

Appendix

Table A1 – UK output per worker estimates, by data vintages

Vintage	Release	Last year of post-GFC period	Compound average annual growth rates (%)			
			Pre-GFC (1997-2007)	Post-GFC (2010-latest/2019)	Slowdown (post-GFC minus pre-GFC)	<i>Memo: Latest estimate of post-GFC period</i>
BB12	Jul-12	2011	2.2	0.5	1.7	0.7
BB13	Jul-13	2012	2.2	-0.1	2.3	0.6
BB14	Oct-14	2013	2.0	0.4	1.6	0.6
BB15	Oct-15	2014	1.9	0.7	1.2	0.6
BB16	Jul-16	2015	1.9	0.5	1.4	0.6
BB17	Oct-17	2016	1.8	0.6	1.2	0.6
BB18	Jul-18	2017	1.8	0.6	1.2	0.7
BB19	Oct-19	2018	2.0	0.6	1.4	0.7
BB20	Oct-20	2019	1.9	0.5	1.4	0.6
BB21	Oct-21	2019	1.6	0.8	0.9	0.6
BB22	Oct-22	2019	1.7	0.7	1.0	0.6
BB23	Oct-23	2019	1.8	0.7	1.2	0.6
BB24	Oct-24	2019	1.8	0.7	1.2	0.6

Source: ONS (various vintages), author's calculations.

Notes: Update and modification of Table 1 from Martin and Mackenzie (2021), which was based on output per hour worked and went to BB21. In this version I have adjusted the post-GFC period to be growth from 2010 (i.e. first year of growth is 2011) to the latest year available or 2019. Parallel to Table 1 in the main text which was the equivalent for output per hour worked.

Table A2 – Descriptive statistics on the breadth of labour productivity growth across industries, 1998-2007

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Mean annual OpH growth across 78 industries (%)										
Unweighted	1.9	4.1	5.1	2.2	3.9	4.1	4.3	2.6	3.3	1.2
Weighted by hours	3.0	2.1	4.3	1.9	2.2	2.3	1.5	1.4	2.3	0.6
Weighted by nominal GVA	2.7	2.5	4.8	1.7	2.5	3.2	2.3	1.9	1.8	2.2
Median annual OpH growth across 78 industries (%)										
Unweighted	1.9	1.9	3.7	1.4	2.8	3.7	1.6	1.8	1.8	0.1
Weighted by hours	2.0	-1.8	1.3	-0.3	-1.1	1.5	0.8	0.1	1.5	-0.5
Weighted by nominal GVA	1.9	-1.8	2.3	-0.5	1.9	2.0	0.8	1.7	1.9	0.0
Proportion of 78 industries with positive annual OpH growth (%)										
Unweighted	59	58	65	54	60	65	65	58	58	51
Weighted by hours	67	44	62	47	50	53	60	56	63	38
Weighted by nominal GVA	62	45	64	46	52	57	60	58	61	43
Share of whole economy OpH growth due to top contributing industry (%)	33	42	28	28	35	26	44	50	39	57

Source: ONS (May 2025), author's calculations.

Notes: Hours weights and nominal GVA weights use the preceding year (e.g. 1997 weights for the 1998 growth rates). Industry breakdown is 78 mostly industry divisions (two-digit industries) of SIC 2007, with some aggregations.

Table A3 – Summary of output per hour worked growth rates before and after slowdown, UK growth accounting studies

