# Analysis of capital related productivity indicators disseminated by Eurostat

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## Abstract.

To better analyse and monitor growth and productivity, Eurostat has extended the dissemination of productivity indicators calculated on the basis of labour input measures and capital input measures. On 15 December 2021, Eurostat started disseminating additional annual labour and capital productivity indicators. These productivity indicators are based on annual national accounts data which have to be transmitted by EU Member States and EFTA countries in accordance with the ESA2010 transmission programme.

Capital productivity indicators (CAPIs) based on net fixed assets, are a set of indicators used to approximate the concept of capital productivity and the capital-labour ratio. Ideally, capital productivity should be calculated using data on capital services. However, when doing so, further information and assumptions are needed to aggregate detailed asset types into 'capital services'. As a more practical and feasible approach, national accounts data on capital stocks are used to calculate CAPIs. This paper present CAPIs and uses these indicators to analyse capital productivity trends for EU Member States (and Norway) and, based on preliminary, not yet published estimates, overall trends at European Union level.

[1] Eurostat, C2 National Accounts Production

DISCLAIMER:
This paper presents work in progress to stimulate discussions, but results should be considered as preliminary. The views expressed in this paper are those of the author(s) and do not represent an official position of Eurostat or any European member state.

***Contents***



## 1. *Introduction*

Together with labour, capital is a key input factor for the production process. Capital productivity indicators (CAPIs) can be classified as single factor productivity measures, relating a measure of output (value added) to a single measure of input (capital). Typically, capital productivity is defined as a ratio of a measure of output in real terms (e.g. value added in chain-linked volumes) to a measure of input in real terms (e.g. capital stock in chain-linked volumes). Ideally, capital productivity should be calculated using data on capital services. However, estimation of capital services require additional information and further assumptions to aggregate detailed asset types into 'capital services'. Therefore, as a more practical and feasible approach, Eurostat decided to disseminate new indicators based directly on National Accounts data on fixed assets to approximate the concept and to assess capital productivity growth. This allows to calculate the indicators directly from the available data, providing also plausibility checks of the released data and consistency within the overall system of National Accounts in view of improving comparability across countries.

The first section of this paper describes the background of the dissemination of this set of indicators to assess capital productivity evolution as well the motivations behind the choice.

An analysis of the overall trends at European Union (EU) level and differences across countries of CAPIs is presented in the second section. The last section concludes and outlines ongoing work

## 2. *New capital productivity indicators as one of the outcomes of Eurostat GPA project*

The Growth and Productivity Accounts (GPA) are part of the European System accounts (ESA 2010, 22.9-22.107), but have never been extensively produced and published by Eurostat. The final phase of a GPA project at Eurostat was scheduled to end of 2021 with the goal to respond to user's demand for productivity indicators based on official statistics. Its main goal was to improve Eurostat's and national publications of productivity indicators and productivity measures in line with the statistical recommendations by making available new indicators and improving the quality of the existing ones. In particular, one of the achievements was the production and publication of Capital Productivity Indicators (CAPI's) based on existing national accounts' main aggregates[2]. CAPI's are released and updated based on annual national accounts data which have to be transmitted by EU Member States and EFTA countries in accordance with deadlines specified in the ESA2010 transmission programme[3]. Eurostat decided to follow a practical and transparent approach to calculate indicators directly from the available National Accounts data, providing a simple but comparable indicator that allows plausibility checks of the released data on fixed assets.

[2]For more information on the new release of labour and capital productivity indicators see the link https://ec.europa.eu/eurostat/web/national-accounts/methodology/european-accounts/productivity-indicators

[3] https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-01-13-429-3A-C

Eurostat disseminates a set of four CAPIs[4] to assess capital evolution in relation to value added and to labour input.

Table *1* provides an overview of the capital productivity indicators. These are based on data on net stocks of fixed assets, value added, and employment, expressed in terms of number of persons employed and hours worked.

