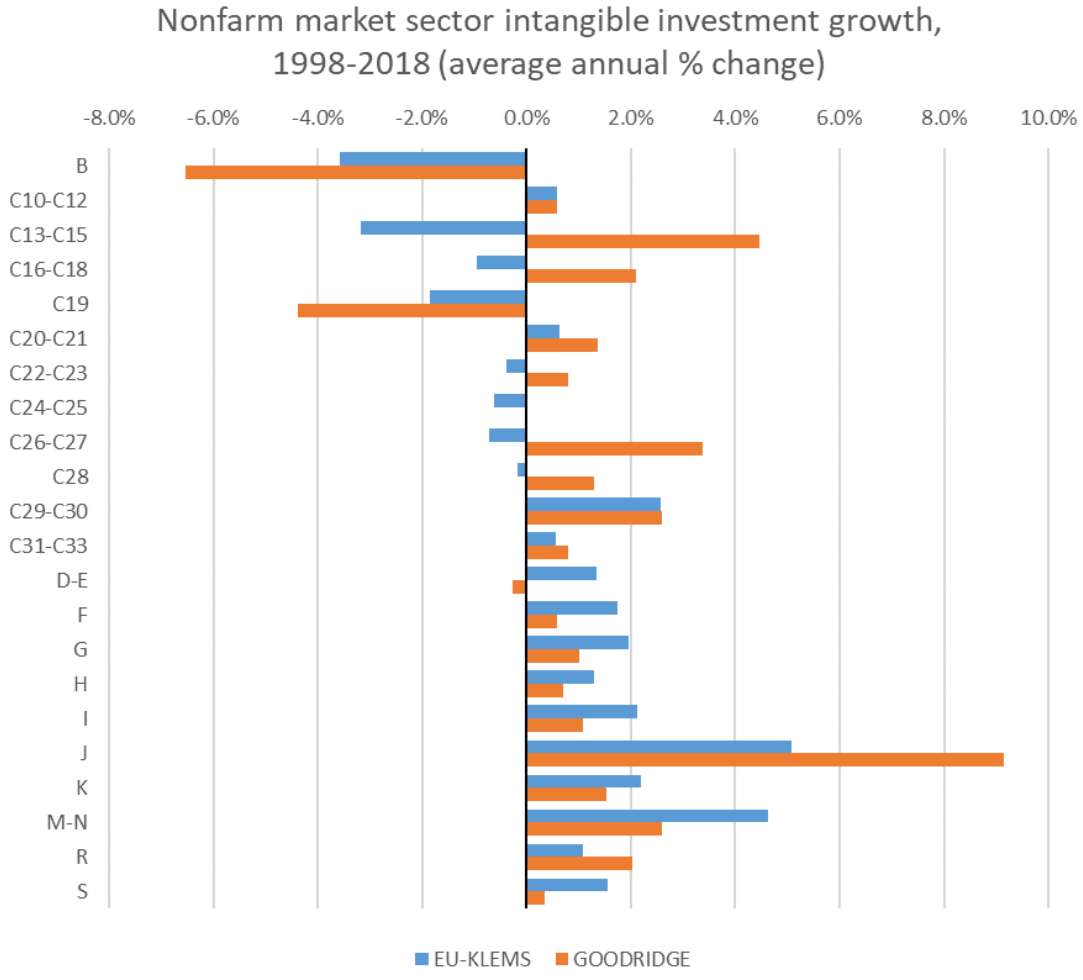


Real investment data is likewise different between these two vintages. Overall real intangible investment grew on average 1.6 percent per year between 1998 and 2018 in the Goodridge/Haskel vintage, versus a much faster 3 percent in the EU-KLEMS data. The differences are largest for design, organizational capital and training where EU-KLEMS data shows much faster growth (in the latter the Goodridge/Haskel data even shows a decline); while for New product development costs in the financial industry the Goodridge/Haskel data shows much faster growth.



Real value added data differences

Real value added data is likewise very different across these vintages, reflecting the blue book revisions that were carried out by the ONS in 2021. The chart below compares average annual real value added growth between 1998 and 2018. Out of the 22 industries considered, only for three industries (food/drinks; transport equipment and other mfg) are there hardly any differences. For all other industries the differences are relatively large. As expected, the information and communication services industry (J) and the electronics / computer manufacturing industry (C26, C27) show the largest differences, with much faster growth in the Goodridge (new ONS) data. But there are also other surprising differences, for example in the textiles and wood processing industries (13-15 and 16-18) and more importantly the professional services industry (M-N) which is a very large sector.



