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Selected capital productivity measures based on EU National Accounts data

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Abstract:
Labour productivity measures are commonly calculated and their developments over time and patterns across countries and industries are extensively studied. Analogous measures for capital inputs are less frequently used in the debate, although capital stocks are important drivers of productivity growth and feature prominently in growth accounting exercises. This research builds on results of the last phase of the Growth and Productivity Accounts (GPA) project launched by Eurostat in 2019. The project, which is carried out in co-operation with NSIs, DG ECFIN, DG GROW, ECB and OECD, aims to improve quality, availability and comparability of productivity measures. The paper focuses first on the availability and quality of capital stock data. Then it focuses on various capital productivity indicators. Based on these data, levels and growth rates of capital productivity and capital-labour ratios by various dimensions are presented in a comparative manner. Finally, the relation between capital productivity measures (including the capital-labour ratio) and labour productivity – both in levels and growth rates – is compared across countries for quality checks. The paper concludes with a discussion on the usefulness of such capital productivity indicators in addition to other productivity indicators and in relation to growth accounting calculations.

Keywords:
Capital and labour productivity indicators, convergence, growth

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1. Introduction

Capital accumulation is seen as an important factor for value added and labour productivity growth and convergence. For example, Kaldor (1963) manifested in his stylised facts – among others – that over the long run (physical) capital per worker ('capital intensity') is growing at a sustained rate (implying 'capital deepening'), whereas the ratio of capital to output has been stable. This is reflected in neoclassical growth models, where convergence (income per capita) is driven by capital accumulation (and thus an increasing capital-labour ratio). (For a detailed assessment of these aspects, see e.g. Barro and Sala-i-Martin, 1995; Acemoglu, 2009.) Furthermore, in the AK model (the simplest form of an endogenous growth model), the capital-labour ratio is growing even at the steady-state growth rate (see e.g. Barro and Sala-i-Martin, 1995). Finally, capital accumulation is also seen as an important carrier of embodied technical progress (see e.g. Boucekkine et al., 2003). Of course, to which extent these relationships between capital accumulation indicators and (productivity) growth hold true for various countries and time periods is an empirical question, which is important particularly in discussions on the ongoing productivity slowdown. Thus, capital accumulation is an important aspect of economic growth and warrants a detailed analysis of the availability and quality of the underlying data, as well as a detailed analysis of the dynamics of the various indicators discussed in the literature. In this paper, we first provide an overview of the calculation of selected indicators and a short description of the data used. Then we provide some selected results for the EU member states (together with Norway and the UK) for the period 2000-2018.

2. Methodology and data

2.1 Capital productivity and capital input indicators

As outlined in the introduction, the use of capital and the role of capital in the growth performance of countries plays an important role in the literature, making it important to focus on this aspect in addition to labour productivity growth. Furthermore, capital inputs – measured as 'capital services' – play an important role in calculating multi-factor productivity (MFP) growth, which warrants a detailed examination of these inputs. Specifically, we present four indicators in terms of levels and their changes over time, which are defined below.

To calculate the '**capital-output ratio**', i.e. the input of capital per unit of output, we use data on the net (wealth) stocks on value added and net (wealth) capital stocks, both in chain-linked volumes (reference year 2015) in national currencies, and calculate the ratio. The inverse of this, the output-capital ratio, might be referred to as '**capital productivity**', which provides information of value added produced per unit of capital input (similar to labour productivity). Using these ratios, one can calculate growth rates over time (here calculated as annual growth rates).

The second indicator we show is the ratio of the net (wealth) stock, again in chain-linked volumes (reference year 2015), divided by the number of persons employed or hours worked. This is referred to as '**capital intensity**'. For an international comparison of capital intensity across countries, value added data have to be converted into a common currency (e.g. using GDP purchasing power parities, PPP). Again, one can consider the changes of these ratios (i.e. calculate growth rates), which is referred to as '**capital deepening**'. In this case, there is no need to express them in a common currency using PPPs.