Paper	Coverage	Source	Vintage	Pre-period	Pre growth	Post-period	Post period	Comments
Goodridge et al. (2014)	MS	ONS*	BB13	1990-2000 2000-2007	2.94 2.54	2007-2011	-0.47	Adjusted for R&D
Rincon-Aznar et al. (2015)	WE	TED	2014	2002-2007	2.7	2008-2013	-0.45	Adjusted for training
Goodridge et al. (2018)	MS	ONS*	BB13	1980-1990 1990-2000	2.70 2.94			Adjusted for R&D
Goodridge et al. (2018)	MS; bottom-up	ONS*	BB13	2000-2007	2.64	2007-2011	-0.46	Adjusted for R&D
Riley et al. (2018)	WE	ONS	BB17	1999-2007	2.1	2008-2016	0.2	
Riley et al. (2018)	MS	ONS	BB17	1999-2007	2.8	2008-2015	0.0	
Tenreyro (2018)	WE	ONS	BB17	2000-2007	2.0	2009-2015	0.4	
Oulton (2019)	WE	EUKLEMS	Sept 2017	2000-2007	1.91	2007-2015	0.08	
Fernald & Inklaar (2022)	WE	PWT	10.0	1985-1995 1995-2007	2.2 2.17	2007-2019	0.13	
Fernald & Inklaar (2022)	MS	ONS	BB20/21	1985-1995 1995-2007	3.8 2.82	2007-2019	-0.17	
Coyle & Mei (2023)	WE	ONS	BB21	1998-2008	1.63	2008-2019	0.35	
Coyle & Mei (2023)	WE _x L	ONS	BB21	1998-2008	1.50	2008-2019	0.05	
Coyle & Mei (2023)	WE _x OPO	ONS	BB21	1998-2008	1.72	2008-2019	0.18	
Chadha & Samiri (2023)	MS	ONS	BB21	1997-2007	2.43	2009-2019	0.4	
Goodridge & Haskel 2023	MS _x A	ONS*	BB22	2000-2007	2.46 2.32	2007-2019	0.12 0.10	National accounts Adjusted for additional intangibles
Goodridge & Haskel 2023	MS _x A; bottom-up	ONS*	BB22	2000-2007	2.69 2.55	2007-2019	0.14 0.14	National accounts Adjusted for additional intangibles
Bontadini et al (2024)	MS _x A	EUKLEMS	2023	1998-2007	2.91	2008-2019 2014-2019	0.49 0.93	Adjusted for additional intangibles
Bontadini et al (2024)	MS _x A; bottom-up	EUKLEMS	2023	1998-2007	3.02	2008-2019 2014-2019	0.5 1.22	Adjusted for additional intangibles
van Reenen & Yang (2024)	WE	ONS	BB22	1997-2007	1.5	2007-2019	0.6	
van Reenen & Yang (2024)	WE	EUKLEMS	2023	1997-2007	1.94	2007-2019	0.51	
van Reenen & Yang (2024)	MS	EUKLEMS	Various	1979-1997 1997-2007	2.2 2.72	2007-2019	0.48	
van Reenen & Yang (2024)	MS	EUKLEMS	2023	1995-2007	2.54 2.65	2007-2019	0.48 0.71	National accounts Adjusted for additional intangibles
Goldin et al. (2024)	WE	EUKLEMS	2019	1996-2005	2.21 2.25	2006-2017	0.45 0.52	National accounts Adjusted for additional intangibles
Goldin et al. (2024)	WE	OECD	2019	1995-2005	2.22	2006-2017	0.47	

Notes: WE is whole economy; BU is bottom-up aggregation of industries; MS is market sector (MS_xA is market sector excluding agriculture). ONS* is ONS data adjusted for additional intangibles.

Table A4 - Summary of TFP growth rates before and after slowdown, UK growth accounting studies

