International Review of Economics and Finance 88 (2023) 1324–1336

Contents lists available at ScienceDirect

International Review of Economics and Finance

journal homepage: www.elsevier.com/locate/iref

How much do public and private sectors invest in physical and human capital? Towards a new classification of investments

Wojtek Paczos [a,b,*], Jakub Sawulski [c], Filip Leśniewicz [d,e]

[a] Cardiff University, UK
[b] Institute of Economics, Polish Academy of Sciences, Poland
[c] Warsaw School of Economics, Poland
[d] Warsaw University, Poland
[e] Inalco, France

ARTICLE INFO

JEL classification:
E01
H5
O16

Keywords:
Human capital
Investment
Public sector
European Union

ABSTRACT

Conventional wisdom says that today's investment drives future economic growth. Recent research shows that returns on human capital investment can be higher than those on physical capital investment. Yet, national accounts classify human capital expenditures as *consumption* and only investment in physical capital is recognized as *investment*. We propose new classification methodology and apply it to the data on public and private expenditures in 28 EU countries. We find that human capital investment constitutes on average 11.1% of GDP, of which 8.8 p.p. come from public sector. Physical capital investment constitutes on average 20.6% of GDP, of which 17.6 p. p. come from private sector. Understanding *investment* in narrow sense may lead to excessive concentration on the expansion of physical capital at the expense of otherwise profitable human capital spending.

1. Introduction

Compared to the Global Financial Crisis, the COVID-19 pandemic has seen a dramatic changes in how fiscal policy is being conducted and evaluated in the EU countries and worldwide. There has been a shift in the approach towards fiscal policy during crisis and recovery, away from fiscal austerity towards fiscal expansion, among the public and policymakers alike.

The empirical literature studying austerity suggests indeed, that government expenditure cuts and tax rises considerably hampered GDP growth in the eurozone countries in 2011–2013, resulting in an estimated aggregate loss of 5.5–8.4 per cent of GDP (Heimberger, 2017; House, Proebsting, & Tesar, 2020). Thus, fiscal consolidation contributed to the second wave of the economic slowdown. Importantly, the main objectives of austerity policies, an improvement in debt-to-GDP ratios, were not necessarily achieved: in 24 out of 28 EU Member States the debt-to-GDP ratio at the end of 2013 was higher than at the end of 2010 (by 14 percentage points on average).[1] Austerity also had undesirable political consequences: it increased political polarisation and support for populist movements (Fetzer, 2019; Hübscher, Sattler, & Wagner, 2020).

The outcome of the austerity policy in the EU countries has recently captured a lot of attention in the public debate. This has been reflected in the policymakers attitude to macroeconomic policy during the Covid-19 crisis. "*Countries should not repeat the mistakes we*

* Corresponding author. Cardiff University, UK.
E-mail address: paczosw@cardiff.ac.uk (W. Paczos).

[1] Based on Eurostat data. See Fig. S6 in Appendix B.

https://doi.org/10.1016/j.iref.2023.07.010
Received 12 November 2021; Received in revised form 10 October 2022; Accepted 11 July 2023
Available online 17 July 2023

made after the last crisis, and try to cut spending or raise taxes too early" – said Angel Gurria, OECD Secretary-General, in the OECD video material in August 2020.[2] "*Continued expansionary fiscal policies are vital to avoid excessive job shedding and* support *household incomes until the economic recovery is more robust*" – continued the message Christine Lagarde, European Central Bank President, as Reuters pointed out in September 2020.[3] This approach also found supporters among the usually fiscally conservative German politicians, as seen in Olaf Scholz's (then Minister of Finance of Germany) voice in February 2021: "*Austerity policy is not a good idea for Europe. We must not repeat the mistake of introducing savings immediately after the crisis. Rather, we should first take care of restoring growth across Europe*".[4] The shift in the attitude to fiscal policy has been embodied in the record-high economic recovery packages – the EU created a Recovery Fund worth EUR 750 billion (almost 6% of GDP) and the US accepted a package of USD 2.2 trillion (almost 11% of GDP).[5]

Policymakers now agree that recovery plans should, among other things (e.g. green transition) focus on investment in people. This is because Covid-19 crisis severely hit the human capital: both through educational losses (Kuhfeld et al., 2020; Grewenig, Lergetporer, Werner, Woessmann, & Zierow, 2021; Hammerstein, König, Dreisörner, & Frey, 2021; The World Bank, 2021; The World Bank, UNESCO, UNICEF, 2021) and health losses (Briggs & Vassall, 2021; Gianino et al., 2021; Taquet et al., 2021; Wyper et al., 2020), including not only the direct impact of Covid-19 on the number of deaths and citizens health deterioration, but also increasing mental health problems among societies (Vindegaard & Benros, 2020; Bourmistrova, Solomon, Braude, Strawbridge, & Carter, 2022; Robinson, Sutin, Daly, & Jones, 2022).

Yet, there remains a large gap in the literature and public statistics: there is no commonly agreed way of calculating how much economies invest in human capital. Thus, even the fundamental statistical questions, e.g. which countries have the lowest human capital investment? Which countries succeeded in increasing it? How much do public and private sectors invest in the economy? cannot be answered without much effort and controversy yet.[6]

Our study contributes to bridge this gap. First, we review the most recent literature on the measurement of human capital and returns to human capital investments (Section 2). This literature has traditionally focused on returns from education, but there is growing research showing, that expenditures on health care behave in largely similar fashion and can bring double to triple-digit percentage returns. Thus we propose to designate educational expenditure and part of health care expenditure as "investment in human capital" category. We then apply our method to publicly available data of 28 EU Member States for the years 2009–2019 and compare it to the readily-available data on investment in physical capital. We pay special attention to the source of funds: whether the investment flows come from private or public sector. We develop the methodology in Section 3 and present results in Section 4. We find that human capital investment constitutes, on average, 11.1% of GDP in European economies, of which the majority is financed by the public sector. Physical capital investment constitutes, on average, 20.6% in European economies, of which the majority is financed by the private sector. We also show that, after including human capital in total investment, public sector invests, on average, 11.8% of GDP, while private sector invests, on average 19.9% of GDP. We present the detailed results for all European economies.

2. Literature review

2.1. Human capital measurement

The concept of human capital as a part of national wealth has its place in the thoughts of the early economists, but it gained a special attention in the second half of the twentieth century. In this period the literature has discovered that human capital is an important determinant of productivity, wages, economic growth and well-being (Schultz, 1961; Becker, 1964; Mincer, 1974; Romer, 1986; Lucas, 1988; Griliches & Regev, 1995). With growing awareness of the importance of human capital, its proper measurement began to gain significance.

Although there is a number of definitions of human capital in the literature, the one which recently gained wide acceptance is the definition by OECD (2001), according to which human capital represents "the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being". This definition captures broad understanding of human capital, putting stress not only on the economic returns, but also non-economic aspects (e.g. health, well-being, social cohesion). In this paper we aim to compare investments in human and physical capital, thus we take a conservative approach and focus on economic returns from both types of investments.

There are two types of human capital measures: monetary and index-based. The index-based measures combine qualitative and quantitative indicators considered as proxies for human capital, e.g. years of schooling and test scores. The monetary measures attempt

[2] Source: https://twitter.com/OECD/status/1292831317042683904 [accessed: 04.10.2022].

[3] Source: https://www.reuters.com/article/ecb-policy-lagarde/ecbs-lagarde-shifts-burden-to-governments-to-aid-recovery-idINKBN2640JU [accessed: 04.10.2022].