***Table 1 – Overview of capital productivity indicators***

| EUROBASE CODE | Capital Productivity Indicators (CAPIs) | FORMULA | | TOTAL ECONOMY &TOTAL FIXED ASSET | | | TOTAL ECONOMY &MAIN ASSET TYPES * | | | BY INDUSTRY (A*21) &TOTAL FIXED ASSET | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | numerator | denominator | growth rate | | Index | growth rate | | Index | growth rate | | Index |
| | | | | 1y | 3y 5y 10y | 2015=100 | 1y | 3y 5y 10y | 2015=100 | 1y | 3y 5y 10y | 2015=100 |
| GVA_NCS | Gross value added per unit of net fixed assets | Value added in CLV | Capital stock in CLV | ✦ | ✦ | ✦ | | | | ✦ | ✦ | ✦ |
| NCS_GVA | Net fixed assets to gross value added | Capital stock in CLV | Value added in CLV | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ |
| NCS_EMP | Net fixed assets per employed person | Capital stock in CLV | Persons employed | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ |
| NCS_HW | Net fixed assets per hour worked | Capital stock in CLV | Hors worked | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ | ✦ |

* The 4 main asset types are the following: 1)N11K (Dwellings + Other buildings and structures); 2)N11M (Machinery and equipment and weapon systems ); 3)N115(cultivated biological resources ); 4)N117(intellectual property products ) plus N1132 (ICT equipment).

✦ available

The specification of the indicators was based on the following considerations and supporting work.

**Gross value added per unit of net fixed assets** is provided for the total economy and total fixed assets and by industry A*10/A*21 (see the annex) and total fixed assets. Unlike the others, it is not provided by main asset types for both methodological reasons and ease of interpretation. Though computable, the interpretation of changes in output according to only one type (or group) of asset can be misleading. This is in line with labour productivity indicators which are also not distinguished by different types of labour.

[4] Capital productivity indicators published by Eurostat differ from those published by OECD which are based on capital stocks constructed from data on gross fixed capital formation following a common methodology across countries. For further details link to *OECD Compendium of Productivity Indicators 2019*, OECD Publishing, Paris. https://doi.org/10.1787/b2774f97-en, page 54.

**Net fixed assets to gross value added** is the inverse of the previous indicators (capital productivity). The level of capital-output ratio shows how many units of capital stocks is necessary to produce a unit of output. An increase in this ratio indicates that more capital is needed per unit of output. This indicator is provided for the total economy and total fixed assets, by industry A*10/A*21 and total fixed assets and the total economy and main four asset types (4+ICT): N11KN, N11MN, N115N, N117N), and ICT equipment (N113N).

In addition, **capital-labour ratios** provide more detailed insights on the use of capital relative to labour. It indicates the intensity of the use of a specific asset type in an industry in respect to the use of labour input. This indicator is calculated in terms of persons employed and hours worked as well and it is provided at the same level of detail than the previous indicator (see table 1).

Within the framework of the GPA project, The Vienna Institute for International Economic Studies (wiiw) conducted a very detailed analysis of fixed assets data, in terms of coverage, relevance, and coherence (also in comparison to the ESA2010 transmission programme). The study provided a cross-country comparison at the level of the total economy and asset types, as well as, to the extent possible, at the level of detailed industries and asset types.

On the basis of this analysis Eurostat, in cooperation with the members of the Task Force on Productivity Indicators (2019-2021), decided to publish this set of four indicators with the level of detailed breakdowns and selected units described in table 1. One main decision was, for instance, not to present level based indicators but to limit the presentation to indices and growth rates, which are deemed more comparable across countries. Indeed, the comparison of the growth rates across the countries is less affected by possible differences in national compilation methods for fixed assets.

With respect to the asset type dimension, the ESA2010 transmission programme requires that, according to the specifications given in Table 20, all asset types, must be delivered at the total economy

level with a maximum delay of 24 months (see the table in the annex with data provision according to table 20). Only a few selected asset types must also be delivered at NACE A*21 industry level breakdowns on a compulsory basis, i.e.: Dwellings (AN.111), Other buildings and structures (AN.112), Machinery and equipment + weapon systems (AN.113+AN.114), and – part of this – Transport equipment (AN.1131), and cultivated biological resources (AN.115). However, users may still note gaps in the dissemination of compulsory data. Even though all derogations expired at the beginning of 2020, data may be flagged as not publishable related to confidentiality or quality concerns and there are also some remaining compliance gaps. On the other hand, many countries also transmit additional breakdowns for additional assets or detail (up to NACE A*64) on a voluntary basis.

Following the analysis, considering data availability, the decision was to provide the indicators for:

- Total economy – Total fixed assets
- Total economy – four main asset types plus ICT equipment detail
- Industry level (A*10, A*21) – Total fixed assets

Moreover, as a consequence of the analysis, it was decided to exclude indicators at Industry level (A*10, A*21) and detailed asset types, to avoid to have a lot of missing data.

In conclusion, the 4 main asset types considered for CAPIs are:

- N11K - Dwellings + Other buildings and structures;
- N11M - Machinery and equipment and weapons systems;
    - Of which: N1132-ICT equipment
- N115 - Cultivated biological resources;
- N117 - Intellectual property products.