Paper	Type	Coverage	Source	Vintage	Pre-period	Pre growth	Post-period	Post period	Comments
Goodridge et al. (2014)	K-L	MS	ONS*	BB13	2000-2007	1.21 1.19	2007-2011	-2.1 -2.09	Baseline Adjusted for R&D
Rincon-Aznar et al. (2015)	K-L	WE	TED	2014	2002-2007	0.98	2008-2013	-1.71	Adjusted for training
Goodridge et al. (2018)	K-L	MS; bottom-up	ONS*	BB13	2000-2007	0.97 0.94	2007-2011	-2.17 -2.17	Baseline Adjusted for R&D
Riley et al. (2018)	K-L	MS; bottom-up	ONS	BB17	1999-2007	2.0	2011-2015	0.0	
Tenreyro (2018)	K-L	WE	ONS	BB17	2000-2007	0.6	2009-2015	-0.2	
Oulton (2019)	K-L	WE	EUKLEMS	2017	2000-2007	1.01	2007-2015	-0.3	
Fernald & Inklaar (2022)	K-Y	WE	PWT	10.0	1985-1995 1995-2007	0.92 1.86	2007-2019	-0.44	Contributions of TFP are $dTFP/(1-a)$
Fernald & Inklaar (2022)	K-Y	MS	ONS	BB20/21	1985-1995 1995-2007	1.21 2.51	2007-2019	-0.31	Contributions of TFP are $dTFP/(1-a)$
Fernald & Inklaar (2022)	K-L	WE	PWT	10.0	1985-1995 1995-2007	0.50 1.08	2007-2019	-0.26	
Fernald & Inklaar (2022)	K-L	MS	ONS	BB20/21	1985-1995 1995-2007	0.74 1.61	2007-2019	-0.21	
Chadha & Samiri (2023)	K-L	MS	ONS	BB21	1997-2007	1.52	2009-2019	0.2	
Chadha & Samiri (2023)	K-Y	MS	ONS	BB21	1997-2007	2.41	2009-2019	0.33	Contributions of TFP are $dTFP/(1-a)$
Goodridge & Haskel (2023)	K-L	MSxA	ONS	BB22	2000-2007	1.64 1.44	2007-2019	-0.31 -0.28	National accounts Adjusted for additional intangibles
Bontadini et al (2024)	K-L	MSxA	EUKLEMS	2023	1998-2007	1.21	2008-2019 2014-2019	-0.22 0.34	Adjusted for additional intangibles (both periods)
Bontadini et al (2024)	K-L	MSxA	EUKLEMS, ONS	2023, BB23	1970-2007	0.74	2008-2019 2014-2019	0.03 0.59	Adjusted for additional intangibles and consumer digital services mismeasurement (both periods)
van Reenen & Yang (2024)	K-L	MS	EUKLEMS	Various	1979-1997 1997-2007	0.64 1.43	2007-2019	0.06	
van Reenen & Yang (2024)	K-L	MS	EUKLEMS	2023	1995-2007	1.22 1.14	2007-2019	0.06 -0.07	National accounts Adjusted for additional intangibles
Goldin et al. (2024)	K-L	WE	EUKLEMS	2019	1996-2005	1.14 1.23	2006-2017	0.3 0.31	National accounts Adjusted for additional intangibles
Goldin et al. (2024)	K-L	WE	OECD		1995-2005	1.73	2006-2017	0.09	TFP includes labour composition

Notes: K-L is capital-labour; K-Y is capital-output; BU is bottom-up aggregation of industries; MS is market sector (MSxA is market sector excluding agriculture); WE is whole economy

Table A5 - Average annual growth in output per hour worked, additional industry groupings and restrictions, before and after slowdown and difference

Industry group	1997-2006	2010-2019	Difference
Whole economy	2.2	0.5	-1.7
x Agriculture (A)	2.1	0.4	-1.7
x Mining and quarrying (B)	2.3	0.6	-1.8
x Manufacturing (C)	1.2	0.4	-0.9
x Utilities (DE)	2.2	0.5	-1.7
x Construction (F)	2.4	0.5	-1.9
x Wholesale and retail; transportation; accommodation and food services (GHI)	2.4	0.6	-1.8
x ICT services (J)	1.4	0.1	-1.3
x Finance and insurance (K)	2.1	0.7	-1.5
x Real estate (L)	2.5	0.4	-2.1
x Imputed rental (part of L)	2.4	0.5	-1.9
x Professional, scientific services; admin and support services (MN)	2.4	0.6	-1.8
x Government services (OPQ)	2.9	0.4	-2.4
x Arts, entertainment; other services (RST)	2.3	0.5	-1.8
x KOPQ	2.9	0.7	-2.2
x LOPQ	3.3	0.3	-3.0
x KLOPQ	3.3	0.7	-2.7
x ALOPQ	3.2	0.3	-2.9
x AKLOPQ	3.2	0.6	-2.6
x ABDELKOPQ (“Core market sector”)	3.6	0.8	-2.8
Market sector (by institutional sector)	2.6	0.3	-2.2
ABCDEH (excluding “Hard to measure”)	5.2	0.4	-4.8
ABC (excluding “Hard to measure” modern)	6.9	1.0	-5.8

Source: ONS, author’s calculations.