[4] Source: https://www.handelsblatt.com/politik/deutschland/konferenz-europe-2021-finanzminister-scholz-warnt-vor-sparkurs-in-europa-nach-der-coronakrise/26875150.html [accessed: 04.10.2022].

[5] Data in 2018 prices. Source: https://ec.europa.eu/info/strategy/recovery-plan-europe_en and https://www.washingtonpost.com/business/2020/03/25/trump-senate-coronavirus-economic-stimulus-2-trillion/[accessed: 04.10.2022].

[6] This paper is not the first to observe this, not by a long distance. Indeed, the conclusion has been present in the literature for a long time. In 1961 T.W. Schultz pointed out in the American Economic Review: "Much of what we call consumption constitutes investment in human capital", and complained that national accounts overlook or misqualify a large part of effort which explains the rise in real earnings per worker and, more broadly, economic growth (Schultz, 1961).

to measure human capital like physical capital: as a value. This is mostly done using three main approaches: residual, income based or cost-based. In the residual methods human capital is measured as the difference between the total wealth and the sum of the tangible components of that wealth: produced capital and the market-component of natural capital. The income-based method looks at the stream of future earnings generated by human capital investment. The cost-based method looks at the stream of past investment undertaken by individuals, households, employers and governments (Liu & Fraumeni, 2016, 2020; Wößmann, 2003).

The cost-based approach is at the center of our method; it concentrates on the monetary expressed inputs: the accumulated value of human capital investment (the other two monetary approaches emphasize the outputs and outcomes). In this approach many authors use the educational spending as a proxy of investment in human capital (sometimes expanded by expenditures for on-the-job training) (Schultz, 1961; Al-Yousif, 2008, p. 42; Liu & Fraumeni, 2016, 2020). Some authors deliver a more inclusive approach, of which the Kendrick's (1976) is the most well-known. The author included the expenditures related to child upbringing until the age of 14, widely-understood educational spending (formal education, informal education, employee training, foregone earnings of students of working age), mobility costs and part of household expenditures on health and safety. This approach was further developed i. a. by Eisner (1989).

However, the cost-based approach to measure the stock of human capital gained some criticism. First, there is no consensus of the components that should enter the investment in human capital. Second, the cost-based approach omits the relationship between investment and the quality of output. Third, the depreciation rate of human capital remains unknown (Le, Gibson, & Oxley, 2003). The latter two points relate to the difficulty in calculating of the stock of human capital. We address this problem by concentrating, in the next part of our review, on the relationship between inputs measured as current investment and outputs measured in monetary terms. This informs our empirical strategy, in which rather than measuring the stock of human capital, we develop a method of measuring current investment flows.

The criticism related to the choice of expenditure categories that could be regarded as investment in human capital is more salient. Following Kendrick (1976), we observe that other than education expenditure, health expenditures should also be regarded as investment in human capital. In the following paragraphs we review the literature that provides quantitative, empirical arguments for this approach.

2.2. Returns to human capital investment

In the scientific literature, an increasingly important role is played by studies estimating returns on expenditure not classified as investments in official statistics. Specifically, these studies address public spending that improves human capital. The relevant public policy evaluations rely on cost–benefit analysis, the calculation of the internal rate of return (IRR), the marginal value of public funds, etc. Each of these methods is based on a similar idea: economists seek to capture the economic effects (e.g. changes in wages, GDP, fiscal balances, etc.) of selected public policies and to compare them to the costs of those policies. Table 1 presents a comprehensive review of the studies we see as the most relevant.

The positive impact of investments in education and training from the perspective of individuals, companies and economic growth is demonstrated in an early literature review contribution by Blundell, Dearden, Meghir, and Sianesi (1999). It is estimated that additional education year in developed economies brings gross return between 5 and 10 per cent. The authors emphasize that early educational achievements are determinants of future educational and training accomplishments, and thus profits and economic growth. Rates of return to education investment are significant, particularly in pre-primary education. According to Heckman, Moon, Pinto, Savelyev, and Yavitz (2010), the overall annual social rate of return on preschool programmes is in the range of 7–10 per cent. Other studies indicate even higher returns. Garcia et al. (2020) show that the return on investment in early childhood programmes for disadvantaged children is 13.7 per cent annually. Reynolds, Robertson, Temple, White, and Ou (2011) estimate a total social return to society of 18 per cent annually for preschool programs for low-income families.

Research on general education shows significant returns on investment as well. Jackson, Johnson, and Persico (2016) show that a 10 per cent increase in per pupil spending each year, for all 12 years of public school, leads to 0.3 more completed years of education, about 7 per cent higher wages, and a 3.2 percentage point reduction in the annual incidence of adult poverty. Sianesi and van Reenen (2003) show that extending the time spent in education by one year can increase output *per capita* by 3–6 per cent but also the output growth rate by up to a percentage point. Similarly, Hanushek, Schwerdt, Wiederhold, and Woessmann (2015) show that one additional year of schooling increase future wages by 7.5 per cent. Investment in children from low-income families exhibit particularly high returns within the education spending. Due to insufficient funds, time, and parenting skills, these children are unable to acquire skills comparable to those learnt by children from wealthy families. At the very beginning of their lives, they experience a gap that most of them cannot close later on (EBRD, 2016). Universal education can bridge a significant part of this gap. In this context, various authors highlight the role of pre-primary education of children, i.e. nurseries and kindergartens (Heckman, 2006; García et al., 2020). While, for children from wealthy families, the benefits of pre-primary education are not always higher that its costs, for low-income children various studies produced two-digit rates of return (Cascio, 2015). Hendren and Sprung-Keyser (2020) analyse 133 historical policy changes over the past 50 years in the US, in both education and health. Children who benefit from higher public expenditure on

Table 1
Returns of public investment – review of studies.