All of these indicators can be calculated at the level of industries, although in this paper we focus on them at the total economy level. Furthermore, some of these indicators can be assessed at the level of more detailed asset types, such as ICT assets or intangible capital inputs (such as R&D, software and databases, or intellectual property products). However, for conceptual reasons, this is not done for the 'capital productivity' indicators (given that labour

productivity is not calculated for various types of workers, whereas labour inputs per unit of output are used in various detailed dimensions).

2.2 Data

Before showing the results in the section, we provide the sources of the data used, as well as giving an overview of its availability across countries. The data are collected from Eurobase downloaded at 15 February 2021. Specifically, data on net (wealth) capital stocks are taken from series *nama_10_nfa_st*, the value added is taken from the series *nama_10_a64*, and series *nama_10_a64_e* provides the number of hours worked and persons employed (for a detailed overview, see Stehrer and Hanzl, 2021).

3. Results

Table 1 presents the results for the indicators described above, based on the data available from Eurobase. Data are available for all EU member states (with the exception of Croatia) and also for Norway and the UK.

Table 1 – Capital productivity and related indicators

	Levels in 2018				Growth rates 2000 - 2018				
			Capital intensity					Capital deepening	
	Capital productivity (= value added to capital ratio)	Capital to value added ratio	Ratio of capital to persons employed	Ratio of capital to hours worked	Capital stock	Capital productivity (= capital to value added ratio)	Value added to capital ratio	Ratio of capital to persons employed	Ratio of capital to hours worked
AT	0.23	4.35	287.4	0.18	1.65	0.08	-0.05	0.65	1.23
BE	0.31	3.26	237.2	0.15	1.50	0.22	-0.20	0.55	0.54
BG	0.23	4.31	111.4	0.07	0.96	2.87	-2.52	0.51	0.52
CY	0.31	3.26	152.0	0.08	2.65	-0.11	0.20	0.86	1.19
CZ	0.24	4.09	206.9	0.12	2.29	0.72	-0.64	3.81	4.13
DE	0.29	3.46	206.6	0.15	0.83	0.65	-0.60	0.10	0.49
DK	0.28	3.58	227.7	0.16	1.44	-0.06	0.09	1.00	1.28
EE	0.29	3.48	148.2	0.08	4.49	-0.70	0.95	3.89	4.41
EL	0.30	3.34	139.3	0.07	1.07	-0.73	0.84	0.57	0.66
ES	0.27	3.64	210.8	0.12	2.47	-0.79	0.84	1.53	1.70
FI	0.28	3.62	214.0	0.13	1.51	0.05	0.04	0.70	1.08
FR	0.28	3.57	233.0	0.15	0.60	0.84	-0.81	-0.04	0.19
HR	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
HU	0.24	4.13	154.8	0.09	1.27	1.34	-1.25	-0.54	0.10
IE	0.35	2.90	339.6	0.19	7.29	-2.16	2.46	5.53	6.01
IT	0.27	3.77	223.7	0.13	0.97	-0.49	0.53	0.35	0.80
LT	0.33	3.07	134.1	0.07	2.66	1.47	-1.22	4.22	3.80
LU	0.42	2.39	224.3	0.15	3.81	-0.76	0.86	0.69	0.99
LV	0.22	4.55	171.6	0.09	0.44	3.38	-3.02	0.31	0.54
MT	0.37	2.71	144.6	0.07	1.90	2.22	-1.88	-1.10	-0.34
NL	0.31	3.19	200.6	0.14	1.46	0.16	-0.14	0.64	0.79
NO	0.28	3.61	252.1	0.18	2.33	-0.76	0.78	0.64	1.00
PL	0.63	1.58	69.8	0.03	3.27	0.49	-0.43	2.48	2.70
PT	0.26	3.79	159.9	0.08	0.81	-0.07	0.11	0.97	1.07
RO	0.27	3.66	128.1	0.07	2.05	2.14	-1.78	-1.04	-0.84
SE*	0.30	3.37	209.3	0.13	2.17	0.24	-0.17	0.76	0.90
SI	0.30	3.38	152.2	0.10	0.87	1.64	-1.52	-0.55	-0.17
SK	0.21	4.66	219.5	0.13	1.49	2.55	-2.39	2.52	2.87
UK	0.44	2.25	105.9	0.06	1.51	0.38	-0.36	-0.77	-0.62