Since the total assets data at industry level (A*10, A*21) is very complete, capital productivity indicators are provided by industry at total assets level of detail. The selection of published specific asset breakdowns by industries could however be expanded at a later stage.

Following their dissemination, the new productivity data can directly be used for comparisons across countries and/or over time.

## 3. *Comparison across countries of capital indicators*

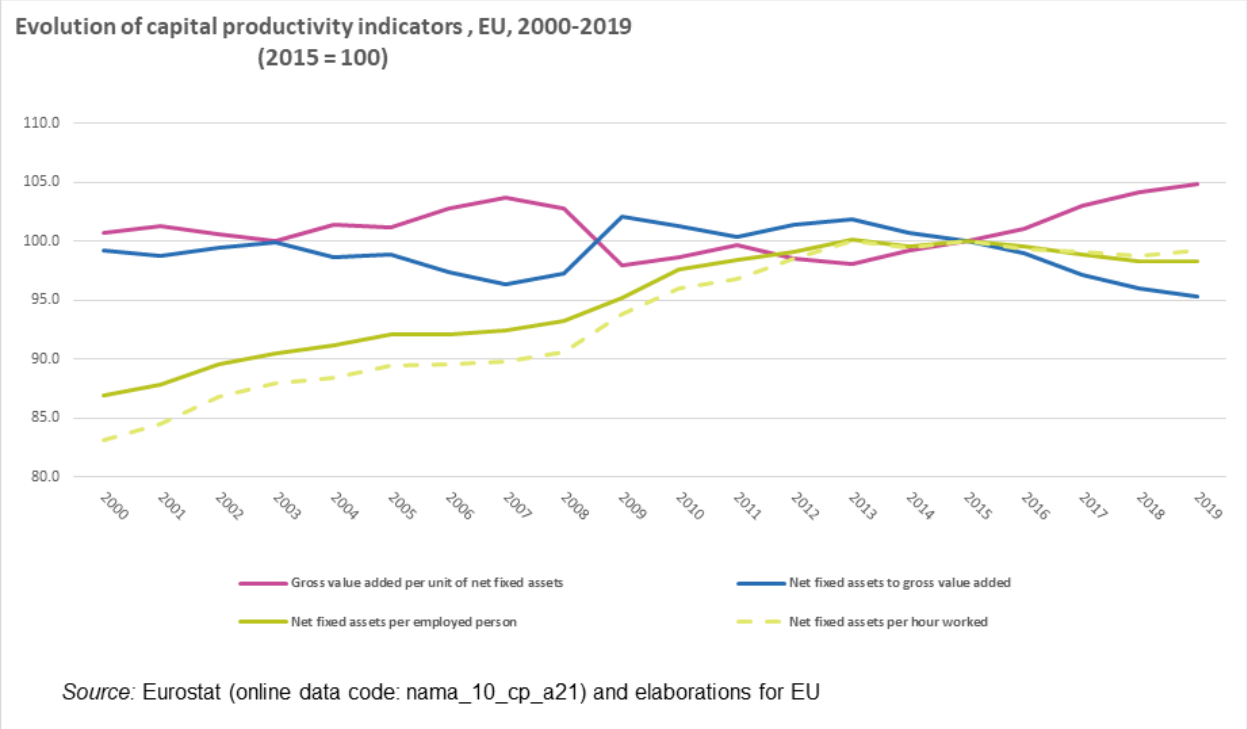
In the following, some interesting aspects can be pointed out for different countries over the period 2010-2019. European Union (EU) fixed assets have not been published so far, since the overall dataset is very complex in terms of full cross-classification of asset and NACE breakdowns and analysis on coverage, consistency and comparability issues is still ongoing. However, first test estimates on EU net fixed assets for total economy level have been compiled and are used in this document to show the overall evolution of capital productivity indicators and complement the presentation of country data. They will be further analysed in view of publication.

The evolution of CAPIs in EU from 2000 to 2019 is presented in Figure 1 and represented in terms of index based 2015. The positive growth trend of Gross value added per unit of net fixed assets was interrupted in 2007 and decreased sharply until 2009 due to the financial crisis. After 2009, it started again to grow slightly, indicating that the increase in gross value added was greater than the increase in net fixed assets. The ratio of net fixed assets to gross value added provides, obviously, a symmetrical view.