Authors	Result	Country	Sample	Method
Pre-primary education				
Heckman et al. (2010)	Overall annual social rate of return on preschool programmes is in the range of 7–10 per cent.	USA	123 treatment and control of high-risk African American children from HighScope Perry Preschool Program, and subsamples from 1979 National Longitudinal Survey of Youth (NLSY79), Panel Study of Income Dynamics (PSID) and others	Internal rate of return, cost-benefit analysis
Garcia, Heckman, Leaf, and Prados (2020)	The internal rate of return from public investments in early childhood programmes for disadvantaged children is 13.7 per cent annually	USA	The Carolina Abecedarian Project (114 families) and the Carolina Approach to Responsive Education (65 families)	Structural production function (mediation) model.
Reynolds et al. (2011)	The preschool program for low-income families provided a total return to society of 18 per cent annually	USA	1539 participants (Chicago Longitudinal Study)	Probit, negative binomial, and linear regression to estimate the marginal effects of Child-Parent Center (CPC) participation
Chetty, Friedman, Saez, Schanzenbach, and Yagan (2011)	Students randomly assigned to a Kindergarten teacher with more than 10 years of experience earn an extra $1093 (6.9 per cent of mean income) on average at age 27 relative to students with less experienced teachers	USA	10922 participants of project STAR (Student/Teacher Achievement Ratio) and 22568 observations of U. S. population (0.25% random sample of the U.S. population born in the same years as the STAR cohort (1979–80)	Randomized control trial, results extrapolated using administrative data
Black, Devereux, Løken, and Salvanes (2014)	Being eligible for lower childcare prices at the age of 5 increases the grade point average and the grade on an oral exam in junior high school (13–16 years of age) by around 0.1–0.3 of the standard deviation.	Norway	367,836 observations from the entire population of Norway (administrative data)	Regression discontinuity (RD), local linear regression (LLR)
Schochet, Johnson (2019)	Childcare subsidies increase mothers' educational attainment. Especially when: (i) mothers receive subsidies when their children are younger; (ii) mothers have low baseline levels of education	USA	approx. 14,000 observations from the Early Childhood Longitudinal Study-Birth Cohort (ECLS-B)	Propensity score matching (PSM); robust regression models
Education				
Jackson et al. (2016)	A 10 per cent increase in per pupil spending each year for all 12 years of public school leads to 0.3 more completed years of education, about 7 per cent higher wages, and a 3.2 percentage point reduction in the annual incidence of adult poverty	USA	15,353 individuals from Panel Study of Income Dynamics (1968–2011)	Difference-in-Difference (DiD)
Sianesi and van Reenen (2003)	A one-year increase in average education raises the level of output *per capita* by 3–6 per cent and leads to an over one percentage point faster growth rate	Particular focus on UK policy	Over 20 empirical contributions	Literature review
Hanushek and Woessmann (2020)	(i) On average, a one-standard-deviation increase in numeracy skills is associated with an 18 per cent wage increase among prime-age workers; (ii) one additional year of schooling increases future wages by 7.5 per cent	23 OECD countries	35,854 observations	Log-linear models; Two-Stage least squares (2SLS) regression analysis, ordinary least squares (OLS) estimator
Égert, Botev, and Turner (2020)	In countries with the worst educational practices: (i) increasing attendance at pre-primary education would boost GDP *per capita* by more than 3 per cent; (ii) reducing the student-teacher ratio would increase GDP *per capita* by 1.5–3.0 per cent; (iii) postponing the age of first tracking would increase GDP *per capita* by 1.5 per cent; (iv) greater	European and OECD countries	The OECD Programme for International Student Assessment (PISA); OECD data; others	OLS estimator, Non-linear Least Squares

(*continued on next page*)

Table 1 (*continued*)

Authors	Result	Country	Sample	Method
	school autonomy would boost GDP *per capita* by 2 per cent			
Hanushek and Woessmann (2020)	Students affected by school closures during the COVID-19 pandemic might expect 3 per cent lower career earnings, whereas countries affected by these learning losses will experience 1.5 per cent lower GDP throughout the remainder of the century	Countries that participated in OECD's Survey of Adult Skills (PIAAC), G20 countries	OECD, World Bank, Global Education Innovation Initiative (Harvard)	Standard deviation
Higher education				
Pfeiffer and Stichnoth (2021)	Public investment into college education in Germany yields a fiscal return of 6.6 per cent per annum over the working age	Germany	2066 observations from The German Socio-Economic Panel (SOEP)	Internal rate of return (IRR) of an educational investment, IRR for return for counterfactual levels of gross earnings
Nonneman & Cortens, 1997	Government investment in tertiary education yields a fiscal rate of return of 8–12 per cent	Belgium	2946 observations from survey of Belgian households (1992)	Rates of return to education (Mincer's log linear specification; Educational cost-benefit tradition)
Trostel (2010)	The average real fiscal internal rate of return on government investment in college students is conservatively estimated to be 10.3 per cent per annum (estimated lifetime fiscal effects per four-year-equivalent degree)	USA	136,514 observations in age 19–79 from 2006 March Annual Social and Economic Supplement of the U.S. Census Bureau's Current Population Survey	Regression Analyses
Health care				
Masters et al. (2017)	For every 1 pound invested in public health, 14 pounds will subsequently be returned to the economy	Australia, Canada, Japan, New Zealand, Western Europe, USA	52 relevant titles published over four decades	Literature review
Chisholm et al. (2016)	The economic benefit-to-cost ratio of investment in improving mental health in the population in selected countries is between 2.3 and 3.0	36 countries	Populations of analysed countries	Global return on investment analysis
Hendren and Sprung-Keyser (2020)	1 dollar spent on extending health insurance for children increases public revenue by a total of 1.78 dollars in the long run	USA	133 historical policy changes over the past half-century in the United States	Comparative welfare analysis: (Marginal Value of Public Funds)
Infrastructure				
Bom and Ligthart (2014)	A 10 per cent increase in the stock of public capital increases GDP by approx. 1 per cent on average	Mainly USA and OECD countries	578 estimates collected from 68 studies for the 1983–2008 period	Production Function approach; Meta-regression analysis
Melo, Graham, and Brage-Ardao (2013)	An increase of 10 per cent in public investment in transport infrastructure is associated with an increase in output of about 0.5 per cent	USA, European countries, other countries	563 estimates obtained from 33 studies	Meta-analysis of the empirical evidence on the output elasticity of transport infrastructure
Leduc and Wilson (2013)	Spending on motorways boosts GDP in the short- and medium-term (mainly during the implementation of the investment project), but the effect fades in the long term	USA	Data set at the state level on highway funding, highway spending, and numerous economic outcomes	Direct projections approach to estimate impulse response functions

education, earn higher incomes (increasing the state's tax revenues) and are less likely to receive social transfers in the future – thus 'repaying' the investment with 'interest' (Hendren and Sprung-Keyser, 2020). The average benefit-cost ratio was 4.13 for child education and 6.78 for college policies.[7]

Another area of effective public investment is healthcare. The economic benefits of improving citizens' health include: increased productivity among workers, fewer people taking sick leave and longer working lives (higher labour inputs and lower transfers). A vital role is also played by preventive healthcare as it reduces future treatment costs, e.g. vaccination schemes or preventing childhood obesity. Masters, Anwar, Collins, Cookson, and Capewell (2017) reviews multiple studies estimating returns on public health

[7] Busemeyer et at. (2018) find, in a representative survey of eight European countries, that citizens express high levels of support for education even when they are forced to choose between education and other areas of social spending. They conduct representative survey of public opinion in eight European countries. Interestingly, increasing spending on early childhood education is less popular than on general schooling and vocational training.

interventions in advanced economies. In most cases, the average benefit was a multiple of the costs: return on investment varied from −21.27 to 221 with median ROI for all public health interventions of 14.3. As concluded by the authors, cuts in spending on healthcare are erroneously perceived as austerity policy measures: in the long term, they may lead to additional economic and social costs, exceeding the amount of potential savings.

A number of studies suggest that a rising stock of infrastructure has positive, albeit limited effect on GDP. According to Bom and Ligthart (2014), who review nearly 70 studies on the subject, the average output elasticity of public capital (roads, motorways, buildings, etc.) amounts to 0.106. This means that a 10 per cent increase in the stock of that capital increases GDP by slightly more than 1 per cent. However, the authors admit that many studies point to elasticity insignificantly above zero. The literature addressing the effects of building new roads and motorways is of particular interest. For example, as indicated by Leduc and Wilson (2013), these investments boost GDP during their implementation and for a few more years, but long-term GDP growth remains unchanged. Other studies show that returns on investment in road infrastructure diminish as the stock of infrastructure increases, this developing countries (characterised by poor infrastructure) obtain higher returns than advanced economies (Gibbons, Lyytikäinen, Overman, & Sanchis-Guarner, 2019).

3. Human capital investment measurement

In official statistics only investment in physical capital is classified as "investment". In the public sector, it is mainly expenditure on roads and motorways, public buildings (schools, hospitals, etc.), and other infrastructure facilities. As demonstrated in the previous chapter, investment in human capital, classified in the national accounts as part of (private or public) consumption, yields returns comparable to, or higher than those on investment in physical capital.

