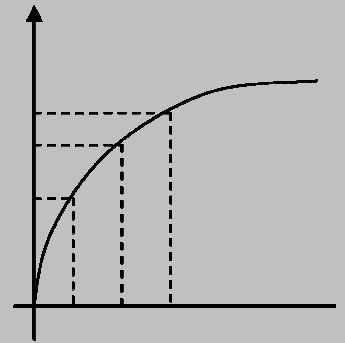


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Investments and capital stocks as estimations for health infrastructure in the European Countries (EU28)

Michael Koch

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Michael Koch

Fachbereich: Sportökonomie und Sportsoziologie

Adresse: Fakultät für empirische Humanwissenschaften
und Wirtschaftswissenschaft
Universität des Saarlandes
66123 Saarbrücken

Tel: 0049 (0)681 302 4912

E-Mail: michael.koch@uni-saarland.de

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c/o Universität des Saarlandes

Sportwissenschaftliches Institut
Arbeitsbereich Sportökonomie und Sportsoziologie
Campus, Gebäude 8.1

66123 Saarbrücken

<http://www.soziooekonomie.org>

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Abstract:

Health is, beside of other services and commodities, e.g. education or social housing, a merit, quasi-public good. Since private provision of health services would presumptively not be sufficient in quality and quantity, one could argue there is a responsibility by the state to provide a sufficient amount of health services to its population. However, it is difficult to quantify the sufficient amount with public goods, in general. One required component of the healthcare provision is infrastructure, such as hospitals, operation theaters etc. and its related equipment, such as beds, imaging devices etc. To estimate the existing infrastructure in the European countries, without an on-the-ground evaluation, we use investment time series for tangible and intangible assets (Gross Fixed Capital Formation) reported to Eurostat and compute Capital Stock for each country, using the Perpetual Inventory Method (PIM) considering country specific depreciation rates and growth rates for each included asset. Based on the last computed capital stock in 2016 as benchmark, we evaluate the effect of the global financial crises in 2008. Furthermore, we run two future scenarios for EU28 in total and each country: (I) how much annual investment is needed, such that the capital stocks keep pace with annual GDP growth rates and (II) how much annual investment is needed, such that the 2016 capital stock per capita can be maintained in the future.

Keywords:

Perpetual-Inventory-Method, Capital Stock, Investment Time Series, Health Infrastructure, European Union

Investments and capital stocks as estimations for health infrastructure in the European Countries (EU28)

by Michael Koch

Preface

This working paper is an adaption of the final report of the project “Capital stocks and investment needs in the physical infrastructure of the health sector in European countries” by Michael Koch on behalf of the European Investment Bank, Luxembourg. This research is based on previous work (unpublished) on ‘capital stocks and investment needs in the physical infrastructure of the education sector’ by Hubert Strauss and Michael Koch.

Any errors remain those of the authors. The findings, interpretations and conclusions presented in this research are entirely those of the authors and should not be attributed in any manner to the European Investment Bank. Results exposed are preliminary and may be subject to future revisions.

Introduction

Health and other services and goods, e.g. social housing and education are major areas of states responsibility. The ideal-typical form of so-called public goods show two main characteristics: First, the use of the good or service by one person does not preclude its simultaneous use by a different person and second, nobody can be excluded from the use of the good or service (e.g. Musgrave, 1969). Examples are national defence, public fireworks, etc. are naturally given public goods like e.g. clean air or nature (mountains, rivers, forest) in general. Depending on how strict public goods are defined, also health, education or museums among others, can be included as public goods. Because excludability is possible here, they are usually classified as quasi-public goods. Those goods (e.g. health, education and social housing) are merit goods, meaning, that the service, or more general commodity, should be universally provided to individuals or the society in total, since without public provision danger increases, that the private offer is not sufficient in quality and quantity. Thus, there is a (greater or lesser) responsibility by the state to provide those goods to its population. Questions about who should be included or excluded as legit user of those goods, how they should be financed and by

whom they should be provided are complex questions for each state and subject of a permanent process of coordination. In the following, merit quasi-public goods, e.g. education, health or social housing are named as 'social goods', with reference to Musgrave (1969) and for a clear differentiation against public goods (for a discussion cf. Desmarais-Tremblay, 2014).

Various historical developments and different degrees of centralisation lead to different approaches in countries about how to provide mentioned services to their inhabitants. They are important areas for the development of a country or in reverse: the development of a country can be indicated by the quantity and quality of provided services.

Future challenges might increase the need of public services:

- In **education**: The need of tertiary education increases since the amount of blue-collar jobs decrease and technological and knowledge related jobs increase.
- In **health**: The amount of elderly population increases, such that naturally the amount of related health problems increases and need treatment.
- In **social housing**: Urban areas experience a steady influx which increases the demand for housing and especially affordable housing. Because construction costs are a major part of total building costs, the difference in construction costs for low and high standard housing are minor while real estate developer can generate an income premium with high standard housing.

In addition, the plurality of countries has committed themselves to pursue the sustainable development goals (SDG, United Nations, 2018). Beside of 'good health and well-being' (Goal 3), 'quality education' (Goal 4) and 'sustainable cities and communities' (Goal 11), which represent the social goods mentioned above, other challenges like 'affordable and clean energy' (Goal 7) and 'industry, innovation and infrastructure' (Goal 9) are targeted.

The provision of social goods and the state's efforts to reach the SDG does not come by no cost. Instead it is a major challenge to provide the optimal amount of services to the country and its inhabitants. The financing of countries' duties is mostly realised by tax and loans. While some taxes are earmarked for certain tasks, others enter the general state budget together and can be used for different duties. The allocation of resources to fulfil government tasks and the monitoring the compliance with the budgetary objectives are amongst the responsibilities of the parliament (in democracies). Since the state

budget is finite, the allocation of resources needs to be negotiated between governmental departments and together with the members of parliament.

While on the “free market” the optimal amount of a normal good (and its price) can be determined by the interplay of supply and demand, it is hard to tell, what quantity and/or quality of a certain social good¹ would be optimal. It depends to a certain amount on the historical development and the resulting ‘philosophy’ of a country, while a real market price cannot be determined². Therefore, negotiations in government and parliament need to be based on other latent variables. This opens the political area for discretionary leeway. When the allocation part is set, more thoughts need to go into the how the production of the (public) goods should be happen. Two major options are possible with their respective advantages and disadvantages, e.g. tendency of increasing bureaucratization and budget-maximization in public administration (Niskanen, 1971), principal-agent-problem when engaging contracting companies (Coase, 1937), rationalization in bureaucracy (Weber, 1921) and allocation efficiency (Arrow, 1962). It also depends on tendencies to monopolization that can result from government interventions.

Typically, politicians, institutions (NGO), scientists and other stakeholders on international, national or even local level, are recurrently concerned in random order that not enough attention and financing has been directed to one or the other public domain and its related commodities³. Since the optimal quality and/or quantity is hard to determine, it is also hard to disagree on further investment, especially when grievances are real. There is a strong knowledge base however, that investment (in infrastructure), the amount of infrastructure⁴ and the economic power (GDP growth, income distribution, inequality, etc) are strongly correlated, which additionally justify high amounts of investments (Calderón & Servén, 2014). On EU28 average, the expenditure for health accounts for 9.6% of GDP in 2014 (WHO, 2017), while middle and north European countries have mostly spent larger percentages. Countries differ regarding the amount

¹ Normally the price for social goods (as quasi-public good) cannot be determined and therefore neither related opportunity costs.

² There is a private sector in health and education and also philanthropist make efforts to provide services. Thus, there is an actual market price for health and education services, however it would be most likely too expensive for the majority of people. In turn, that is why government make the provision their duty.

³ Institutions, which go public with specific concerns in their scope, regardless if it is true or false, also signal the necessity of their existing (Crawford & Sobel, 1982).

⁴ In National Accounts (ESA2010) investments in infrastructure is defined as Gross Fixed Capital Formation and includes tangible and intangible assets. In this revised edition also investments in Research and Development are considered. (Lequiller & Blades, 2014)

individuals must pay *out of pocket* for health services. While in northern countries, social goods, e.g. health service are taxed financed to a major degree⁵, other countries rely more on private (for profit and non-profit) providers (OECD, 2018).

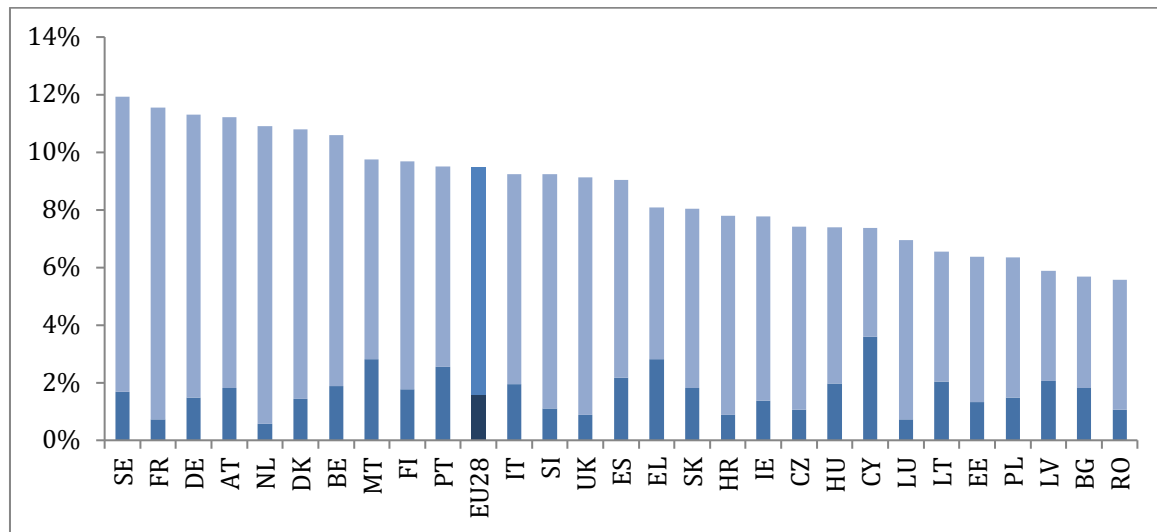


Figure 1: Health expenditure as % of GDP and share of private out of pocket expenditure. Source: WHO (H2020_30, H2020_29), own calculations.