At total economy and total assets levels, the two indicators represent opposite sides of the same coin but, whereas the ratio of net fixed assets to gross value added is presented by industry and by main asset type, gross value added per unit of net fixed assets is provided only for total fixed assets. Indeed, as for labour productivity indicators, the interpretation of changes in output according to only one type (or group) of asset can be misleading.

Over the same period, it can be observed that the two measures of capital-labour ratio (net fixed assets per employed person and per hour worked) show an overall upward trend according to both indicators until 2013, when they start to decrease slightly.

**Figure 1 Evolution of Capital Productivity Indicators, EU years 2000-2019**




*Source:* Eurostat (online data code: nama_10_cp_a21) and elaborations for EU

The subsequent analysis of trends for the 2010-2019 average of different CAPI indicators provides some interesting insights on cross-country differences. Table 2 reports the average growth rates of the period at county level and for EU.

**Table 4: Gross value added per unit of net fixed assets, Net fixed assets to gross value added, Net fixed assets per employed person and Net fixed assets per hour worked, annual average growth rate, 2010-2019**

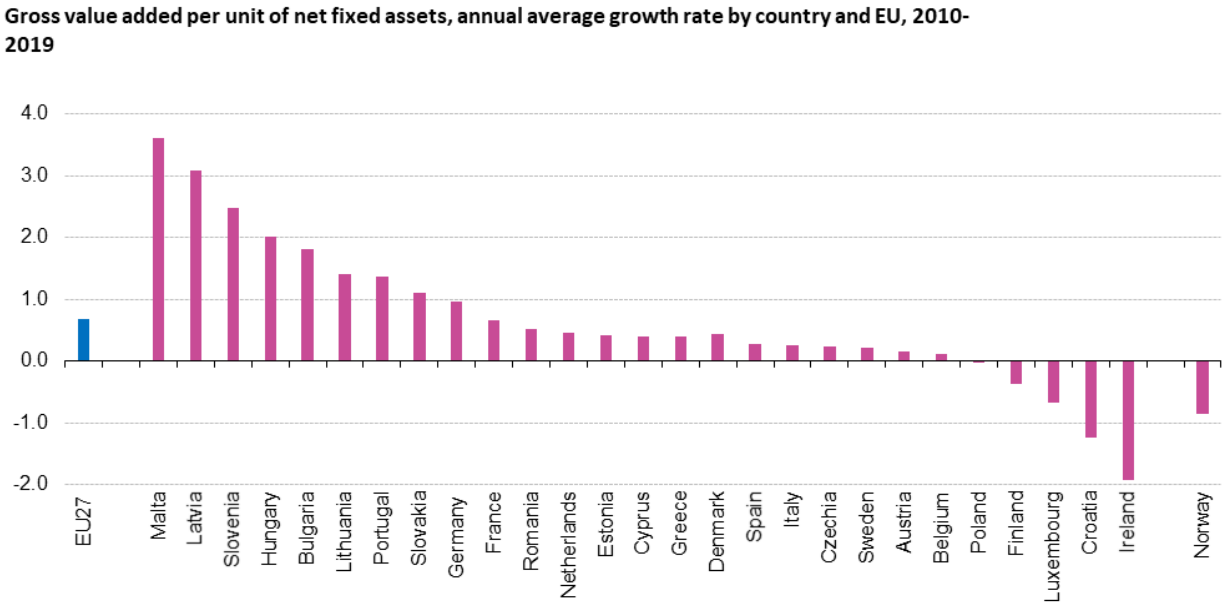
| | Gross value added per unit of net fixed assets | Net fixed assets to gross value added | Net fixed assets per employed person | Net fixed assets per hour worked |
|---|---|---|---|---|
| | 2010-2019 | 2010-2019 | 2010-2019 | 2010-2019 |
| **EU** | **0.7 p** | **-0.7 p** | **0.1 p** | **0.4 p** |
| **Belgium** | 0.1 | -0.1 | 0.4 | 0.4 |
| **Bulgaria** | 1.8 | -1.8 | 0.3 | 0.3 |
| **Czechia** | 0.2 | -0.2 | 1.5 | 1.5 |
| **Denmark** | 0.4 | -0.4 | 0.5 | 0.9 |
| **Germany** | 1.0 p | -1.0 p | -0.3 p | 0.0 p |
| **Estonia** | 0.4 | -0.4 | 1.8 | 2.5 |
| **Ireland** | -1.9 | 2.0 | 5.9 b | 5.6 b |
| **Greece** | 0.4 p | -0.4 p | -1.9 p | -1.9 p |
| **Spain** | 0.3 p | -0.3 p | 0.3 p | 0.5 p |
| **France** | 0.7 p | -0.7 p | 0.0 p | 0.2 p |
| **Croatia** | -1.2 p | 1.3 p | 2.3 | 3.0 |
| **Italy** | 0.3 | -0.3 | -0.4 | 0.0 |
| **Cyprus** | 0.4 | -0.4 | 0.2 | 0.4 |
| **Latvia** | 3.1 | -3.0 | -0.8 | -0.4 |
| **Lithuania** | 1.4 | -1.4 | 1.2 | 1.4 |
| **Luxembourg** | -0.7 | 0.7 | 0.3 | 0.4 |
| **Hungary** | 2.0 | -2.0 | -0.9 | -0.6 |
| **Malta** | 3.6 p | -3.5 p | -2.2 p | -1.8 p |
| **Netherlands** | 0.5 | -0.5 | 0.0 | -0.1 |
| **Austria** | 0.1 | -0.1 | 0.2 | 0.6 |
| **Poland** | 0.0 | 0.0 | 2.9 | 3.2 |
| **Portugal** | 1.4 | -1.4 | -0.8 | -0.8 |
| **Romania** | 0.5 | -0.5 | 3.4 | 3.6 |
| **Slovenia** | 2.5 | -2.4 | -1.2 | -0.7 |
| **Slovakia** | 1.1 | -1.1 | 0.0 | 0.7 |
| **Finland** | -0.4 | 0.4 | 0.4 | 0.7 |
| **Sweden** | 0.2 d | -0.2 d | 0.5 d | 0.7 d |
| **Norway** | -0.8 | 0.9 | 1.1 | 1.2 |