This study proposes to include human capital investment in the statistical definition of investment. Economic textbook definition of "investment" says that it "involves the use of resources to obtain future economic benefits" (e.g. Begg, Vernasca, Fischer, & Dornbusch, 2014). Spending on human capital not only meets this definition, but is in fact necessary for improving the prosperity of future generations.

The data comes from Eurostat databases. *Investment in physical capital* is well-described and reported (as gross fixed capital formation) in accordance with uniform international standards (ESA 2010) in the main national accounts, in addition to GDP, consumption, imports, exports, etc. The available data [NAMA_10_GDP] allows us to break down gross fixed capital formation by origin into private and public spending.

Whereas investment in physical capital has been extensively described and reported using uniform international standards, there is no comparable and uniform method for defining human capital investment. Based on evidence provided in the literature discussed in the previous chapter, we propose to include educational expenditure and part of healthcare expenditure in the *investment in human capital* category. For this, we use the data on healthcare and education spending collected by Eurostat. The data is based on uniform methodologies, thus it is comparable across countries and time ([EDUC_UOE_FINE01] and [HLTH_SHA11_HPHF] databases). Most importantly, both education and healthcare spending data are available in division by the source: including private and public funds.

We use nine data series from the three datasets cited above as our inputs. We aggregate the inputs into six output series: investment in physical capital, investment in education, and investment in healthcare - each divided between public and private sector. The details of input series, source datasets and aggregation procedure are explained step-by-step in Appendix A. Full source datasets and the results of each aggregation step are available in the Online Data Appendix. Here, we present our method intuitively using two examples of Ireland and Sweden. To give a slight preview of the results, of all the EU economies, Ireland has the highest average private sector investment, while Sweden has the highest average public sector investment.

First, we collect the available data for gross capital formation as % of GDP, for the total economy and for the public sector. This data is fully available for all 31 European single market economies for each year in the 2011–2019 period (tables A1 and A2 in Online Data Appendix). By deducting public sector investment from the total investment we obtain figures for private sector investment. Ireland's private investment and public sector investments rates are, on average across years, 25.8% and 2.1% of GDP, while Sweden's are 19.7% and 4.5% of GDP.

Next we collect health expenditure data, separately for all financing schemes, and for government and compulsory contributory schemes (tables B1, B2 in Online Data Appendix). Here, we adopt a conservative approach and exclude spending by hospitals from human capital investment (tables B4, B5 in Online Data Appendix). We assume that hospital intervention is closer to the function of 'saving' human health than to 'building' human capital through health. Hospital spending accounts for, on average, 38 per cent of total healthcare spending in the EU and is mostly funded by the public sector. By adopting this assumption we are likely underestimating the final human capital investment figures – mostly for the public sector. The data is available between 2009 and 2018, with full availability for all countries and years after 2013. As a result, in Ireland private sector and public sector investment rates in health are, on average across years, 1.5% and 3.2% of GDP, while in Sweden's these are 1.6% and 4.95% of GDP.

Finally, we collect data on education expenditure, separately for general government and for private sector (tables C1, C4 in Online Data Appendix).[8] The public sector education expenditures are available for all countries except Croatia, and for the most years between 2012 and 2017. The private sector education expenditure have the lowest coverage: data is fully available for 14 countries, partially available for 13 countries, and not available for 5 countries (see table C4 for details). As a result, in Ireland private sector and

[8] These data series are in million euros, current prices, so need to be scaled by respective GDP series (table C2 in Online Data Appendix).

public sector investment rates in education are, on average across years, 0.45% and 5.3% of GDP, while in Sweden's these are 0.24% and 7.03% of GDP.

The database used in the report covers all 31 member states of the European single market, i.e. 28 European Union Member States (including the United Kingdom), Iceland, Norway and Switzerland, in the years 2009–2019. Data availability varies between categories, years and countries. The uniform aggregate categories (e.g. gross fixed capital formation) have the best coverage, while more detailed categories (e.g. private expenditure on hospitals), data for smaller EU member states, and data for the early years of the sample period have the lowest (see Online Data Appendix for details).

Each category is calculated as a percentage of the member state's current GDP. We then calculate the average value for the years with the data availability for every member state. Human capital investment, both public and private, and investment in physical capital in the public sector exhibit little variation over time. In contrast, private investment in physical capital is among the most variable macroeconomic categories over time. In the sample used in the report, the standard deviation of private investment in physical capital is 9 per cent of the mean value. Ireland has the highest variation (38 per cent) and Czech Republic has the lowest (2 per cent). Table 2 in Appendix B gives comparative statics overview of the input series.

Whereas the methodology for creating each of the three categories is uniform across member states, the data is not fully comparable across categories. In national accounts [NAMA_10_GDP], investment is defined by the *type* of expenditure (i.e. on fixed capital). In this paper we approximate human capital expenditure using the data broken down by the *function* of expenditure (e.g. healthcare, education). As a result, both classifications may include certain common elements, especially in education: for example construction of school buildings is *investment in physical capital* by type and *investment in human capital* in education by function. The healthcare category has little overlap: expenditure on the construction of hospitals is only contained in the *investment in physical capital*, as total hospital expenditure is excluded from the human capital investment category.

The proposed new approach to human capital investment is a simplification, resulting from statistical data limitations. Full data availability would enable us to clear the investment in physical capital category of expenditure already included in human capital category and to significantly extend the human capital investment category to cover relevant items of healthcare expenditure at the hospital level and elsewhere. The results in this paper should therefore be treated as the upper bound estimate of *investment in physical capital* and the lower bound estimate of *investment in human capital*.

4. Results

The findings on literature review presented in Chapter 2 and our data work described in Chapter 3 are best conceptualized with the help of Fig. 1. It represents the flow of funds in the production economy. In the top half of the figure we depict public and private sectors that undertake investment activities. The sizes of arrows show, that private sector is mostly responsible for the investment in physical capital, while public sector is mostly responsible for the investment in human capital. The bottom half of the figure represents the production stage. There are three factors of production: physical capital, labour and human capital that is inseparable from labour. Production factors receive returns from taking part in the production process: physical capital is being paid profits, dividends and interest, while labour (equipped with human capital) receives remuneration from work. Investment from the top of the panel spills down all the way through production factors contributing to the economics growth. Most importantly, both types of investment are necessary: in physical as well as in human capital.[9]

Our main finding is that the private sector mostly invests in fixed capital, whereas the public sector mostly invests in human capital. Fig. 2 presents the average figures for public and private investment in physical and human capital in European economies. The left bar depicts investment undertaken by the private sector. It spends on average 17.6% of GDP in investment in physical capital and 2.3% of GDP in investment in human capital. The right bar depicts investment undertaken by the public sector. It spends on average 3% of GDP on investment in physical capital and 8.8% on investment in human capital.

When we look at those same numbers from the different perspective, we notice that most investment in physical capital (86 per cent) comes from the private sector. On the other hand, most investment in human capital investment (80 per cent) comes from the public sector. The private sector tends to focus on investment in physical capital. Human capital, which is at least as important for long-term development, is mostly financed by the public sector. In the private sector, investment in physical capital constitutes 78%, while investment in human capital constitutes 12% of its total investment. In the public sector the proportions are reverse: investment in physical capital is 25%, while investment in human capital is 75% of its total investment.