Infrastructure

Infrastructure together with human resources and operation are crucial assets for the provision of social goods. While infrastructure might be less important in the case of education, while human resources play an essential role (Nicoletti & Rabe, 2012, OECD, 2012)⁶, the need of infrastructure for the provision of health services (hospitals, operation theatres, MRI, RT, etc.) or social housing (apartments, houses, etc.) is obvious. Various events in recent time show for different countries, that infrastructure is a main concern in society and thus in politics and media.

One reason for low infrastructure investments in recent years might be the global financial crises. If circumstances ask for expenditure cuts, the reduction of investments in infrastructure is a common reaction, since expenditure for human resources (e.g. medical and nursing staff) and operation resources and systems (e.g. food supply in hospital for patients and staff) cannot be spontaneously reduced. Whereas existing infrastructure can

⁵ Even though the health system in the northern European countries is predominantly taxed financed, out of pocket expenditure for health still account for 14% in Sweden, 13% in Denmark and 18% in Finland (WHO, 2017).

⁶ Even though new technologies have become more important as didactic methods lately and a technology driven modern working world ask for a corresponding educational programme.

be still used for the provision of services to a certain extent, even if no new investments are made. Maintenance works can be postponed to a later date. Even though some European countries issued investment programs to stimulate the domestic economy during crisis years the total infrastructure investments in EU28 arguably would have been higher, since economy was on the rise pre-crisis.

Table 1: Composition of Gross Domestic Product (e.g. Lequiller & Blades, 2014).

Gross Domestic Product =

Final consumption expenditure

- + Household and non--profit institutions serving households final expenditure
- + Governmental final consumption expenditure

+ Gross capital formation

- + Gross fixed capital formation
- + Changes in inventories
- + Acquisition less disposal of valuables

+ External balance of goods and services

- + Exports
- Imports

A countries' infrastructure investments are represented in the structure of national accounts (ESA2010) as *Gross Fixed Capital Formation (GFCF)* and account for approx. 20% of GDP (Eurostat, 2018). Here all investments for the production and maintenance of tangible and intangible assets are accumulated. The investment in infrastructure based on GFCF data (ESA2010) in the health sector can be estimated with 0,74% of GDP in 2017. Larger shares of GFCF are going into real estate activities (5,8%), industry (except construction) (4,1%) and wholesale and retail trade, transport, accommodation and food service activities (2,3%) (Figure 2-4).

Consequently, investments in adequate infrastructure in the health sector are only a minor fraction of total health expenditure, but crucial for the provision of health services while operation and human resources are more cost-intensive.

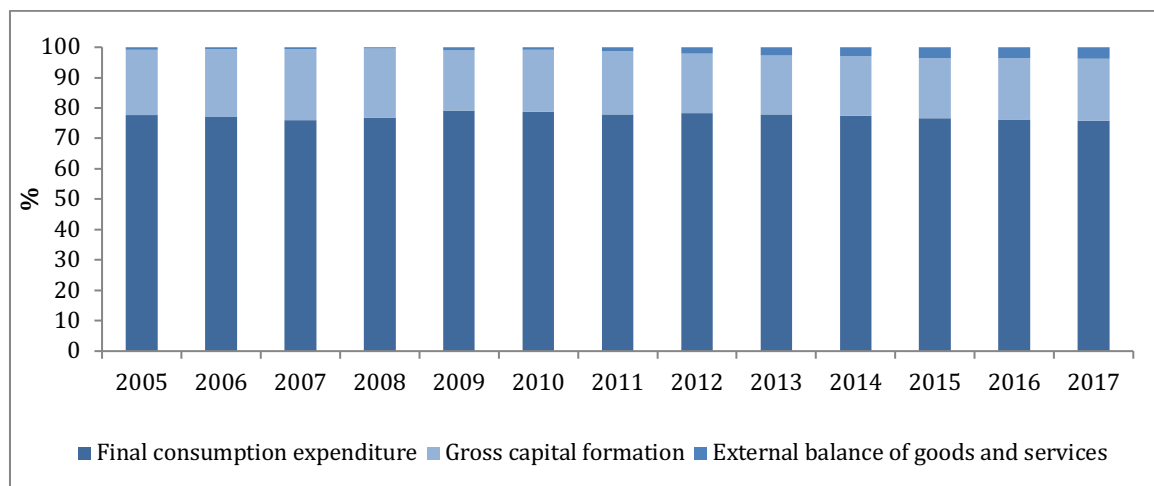


Figure 2: Composition of the Gross Domestic Product of the European Union (EU28) 2005-2017.
Source: Eurostat.

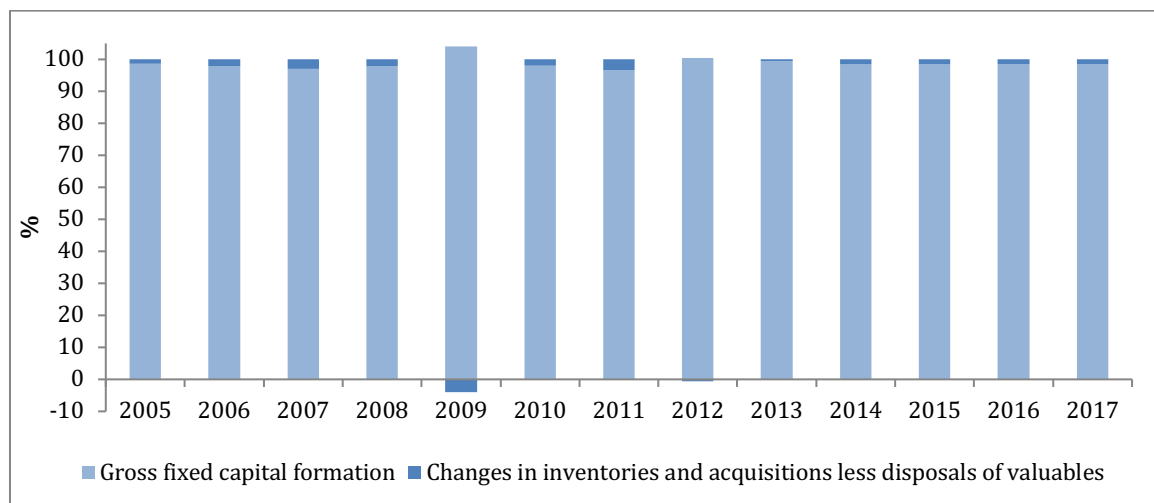


Figure 3: Composition of Gross capital formation of the European Union (EU28) 2005-2017.
Source: Eurostat.

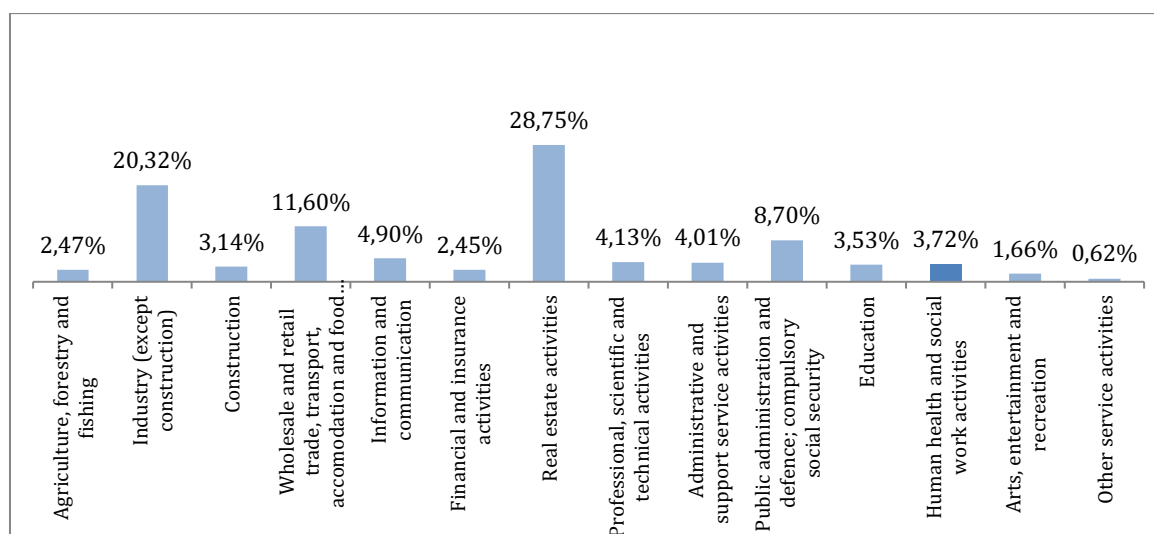


Figure 4: Proportions of industries on Gross Fixed Capital Formation in 2017.
Source: Eurostat.

In the following we are looking into the past investment on health services and potential investment needs in European countries in the future. Since expenditures for human and operation resources are inevitable and quiet constant over time, we are not too much interested in those production factors in this paper. The evaluation of investments and the investment needs is based on National Accounts data (for details on data quality: OECD, Eurostat, WHO, 2011; raw data: Eurostat, 2018). Because investment data themselves are quiet volatile, such that interpretations might produce inaccurate results, we estimate capital stocks in total and for different assets based on the Perpetual Inventory Method (PIM; OECD, 2009). Capital stocks are said to be good estimators for the existing infrastructure considering previous capital stocks, new investments and depreciation rates, which are derived from expected average service life of considered assets. However, capital stocks do not account for the quality of infrastructure or if it is located in the right place at the right time. Thus, a high level of capital stock indicates high levels of infrastructure but is not a sufficient measure per se. Inequitable allocations could lead to a shortage in one area, while other areas receive outstanding investments. The reasons for inequitable distribution in this case would be subject of a politico-economic perspective (e.g. Cadot, Röller & Stephan, 2002).

We are aware, that Eurostat also report Capital Stocks (Eurostat, 2018). However, because Eurostat retrieve this data set from the national statistic offices, neither information are available here on how the capital stock has been computed, nor can we expect, that methods are congruent between countries (Eurostat, OECD, 2015). Since we would like to control for inter-country differences, which are results of different methods, out of our analysis.

To establish comparability between countries (cross section) and in the course of time (longitudinal section), investments and capital stocks must be related to the relevant risk population. In the health sector we consider the country's population, since all inhabitants are potential users of the health system in given country.

Sources and Methods

National Accounts (ESA2010)

The first data source is “Cross-classification of gross fixed capital formation by industry and by asset (flows)”, retrieved from Eurostat (2018). Here all acquisitions, less disposals, which are realized by all sectors (household account, business account, financial and balance sheet account, general government account) of the EU28 countries, as far as available are considered, as ESA2010 take a broad view of national accounts (Lequiller & Blades, 2014, p. 356). GFCF is part of the gross domestic product (GDP) and accounts for 20-25% (World Bank, 2018).