Note:
b - break in time series
p - provisional data for either 2018 and 2019 or 2019
d - definition differs

Figure 2 presents a cross-country comparison of capital productivity, measured as real gross value added per unit of net fixed assets. Over the period 2010-2019, the annual average growth rate of gross value added per unit of net fixed assets varied considerably across countries.

A large majority of Member States recorded positive growth, in other words, on average, output grew faster than the underlying capital stock. The highest growth was registered by Malta (+3.6 %), followed by Latvia (+3.1 %) and Slovenia (+2.5 %). On the other hand, the indicator declined for a few countries, notably Ireland (-1.9 %) and Croatia (-1.2 %).

**Figure 2. Gross value added per unit of net fixed assets.**

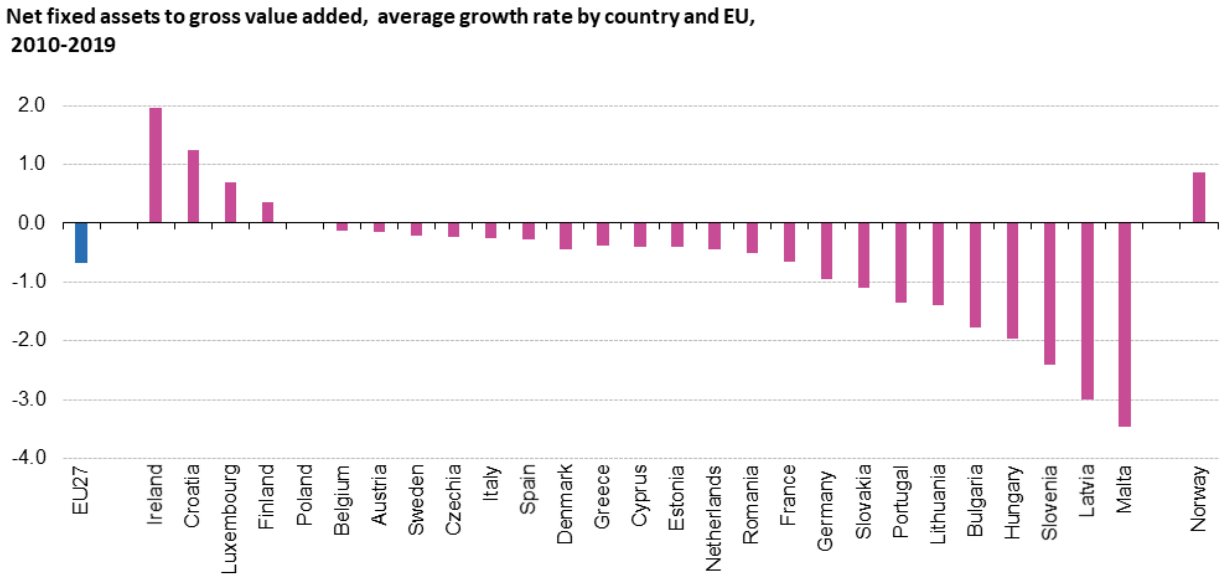



*Source:* Eurostat (online data code: nama_10_cp_a21) and elaborations for EU

It is also interesting to look at the differences across countries of net fixed assets to gross value added that represents the intensity of using fixed assets in the production of one unit of output (Figure 3). Comparing this indicator across countries, it should be taken into account that the structure by industry of the economy largely affects the overall level of fixed assets used in the economy.