Appendix B – Correlations between different intangible asset intensities

The correlation among the different intangible asset intensities in the 6-country sample is also positive but with a different magnitude (Table 4.4). The relationship is strong between organizational capital and brand in both pre-and post-crisis periods. Brand capital seems to have lost its degree of association with other intangibles in general, and especially its strong co-movement with design has lost in the post-crisis period.

Table B.` Correlation between intangible capital intensity growth rates:
Sample: 6 countries, 22 industries

	1999-2006					2010-2018				
Variables	Brand	Organizational Capital	Training	R&D	Design	Brand	Organizational Capital	Training	R&D	Design
Organizational Capital	0.548					0.41				
Training	0.124	0.085				0.059	0.101			
R&D	0.212	0.27	0.042			0.183	0.298	0.086		
Design	0.618	0.531	0.142	0.297		0.281	0.318	0.085	0.31	
Software & Databases	0.248	0.206	0.158	0.16	0.338	0.182	0.224	0.062	0.161	0.143

Table B.2 Correlation between intangible capital intensity growth rates: Sample: US, 22 industries

	1999-2006					2010-2018				
Variables	Brand	Organizational Capital	Training	R&D	Design	Brand	Organizational Capital	Training	R&D	Design
Organizational Capital	0.605					0.417				
Training	0.03	0.058				0.304	0.331			
R&D	0.195	0.227	-0.01			0.197	0.29	0.565		
Design	0.727	0.603	0.075	0.115		0.533	0.549	0.44	0.334	
Software & Databases	0.173	0.025	0.039	0.053	0.286	-0.129	0.029	-0.032	-0.127	0.035

Table B.3 Correlation between intangible capital intensity growth rates: Sample: UK, 22 industries

	1999-2006					2010-2018				
Variables	Brand	Organizational Capital	Training	R&D	Design	Brand	Organizational Capital	Training	R&D	Design
Organizational Capital	0.281					0.589				
Training	0.152	0.359				0.345	0.229			
R&D	0.096	0.272	0.325			0.499	0.35	0.638		
Design	0.356	0.179	0.365	0.251		0.285	0.037	0.626	0.477	
Software & Databases	0.24	0.233	0.225	0.126	0.409	0.505	0.52	0.399	0.412	0.372

Appendix C – Additional regression analysis on UK and US industries

Table C.1: t-test results for pre and post crisis growth rates (difference is post-crisis minus pre-crisis)

variable	Mean difference	t-value
Non-ICT capital	-3.12	8.75***
ICT capital	-10.13	15.75***
Brand	-0.323	0.6
Organizational K	-2.917	5.05***
R&D	-2.343	3.8***
Design	-4.02	8.65***
Software & DB	-1.974	3.15***
Labor productivity	-3.029	4.4***
TFP	-1.881	3.05***

Note: the data is across all industries, for the combined sample of US and UK.
**** p<.01, ** p<.05, * p<.1*

Appendix Table C.2: OLS with dummy for intangible intensive industries: US 22 industries, Models 5 and 6

	Labor Productivity growth		TFP growth	
	Model 5	Joint significance (F test) with period interaction#	Model 6	Joint significance (F test) with period interaction#
d.Non-ICT capital	.271		-.253	
	(.257)		(.237)	
d.ICT capital	-.069		-.045	
	(.082)		(.081)	
d.Brand	-.074		-.131	
	(.114)		(.111)	
d.Organizational K	-.161		-.21	
	(.145)		(.138)	
d.R&D	.021		.006	
	(.03)		(.026)	
d.Design	-.125		-.111	
	(.134)		(.131)	
d.Software & DB	.091*		.092*	
	(.049)		(.047)	
d.Labor Quality	-.462**		-.656***	
	(.2)		(.185)	
Dummy (Int-intensive=1)	2.533***		2.044**	
	(.87)		(.816)	
Dummy 2011-2011=1	-2.728**		-2.542**	
	(1.284)		(1.243)	
Interactions with period Dummy				
d.Non-ICT capital	.407	6.77***	.368	0.21
	(.366)	(0.0097)	(.348)	(0.6501)
d.ICT capital	.166	1.82	.053	0.01
	(.109)	(0.1785)	(.11)	(0.9095)
d.Brand	.246*	3.93**	.288**	4.02**
	(.143)	(0.0483)	(.136)	(0.0459)
d.Organizational K	-.115	5.25**	-.144	10.74***
	(.189)	(0.0226)	(.175)	(0.0012)
d.R&D	.002	0.1	-.006	0
	(.077)	(0.749)	(.082)	(0.9959)
d.Design	.087	0.05	.092	0.01
	(.22)	(0.828)	(.208)	(0.9073)
d.Software & DB	-.076	0.08	-.072	0.16
	(.073)	(0.7741)	(.07)	(0.6936)
d.Labor Quality	.355	0.45	.478**	1.34
	(.256)	(0.5045)	(.241)	(0.2477)
Dummy (Int-intensive=1)	-.855	10.8***	-.631	7.76***
	(1.008)	(0.0011)	(.96)	(0.0057)
Constant	2.902***		2.716**	
	(1.1)		(1.054)	
Observations	336		336	
R-squared	.266		.193	
Adj R^2	.222		.144	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Appendix Table C.3: OLS with dummy for intangible intensive industries: UK 22 industries, Models 5 and 6