The European economies vary greatly in their public and private investment rates. Fig. 3 shows the average public investment rates in human and physical capital in each member state. The rate of public investment ranges from less than 9% of GDP in Greece to over 16% in Sweden (Fig. 3). The Southern European countries (Greece, Italy, Spain and Portugal) as well as Bulgaria and Romania exhibit the lowest public investment rates. In contrast, public investment is highest in the Nordic countries (Sweden, Denmark and Finland) and in advanced Western European economies (the Netherlands, France, Belgium and Germany).

Around three-quarters of public investment in the EU goes to human capital development. In individual countries, the proportion of human capital expenditure in total public investment ranges from 50 to 90 per cent. There is a clear divide between the Central and Eastern European countries and the other European countries. The former are characterised by a relatively large share of investment in physical capital: an average of 4.3 per cent of GDP, compared to 3.1 per cent on average in the latter. The likely causes is the

[9] Our conceptual framework builds on the theoretical tradition of growth models with human capital as a distinct production factor that can be traced back to Romer (1990) and Mankiw, Romer, and Weil (1992).

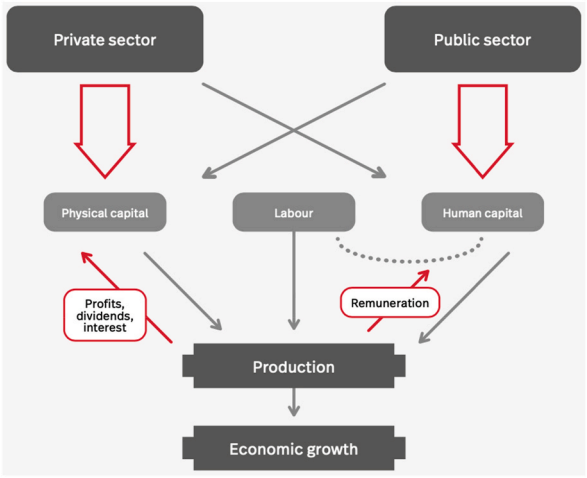

Fig. 1. The impact of private and public sector investments on economic growth.
Source: Own elaboration.

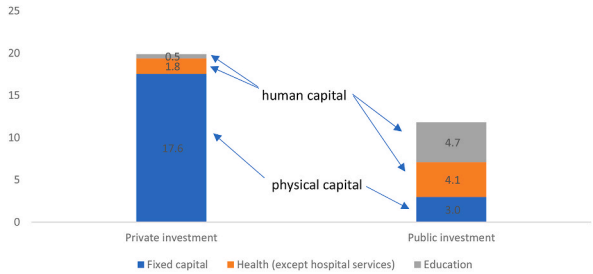

Fig. 2. Private vs. public investment structure in the EU (percentage of GDP, 2009–2019 average).
Source: own calculations based on Eurostat data.

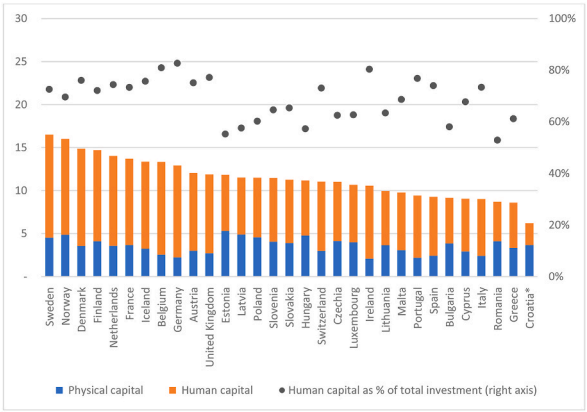

Fig. 3. Public investment as a percentage of GDP in the European single market members (2009–2019 average)
Notes: Bars show public sector investment-to-GDP in the European single market member states. The scale is in percentage points on the left vertical axis. Blue bars represent public physical investment, orange bars represent public human capital investment. Public human capital investment was calculated as a sum of public education and public health expenditures. The figures are based on averages of the available yearly datapoints between 2009 and 2019. Black dots represent public human capital investment as a percentage of total public investment. The scale is in percent on the right vertical axis. Aggregation procedure and data sources are available in Appendix A. Replication files are available in Online Data Appendix. *Figures for Croatia do not include public education expenditure due to data limitations. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)
Source: own calculations based on Eurostat data.

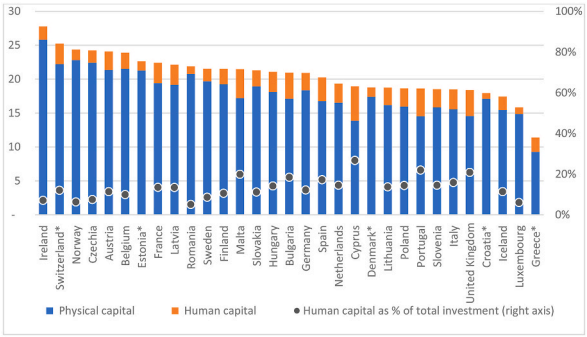

Fig. 4. Private investment as a percentage of GDP in the European single market members (2009–2019 average). Notes: Bars show private sector investment-to-GDP in the European single market member states. The scale is in percentage points on the left vertical axis. Blue bars represent private physical investment, orange bars represent private human capital investment. Private human capital investment was calculated as a sum of private education and private health expenditures. The figures are based on averages of the available yearly datapoints between 2009 and 2019. Black dots represent private human capital investment as a percentage of total private investment. The scale is in percent on the right vertical axis. Aggregation procedure and data sources are available in Appendix A. Replication files are available in Online Data Appendix. *Figures for Croatia, Denmark, Estonia, Greece, and Switzerland do not include private education expenditure due to data limitations. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)
Source: own calculations based on Eurostat data.

underdevelopment of infrastructure and a strong focus of inflowing EU funds on improving it. The other economies spend much more public funds on the development of human capital – an average of 8.7 per cent of GDP, compared to the CEE average of 6.4 per cent. We present the full breakdown of human and physical capital investment, by country and by sector, in Table 3 in Appendix B.

Fig. 4 presents the average private sector investment rates in human and physical capital in each member state. Average private sector investment rates, including investment in physical and human capital, vary from 17.4% of GDP in Luxembourg to 27.8% in Ireland[10]. Ireland also has the highest average rate of private sector investment in physical capital (25.8%), while Greece has the lowest (9.3%). When looking at private sector investment in human capital, Luxembourg has the lowest average rate (1%) while Cyprus has the highest (5.1%).

Fig. 5 concentrates on public sector investment in human capital and presents it as a percentage of total public expenditure. On average, investment spending is responsible for one quarter of total public expenditure in the European economies, according to our broad definition. For comparison, according to the narrow definition, public investment spending (on physical capital only) would represent only 8% of total public expenditure. The narrow definition not only excludes a significant part of public spending that may yield high returns in the future, but it also misrepresents the public sector as excessively focused on consumption spending.

Data show low values of public investment in Southern European countries, both relative to GDP and relative to total public expenditure (Figs. 3 and 4). Such a composition may hamper overcoming the structural problems of these economies and may reduce their long-term development potential. Among other factors, public investment expenditure in the Southern European countries was heavily reduced by the austerity policies implemented in the 2010s. Research shows that contractionary fiscal policies may also lead to the reallocation of spending away from efficient policies oriented towards long-term objectives towards less efficient, short-term ones (Ardanaz, Cavallo, Izquierdo, & Puig, 2020; Breunig & Busemeyer, 2012).