Detailed breakdowns are available on request for GFCF:

- **by type of asset**, e.g. plants, machinery, land improvements, buildings, vehicles, etc.
- **by industry**, e.g. manufacturing, construction, services
- **by economic sector**, e.g. residential buildings vs. non-residential buildings, government sector vs. private sector, market sector vs. non-market sector

Following ESA2010 five different asset types and its sub-categories are available:

- **Total Fixed Assets**
- **Construction**
 - Dwellings
 - other buildings and structures
- **Machinery and equipment and weapons systems**
 - Transport equipment
 - ICT equipment
 - Computer hardware
 - Telecommunication equipment
 - other machinery and equipment and weapons systems
- **Cultivated biological resources**
- **Intellectual property products**
 - Research and development
 - Computer software and databases

GFCF time series in the health sector are available from Eurostat (2018) for most EU-28 countries⁷. For countries with missing data in National Accounts statistics, the OECD STAN Database for Structural Analysis (Revision 3 and 4, OECD 2011 & 2012) have been used, however, only data for Total Fixed assets are included there⁸. Calculations are based on nominal data in million units of national currency. GFCF time series are available from 1995-2015 for most countries, however for some countries earlier data, but for others only later annual data are reported. Some asset types are not available at all for some countries. Because only minor values are presented for *cultivated biological resources* due to the lack of relevance in health sector, we dismiss the asset class for further calculations. To compute the EU-28-Aggregate we use the same dataset in million units of EURO. We may also show data in EURO for a better comparability.

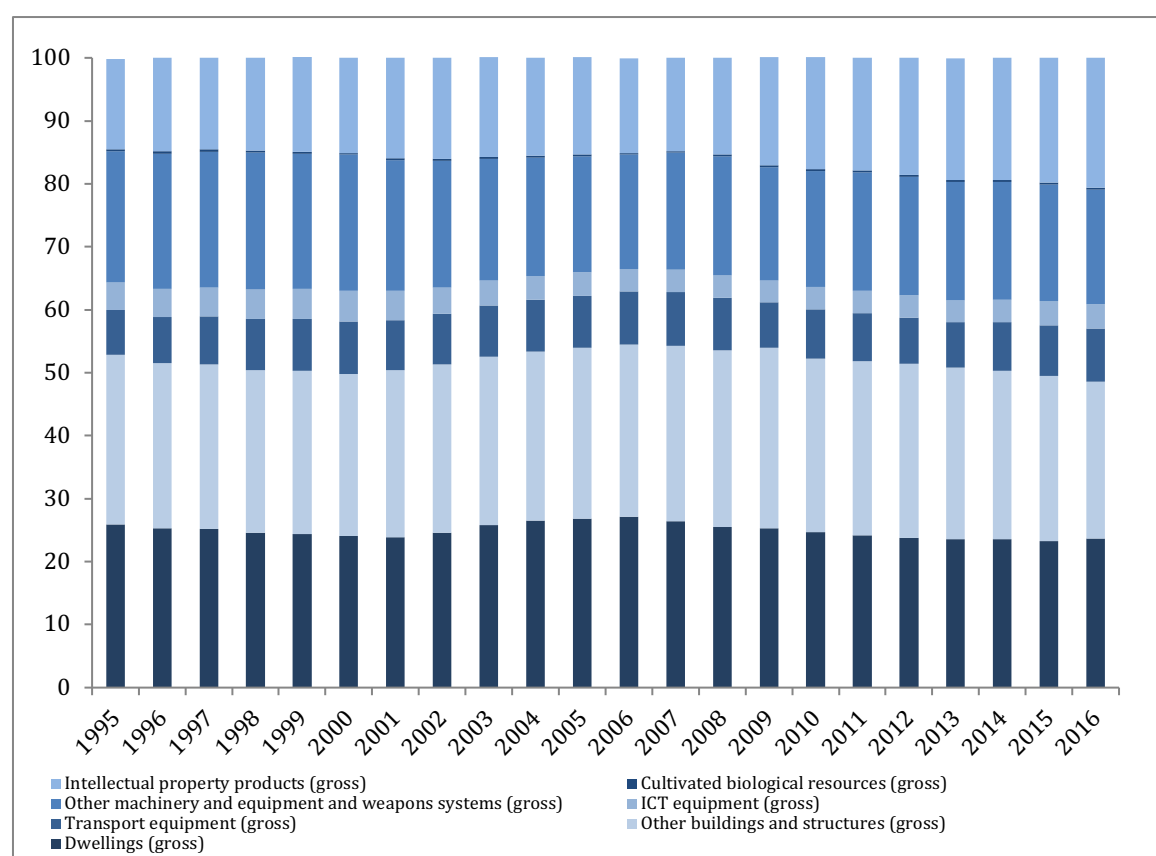


Figure 5: Composition of EU28 Gross fixed capital formation (all industries) by asset type. 1995-2016. Source: Eurostat.

⁷ In National accounts no data are available for: Germany, Estonia, Ireland, Spain, Cyprus, Croatia, Latvia, Lithuania, Malta, Poland and Slovenia.

⁸ Using OECD STAN Database for structural analysis, finally only for four countries are without data: Croatia, Latvia, Lithuania and Malta.

The amount of investments for infrastructure and the composition of investments for infrastructure by asset types change cyclically and depend i.a. on macro-economic parameter. Investments in construction (dwellings, other buildings and structures) are the largest portions of overall investments and account for 50% (2001) or more (54% in 2006) (cf. figure 5). In recent years the significance of intellectual property products increased, which is reflected in its greater proportion of the total investment. Since the service life of buildings is particularly long (in the following we assume a average service life of 40 years for construction, cf. table 2).

General government expenditure by function (COFOG)

The second dataset we use is “General government expenditure by function (COFOG) [gov_10a_exp]”, (Eurostat, 2018)⁹. Here we also examine GFCF time series as nominal data in national currency. In contrast to the first dataset above (Cross-classification of gross fixed capital formation by industry and by asset), COFOG only report investments by the public sector as Total Fixed Assets and for different health levels, but not in a breakdown for different asset types. The times series are available from 1995 – 2016 for most European countries and Norway, with earlier data availability for Finland but solely later data for Bulgaria and United Kingdom. There are also aggregated time series for the European Union (28 countries) available from 2002.

The Data are available for the health sector in total, as well as for sub-categories:

- Medical products, appliances and equipment
- Outpatient services
- Hospital services
- Public health services
- R&D Health
- Health nowhere else classified

⁹ Data are available for almost all countries. Because no implicit deflator is available for some countries, no real volumes can be computed for Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland and Slovenia.

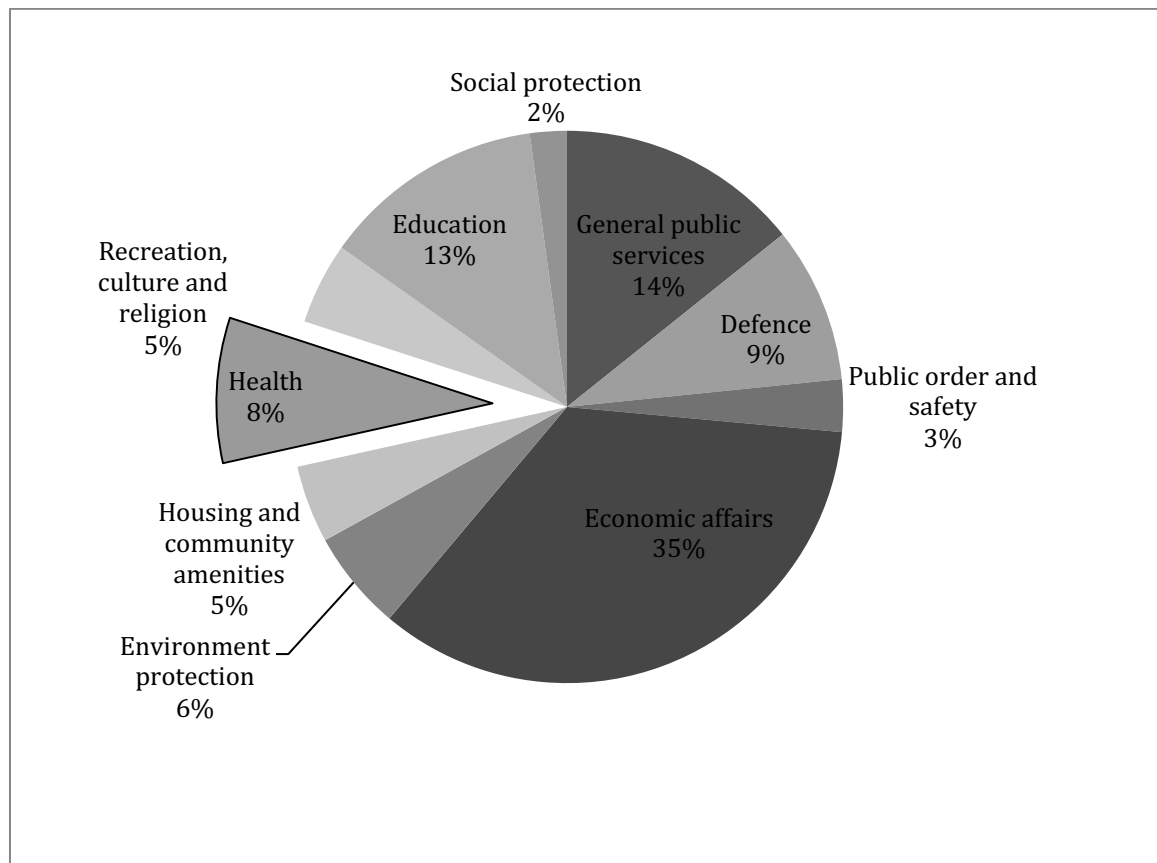


Figure 6: Composition of General government expenditure by function (COFOG) in 2015. Total: EUR 429.1 bn, 2.9% of GDP. Source: Eurostat.

Additional data

To further extend the investment time series for some of the countries until 1970, which is crucial to build capital stocks with predictive power, we generate annual investment growth rates for earlier years from:

- **OECD Structural Analysis (STAN) database (OECD, 2012) fourth revision:** The structure is comparable but not identical to the National Accounts statistics following SNA08-Standard (e.g. ESA2010) and advantageously available till 1970 for some countries.
- **OECD Structural Analysis (STAN) database (OECD, 2011) third revision:** The structure is comparable but not identical to SNA93-Standard, which is used in ESA1995. Because of the narrow sector specification for health, we assume, that growth rate retrieved from OECD STAN ISIC 3 are a good estimation for real growth rate and preferable over no data.