The graphical representation (Figure 3) provides a symmetrical ordering of countries (compared to Figure 2), showing differences in the annual growth rate of net fixed assets to gross value added.

**Figure 3 Net fixed assets to gross value added**



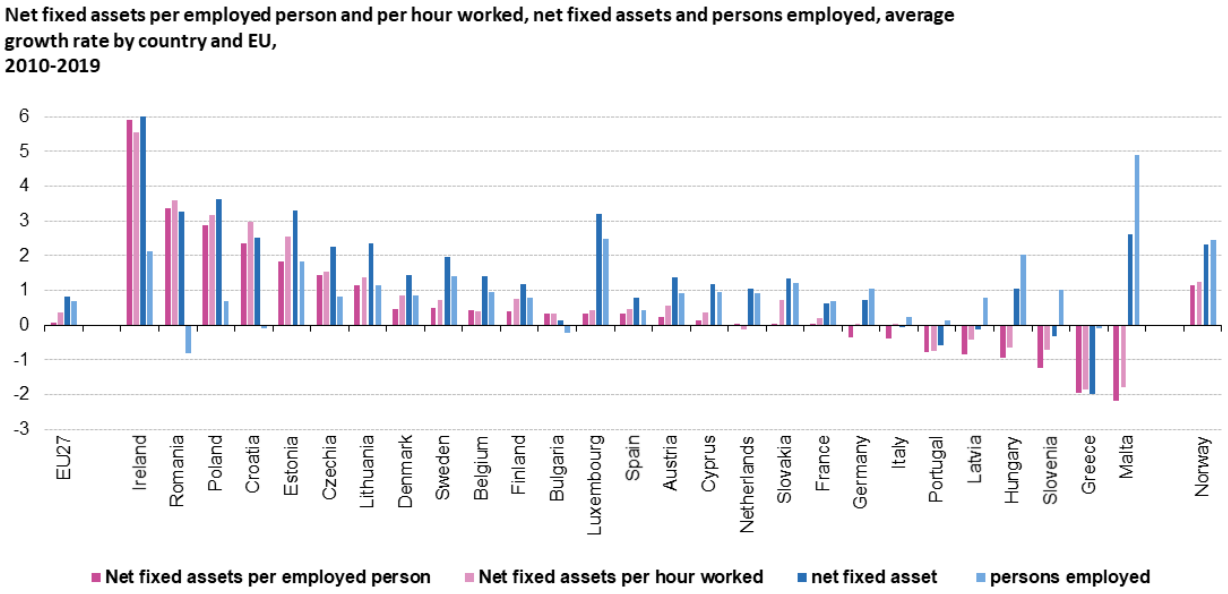

*Source*: Eurostat (online data code: nama_10_cp_a21) and elaborations for EU

Finally, by looking at the capital-labour ratio it is possible to analyse the intensity of the use of fixed assets in relation to the use of labour input (Figure 4). Differences across countries are also related to different types of industry structure and technologies, which both imply different degrees of capital intensity compared to labour intensity.

Over the period 2010-2019, comparing net fixed assets per employed person and per hour worked, it can be seen that differences were usually minor. For most countries, the average annual growth rate of this ratio was positive. In other words, capital stocks grew more quickly than labour input, implying an increasing intensity in the use of capital in the production process. The country with the highest increase in capital stocks compared to labour input (in terms of persons employed) was Ireland (+5.9 %), followed by Romania (+3.4 %), Poland (+2.9 %) and Croatia (+2.3%). In these countries the labour input grew more slowly than the capital stocks. On the other hand, Malta (-2.2 %) and Greece (-1.9 %) had the most negative average growth rates in this ratio, indicating a faster growth in labour share compared to capital. Over time, changes in the aggregate capital-to-labour ratio (Figure 4) are basically driven by

capital accumulation for most of the countries, especially in eastern and central European countries. Ireland ranked first thanks to the significant increase in fixed assets, especially impacted by the high level of addition of intellectual property products.