5. Conclusions

This study proposes a new understanding of the term ‘investment’ so that it may be applied to both traditional investment in physical capital and investment in human capital. This proposal should be treated as a contribution to the debate on the role of investment and the public sector in the economy, as well as that on economic development models. Each of these areas offers research that can and should be used in economic policy design. A number of issues require further study, as highlighted in this article. At present, there is no uniform and widely accepted methodology for systematic calculations and comparisons of returns on investments in physical and human capitals.

Our proposal is to designate a separate category in national accounts called human capital investment which would include education and health spending. We show that, on average, in European economies human capital investment constitutes 11.1% of GDP, while physical capital investment constitutes 20.6%. We also show that the majority of human capital investment comes from the public sector, while majority of physical capital investment comes from the private sector. Our proposal is by no means exhaustive.

[10] In Fig. 4 we also include Greece, where the calculated rate of private investment is on average 11.4%, but this number does not include private investment in education due to missing data and it thus not directly comparable. It is also the case for four other countries, where the case of Switzerland is particularly interesting: it’s total private sector investment rate is 25.2%, and even though it is underestimated (by construction), it is the second highest in the sample. The average private sector investment in education is 0.82% of GDP in the sample (see Online Data Appendix).

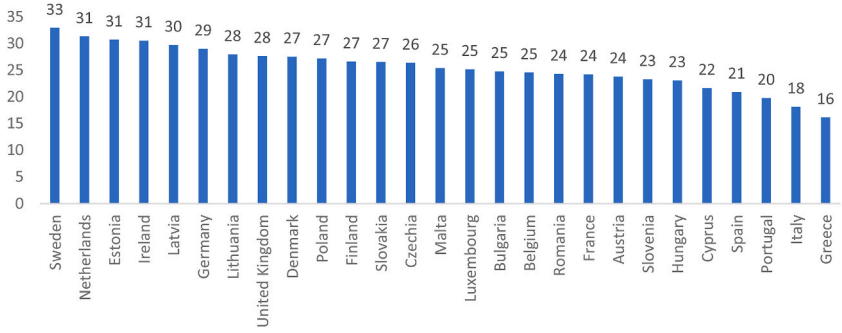

Fig. 5. Public investment as a percentage of total public expenditure in the EU Member States (2009–2019 average). Notes: Bars show public sector investment to public sector expenditure in the European single market member states. The scale is in percentage points. Public sector investment is calculated as a sum of physical capital and human capital investment. Human capital investment is calculated as a sum of education and health expenditures. The figures are based on averages of the available yearly datapoints between 2009 and 2019. Aggregation procedure and data sources are available in Appendix A. Replication files are available in Online Data Appendix.
Source: own calculations based on Eurostat data.

Future research and statistical practice should concentrate on overcoming two main obstacles identified in this article. First, to identify and include other categories of expenses that should be treated as human capital investment, but are separate from education and health expenditures. Second, to eliminate the possible minor overlaps between the two categories (like construction of new school buildings). It is highly desirable to develop such a methodology, but it would also involve far-reaching changes in the collection, aggregation and analysis of statistical data.

Disclosure statements

The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

Wojtek Paczos gratefully acknowledges financial support from the Polish Economic Institute during the work on this paper. Jakub Sawulski and Filip Lesniewicz have held positions at the Polish Economic Institute during the work on this paper.

Prior to and during its circulation the paper has been reviewed by academics only.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.iref.2023.07.010.

Appendix A. Source Datasets and Calculation Algorithm

Source datasets, all available in the Online Data Appendix. We apply names to each data as they appear in the Online Data Appendix:

A1: Public investment in physical capital, in % of GDPSource: Eurostat, dataset: Government revenue, expenditure and main aggregates [GOV_10 A_MAIN], National Accounts Indicator: Gross Capital Formation, Sector: General Government; https://ec.europa.eu/eurostat/databrowser/view/GOV_10A_MAIN_custom_628294/default/table, accessed on February 15, 2021
A2: Investment in physical capital – total, in % of GDPSource: Eurostat, dataset: GDP and main components (output, expenditure and income) [NAMA_10_GDP], National Accounts Indicator: Gross capital formation https://ec.europa.eu/eurostat/databrowser/view/NAMA_10_GDP_custom_628046/default/table, accessed on March 1, 2021
A3: Private investment in physical capital, in % of GDPSource: Own calculation: A2-A1
B1: Health expenditure – total, in % of GDPSource: Eurostat, dataset: Expenditure for selected health care providers by health care financing schemes [HLTH_SHA11_HPHF], All providers of health care, All financing schemes, https://ec.europa.eu/eurostat/databrowser/view/HLTH_SHA11_HPHF_custom_639681/default/table, accessed on February 22, 2021
B2: Health expenditure – public, in % of GDPSource: Eurostat, Dataset: Expenditure for selected health care providers by health care financing schemes [HLTH_SHA11_HPHF], All providers of health care, Classification of health care financing schemes - SHA 2011: Government schemes and compulsory contributory health care financing schemes, https://ec.europa.eu/eurostat/databrowser/view/HLTH_SHA11_HPHF_custom_639681/default/table, accessed on February 22, 2021
B3: Health expenditure – private, in % of GDPSource: Own calculation: B1–B2
B4: Health expenditure - total expenditure on hospitals, in % of GDPSource: Eurostat, Dataset: Expenditure for selected health care providers by health care financing schemes [HLTH_SHA11_HPHF], Classification of health care providers - SHA 2011: Hospitals, Classification of health care financing schemes - SHA 2011: All financing schemes, https://ec.europa.eu/eurostat/databrowser/view/HLTH_SHA11_HPHF_custom_639681/default/table, accessed on February 22, 2021

B5: Health expenditure – public expenditure on hospitals, in % of GDPSource: Eurostat, Dataset: Expenditure for selected health care providers by health care financing schemes [HLTH_SHA11_HPHF], Classification of health care providers - SHA 2011: Hospitals, Classification of health care financing schemes - SHA 2011: Government schemes and compulsory contributory health care financing schemes, https://ec.europa.eu/eurostat/databrowser/view/HLTH_SHA11_HPHF__custom_639681/default/table, accessed on February 22, 2021
B6: Health expenditure - public less public on hospitals, in % of GDPSource: Own calculation: B2–B4
B7: Health expenditure - private less private on hospitals, in % of GDPSource: Own calculation: B3–B4+B5
C1: Education expenditure – public, in current million eurosSource: Eurostat, Dataset: Total educational expenditure by education level, programme orientation and type of source [EDUC_UOE_FINE01], Sector: general government, International Standard Classification of Education (ISCED 2011; All ISCED 2011 levels excluding early childhood educational development, https://ec.europa.eu/eurostat/databrowser/view/EDUC_UOE_FINE01__custom_659646/default/table, accessed on March 9, 2021
C2: GDP, in current million eurosSource: Eurostat, Dataset: GDP and main components (output, expenditure and income) [NAMA_10_GDP], National accounts indicator (ESA 2010): Gross domestic product at market prices https://ec.europa.eu/eurostat/databrowser/view/NAMA_10_GDP__custom_639331/default/table, accessed on March 3, 2021
C3: Education expenditure – public, in % of GDPSource: Own calculation: C1/C2*100
C4: Education expenditure – private, in current million eurosSource: Eurostat, Dataset: Total educational expenditure by education level, programme orientation and type of source [EDUC_UOE_FINE01], Sector: Non-educational private sector, International Standard Classification of Education (ISCED 2011; All ISCED 2011 levels excluding early childhood educational development https://ec.europa.eu/eurostat/databrowser/view/EDUC_UOE_FINE01__custom_659646/default/table, accessed on March 9, 2021
C5: Education expenditure – private, in % of GDPSource: Own calculation: C4/C2*100

Appendix B. Additional Results

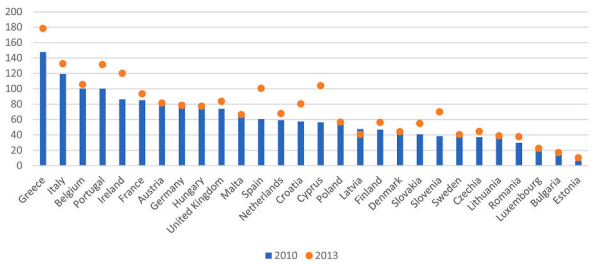

Fig. 6. General government debt to GDP in the EU countries in 2010 and 2013.
Source: "Government revenue, expenditure and main aggregates" in Eurostat.