- **Gross fixed capital formation all industries time series (European Commission, AMECO, 2018):** Data are only available across industries. Thus we have to assume that investments in the health sector are constant over time and country.

Unknown investments in earlier years are then estimated by applying growth rates to the earliest known investment data point. We intent to build investment time series from 1970 until today for as many EU28-countries as possible, ideally for all asset classes (ESA2010) and all health levels (COFOG).

For comparison of annual data, real volume data are computed by adjusting for inflation using price indices for each asset type (implicit deflator) (Eurostat, 2018). These price indices are chain-linked with reference 2010. The average annual price structure of the previous and the current period is used to measure changes in the real volumes (Lequiller & Blades, 2014, S. 58). On the one hand, the derived growth rates are more accurate. On the other hand, because of this transformation from nominal values to chain-linked volumes, investments for different asset types technically cannot be aggregated by a sum (ibid, S. 61). However, because the error is considered as small, we accept the deviation in the aggregate (ibid.; own sensitivity analysis). For comparison of COFOG annual data, real volume data are calculated by adjusting for inflation with the price index computed with ESA2010 time series by dividing the sum of nominal data of Total Fixed Assets by its real volumes data.

Perpetual inventory method (PIM)

The perpetual inventory method is a tool to build capital stocks given annual investments and an initial capital stock. Assets built by past investments diminish over the course of time through obsolescence and through wear and tear, thus the depreciation of each asset need to be considered with respect to its vintage. In the following the formalization of the PIM is presented (c.f. OECD, 2009; Berlemann & Wesselhöft, 2014).

We assume that the capital stock K_t at any time t is the capital stock K_{t-1} from previous time period $t-1$, minus the depreciation D_t adding new investments I_t at time t :

$$K_t = K_{t-1} - D_t + I_t$$

$$\text{with } D_t = \delta * K_{t-1}$$

We further assume geometric depreciation¹⁰ pattern with a constant depreciation rate δ , we can rewrite:

$$K_t = (1 - \delta)K_{t-1} + I_t$$

For $t = 1$ the equation is

$$K_1 = (1 - \delta)K_0 + I_1$$

with $K_0 \equiv 0$

$$K_1 = I_1$$

and

$$K_t = \sum_{i=0}^{t-1} (1 - \delta)^i * I_{t-i}$$

Herewith the Capital Stocks K at time t is the sum of investment depreciates with its depreciation rate δ and with respect to its vintage. In fact, the perpetual inventory method rest on some underlying assumptions.

For our purpose we assume:

- We use a geometric depreciation, which is based on works by OECD and EUROSTAT. We also consider a balance rate of $\alpha = 1.6$ to get a better match of depreciation pattern and real life (Blades, 2000; OECD, 2009; Erumban, 2008; Bergen et al. 2009). The influence of a mortality function is already included here (table 2).
- We start the calculation of the capital stocks in 1970 with a benchmark capital stock K_{t0} . We should have a time series reaching into the past long enough, such that the tangible assets, which have been acquired with past investment, are fully replaced when capital stocks are analysed. With expected service lives of 40 years for construction work, we therefore seek investment time series till at least 1975, with the more years the better. We start in 1970.
- Following Blades (2015) and the OECD manual (2009), the initial benchmark capital stock can be approximated with the first known (but in some cases estimated) investment I_{t0} , the average depreciation rate \bar{d} for each asset type and the average growth rate \bar{g} . Instead of assuming K_0 to be 0 we estimate K_0 as follows:

$$K_0 = \frac{I_{t0}}{(\bar{d} + \bar{g})}.$$

¹⁰ We are going with geographic depreciation rates, meaning that actually no asset would normally retire. However, following Eurostat, & OECD (2015), assets are normally going out of service with a salvage value of 10% of initial value, while new investments for maintenance extend the service life of assets.

Table 2: Asset type, expected average service life and depreciation rate considering a balance rate of $\alpha = 1.6$.

Asset type	Service Life	Depreciation rate
Construction (dwellings and other buildings and structures)	40	4,0%
Machinery and Equipment		
Transport	9	17,8%
ICT	5	32%
Other Machinery and Equipment	12	13,3%
Intellectual properties / R&D	10	16,0%
Software	3	53,3%
EU-28 average (2005-2016)		6,81%

Benchmarking and future scenarios

The first part of our analysis is retrospective and evaluates the amount of past investments and the development of the dependent Capital Stocks. With given information on historical landmarks (e.g. the global financial crises or political intervention in different countries) we might explain the evolution of investments and the Capital Stocks. Furthermore, we can examine if targeted milestones have been reached (e.g. did investments in the health sector follow the national (regional) growth rates of GDP? Or could a country maintain or even increase the capital stock volumes?).

In a second part we model two different scenarios to predict how the investments, as affecting variable, have to develop, such that predefined benchmarks can be reached. The scenarios start in 2016 and run till 2030. We also consider population estimates retrieved from Eurostat (2018). Possible changes of the health system in the future are not considered and kept constant. The Capital Stocks of 2016 is taken as the basis for the scenarios. Future depreciation rates (to compute future Capital Stocks) are kept constant with the average of past depreciation rates from 2014-2016. The scenarios are defined as follows:

- **Scenario 1 (optimistic scenario):** Given the Capital Stocks of 2016 and the estimates of population size in the future, we change investments with the growth rates of GDP projections (OECD, 2018).
 - **Idea:** GFCF and thus investments in the health sector is a fraction of the national GDP. Assuming that the portion should be more or less constant, the annual investments should increase, when GDP increases.
- **Scenario 2 (conservative scenario):** Given the estimates for the population size in the future, and Capital Stocks at 2016 level, we change the Capitals Stocks in a way, such that the ratio of Capital Stocks per capita stay constant over time.
 - **Idea:** The need of health service changes over time due to population changes (birth rates), migration, etc. Thus, we examine how Capital Stocks and therefore investments might change without individuals experience a loss.

Neither scenario 1 or 2 imply, that countries' capital stock volumes in 2016 are optimal volumes, nor that estimated investments in the future are on optimal level for each country. Even no other capital stock can be seen as the only optimal volume and therefore cannot function as benchmark per se. Hence either the benchmark is set in a relationship with performance parameter such that effectiveness or efficiency count, e.g. for a cross-country analysis, or in a longitudinal perspective the highest capital stock volume in the course of time is set as benchmark. Then any downward deviation must be considered as negative development. We examine both perspectives later on. In contrast to common concerns (e.g. Fransen et al. 2017) however, we would rate lower investments as a crucial issue only if investment go down for longer periods and there is a risk for or an actual decrease of capital stock volumes. Otherwise volatility is viewed as "normal".

Results

As mentioned before, investments, e.g. in infrastructure are volatile in longitudinal perspective and are affected by macro-economic variables and political decisions. Infrastructure investments happen cyclical, meaning after times of high investments in tangible and intangible assets, investments might be reduced. Wear and tear only show after a longer period depending on the average service life, such that the assets can be utilized without a noticeable loss of function for some time.

Investments in health made by EU28 countries in 2016 accumulate to EUR 65.8 bn, which is similar to pre-crises volumes from 2007 (EUR 64.7 bn). In pre-crises years investments showed an annual increase of 3 to 4 %, but when in 2008 the global financial crises emerged, investments stagnated and/or temporary decreased in the following years, with the lowest amount in 2013 (EUR 60.2 bn). Between 2007-2016 lowered investments accumulated to an “investment gap” of EUR 13.9 bn, in comparison to the case, when 2007 investment level would have been kept constant until 2016. Decreasing investments become evident in GER, EST, GRE, ESP, ITA, CYP, LUX, SVK and UK¹¹.

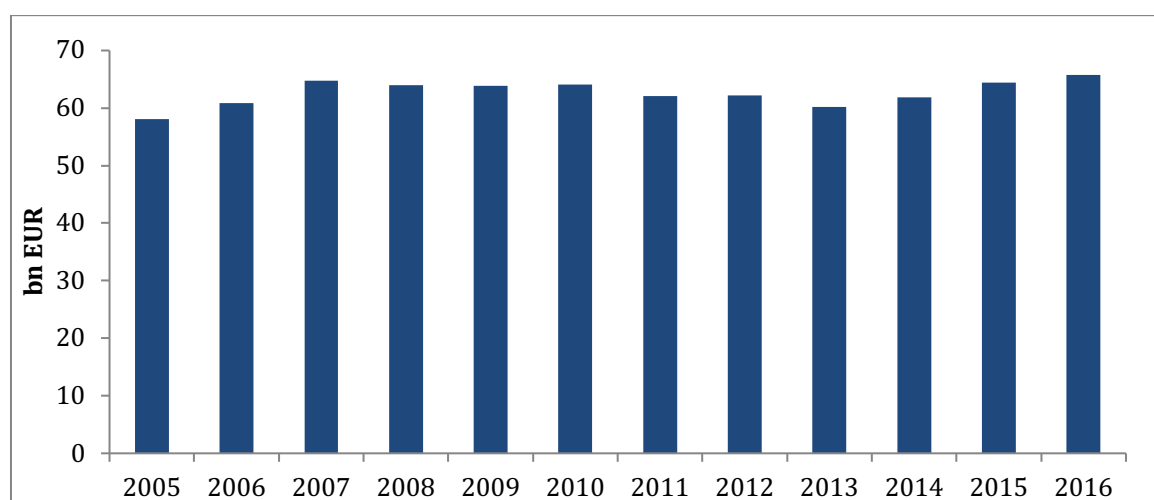


Figure 7: EU28 investments in health infrastructure 2005-2016. Gross fixed capital formation, accumulated data for EU28. Real volumes. Inflation-adjusted with implicit deflator (2010 = 100). EU28 aggregate does not include data from Croatia, Latvia, Lithuania, Malta. Source: Eurostat (nama_10_nfa_fl), own calculations.

Public investment in health in EU28 is around half (56%) of total investment and accumulate to EUR 35.2 bn in 2016, which is a plus of 5% in comparison to 2007 but a decrease of 2,8% (EUR 1bn) in comparison to 2010. In meantime no investment gap but a plus of EUR 12.0 bn can be observed in comparison to the case, when 2007 investment level would have been kept constant until 2016. With 2010 investment as baseline the investment gap would accumulate to EUR 13.4 bn,. While the total investment in EU28 decreased in crises years, the public investment increased until 2010 which might be due to an anti-cyclical Keynesian economic policy in some countries, but has been reduced afterwards, starting to increase again in 2013. In 2016 however, former investment levels have not been reached yet, which indicates a tendency for state budget consolidations.