Notes: The pre-slowdown period uses data for 1997-2006 since data on hours worked for detailed industries are not available prior to 1997. Industry sections from SIC 2007 given in brackets. “Core market sector” as defined in text. Period averages calculated as simple averages of annual natural log changes. “Hard to measure” definitions following Coyle (2025).

Chart A1 – Contributions of parts of the firm-level productivity distribution to aggregate labour productivity growth



Source: ONS (2024), author's calculations.

Notes: Trailing three-year averages in solid lines, annual data (as published) in dashed lines.

Productivity adjustment in GDP(O) industry output deflators

ONS use “productivity adjustment” in the calculation of real GVA estimates for approximately 8.7% of nominal GVA across a range of services industries. This is calculated based on the ONS “GDP(o) data sources catalogue”, version published 11 October 2024 consistent with Blue Book 2024, available at:

<https://www.ons.gov.uk/economy/grossdomesticproductgdp/datasets/gdpodatasourcescatalogue>

Table “BB24 - CURRENT PRICE & VOLUME” provides details about the sources and methods for nominal (current price) and real (volume) estimates of industry output. Column O, titled “Use of Prod Adj”, shows whether an industry estimate uses a productivity adjustment. On the “Cover” tab, this is described as “used to take account of efficiency gains in the production process when using input series such as jobs and wages”.

The table below summarises the instances of the use of the productivity adjustment. This is usually the case when the industry output volume measure is based on the number of workers (from Workforce jobs = WFJ), or where the deflator is wage-based (using Average Weekly Earnings = AWE). The sum of the weights of associated industry output (based on column H of the table) is 8.7% (87 parts per 1000).

The use of productivity adjustments is not recommended by Eurostat in their Price and Volume Handbook, because any adjustment in the absence of appropriate evidence is arbitrary. Of course, making no adjustment is also an assumption of no productivity growth, which is just as arbitrary. The preferred solution then must be to identify or construct suitable independent price indices that can be used as deflators, or direct volume estimates that are not based on production inputs (e.g. labour).

It is unclear what measure of productivity ONS uses for these productivity adjustments. If it is based on a measure of productivity that has seen a slowdown (and most have) then this adjustment may be reinforcing this slowdown by spreading it into other industries. For instance, if ONS are using whole

economy output per hour worked as the productivity adjustment measure, then the slowdown in manufacturing productivity will be ‘spread’ to other industries.

Table A6 – Summary of use of productivity adjustment in industry output deflators

Industry	Weight of relevant part in total industry GVA (parts per 1000)	Way in which the productivity adjustment is used
Mining support service activities (division 9)	0.8	Output volume is number of workers with prod adj
Motion picture, video and television programme production, sound recording and music publishing activities (division 59, market and non-market elements)	6.3	Deflator is wage-based with prod adj
Programming and broadcasting activities (division 60, part of market sector element)	0.5	Output volume is number of workers with prod adj
Computer programming, consultancy and related activities (division 62)	27.2	Deflator is SPPI with prod adj
Information service activities (division 63)	4.4	Deflator is SPPI with prod adj
Financial service activities, except insurance and pension funding (division 64, parts)	11.7	Deflator is wage-based with prod adj
Activities auxiliary to financial services and insurance activities (division 66, parts)	5.4	Deflator is wage-based with prod adj
Activities of head offices; management consultancy activities (division 70, part associated with head offices)	1.4	Output volume is number of workers with prod adj
Scientific research and development (division 72, both market and non-market elements)	9.0	Deflator is wage-based with prod adj
Education (division 85, part of private sector element)	0.8	Deflator is wage-based with prod adj
Residential care activities (division 87, market sector element)	7.9	Deflator is wage-based with prod adj
Social work activities without accommodation (division 88, market sector element)	8.2	Deflator is wage-based with prod adj
Activities of membership organisations (division 94, market sector element)	3.1	Deflator is wage-based with prod adj

Source: Author’s elaboration of ONS GDP(o) data sources catalogue.