Table 2
Descriptive Statistics for Input Variables

	Mean	Median	Standard Dev.	Minimum	Maximum
Investment in physical capital (% of GDP)	21.60	21.40	4.15	11.90	46.00
Public investment in physical capital (% of GDP)	5.69	4.06	5.09	0.04	25.81
Health expenditure (% of GDP)	8.59	8.94	1.86	4.70	11.90
Public health expenditure (% of GDP)	6.37	6.43	1.79	2.79	9.70
Expenditure on hospitals (% of GDP)	3.29	3.37	0.75	1.62	4.55
Public expenditure on hospitals (% of GDP)	2.95	3.03	0.73	1.48	4.29
Public education expenditure (% of GDP)	4.99	4.85	1.11	2.58	7.27
Private education expenditure (in % of GDP)	0.88	0.87	0.50	0.01	2.15

Table 3
Public and private capital investment in physical and human capital in European single market member states (in % of GDP).

	Public			Private		
	Investment in physical capital	Investment in human capital: health	Investment in human capital: education	Investment in physical capital	Investment in human capital: health	Investment in human capital: education
European Union (28)	2.97	4.13	4.72	17.56	1.83	0.49
Austria	3.	3.68	5.37	21.36	2.25	0.49
Belgium	2.54	4.4	6.4	21.52	1.68	0.69
Bulgaria	3.84	1.4	3.93	17.1	2.88	1.
Croatia	3.66	2.56	.	17.09	0.86	.
Cyprus	2.92	0.1	6.03	13.88	3.01	2.04
Czechia	4.13	3.09	3.8	22.43	1.22	0.6

(*continued on next page*)

Table 3 (*continued*)

	Public			Private		
	Investment in physical capital	Investment in human capital: health	Investment in human capital: education	Investment in physical capital	Investment in human capital: health	Investment in human capital: education
Denmark	3.57	4.05	7.27	17.4	1.37	.
Estonia	5.3	1.81	4.74	21.28	1.36	.
Finland	4.1	4.01	6.6	19.24	1.96	0.31
France	3.66	4.59	5.47	19.41	2.16	0.86
Germany	2.23	6.12	4.57	18.36	1.66	0.89
Greece	3.33	1.65	3.61	9.26	2.13	.
Hungary	4.78	2.3	4.11	18.1	2.09	0.9
Iceland	3.24	3.53	6.6	15.46	1.55	0.44
Ireland	2.08	3.18	5.33	25.81	1.52	0.45
Italy	2.4	2.59	4.03	15.56	1.99	0.95
Latvia	4.89	1.47	5.17	19.17	2.03	0.94
Lithuania	3.64	2.16	4.16	16.18	1.92	0.66
Luxembourg	3.98	2.84	3.85	14.87	0.81	0.15
Malta	3.07	1.84	4.88	17.2	3.21	1.07
Netherlands	3.59	5.05	5.4	16.52	1.63	1.18
Norway	4.87	4.38	6.77	22.82	1.33	0.22
Poland	4.57	2.13	4.79	15.96	1.78	0.91
Portugal	2.19	2.33	4.92	14.52	2.67	1.43
Romania	4.1	1.94	2.67	20.77	1.08	0.04
Slovakia	3.9	3.29	4.08	18.92	1.35	1.03
Slovenia	4.06	2.6	4.81	15.83	1.88	0.82
Spain	2.41	2.7	4.17	16.77	2.24	1.25
Sweden	4.52	4.95	7.03	19.69	1.62	0.24
Switzerland	2.98	3.25	4.83	22.21	3.03	.
United Kingdom	2.71	3.77	5.42	14.56	1.79	2.04
	Notes: Averages over 2011–2019 Source: Table A1, Data Online Appendix	Notes: Averages over 2009–2018 Source: Table B6, Data Online Appendix	Notes: Averages over 2012–2017 Source: Table C3, Data Online Appendix	Notes: Averages over 2011–2019 Source: Table A3, Data Online Appendix	Notes: Averages over 2009–2018 Source: Table B6, Data Online Appendix	Notes: Averages over 2012-19 Source: Table C5, Data Online Appendix

References

Al-Yousif, Y. K. (2008). Education expenditure and economic growth: Some empirical evidence from the GCC countries. *The Journal of Developing Areas*.

Ardanaz, M., Cavallo, E., Izquierdo, A., & Puig, J. (2020). *Growth-friendly fiscal Rules? Safeguarding public investment from Budget cuts through fiscal Rule design*. Inter-American Development Bank, IDB Working Paper, 1083.

Becker, G. S. (1964). *Human capital*. New York: Columbia University Press.

Begg, D., Vernasca, G., Fischer, S., & Dornbusch, R. (2014). *Economics* (11th ed.). Berkshire: McGraw-Hill Education.

Black, S. E., Devereux, P. J., Løken, K. V., & Salvanes, K. G. (2014). Care or cash? The effect of child care subsidies on student performance. *The Review of Economics and Statistics, 96*(i).

Blundell, R., Dearden, L., Meghir, C., & Sianesi, B. (1999). Human capital investment: The returns from education and training to the individual, the firm and the economy. *Fiscal Studies, 20*(1).

Bom, P., & Ligthart, J. E. (2014). What have we learned from the three decades of research on the productivity of public capital. *Journal of Economic Surveys, 28*(5).

Bourmistrova, N. W., Solomon, T., Braude, P., Strawbridge, R., & Carter, B. (2022). Long-term effects of COVID-19 on mental health: A systematic review. *Journal of Affective Disorders, 299*.

Breunig, C., & Busemeyer, M. R. (2012). Fiscal austerity and the trade-off between public investment and social spending. *Journal of European Public Policy, 19*(i), 6.

Briggs, A., & Vassall, A. (2021). Count the cost of disability caused by COVID-19. *Nature, 593*(7860).

Busemeyer, M. R., Garritzmann, J. L., Neimanns, E., & Nezi, R. (2018). Investing in education in Europe: Evidence from a new survey of public opinion. *Journal of European Social Policy, 28*(1), 34–54.

Cascio, E. (2015). *The Promises and Pitfalls of Universal Early Education* (Vol. 116). IZA World of Labour.

Chetty, R., Friedman, J. N., Saez, E., Schanzenbach, D. W., & Yagan, D. (2011). How does your kindergarten classroom affect your earnings? Evidence from project star. *Quarterly Journal of Economics, 126*.

Chisholm, D., Sweeny, K., Sheehan, P., Rasmussen, B., Smit, F., Cuijpers, P., et al. (2016). Scaling-up treatment of depression and anxiety: A global return on investment analysis. *The Lancet Psychiatry, 3*(i), 5.

