# Appendix

## A1. Industries in the EUKLEMS & INTANProd dataset

In the table below we also report the list of industries and industry aggregates that are covered in the EUKLEMS & INTANProd dataset. Aggregations and definitions are consistent throughout the database.

To maximize country coverage, this paper uses aggregates built using NACE one-digit ("letter level") industries. This refers to the bolded industries in this table.

## A2. Data Summary for EU Countries

Table A2 below (column 1) shows each EU country according to the regions used for analysis in section 2. The subsequent groups of columns summarize the availability of data on intangibles, labour productivity and total factor productivity according to individual country and time. Note that to measure national accounts intangibles and nonresidential tangible investment for market sector industries, a country needs to issue complete data on investment by asset type by industry. Thus, we may have tangible investment for the total of all industries in an economy but not for market sector industries, which are a subset of the total (as seen above in Table A1). The comparison of column (6) with (9) suggests that information on industry-level investment by asset type is not available for six countries.

## A3. How is measured TFP growth affected by the inclusion of additional intangibles?

In section 3 we discuss how when intangibles are excluded from productivity analysis, measured TFP may be overstated, at least for a time. All told, the misstatement of TFP growth due to omitted intangibles in any given country is an empirical matter, depending on the investment and asset income dynamics described in box 2 in section 3, as well as changes over business cycles and in the relative prices of productive assets (tangible and intangible).

In Table A3 below we quantify the impact of the additional intangibles in EU KLEMS & INTANProd. As may be seen, for the conditions that prevail during the periods covered by the database, the inclusion of additional intangibles lowers estimates of TFP growth. Table A3, which currently is for the US only, sheds light on just how much TFP growth is lowered in this country by comparing the relevant line items in Table 3 of the main text with TFP calculated on using only those intangibles included in national accounts as shown in the table below.

Table A3 yields two findings. First, the table shows that US TFP growth is consistently lower using the expanded asset boundary. As shown in column (3, lines 1 and 2, and lines 4 and 5), the differences across the table's selected periods are within a narrow range. Over the entire period 1996-2019 (line 7), TFP growth using the expanded asset boundary averages

**Table A1: Industry Aggregates**

| Industry Code | Description |
|---|---|
| TOT | Total - all NACE activities (A-U) |
| TOT | Total (A-U) |
| TOT_IND | Total industries (A-S) |
| MARKT | Market economy (all industries excluding L, O, P, Q, T and U) |
| MARKxAG | Non-agricultural market economy (Market economy less industry A) |
| | |
| A | Agriculture, forestry and fishing |
| | |
| A | Agriculture, forestry and fishing |
| B | Mining and quarrying |
| C | Total manufacturing |
| C10-C12 | . . . Food products, beverages and tobacco |
| C13-C15 | . . . Textiles, wearing apparel, leather and related products |
| C16-C18 | . . . Wood and paper products; printing and reproduction of recorded media |
| C19 | ...Coke and refined petroleum products |
| C20-C21 | . . . Chemicals; basic pharmaceutical products |
| C20 | . . . Chemicals and chemical products |
| C21 | . . . Basic pharmaceutical products and pharmaceutical preparations |
| C22-C23 | . . . Rubber and plastics products, and other non-metallic mineral products |
| C24-C25 | . . . Basic metals and fabricated metal products, except machinery and equipment |
| C26-C27 | . . . Computer, electronic, optical products; electrical equipment |
| C26 | . . . Computer, electronic and optical products |
| C27 | . . . Electrical equipment |
| C28 | . . . Machinery and equipment n.e.c. |
| C29-C30 | . . . Transport equipment |
| C31-C33 | . . . Other manufacturing; repair and installation of machinery and equipment |
| D-E | Electricity, gas, steam; water supply, sewerage, waste management |
| D | Electricity, gas, steam and air conditioning supply |
| E | Water supply; sewerage; waste management and remediation activities |
| F | Construction |
| G | Wholesale and retail trade; repair of motor vehicles and motorcycles |
| G45 | . . . Wholesale and retail trade and repair of motor vehicles and motorcycles |
| G46 | . . . Wholesale trade, except of motor vehicles and motorcycles |
| G47 | . . . Retail trade, except of motor vehicles and motorcycles |
| H | Transportation and storage |
| H49 | . . . Land transport and transport via pipelines |
| H50 | . . . Water transport |
| H51 | . . . Air transport |
| H52 | . . . Warehousing and support activities for transportation |
| H53 | . . . Postal and courier activities |
| I | Accommodation and food service activities |
| J | Information and communication |
| J58-J60 | . . . Publishing, audio-visual and broadcasting activities |
| J61 | . . . Telecommunications |
| J62-J63 | . . . IT and other information services |
| K | Financial and insurance activities |
| L | Real estate activities |
| L68B | Real estate activities excluding imputed rents |
| L68A | Imputed rents of owner-occupied dwellings |
| M-N | Professional, scientific, technical, administrative and support service activities |
| M | Professional, scientific and technical activities |
| N | Administrative and support service activities |
| O-Q | Public administration, defence, education, human health and social work activities |
| O | Public administration and defence; compulsory social security |
| P | Education |
| Q | Health and social work |
| Q86 | ...Human health activities |
| Q87-Q88 | ...Residential care activities and social work activities without accommodation |
| R-S | Arts, entertainment, recreation; other services and service activities, etc. |
| R | Arts, entertainment and recreation |
| S | Other service activities |
| T | Activities of households as employers; undifferentiated goods- and services-producing activities of households for ow |
| U | Activities of extraterritorial organizations and bodies |

Note: NACE industry U is included for NACE definitional completeness, but data are not available for this concept.