Table A7 – Summary of output per hour worked growth in selected industries, across countries

	Average annual growth (%)		Rankings	
	UK	Median of other countries	UK rank	Countries with slower growth than UK
Energy (section D)				
1995-2006	5.0	4.2	6/19	JP, AT, FR, CZ, FI, SI, LU, BE, DK, IT, LV, DE, SE
2010-2019	0.1	0.5	12/19	IT, JP, BE, EL, DE, LV, CZ
2005-2019	-2.8	-1.1	18/19	CZ
1995-2019	0.5	1.7	16/19	SE, LV, CZ
Water and waste (section E)				
1995-2006	-1.8	-0.5	15/19	DE, LV, DK, IT
2010-2019	-2.6	-0.5	17/19	IT, SI
2005-2019	-3.4	-0.7	18/19	IT
1995-2019	-2.4	-0.8	17/19	SI, IT
Utilities (sections D and E combined)				
1995-2006	1.8	1.9	10/19	CZ, BE, LV, ES, DK, DE, US, SE, IT
2010-2019	-1.2	-0.2	16/19	IT, LV, CZ
2005-2019	-3.0	-0.5	18/19	CZ
1995-2019	-0.8	0.4	17/19	CZ, IT
Mining and quarrying (section B)				
1995-2006	-5.4	2.7	18/18	
2010-2019	-3.1	0.8	16/18	NL, DK
2005-2019	-6.3	1.2	16/18	NL, DK
1995-2019	-5.6	2.0	18/18	

Source: EUKLEMS-INTANProd (2025 vintage), author's calculations.

Notes: Data for Estonia, Slovenia and Slovakia start in 2000. US not available for energy and water separately, but available for combined utilities industry. Estimates use 'basic' module, which does not include adjustment for capitalisation of additional intangible assets. Figures quoted in text based on period 1995-2019.

Country codes

Presented in order as in Chart 4 in the main text. Selection based on countries with complete data in EUKLEMS-INTANProd 2025-vintage.

Country code	Country name
UK	United Kingdom
FI	Finland
IT	Italy
NL	Netherlands
FR	France
AT	Austria
ES	Spain
US	United States
DK	Denmark
DE	Germany
SE	Sweden
CZ	Czechia

Changes in carbon dioxide emissions and water use per capita

The UK has seen one of the largest falls in carbon dioxide per capita emissions over recent decades among advanced economies, which may be associated with weaker measured productivity growth.

Table A8 shows carbon dioxide emission per capita for selected advanced economies and selected years, using data gathered by Our World in Data, available from:

<https://ourworldindata.org/grapher/co-emissions-per-capita>

The UK saw modest falls between 1990 and 2005, and substantial falls between 2005 and 2019.

Between 1990 and 2019 or between 2005 and 2019, the UK has the second largest fall in per capita carbon dioxide emissions (behind Denmark in both cases) of the advanced economies included in the table.

Table A8 – Summary of trends in carbon dioxide emissions per capital across selected advanced economies