¹¹ UK accumulated investment gap is highest with EUR 28.5 bn, thus excluding UK because of Brexit would result in investment surplus for then EU27 (+ EUR 14.5 bn).

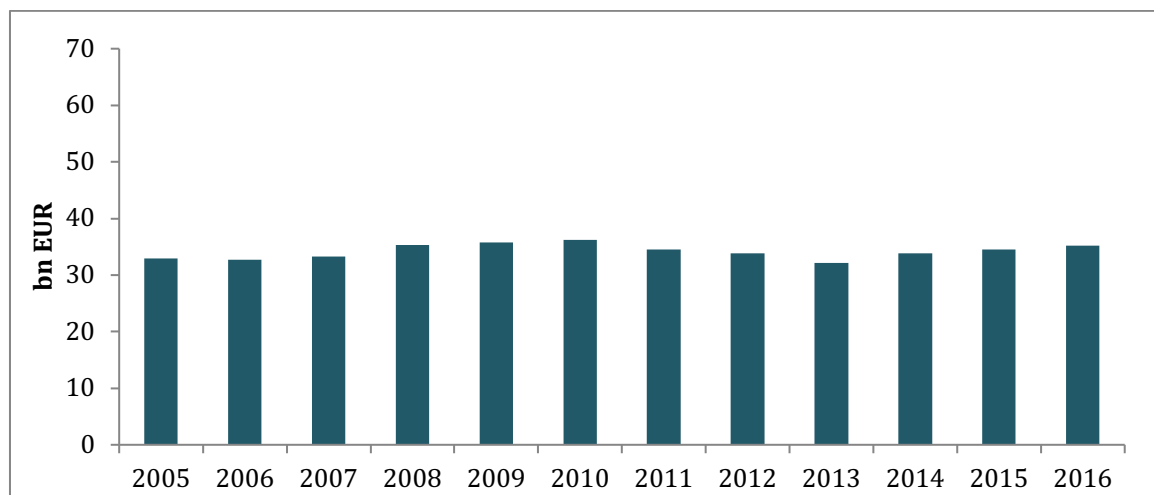


Figure 8: EU28 public investment in health infrastructure 2005-2016. Gross fixed capital formation, accumulated data for EU28. Real volumes. Inflation-adjusted with implicit deflator (2010 = 100). EU28 aggregate does not include data from Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia. Source: Eurostat (gov_10a_exp), own calculations.

Taking the population into account, the investments per capita in health infrastructure in EU28 accumulate to volumes between EUR 117 (2005) and EUR 129 (2007) per capita per year. Since population numbers only increase a little (cf. EUROSTAT demo_pjan), the change in investments per capita is mostly driven by the variation of total investment numbers. Public investments per capita account for volumes between EUR 63 (2013) and EUR 72 (2010) per capita per year.

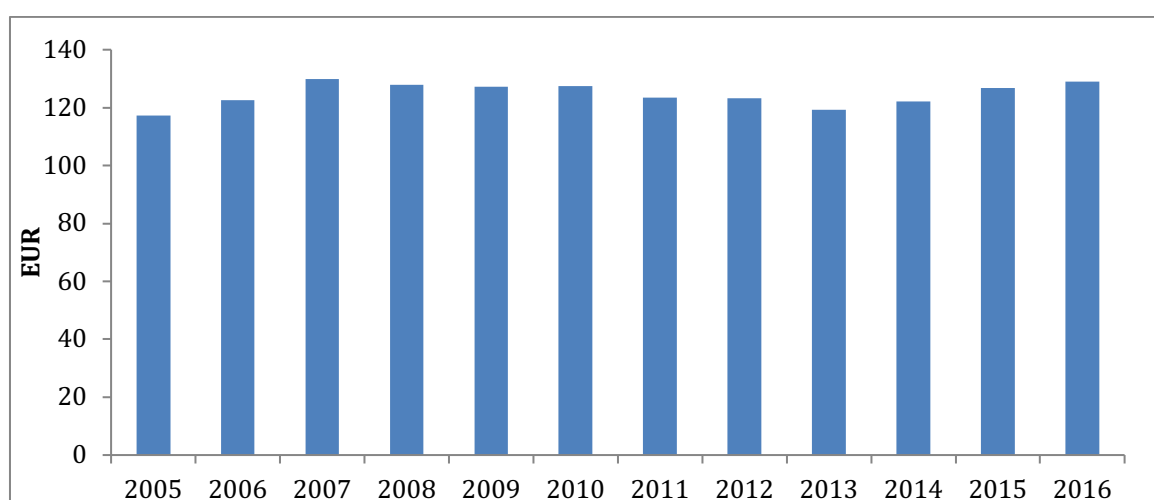


Figure 9: EU28 investment in health infrastructure per capita 2005-2016. Gross fixed capital formation, accumulated data for EU28. Real volumes. Inflation-adjusted with implicit deflator (2010 = 100). EU28 aggregate does not include data from Croatia, Latvia, Lithuania, Malta. Source: Eurostat (nama_10_nfa_fl, demo_pjan), own calculations.

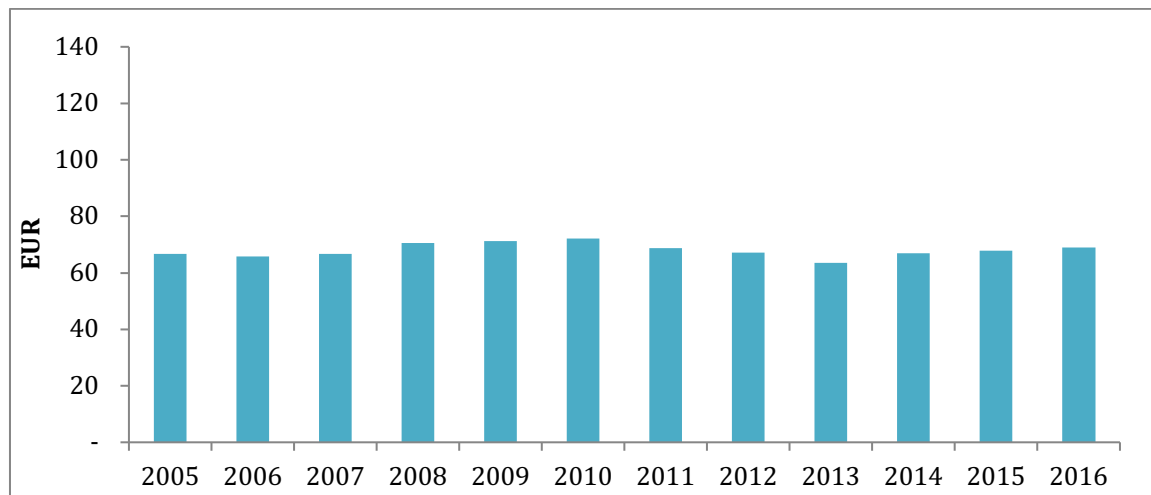


Figure 10: EU28 public investment in health infrastructure 2005-2016. Gross fixed capital formation, accumulated data for EU28. Real volumes. Inflation-adjusted with implicit deflator (2010 = 100). EU28 aggregate does not include data from Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia. Source: Eurostat (gov_10a_exp, demo_pjan), own calculations.

The accumulated capital stock for EU28 in 2005, based on the perpetual inventory method (PIM) can be estimated with approx. EUR 645 bn in total and with EUR 1,302 per capita. While investments vary significantly over time, the annual capital stocks show steady annual increase of 1.92%, which is a plus of 1.63% p.a. for capital stocks per capita. Thus, even though a reduction of health infrastructure investments is evident between 2008 and 2016, investments have been high enough not only to replace depreciated capital stock but also to further extend the capital stock volume. The annual growth of the capital stock depends i.a. on the ratio between investment and current capital stock which is 8.3% for the national accounts time series. Nevertheless, the lower investments lead to a restrained increase of the capital stock from 2010 to 2014 but accelerate again thereafter. In 2016 the capital stock increased to EUR 1,556 per capita.

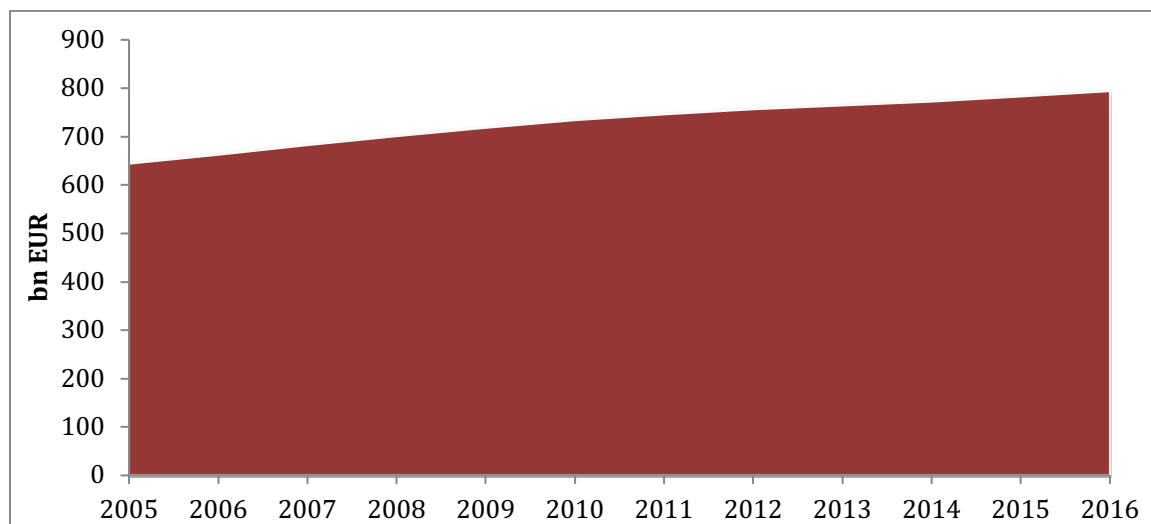


Figure 11: Capital stock estimation using PIM. Real volumes. EU28 aggregate does not include data from Croatia, Latvia, Lithuania, Malta. Source: Eurostat (nama_10_nfa_fl), own calculations.