	Labor Productivity growth		TFP growth	
	Model 5	Joint significance (F test) with period interaction#	Model 6	Joint significance (F test) with period interaction#
d.Non-ICT capital	.448***		.25*	
	(.126)		(.135)	
d.ICT capital	.017		.001	
	(.04)		(.042)	
d.Brand	.179		.119	
	(.178)		(.182)	
d.Organizational K	.285*		.137	
	(.162)		(.166)	
d.R&D	.029		.024	
	(.086)		(.09)	
d.Design	.364**		.296**	
	(.148)		(.15)	
d.Software & DB	-.135		-.121	
	(.096)		(.102)	
d.Labor Quality	-.919		-1.308*	
	(.734)		(.74)	
Dummy (Int-intensive=1)	1.566		2.242	
	(1.428)		(1.44)	
Dummy 2011-2011=1	-.624		-.486	
	(1.689)		(1.625)	
Interactions with period Dummy				
d.Non-ICT capital	-.456**	0.0001	-.35*	0.56
	(.187)	(0.9539)	(.189)	(0.4541)
d.ICT capital	.169	1.72	.139	1.06
	(.148)	(0.1904)	(.142)	(0.3036)
d.Brand	.412	8.85***	.456*	8.68***
	(.267)	(0.0032)	(.267)	(0.0034)
d.Organizational K	-.144	0.54	-.103	0.04
	(.25)	(0.4614)	(.246)	(0.8483)
d.R&D	.412**	8.8***	.352**	7.85***
	(.171)	(0.0032)	(.161)	(0.0054)
d.Design	-.031	3.07*	-.046	2.18
	(.241)	(0.0808)	(.226)	(0.1411)
d.Software & DB	-.144	1.81	-.185	2.28
	(.228)	(0.1793)	(.226)	(0.1324)
d.Labor Quality	2.175**	4.76**	2.116**	2.13
	(.933)	(0.0299)	(.924)	(0.1452)
Dummy (Int-intensive=1)	-1.769	0.02	-2.33	0.00004
	(1.993)	(0.8837)	(1.957)	(0.947)
Constant	.655		.332	
	(.949)		(.974)	
Observations	352		352	
R-squared	.542		.424	
Adj R^2	.516		.391	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Appendix Table C.4: OLS with dummy for intangible intensive industries: US 22 industries, Models 7 and 8