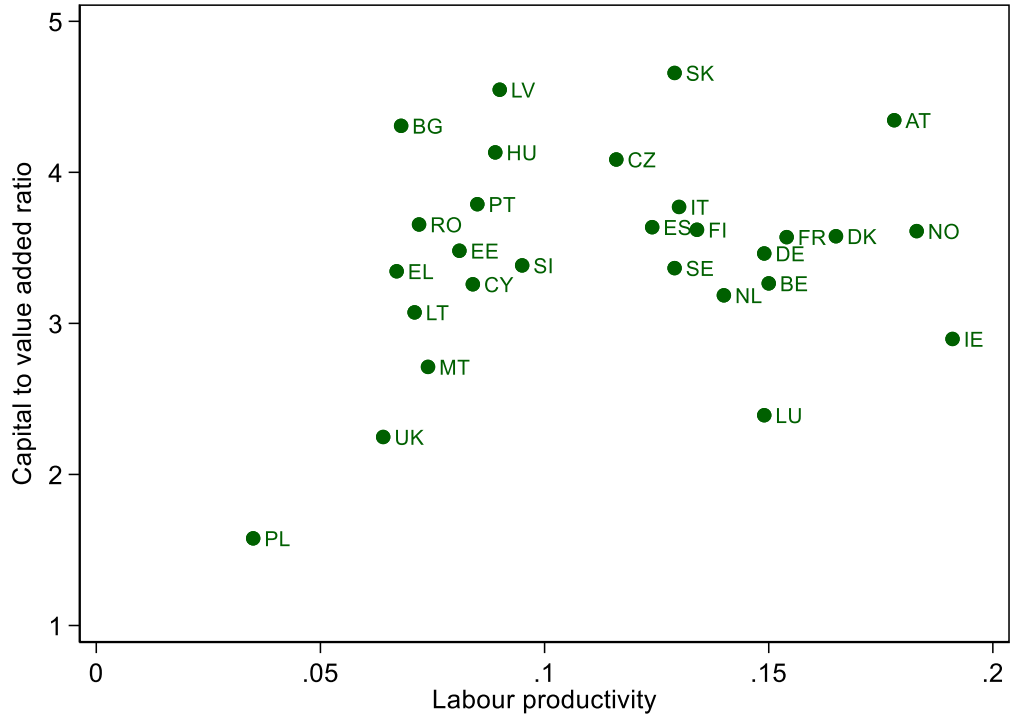
Note: * Data for 2017
Sources: Eurostat; own calculations.

3.1 Level comparisons across countries

The first column reports the levels of capital productivity (converted at GDP PPPs) and the second column the inverse of it, i.e. the capital to value added ratio (one of Kaldor's stylised facts). Focusing on the latter, the arithmetic mean (and also the median) is about 3.5, with the inter-quartile range being 3.2 and 3.8 respectively. However, the overall range is quite large, with values from 1.6 in Poland to 4.7 in Slovakia. For six countries (SK, LV, AT, BG, HU, CZ), values are larger than the 75th-percentile, whereas for seven countries (NL, LT, IE, MT, LU, UK, PL), the indicator is below the 25th-percentile. Both the large range and the ranking of countries (as well as the groups above and below the 75th- and 25th-percentiles, respectively)

are to some extent unexpected. The correlation coefficient with labour productivity (measured as value added in chain-linked volumes, reference year 2015, and converted with GDP PPP divided by hours worked) is only 0.2 (see Figure 1). These outcomes therefore might indicate different methodologies and assumptions concerning the construction of the capital stocks, which needs to be examined in detail before drawing economic and policy conclusions.