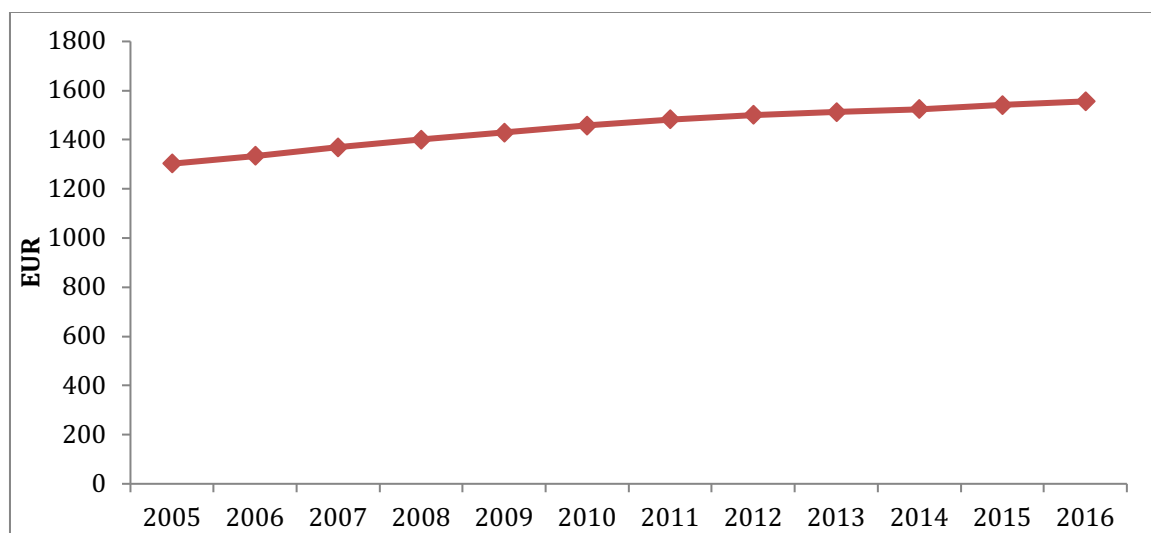


Figure 12: Capital stock per capita estimation using PIM. Real volumes. EU28 aggregate does not include data from Croatia, Latvia, Lithuania, Malta. Source: Eurostat (nama_10_nfa_fl, demo_pjan), own calculations.

The capital stock of the public domain has a volume of approx. EUR 350 bn which is ca. 54% of the total capital stock in EU28 in 2005. The annual increase is 1,48%, which is a plus of 1.2% p.a. on capita level and slightly lower rates than in total. Similar to the total capital stock, growth is slowed after 2010 in total volumes and per capita. The ratio between investments and capital stock is 8.4%. If public investments stay on current levels, further extension of public capital stock will completely trail off.

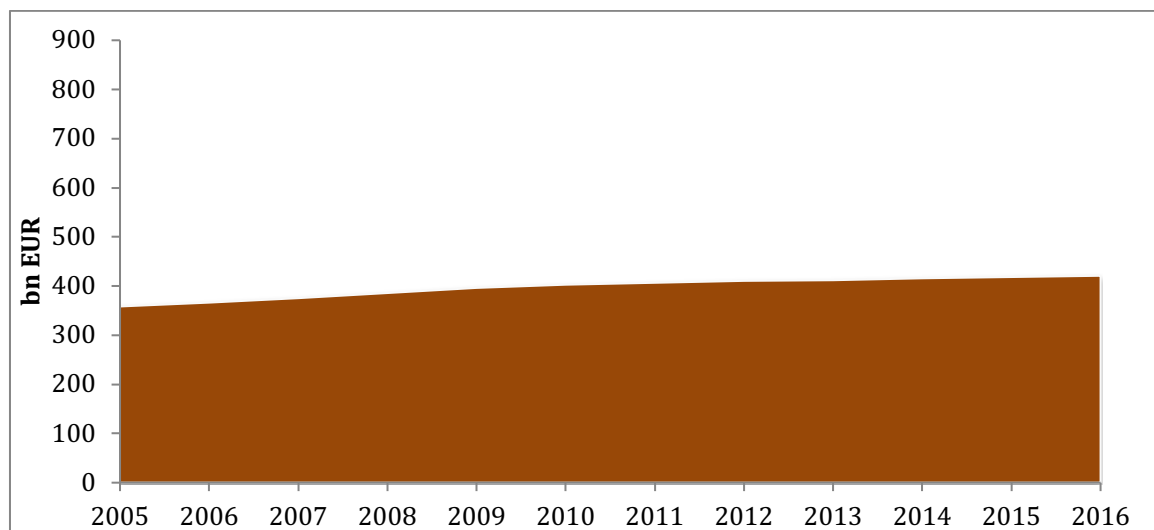


Figure 13 Capital stock estimation using PIM. Real volumes. EU28 aggregate does not include data from Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia. Source: Eurostat (gov_10a_exp), own calculations.

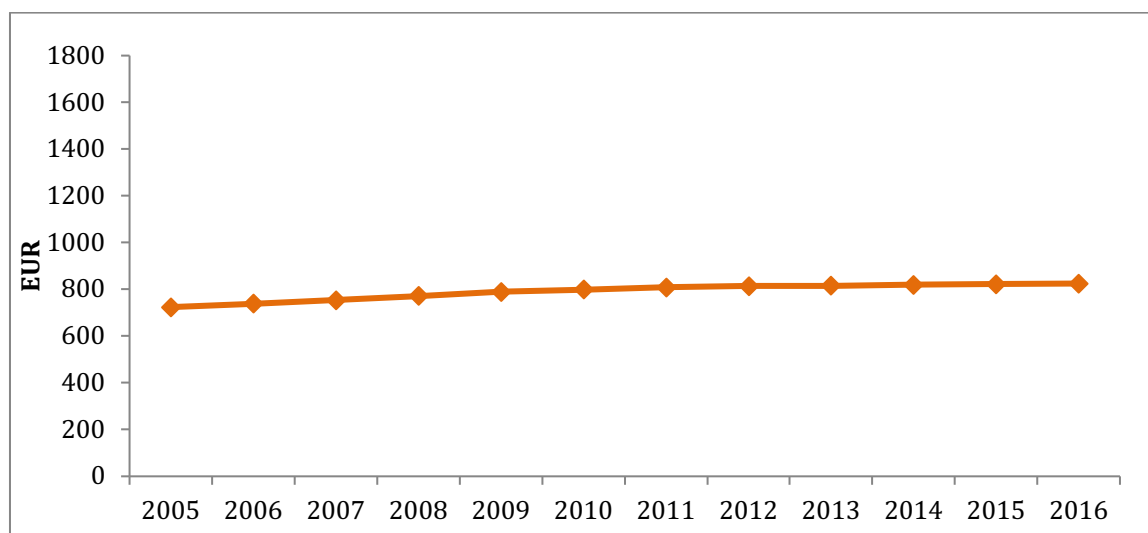


Figure 14: Public capital stock per capita estimation using PIM. Real volumes. EU28 aggregate does not include data from Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia. Source: Eurostat (gov_10a_exp, demo_pjan), own calculations.

In comparison with the evolution of GDP (figure 15), capital stock increases faster than GDP especially during the financial crisis, thus the gap widened. Public stock developed slower until 2007, but during the financial crisis growth rates have been higher than for GDP. Since 2012 the gap decreases between GDP and public capital stock and in 2015 GDP growth overtake the public capital stock again. It can be assumed that in the early crisis years, public investments protected the total capital stock from declining.

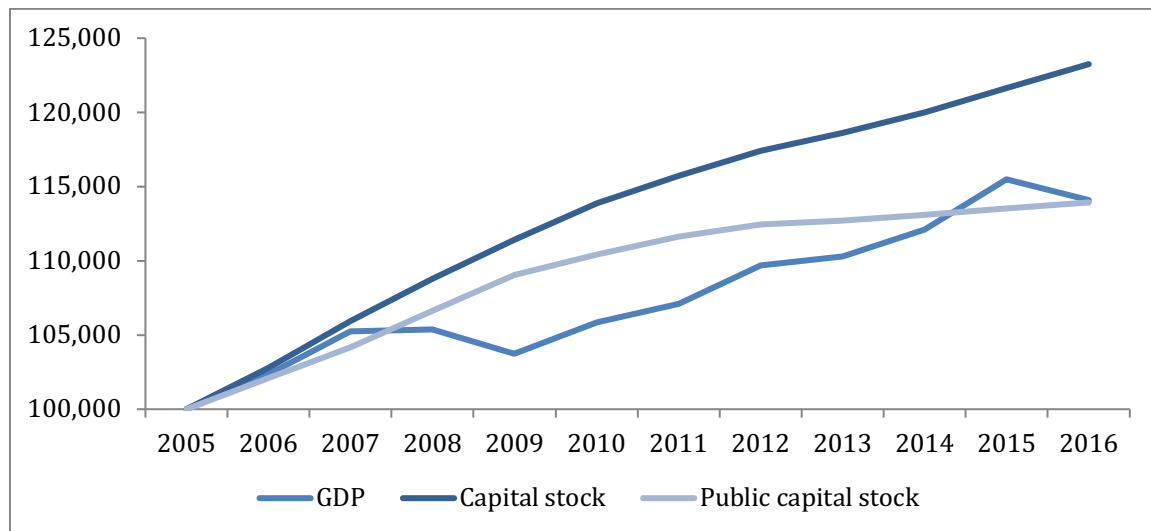


Figure 15: Development of GDP, capital stock and public capital stock (2005=100). Source: Eurostat (nama_10_gdp, nama_10_nfa_fl, gov_10a_exp), own calculations.

In conclusion total investments in EU28 are sufficient to increase the capital stock, even though investments have been lowered during the global financial crisis. Taking the highest investment in crisis years as reference point, the lowered investment accumulates into an ‘investment gap’ of EUR 13.9 bn and EUR 13.4 bn respectively for total and public investments. It can be assumed, that capital stock could have been higher without the crises, the ‘investment gap’ however did not lead to a decline of the EU28 total or public capital stock, estimated with state budget data and the underlying assumptions.

While financing on European stage can therefore be regarded as positive, the situation might differ in the EU28 member states, most obvious in the so-called program countries, which have been or are partly still supported by different institutions and the other European countries.

Results for countries

Aggregated investments in the health sector and derived estimations for capital stock as an indicator for existing infrastructure on EU28 level imply, that health infrastructure develops over the course of time, even though investments have been lowered during the global financial crises. Situations on country level however, indicate major differences. In the following, we present summarized results for the EU28 member states.

Unavailable data

Total investments reported in National Accounts (ESA2010, Eurostat, 2018) are not available at all for Croatia, Latvia, Lithuania, Malta¹². Public investment, which are reported in COFOG (Eurostat, 2018) are not available for Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia.