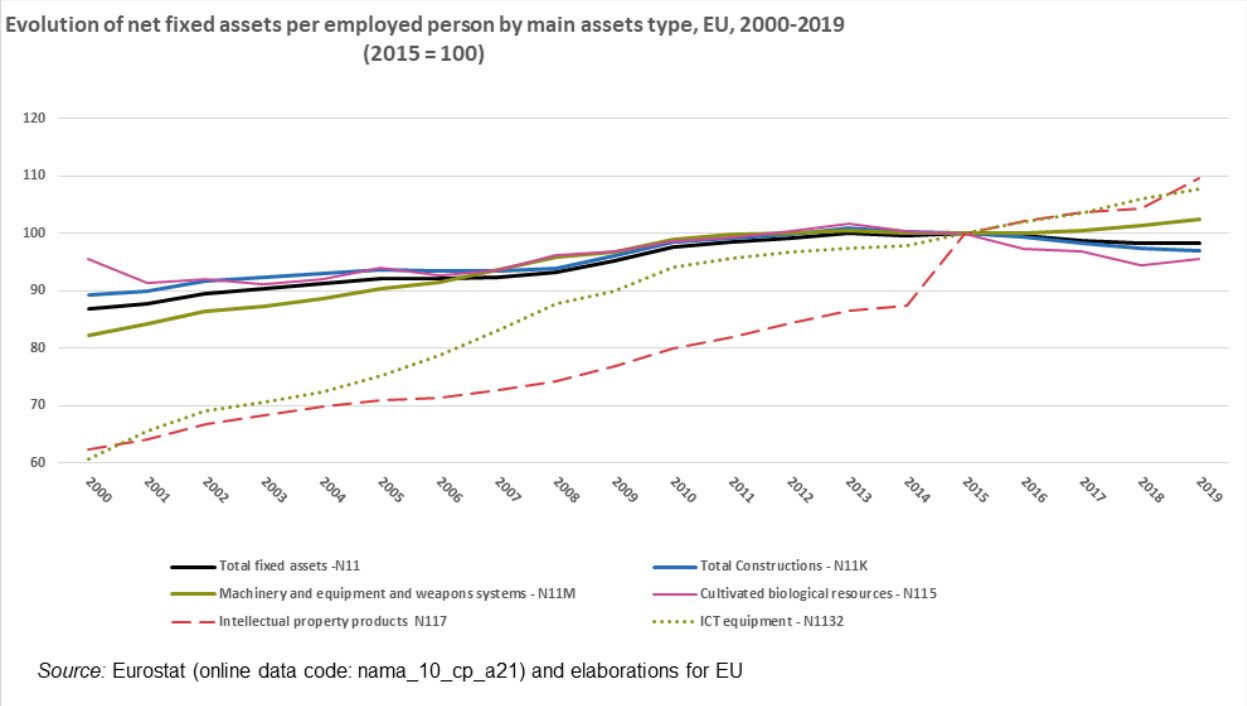
**Figure 4 Net fixed assets per employed persons and net fixed assets per hour worked.**




*Source:* Eurostat (online data codes: nama_10_nfa_st, nama_10_pe and nama_10_cp_a21) and elaborations for EU

Finally, going on to deeper analysis of capital-to-labour ratio, in terms of person employed, by main assets type Figure 5 indicates which assets type was more or less used per unit of labour input over time at European level. The slight increase of total net fixed assets per employed person over time was strongly supported by the predominant rise of intellectual property products and ICT equipment since 2000.

**Figure 5 Net fixed assets per employed person by main assets type**




*Source:* Eurostat (online data code: nama_10_cp_a21) and elaborations for EU

## 4. *Conclusion and ongoing work*

In this paper we have provided some analysis of the trend of different capital productivity indicators that have been published on the Eurostat website since the end of 2021. The aggregated European Union (EU) data have been added to presentation, but not been published so far as further analysis of the overall dataset in terms of coverage, consistency and comparability, is still ongoing in view of progressively compiling and publishing a more comprehensive set of European asset stock aggregates.

At the total economy level most countries provide all asset types stating 2000 or even 1995. However, data gaps exist for some countries for various reasons including non-publishable data. At the more detailed industry level (A*21) the data situation concerning total fixed assets is quite good, data are only missing for a few countries. However, when considering the availability by asset types, some countries report data on detailed assets (beyond the requirements of Table 20 of ESA 2010 transmission programme), others stick more to the regulation and only provide the required asset types. In most

cases data gaps arise and in order to calculate indicators based on EU aggregates, it is necessary to deal with imputations of missing values in the time series. The allocation of assets by industries by different countries is also currently analysed.