Figure 1 – Capital to value added ratio and labour productivity levels, 2018



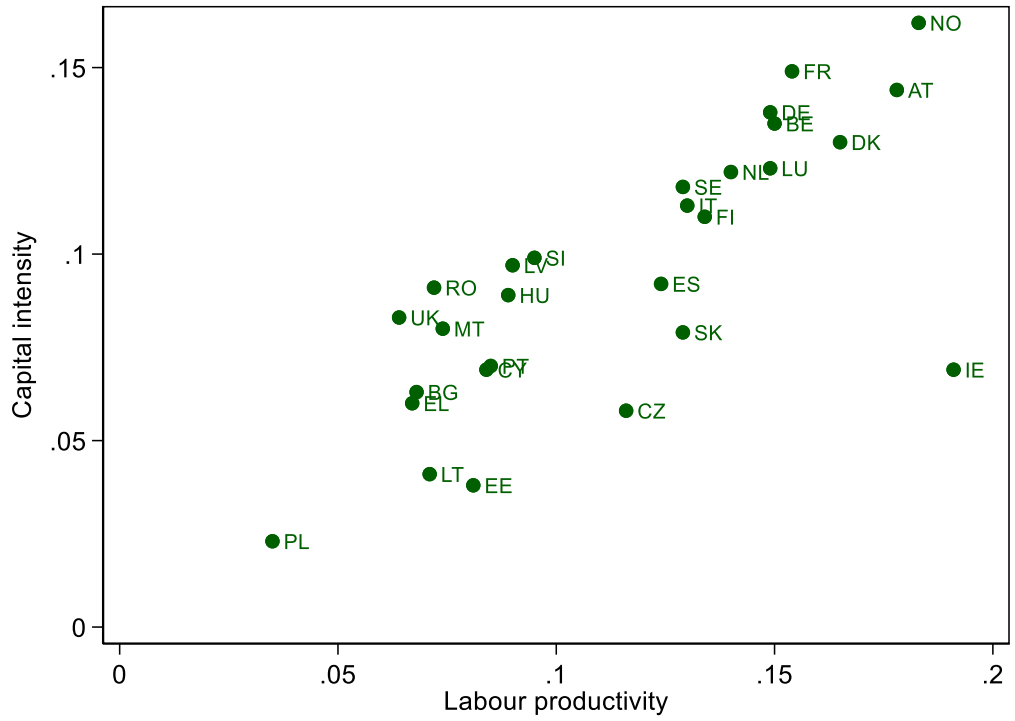
Sources: Eurostat; own calculations.

However, when considering capital intensity, i.e. the ratio of capital to hours worked, the results appear more intuitive. Although the range is still large (from 0.03 in PL to 0.19 in IE), the interquartile range is from 0.075 to 0.15; the countries above this threshold are IE, NO, AT and DK, and the countries below are LT, EL, MT, RO, BG, UK and PL. There is also a much stronger relationship of this indicator with labour productivity, with a correlation coefficient of 0.76 (Figure 2).

3.2 Convergence

The next step is to analyse whether convergence takes place across the economies – i.e. we examine whether countries with a low capital to value added ratio or a low capital intensity are characterised by higher growth rates of these indicators. From a convergence perspective, one expects that countries with lower initial levels of a respective indicator face larger growth rates. Figure 3 shows this relationship for the value added to capital ratio and Figure 4 for the capital to labour ratio (in hours worked).

Figure 2 – Capital intensity and labour productivity levels (in PPPs), 2018



Sources: Eurostat; own calculations.

In both cases, we find a strong negative relation, indicating that convergence with respect to these indicators has taken place over the last two decades. One can also see from Figure 3 that the capital to value added ratio has been decreasing as the average annual growth of the capital to value added ratio has been negative for many countries, indicating that capital productivity has been increasing (which can either be due to an increase in MFP or a decrease in capital intensity).