Investments 2005-2015

In 2005 the highest amounts per capita have been invested in LU, DE and AT. In the following years until 2015, which include the period of the global financial crisis, the annual investments for health infrastructure went down in five countries (Greece, Italy, Cyprus, Luxembourg, United Kingdom). In 18 countries we can observe a positive development of investments. While the growth rates are below GDP growth in six countries (Bulgaria, Germany, Estonia, France, Poland, Romania), investments grow stronger than the average economy (GDP) in 12 countries (Belgium, Czech Rep., Denmark, Ireland, Spain, Hungary, Netherlands, Austria, Portugal, Slovenia, Slovakia, Finland, Sweden).

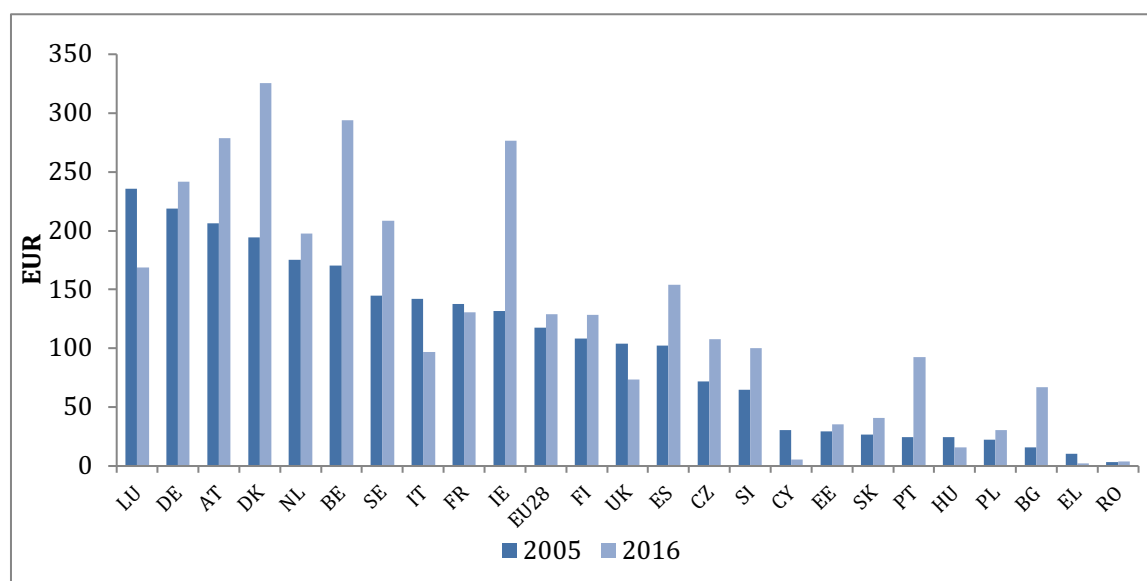


Figure 16: Investment in health infrastructure per capita and by country for 2005 and 2016. Gross fixed capital formation. Real volumes. Inflation-adjusted with implicit deflator (2010 = 100). Source: Eurostat (nama_10_nfa_fl, demo_pjan), own calculations.

¹² In ESA2010 unavailable data are an issue for more countries. With OECD STAN Database for Structural Analysis missing data have been replaced.

Public investment per capita in 2005 is highest in AT, DK and SE, countries with highly tax-based provision of social goods. After 2005 less have been invested in four countries (Greece, France, Italy, Portugal). It has been reported that those European countries among others heavily struggled during crisis years. 13 countries showed increasing investments on average from 2005 to 2015. Annual public investment growth is below GDP growth (Belgium, UK) in two of those countries, while investments grow faster than GDP in the remaining 11 countries. Four countries mostly rely on private investments (Belgium (98% of total investment), Czech Rep. (87%), Luxembourg (84%), Netherlands (75%)) and nearly evenly distributed in Slovakia (57%). In 12 countries the major share of investments is public.

Capital Stock 2005 – 2015

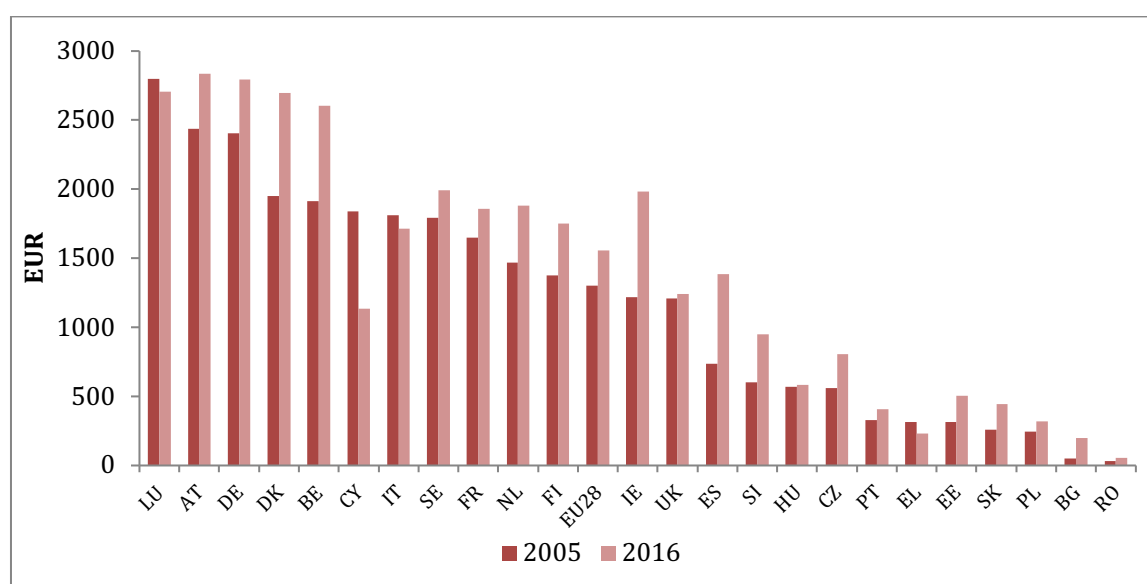


Figure 17: Capital stock volumes in health infrastructure per capita and by country for 2005 and 2016. Gross fixed capital formation. Real volumes. Inflation-adjusted with implicit deflator (2010 = 100). Source: Eurostat (nama_10_nfa_fl, demo_pjan), own calculations.

In most EU28 countries the investments from 2005-2015 were sufficiently high to improve the existing capital stock, which is the case for 20 countries. It should be mentioned, that low capital stock volumes (less than EUR 1,000 p. capita) can primarily be seen in east European countries¹³. Due to declining investments in Greece and Cyprus capital stocks cannot be maintained in these two countries (cf. Figure 15 for Greece). In Italy

¹³ There are two main reasons. First, investment data (GFCF) are unavailable before 1990 (Eurostat, 2018) and estimations might be set too low and therefore also the accumulated capital stock. Second, lower rates of life expectancy are related to lower health system standards, which are most likely unrelated to the existing capital stocks in those countries.

and Hungary investments are high enough to maintain the existing capital stocks, but no improvement can be reached. Only two countries, or if viewed in a more stringent manner, four countries experienced insufficient investments to maintain or improve their capital stocks.

Future Scenarios

Running two future scenarios, we determine how countries' capital stocks would develop in case of ambitious investment targets (scenario I: investment grow with expected GDP growth rates, OECD 2017) or more conservative investment targets (scenario II: investment is set such that capital stock per capita volumes can maintained on 2016 level).

If countries' investments would keep pace with expected GDP growth rates, 17 countries would experience a significant increase of their capital stocks. In four countries (Estonia, Italy, Poland, United Kingdom) such investment developments would be enough to maintain capital stock volumes without further improvements. For Greece and Cyprus, investments growth in line with GDP growth rate would be insufficient to maintain capital stock volumes, because the investment shortfall in recent years cannot be counterbalanced given this investment scenario. To maintain 2016 estimated capital stock volume of Greece, investment in 2017 have to be more than four times the countries' investment volume from 2016, which would be unrealistic. Assuming that 2016 capital stock volumes should be reached again in 2028, investments in Greece have to grow with an annual increase of 19% (cf. figure 15).

In contrast, if countries would target investments, which are enough to perpetuate the countries' 2016 capital stock per capita volumes, 16 countries could invest less, as current spending not only replace depreciation in value but also increase the capital stock volumes. Three countries (Netherlands, Austria, Sweden) could keep investment volumes constant on 2016 levels. The investments in five countries however would be insufficient to maintain 2016 capital stock per capita volumes (Estonia, Greece, Cyprus, Poland, United Kingdom).