Égert, B., Botev, J., & Turner, D. (2020). The contribution of human capital and its policies to per capita income in Europe and the OECD. *European Economic Review, 129*.

Eisner, R. (1989). *The Total Incomes System of Accounts*. Chicago: The University of Chicago Press.

European Bank for Reconstruction and Development (EBRD). (2016). *Transition for all: Equal opportunities in an unequal world*. Transition Report 2016-17.

Fetzer, T. (2019). Did austerity cause brexit? *The American Economic Review, 109*(11), 2019.

Garcia, J. L., Heckman, J. J., Leaf, D. E., & Prados, M. J. (2020). Quantifying the life-cycle benefits of an influential early childhood program. *Journal of Political Economy, 128*, i–7.

Gianino, M. M., Savatteri, A., Politano, G., Nurchis, M. C., Pascucci, D., & Damiani, G. (2021). Burden of COVID-19: Disability-adjusted life years (DALYs) across 16 European countries. *European Review for Medical and Pharmacological Sciences, 25*(17).

Gibbons, S., Lyytikäinen, T., Overman, H. G., & Sanchis-Guarner, R. (2019). New road infrastructure: The effects on firms. *Journal of Urban Economics, 110*.

Grewenig, E., Lergetporer, P., Werner, K., Woessmann, L., & Zierow, L. (2021). COVID-19 and educational inequality: How school closures affect low- and high-achieving students. *European Economic Review, 140*.
Griliches, Z., & Regev, H. (1995). Firm productivity in Israeli industry, 1979- 1988. *Journal of Econometrics, 65*.
Hammerstein, S., König, C., Dreisörner, T., & Frey, A. (2021). Effects of COVID-19-related school closures on student achievement – a systematic review. *Frontiers in Psychology, 12*.
Hanushek, E. A., Schwerdt, G., Wiederhold, S., & Woessmann, L. (2015). Returns to skills around the world: Evidence from PIAAC. *European Economic Review, 73*.
Hanushek, E. A., & Woessmann, L. (2020). *The economic impacts of learning losses*. OECD.
Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science, 312*(i), 5782.
Heckman, J. J., Moon, S. H., Pinto, R., Savelyev, P., & Yavitz, A. (2010). The rate of return to the HighScope perry preschool program. *Journal of Public Economics*, 94.
Heimberger, P. (2017). Did fiscal consolidation cause the double-dip recession in the euro area? *Review of Keynesian Economics, 5*.
Hendren, N., & Sprung-Keyser, N. (2020). A unified welfare analysis of government policies. *Quarterly Journal of Economics, 135*(i), 3.
House, C. L., Proebsting, C., & Tesar, L. L. (2020). Austerity in the aftermath of the great recession. *Journal of Monetary Economics, 115*.
Hübscher, E., Sattler, T., & Wagner, M. (2020). Does austerity cause polarization? *British Journal of Political Science*, 1–19.
Jackson, C. K., Johnson, R. C., & Persico, C. (2016). The effects of school spending on educational and economic outcomes: Evidence from school finance reforms. *Quarterly Journal of Economics, 131*(i), 1.
Kendrick, J. (1976). *The Formation and Stocks of Total Capital*. New York: Columbia University Press.
Kuhfeld, M., Soland, J., Tarasawa, B., Johnson, A., Ruzek, E., & Liu, J. (2020). Projecting the potential impact of COVID-19 school closures on academic achievement. *Educational Researcher, 49*.
Leduc, S., & Wilson, D. (2013). Roads to prosperity or bridges to nowhere? Theory and evidence on the impact of public infrastructure investment. In , *Vol. 27. NBER Macroeconomics Annual Book Series*.
Le, T., Gibson, J., & Oxley, L. (2003). Cost- and income-based measures of human capital. *Journal of Economic Surveys, 17*(3).
Liu, G., & Fraumeni, B. M. (2016). Measuring human capital: Country experiences and international initiatives. In D. W. Jorgenson, K. Fukao, & M. P. Timmer (Eds.), *The World Economy: Growth or Stagnation*. Cambridge University Press.
Liu, G., & Fraumeni, B. M. (2020). *A brief introduction to human capital measures (No. w27561)*. National Bureau of Economic Research.
Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics, 22*.
Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. *Quarterly Journal of Economics, 107*(2), 407–437.
Masters, R., Anwar, E., Collins, B., Cookson, R., & Capewell, S. (2017). Return on investment of public health interventions: A systematic review. *Journal of Epidemiology & Community Health, 71*(8).
Melo, P. C., Graham, D. J., & Brage-Ardao, R. (2013). The productivity of transport infrastructure investment: A meta-analysis of empirical evidence. *Regional Science and Urban Economics, 43*(i), 5.
Mincer, J. (1974). *Schooling, experience and earnings*. New York: Columbia University Press.
Nonneman, W., & Cortens, I. (1997). A note on the rate of return to investment in education in Belgium. *Applied Economics Letters, 4*(i), 3.
OECD. (2001). *The well-being of Nations: The role of human and social capital*. Paris: OECD Publishing.
Pfeiffer, F., & Stichnoth, H. (2021). Fiscal and individual rates of return to university education with and without graduation. *Applied Economics Letters, 28*(16), 1432–1435.
Reynolds, A. J., Robertson, D. L., Temple, J. A., White, B. A., & Ou, S. R. (2011). Age 26 cost–benefit analysis of the child-parent center early education program. *Child Development, 82*(i), 1.
Robinson, E., Sutin, A. R., Daly, M., & Jones, A. (2022). A systematic review and meta-analysis of longitudinal cohort studies comparing mental health before versus during the COVID-19 pandemic in 2020. *Journal of Affective Disorders, 296*.
Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of Political Economy, 94*.
Romer, P. M. (1990). Human capital and growth: Theory and evidence. *Carnegie-Rochester Conference Series On Public Policy, 32*, 251–286.
Schochet, O. N., & Johnson, A. D. (2019). The impact of child care subsidies on mothers' education outcomes. *Journal of Family and Economic Issues, 40*(i), 3.
Schultz, T. W. (1961). Investment in human capital. *The American Economic Review, 51*(1).
Sianesi, B., & van Reenen, J. (2003). The returns to education: Macroeconomics. *Journal of Economic Surveys, 17*.
Taquet, M., Dercon, Q., Luciano, S., Geddes, J. R., Husain, M., & Harrison, P. J. (2021). Incidence, co-occurrence, and evolution of long-COVID features: A 6-month retrospective cohort study of 273,618 survivors of COVID-19. *PLoS Medicine, 18*(9).
The World Bank. (2021). *Investing in human capital for a resilient recovery: The role of public finance* (Washington).
The World Bank, UNESCO, UNICEF. (2021). *The state of the Global education crisis: A Path to recovery* (Washington, Paris, New York).
Trostel, P. A. (2010). *The Fiscal Impacts of College Attainment, Research in Higher Education, 51*(i), 3.
Vindegaard, N., & Benros, M. E. (2020). COVID-19 pandemic and mental health consequences: Systematic review of the current evidence. *Brain, Behavior, and Immunity, 89*.
Wößmann, L. (2003). Specifying human capital. *Journal of Economic Surveys, 17*.
Wyper, G. M. A., Fletcher, E., Grant, I., McCartney, G., Fischbacher, C., Harding, O., et al. (2020). Measuring disability-adjusted life years (DALYs) due to COVID-19 in Scotland. *Archives of Public Health, 80*(1).