**Table A3:Impact of Expanded Asset Boundary on TFP growth, United States, selected periods (annual average change)**

| Period | (1) Expanded Boundary | (2) National Accounts | (3) Column (1) - Column (2) |
|---|---|---|---|
| 1. 1996-2007 | 0.90 | 1.23 | -0.33 |
| 2. 2008-2019 | 0.11 | 0.31 | -0.20 |
| Slowdown (level indicator) | | | |
| 3. (lines 1-2) | 0.79 | 0.92 | -0.13 |
| 4. 2008-2013 | -0.24 | -.10 | -0.14 |
| 5. 2014-2019 | 0.45 | 0.71 | -0.26 |
| Slowdown (growth indicator) | | | |
| 6. (lines 1-5) | 0.45 | 0.52 | -0.07 |
| Memo: | | | |
| 7. 1996-2019 | 0.50 | 0.77 | -0.27 |

Note: Growth rates are log differences multiplied by 100. Lines 3 and 6 and column (3) are point differences in growth rates.
Source: Authors' calculations using the EU KLEMS & INTANProd database (LUISS 2023). Column (1) above is from table 3.

about ¼ percentage point less than using the narrower group of intangibles treated as productive assets in national accounts. This estimate of the impact of the boundary expansion likely also applies to countries whose trajectory for investment in market sector intangibles is broadly like the pattern in the United States.

Second, table A3 suggest the estimated US productivity slowdown may be slightly more moderate using the expanded boundary (line 3). This finding stems from the pattern of differences across time in table 5, which while small when averaged across 12 years, are larger prior to the onset of the GFC (line 1) than after (line 2). To suggest that the productivity slowdown is diminished by about .1 percentage point when the asset boundary is extended to include all CHS intangibles implies that the same pattern shown in table A3 is found in other countries, which may be unlikely. Given the small size of the effect for the US, the topic of whether there is a common cross-country pattern in the impact of the boundary extension on the productivity slowdown is left to future work.

The impact of the capitalization of additional intangibles on frontier TFP growth in the long run may or may not be in line with the average impact shown in table 5. For the interpretation of recent TFP growth and its slowdown after the onset of the GFC, however, we are comfortable using the average impact shown in the table to develop our notion of frontier TFP growth with all intangibles.

## A4. Decompositions for five European Economies

Table A4 complements text table 4, showing decompositions of labour productivity growth in the remaining nine countries included in the European aggregate used in text Table 3.

**Table A4. Decompositions of Labour Productivity Growth in the Market Sector of Selected European countries (average annual change, selected periods)**