More generally, Eurostat is also carrying on a parallel work with the ongoing task force on fixed assets and estimation of consumption of fixed capital under ESA2010 (TF FIXCAP), aiming to harmonize compilation practices (e.g. in relation to asset depreciation patterns and service lives) and improve the quality, coherence and comparability among countries with the next benchmark revision in 2024. The expected improvements in accuracy and comparability of asset stock data will also benefit productivity analysis.

# Annex

## Industry list (A*10)

**TABLE A.1 - INDUSTRY LIST A*10**

| Nr | A*10/11 code | Description |
|---|---|---|
| 1 | A | Agriculture, forestry and fishing |
| 2 | B-E | Manufacturing, mining and quarrying and other industry |
| 2a | … C | … of which manufacturing |
| 3 | F | Construction |
| 4 | G-I | Wholesale and retail trade, transportation and storage, accommodation and food service activities |
| 5 | J | Information and communication |
| 6 | K | Financial and insurance activities |
| 7 | L | Real estate activities |
| 8 | M_N | Professional, scientific, technical, administration and support service activities |
| 9 | O-Q | Public administration, defence, education, human health and social work activities |
| 10 | R-U | Arts, entertainment and recreation; other service activities; activities of household and extra-territorial organizations and bodies |

*Note*: For industries in light blue CAPI are not provided.

## Industry list (A*21)

**TABLE A.2 - INDUSTRY LIST A*21**

| Nr | A*21 Code | Description | Divisions |
|---|---|---|---|
| 1 | A | Agriculture, forestry and fishing | 01-03 |
| 2 | B | Mining and quarrying | 05-09 |
| 3 | C | Manufacturing | 10-33 |
| 4 | D | Electricity, gas, steam, and air conditioning supply | 35 |
| 5 | E | Water supply; sewerage, waste management and remediation activities | 36-39 |
| 6 | F | Construction | 41-43 |
| 7 | G | Wholesale and retail trade; repair of motor vehicles and motorcycles | 45-47 |
| 8 | H | Transportation and storage | 49-53 |
| 9 | I | Accommodation and food service activities | 55-56 |
| 10 | J | Information and communication | 58-63 |
| 11 | K | Financial and insurance activities | 64-66 |
| 12 | L | Real estate activities | 68 |
| 13 | M | Professional, scientific and technical activities | 69-75 |
| 14 | N | Administrative and support service activities | 77-82 |
| 15 | O | Public administration and defence; compulsory social security | 84 |
| 16 | P | Education | 85 |
| 17 | Q | Human health and social work activities | 86-88 |
| 18 | R | Arts, entertainment, and recreation | 90-93 |
| 19 | S | Other service activities | 94-96 |
| 20 | T | Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use | 97-98 |
| 21 | U | Activities of extraterritorial organisations and bodies | 99 |

*Note*: For industries in light blue CAPI are not provided.

## Net fixed assets classification

**TABLE A2.3 – CROSS CLASSIFICATION OF FIXED ASSETS BY INDUSTRY AND BY ASSET (NET) ACCORDING TO TABLE 20 OF ESA 2010 TRANSMISSION PROGRAMME**

| | | Total economy | A*21 | A*38 | A*64 |
|---|---|---|---|---|---|
| AN.11n | 13. Fixed assets, net | X | | | |
| | Total construction (net) | ∑ | | | |
| AN.111n | 14. Dwellings, net | X | X | V | V |
| AN.112n | 15. Other buildings and structures, net | X | X | V | V |
| AN.113n+AN.114n | 16. Machinery and equipment, net + weapon systems, net | X | X | V | V |
| AN.1131n | 17. Transport equipment, net | X | X | V | V |
| AN.1132n | 18. ICT equipment, net | X | | | |
| AN.11321n | 19. Computer hardware, net | X | | | |
| AN.11322n | 20. Telecommunications equipment, net | X | | | |
| AN.1139n+AN.114n | 21. Other machinery and equipment, net + weapon systems, net | X | | | |
| AN.115n | 22. Cultivated biological resources, net | X | X | V | V |
| AN.117n | 23. Intellectual property products, net | X | | | |
| AN.1171n | Research and development (net) | NI | | | |
| AN.1173n | 24. Computer software and databases, net | X | | | |

*Note*: *X=compulsory, V= voluntary, ∑=computable - not included in table 20 and NI=not included in Table 20*