	LP growth		TFP growth	
	Model 7	Joint significance (F test) with period interaction#	Model 8	Joint significance (F test) with period interaction#
d.Non-ICT capital	.184		-.271	
	(.25)		(.247)	
d.ICT capital	-.037		-.019	
	(.179)		(.18)	
d.Intangible capital	-.045		-.306	
	(.213)		(.21)	
Brand /Tangible	.042		.058	
	(.189)		(.183)	
Org. K /Tangible	-.209		-.169	
	(.168)		(.169)	
R&D /Tangible	.071***		.052**	
	(.024)		(.025)	
Design /Tangible	-.022		-.031	
	(.036)		(.036)	
Software & DB /Tangible	.915**		.875**	
	(.417)		(.403)	
d.Labor Quality	-.207		-.492**	
	(.228)		(.225)	
d.ICT * Org. K /Tangible	.005		.005	
	(.012)		(.012)	
Dummy (Int-intensive=1)	.696		.216	
	(1.204)		(1.207)	
Dummy 2011-2011=1	-2.941		-2.208	
	(2.304)		(2.34)	
Interactions with period Dummy				
d.Non-ICT capital	.419	6.16**	.492	0.85
	(.348)	(0.0136)	(.344)	(0.3567)
d.ICT capital	.436*	4.62**	.312	2.99*
	(.257)	(0.0324)	(.247)	(0.0846)
d.Intangible capital	-.045	0.11	-.139	2.8*
	(.346)	(0.7423)	(.339)	(0.095)
Brand /Tangible	-.18	0.75	-.222	1.09
	(.248)	(0.3877)	(.241)	(0.2975)
Org. K /Tangible	.365*	1.77	.347*	2.72
	(.204)	(0.1841)	(.201)	(0.1004)
R&D /Tangible	-.089***	3.48*	-.073***	5.86**
	(.026)	(0.0631)	(.027)	(0.0161)
Design /Tangible	-.006	0.44	-.036	2.82*
	(.056)	(0.5075)	(.054)	(0.094)
Software & DB /Tangible	-.712	3.41*	-.682	3.35*
	(.431)	(0.0658)	(.416)	(0.0681)
d.Labor Quality	.094	0.62	.226	3.77*
	(.269)	(0.4301)	(.264)	(0.0531)
d.ICT * Org. K /Tangible	-.032*	3.9**	-.03*	3.8*
	(.018)	(0.0493)	(.017)	(0.0522)
Dummy (Int-intensive=1)	-.107	0.37	.057	0.08
	(1.543)	(0.542)	(1.53)	(0.7715)
Constant	2.248		2.086	
	(2.052)		(2.121)	
Observations	336		336	
R-squared	.279		.157	
Adj R^2	.226		.095	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*

Appendix Table C.5: OLS with dummy for intangible intensive industries: UK 22 industries, Models 7 and 8

	LP growth		TFP growth	
	Model 7	Joint significance (F test) with period interaction#	Model 8	Joint significance (F test) with period interaction#
d.Non-ICT capital	.577***		.38**	
	(.148)		(.156)	
d.ICT capital	.045		.027	
	(.061)		(.059)	
d.Intangible capital	.239		-.023	
	(.291)		(.273)	
Brand /Tangible	.068		.094	
	(.123)		(.119)	
Org. K /Tangible	-.05***		-.055***	
	(.018)		(.017)	
R&D /Tangible	-.307***		-.382***	
	(.101)		(.1)	
Design /Tangible	-.054		-.038	
	(.066)		(.064)	
Software & DB /Tangible	.073		.014	
	(.099)		(.098)	
d.Labor Quality	-1.108		-1.416*	
	(.747)		(.737)	
d.ICT * Org. K /Tangible	.001		.001	
	(.001)		(.001)	
Dummy (Int-intensive=1)	1.22		1.327	
	(.94)		(.946)	
Dummy 2011-2011=1	7.77		5.63	
	(7.361)		(7.015)	
Interactions with period Dummy				
d.Non-ICT capital	-.397**	2.22	-.301	0.56
	(.192)	(0.1374)	(.188)	(0.4533)
d.ICT capital	-.969***	18.64***	-.992***	22.42***
	(.223)	(0.00001)	(.212)	(0.0004)
d.Intangible capital	.614	10.42***	.564	4.32**
	(.393)	(0.0014)	(.378)	(0.0385)
Brand /Tangible	-.902**	5.22**	-.921**	5.18**
	(.385)	(0.023)	(.382)	(0.0234)
Org. K /Tangible	.273*	2.29	.246*	1.8
	(.149)	(0.1315)	(.144)	(0.1807)
R&D /Tangible	-.378	4.05**	-.176	3.12*
	(.355)	(0.045)	(.331)	(0.0783)
Design /Tangible	-.055	0.29	-.11	0.53
	(.211)	(0.5881)	(.212)	(0.4652)
Software & DB /Tangible	.601*	4.43**	.616*	4.3**
	(.336)	(0.0361)	(.319)	(0.0388)
d.Labor Quality	1.763	0.73	1.616	0.08
	(1.07)	(0.3928)	(1.033)	(0.7817)
d.ICT * Org. K /Tangible	.054***	55.9***	.054***	59.2***
	(.007)	(0.00001)	(.007)	(0.0003)
Dummy (Int-intensive=1)	-.976	0.04	-.76	0.25
	(1.527)	(0.8394)	(1.467)	(0.6142)
Constant	7.618***		9.048***	
	(2.737)		(2.661)	
Observations	352		352	
R-squared	.64		.561	
Adj R^2	.615		.53	

*Notes: Standard errors are in parentheses; # p values in parentheses; *** p<.01, ** p<.05, * p<.1; the prefix d. indicates growth rate of the intensity of that variable (e.g. d.Non-ICT capital = growth rate of non-ICT capital per worker)*