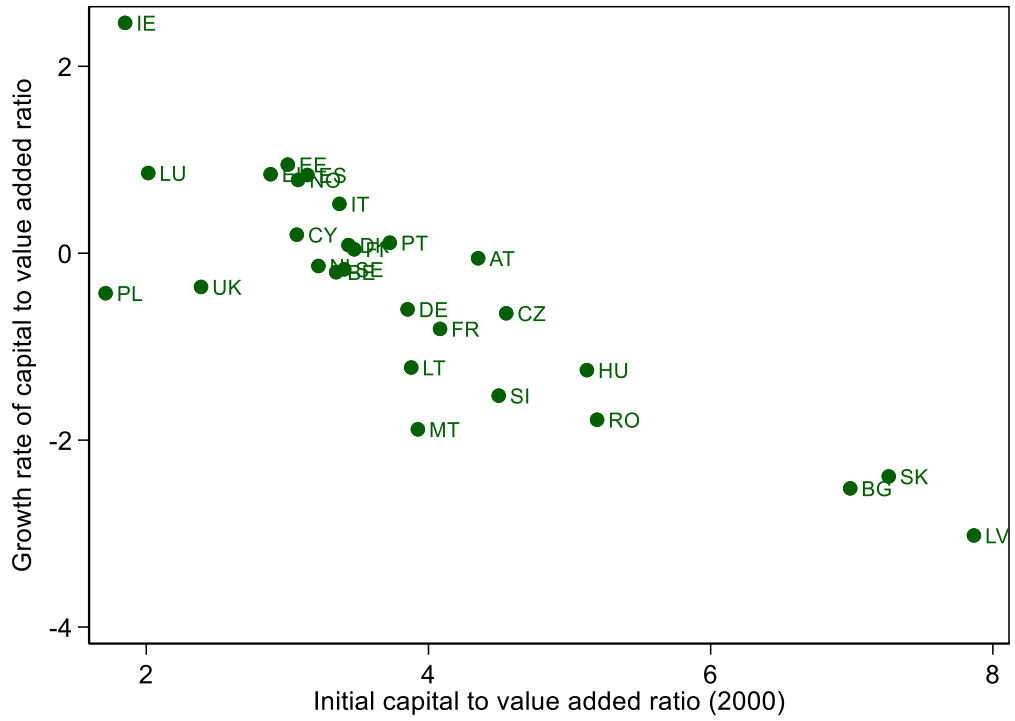
3.3 Capital deepening and labour productivity growth

Finally, Figure 5 shows the strong positive relationship between labour productivity growth and capital deepening. This implies that capital deepening is an important source of labour productivity growth, as suggested by standard production functions.

4. Discussion and conclusion

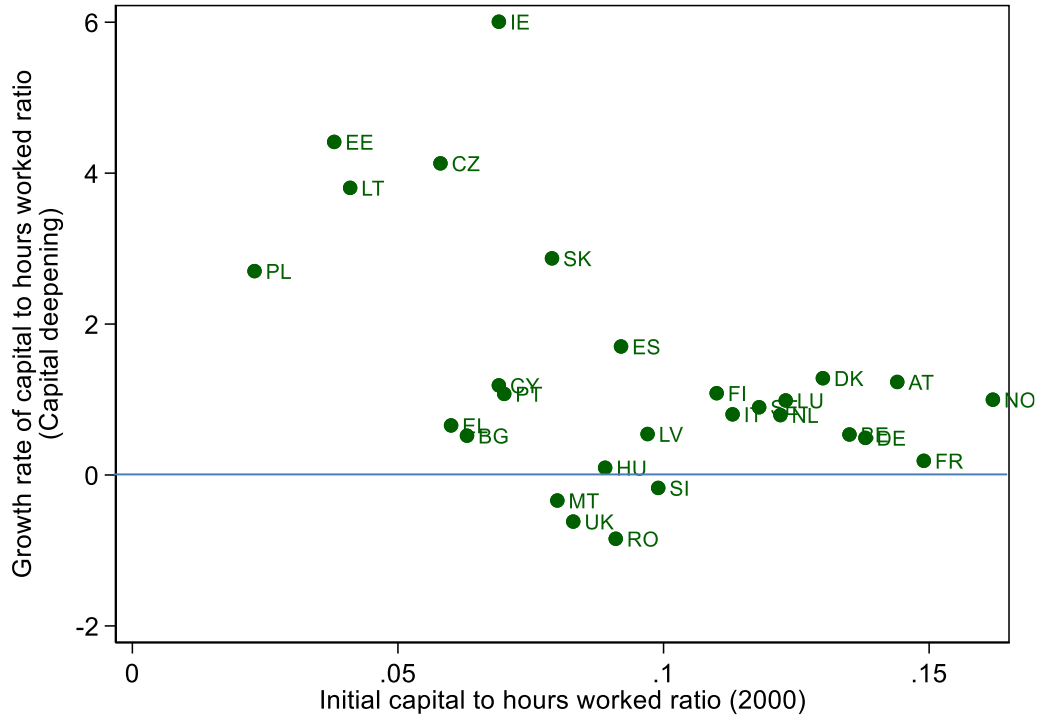
Given the importance of capital accumulation in the growth performance of countries with respect to value added and labour productivity growth, we provided an overview of the available data for the EU member states. The analysis pointed out potential challenges in the comparability of these in terms of levels, which suggests the need to assess the underlying methodologies and assumptions made in the construction of the capital stocks across countries. Given the available data, the results provide evidence that labour productivity is positively correlated with the capital-labour ratios (capital intensity). Further, we find convergence of the capital to value added ratios and capital intensity across countries. Whereas in most countries, capital intensity is increasing (i.e. capital deepening is taking place), we also find that the capital to value added ratio is decreasing (implying an increase in capital productivity), suggesting that value added growth could be driven by further factors such as human capital and total factor productivity growth.