| | | | | Contributions (p.p) to value added-weighted LP Growth | | | |
|---|---|---|---|---|---|---|---|
| | Aggregate LP growth | Reallocation | Value-added weighted LP growth | Labour Comp. | Tangible Capital Deepening | Intangible Capital Deepening | TFP |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| **Chezia** | | | | | | | |
| 1) 1996-2007 | 4.26 | 0.12 | 4.14 | 0.37 | 2.14 | 0.54 | 1.09 |
| 2) 2008-2019 | 1.56 | 0.22 | 1.34 | 0.30 | 0.60 | 0.41 | 0.03 |
| 3) 2020 | 1.27 | 1.62 | -0.35 | -0.03 | 2.32 | 1.30 | -3.94 |
| Slowdown | | | | | | | |
| 4) (lines 1-2) | 2.69 | -0.11 | 2.80 | 0.07 | 1.54 | 0.14 | 1.06 |
| 5) percent of col. (3) | | | 100 | 2 | 55 | 5 | 38 |
| 6) 2008-2013 | 0.20 | 0.26 | -0.06 | 0.42 | 0.88 | 0.34 | -1.71 |
| 7) 2014-2019 | 2.93 | 0.18 | 2.74 | 0.18 | 0.32 | 0.48 | 1.77 |
| Slowdown (recent growth) | | | | | | | |
| 8) (lines 1-7) | 1.33 | -0.07 | 1.40 | 0.19 | 1.82 | 0.07 | -0.68 |
| 9) percent of col. (3) | | | 100 | 14 | 130 | 5 | -49 |
| **Denmark** | | | | | | | |
| 10) 1996-2007 | 1.60 | -0.16 | 1.76 | 0.31 | 0.79 | 0.56 | 0.11 |
| 11) 2008-2019 | 1.55 | -0.15 | 1.70 | 0.15 | 0.38 | 0.61 | 0.56 |
| 12) 2020 | – | – | – | – | – | – | – |
| Slowdown | | | | | | | |
| 13) (lines 9-10) | 0.05 | -0.01 | 0.06 | 0.16 | 0.41 | -0.05 | -0.45 |
| 14) percent of col. (3) | | | 100 | 249 | 657 | -85 | -721 |
| 15) 2008-2013 | 0.91 | 0.13 | 0.78 | 0.36 | 0.36 | 0.60 | -0.54 |
| 16) 2014-2019 | 1.79 | -0.30 | 2.10 | 0.16 | 0.26 | 0.31 | 0.60 |
| Slowdown (recent growth) | | | | | | | |
| 17) (lines 9-15) | | | -0.34 | 0.14 | 0.53 | 0.24 | -0.50 |
| 18) percent of col. (3) | | | 100 | -43 | -157 | -72 | 149 |
| **Finland** | | | | | | | |
| 19) 1998-2007 | 3.06 | -0.38 | 3.45 | 0.08 | -0.02 | 0.53 | 2.85 |
| 20) 2008-2019 | 0.14 | -0.28 | 0.42 | 0.16 | 0.26 | 0.37 | -0.37 |
| 21) 2020 | 1.23 | 1.25 | -0.01 | 0.32 | 0.59 | 0.62 | -1.54 |
| Slowdown | | | | | | | |
| 22) (lines (18-19) | 2.92 | -0.11 | 3.03 | -0.08 | -0.28 | 0.16 | 3.23 |
| 23) percent of col. (3) | | | 100 | -3 | -9 | 5 | 107 |
| 24) 2008-2013 | -0.67 | -0.30 | -0.37 | 0.18 | 0.27 | 0.50 | -1.31 |
| 25) 2014-2019 | 0.96 | -0.25 | 1.21 | 0.15 | 0.25 | 0.24 | 0.57 |
| Slowdown (recent growth) | | | | | | | |
| 26) (lines 18-23) | 2.11 | -0.13 | 2.24 | -0.06 | -0.27 | 0.28 | 2.28 |
| 27) percent of col. (3) | | | 100 | -3 | -12 | 13 | 102 |
| **Netherlands** | | | | | | | |
| 28) 1996-2007 | 2.14 | -0.24 | 2.37 | 0.27 | 0.50 | 0.48 | 1.13 |
| 29) 2008-2019 | 0.45 | -0.28 | 0.73 | 0.38 | 0.19 | 0.58 | -0.43 |
| 30) 2020 | -0.57 | 1.56 | -2.13 | 0.90 | 0.62 | 0.82 | -4.47 |
| Slowdown | | | | | | | |
| 31) (lines 26-27) | 1.69 | 0.04 | 1.65 | -0.11 | 0.30 | -0.10 | 1.56 |
| 32) percent of col. (3) | | | 100 | -7 | 18 | -6 | 95 |
| 33) 2008-2013 | 0.65 | 0.05 | 0.61 | 0.48 | 0.17 | 0.66 | -0.70 |
| 34) 2014-2019 | 0.21 | -0.65 | 0.87 | 0.28 | 0.18 | 0.49 | -0.08 |
| Slowdown (recent growth) | | | | | | | |
| 35) (lines 26-32) | 1.92 | 0.42 | 1.51 | -0.01 | 0.32 | -0.02 | 1.21 |
| 36) percent of col. (3) | | | 100 | -1 | 21 | -1 | 80 |
| **Sweden** | | | | | | | |
| 37) 1996-2007 | 3.50 | -0.03 | 3.53 | 0.42 | 0.99 | 0.86 | 1.26 |
| 38) 2008-2019 | 1.26 | -0.12 | 1.38 | 0.09 | 0.52 | 0.73 | 0.04 |
| 39) 2020 | 2.64 | 1.82 | 0.83 | 0.33 | 1.01 | 1.46 | -1.97 |
| Slowdown | | | | | | | |
| 40) (lines 26-27) | 2.24 | 0.09 | 2.15 | 0.32 | 0.47 | 0.13 | 1.22 |
| 41) percent of col. (3) | | | 100 | 15 | 22 | 6 | 57 |
| 42) 2008-2013 | 0.79 | -0.12 | 0.92 | 0.07 | 0.64 | 0.76 | -0.55 |
| 43) 2014-2019 | 1.77 | -0.24 | 2.01 | 0.13 | 0.42 | 0.78 | 0.68 |
| Slowdown (recent growth) | | | | | | | |
| 44) (lines 26-32) | 1.73 | 0.22 | 1.52 | 0.29 | 0.58 | 0.08 | 0.57 |
| 45) percent of col. (3) | | | 100 | 19 | 38 | 5 | 38 |

Note: Annual changes are log changes multiplied by 100.
Source: Authors" elaboration of data from EUKLEMS & INTANProd (LLEE 2023)