Country	Carbon dioxide emissions per capita (tonnes per person)							Cumulative change (%)	
	1990	1995	2000	2005	2010	2015	2019	1990 to 2019	2005 to 2019
UK	10.5	9.7	9.6	9.4	8.1	6.5	5.4	-48.2	-42.3
USA	20.2	20.2	21.4	20.7	18.3	16.5	15.6	-22.9	-24.9
Canada	16.5	16.7	18.3	17.7	16.2	15.7	15.4	-6.5	-12.8
France	6.9	6.6	6.8	6.7	5.9	5.1	4.8	-30.6	-29.0
Germany	13.2	11.5	11.0	10.6	10.2	9.8	8.5	-35.8	-19.7
Italy	7.7	7.8	8.2	8.6	7.2	6.0	5.6	-26.5	-34.1
Japan	9.4	9.9	10.0	10.1	9.5	9.6	8.7	-7.0	-13.5
Austria	8.1	8.1	8.3	9.6	8.6	7.7	7.7	-5.5	-20.4
Belgium	12.1	12.4	12.4	12.0	10.5	9.0	8.7	-28.2	-27.6
Czechia	15.9	12.8	12.4	12.2	11.2	10.0	9.6	-40.0	-21.7
Denmark	10.4	11.8	10.2	9.5	8.9	6.2	5.3	-48.8	-44.0
Finland	11.4	11.4	11.0	10.9	12.0	8.1	7.7	-32.7	-29.3
Netherlands	10.8	11.1	10.7	10.8	10.9	9.6	8.7	-19.8	-19.6
Spain	5.9	6.6	7.6	8.4	6.0	5.8	5.3	-10.3	-37.0
Sweden	6.7	6.7	6.2	6.0	5.7	4.4	4.0	-40.9	-33.4
EU27	9.2	8.5	8.4	8.6	7.8	7.0	6.5	-29.5	-24.5
World	4.3	4.1	4.1	4.5	4.8	4.7	4.8	11.3	5.7

Source: Our World in Data, author's calculations.

A similar pattern exists for water use. Data on water use from Our World in Data is sourced from UN Food and Agricultural Organization (FAO) AQUASTAT database, which has more years of data and more up to date data available, so I extract data on “Total water withdrawal per capita” directly from AQUASTAT., available here: <https://data.apps.fao.org/aquastat/?lang=en>

The data on water withdrawals is lumpy for several countries, including for the UK. It is unclear if this reflected genuine year-to-year changes or measurement inconsistencies over time. The UK sees a sharp increase in water withdrawals per capital in 2000, having been roughly flat from 1990 to 1999 – this may reflect a measurement change. It then declines sharply between 2000 and 2007, with the exception of a spike in 2006 which is likely a genuine change associated with a hot summer that year. Per capital water withdrawals then decline modestly from 2007 onwards.

Given the lumpiness of the data, the UK's position relative to other countries depends markedly on the time periods chosen. Between 2000 and 2019, the UK has the largest relative fall of economies in the

table. However, relative to 1990 or 2005 (shown in Table A9) the fall is only slightly larger than average.

Table A9 – Summary of trends in water use per capita across selected advanced economies

Country	Total water withdrawal per capita (cubic meters per person)							Cumulative change (%)	
	1990	1995	2000	2005	2010	2015	2019	1990 to 2019	2005 to 2019
UK	210	208	276	170	127	125	125	-40.3	-26.1
USA	2207	2085	1987	1902	1561	1362	1315	-40.4	-30.8
Canada	1602	1453	1312	1267	1186	978	954	-40.4	-24.7
France	661	582	550	550	451	433	399	-39.7	-27.4
Germany		595	549	492	485	363	309		-37.2
Italy	723	762	792	630	563	564	564	-22.0	-10.4
Japan	737	707	712	653	633	628	619	-16.1	-5.3
Austria	496	434	454	423	407	377	354	-28.7	-16.5
Belgium	856	814	735	610	518	354	365	-57.4	-40.2
Czechia		266	227	200	174	152	143		-28.6
Denmark	245	185	139	119	129	143	163	-33.7	36.9
Finland	471	506	453	429	430	432	634	34.7	47.6
Netherlands	546	440	526	702	651	492	479	-12.3	-31.7
Spain	990	883	891	865	752	675	616	-37.8	-28.8
Sweden	347	318	303	291	287	242	207	-40.3	-28.9

Source: AQUASTAT, author's calculations.

Notes: Total water withdrawal is defined as "Annual quantity of water withdrawn for agricultural, industrial and municipal purposes. It can include water from primary renewable and secondary freshwater resources, as well as water from over-abstraction of renewable groundwater or withdrawal from fossil groundwater, direct use of agricultural drainage water, direct use of (treated) wastewater, and desalinated water. It does not include in-stream uses, which are characterized by a very low net consumption rate, such as recreation, navigation, hydropower, inland capture fisheries, etc." (UN FAO).