Figure 3 – Relationship between initial capital to value added ratio level and growth rate



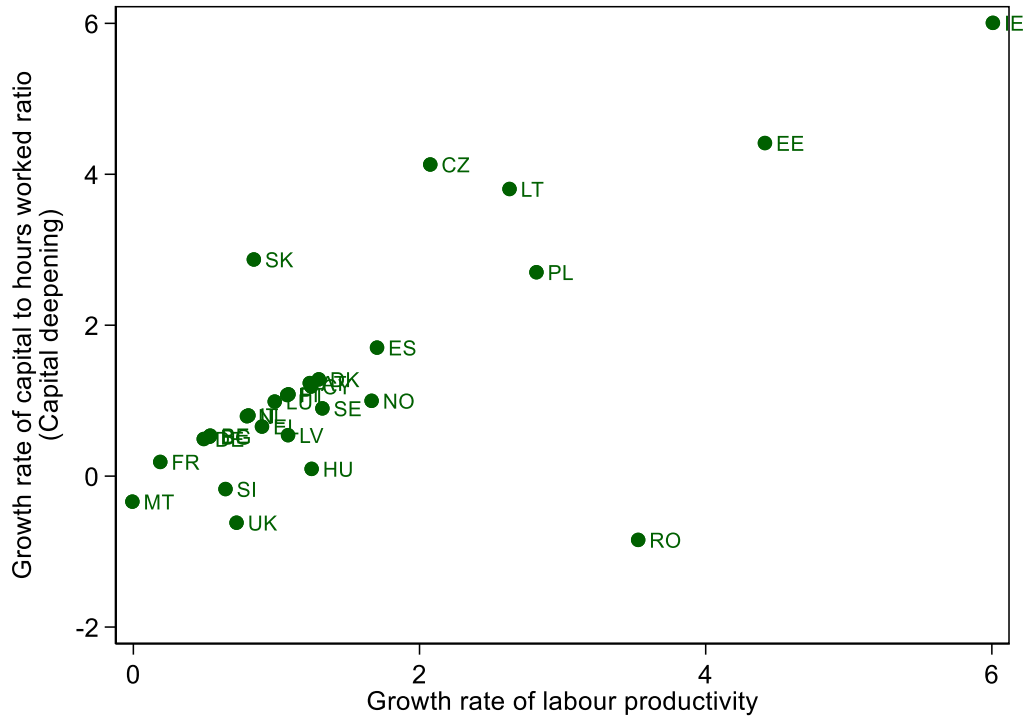
Sources: Eurostat; own calculations.

Figure 4 – Relationship between initial capital intensity and capital deepening



Sources: Eurostat; own calculations.

Figure 5 – Relationship between capital deepening and labour productivity growth



Sources: Eurostat; own calculations.

Further initiatives and research should therefore aim to provide a stringent documentation of the methods and assumptions underlying the construction of the capital stocks and aim at comparability of capital stock data across countries. Further analysis should focus in more depth on the above highlighted dynamics across countries and industries (in line with recent literature on growth empirics and growth accounting), and a detailed assessment of the role of various asset types in the growth dynamics based on these data (see e.g. Adarov and Stehrer, 2020).

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