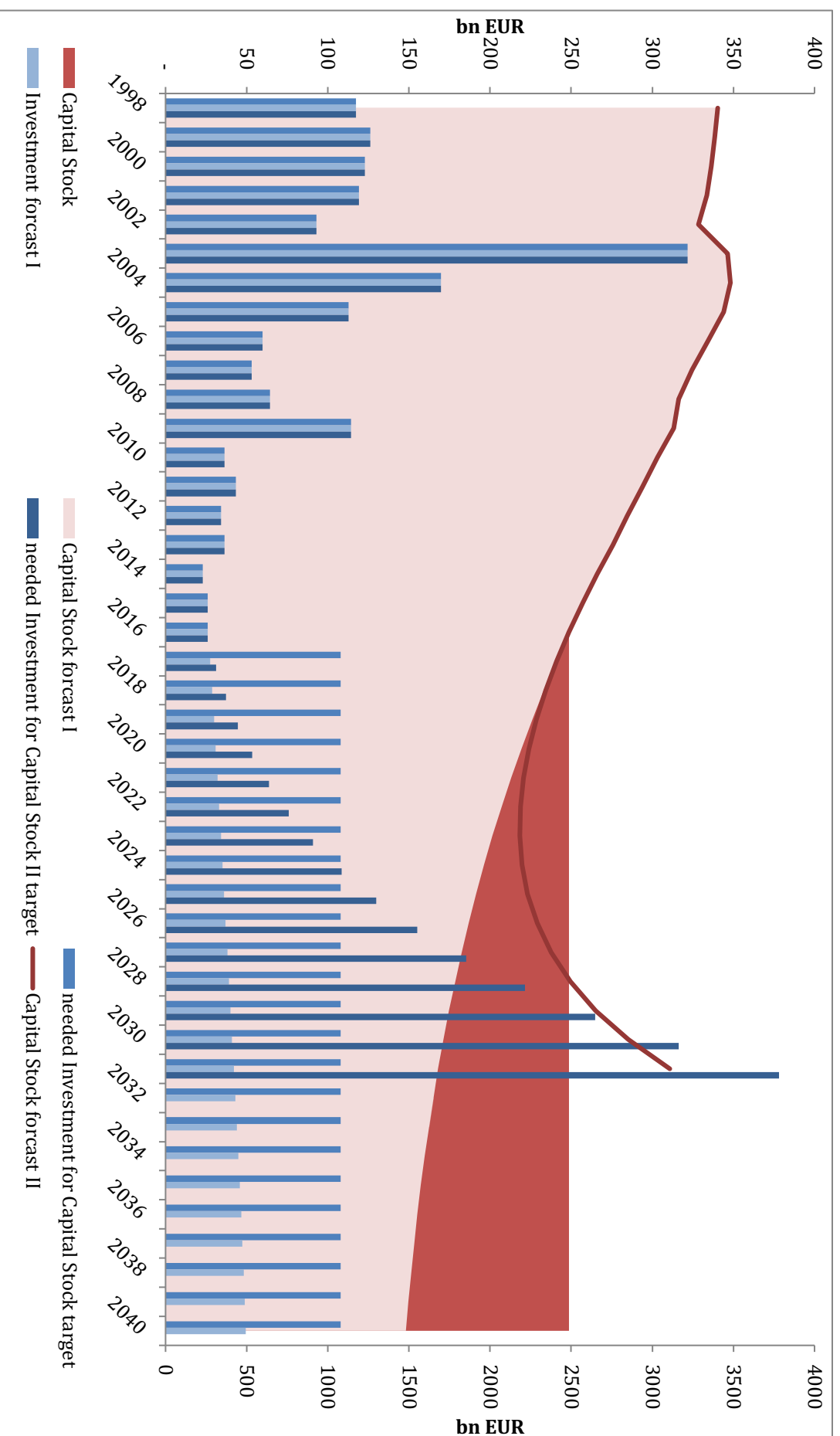


Figure 18: Investments and Capital Stocks for Greece. Estimations until 2016 and future scenarios. Scenario 0: Investment needed to maintain 2016 capital stock volumes. Scenario I: Investment grows with GDP growth rate, Scenario II: Investment grows with 19,4% p.a.

It can be therefore concluded, that most EU28 countries sufficiently invest into health infrastructure to maintain or even improve the 2016 capital stock volumes. In five countries we can identify an investment gap (Greece, Italy, Cyprus, Luxembourg, United Kingdom), meaning during the global financial crises the investment declined. However, only in Greece and Cyprus we can observe inhibiting investment gaps which lead to a reducing of countries' capital stock, while Italy invested at least enough to maintain current capital stock volumes. In Hungary, even annual investments grow faster than GDP, those investment levels are only enough to maintain capital stocks. In Luxembourg and United Kingdom, investments do not drop as far as the capital stock could not maintained.

Health system performance

Beside of the pecuniary perspective, which evaluate the annual spending for health infrastructure, performance parameters indicate, how the health sector perform in different countries and with the consideration of the countries' annual investment and capital stock volumes. Subjective ratings in a survey concerning unmet needs in the health sector point out, that the main issues are related to a waiting list for health services and to financial reasons, whereas distance or transportation issues do not cause major problems for the survey sample (figure 16-18) (Eurostat, 2018).

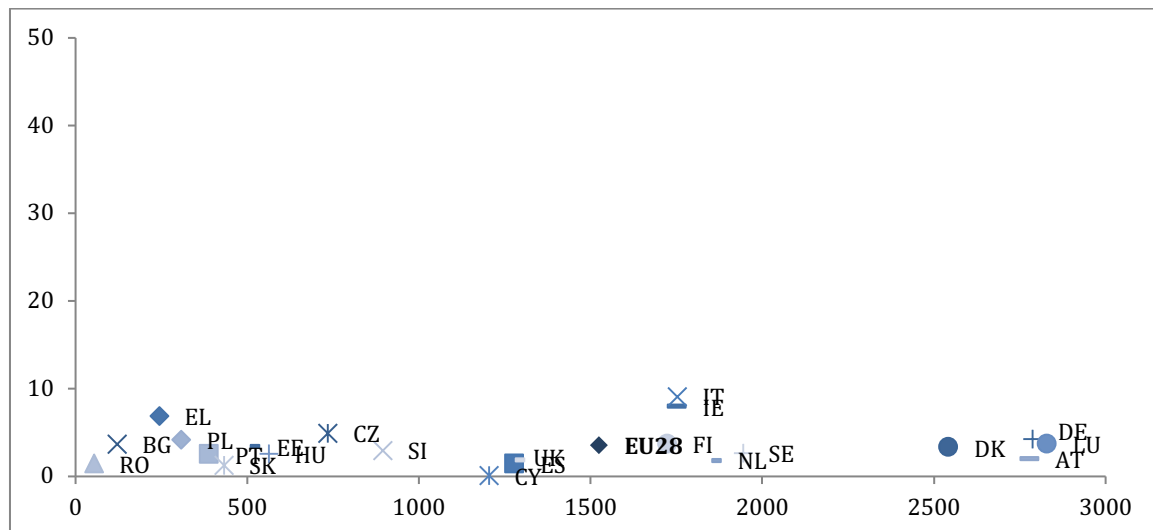


Figure 19: capital stock p. capita (x-axis) vs. unmet needs - distance or transportation (y-axis).
Source: Eurostat (hlth_silc_21), own calculation

Up to 30% (with a low of 2,4%) of the sample in different countries name “waiting list” related issues a problem for unmet needs, with highest agreement on this in PL, PT, IT, IE

and LU. Low agreement rates are given for RO, BG, SK and CY. No relationship can be observed with the capital stocks per capita volumes, which suggest once more that high capital stock volumes do not indicate exceptional good health services per se. The same applies to unmet needs due to financial reasons. The agreement rates in most countries lie between 5% and 20%, with higher percentages in EL, PT, EE and IE.

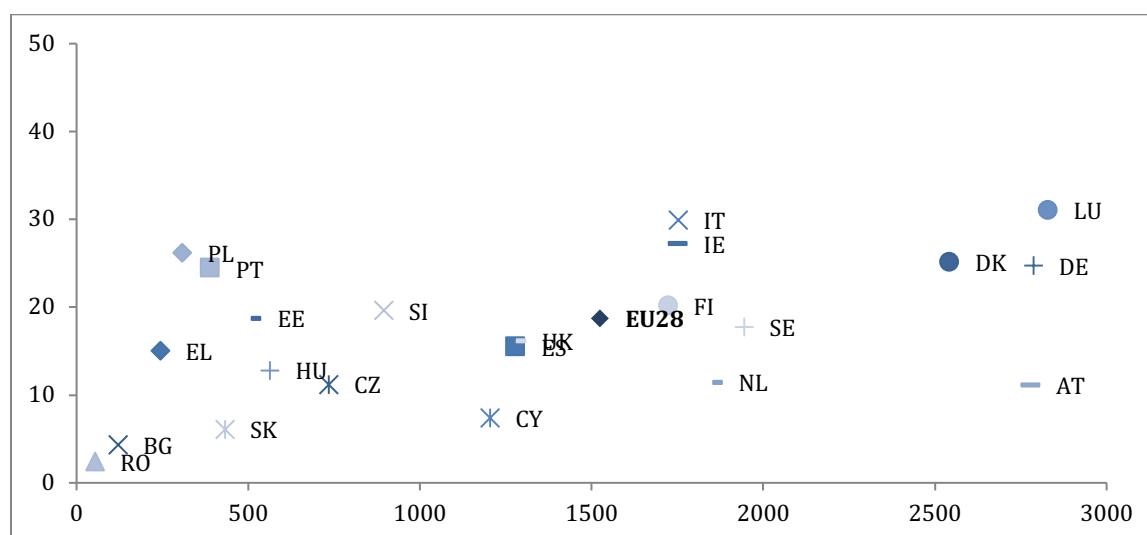


Figure 20: capital stock p. capita (x-axis) vs. unmet needs - waiting list (y-axis). Source: Eurostat (hlth_silc_21), own calculation

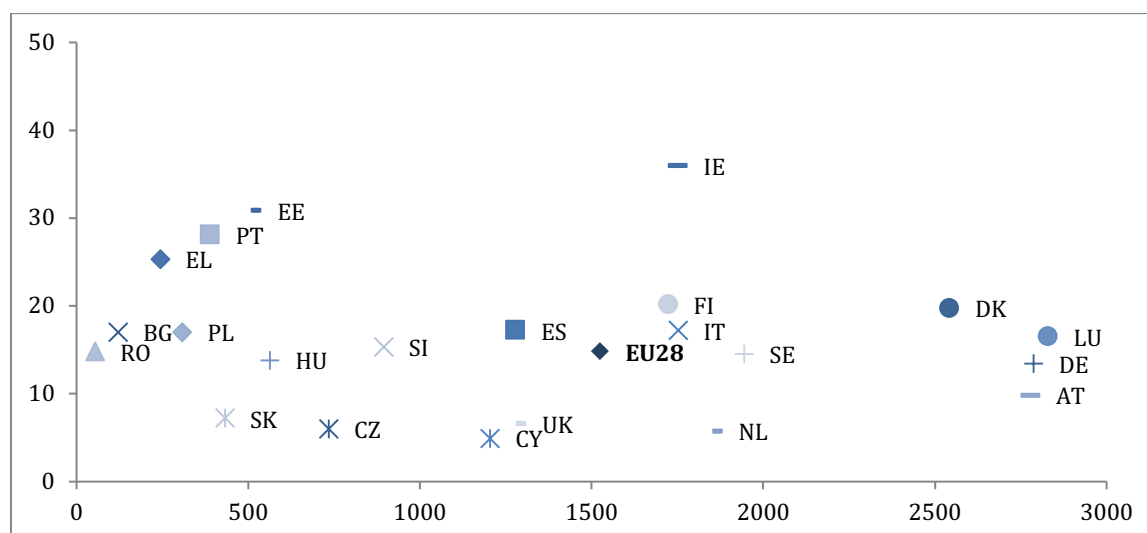


Figure 21: capital stock p. capita (x-axis) vs. unmet needs - financial reasons (y-axis). Source: Eurostat (hlth_silc_21), own calculation

More objective parameters for the performance of the health system are given by life expectancy and death rates. It is common knowledge, that the life expectancy for women is higher on average (EU28: 83,6) than for men (EU28: 78,1), which can be observed for all EU28 countries as well (Figure 19). For countries with low capital stocks life

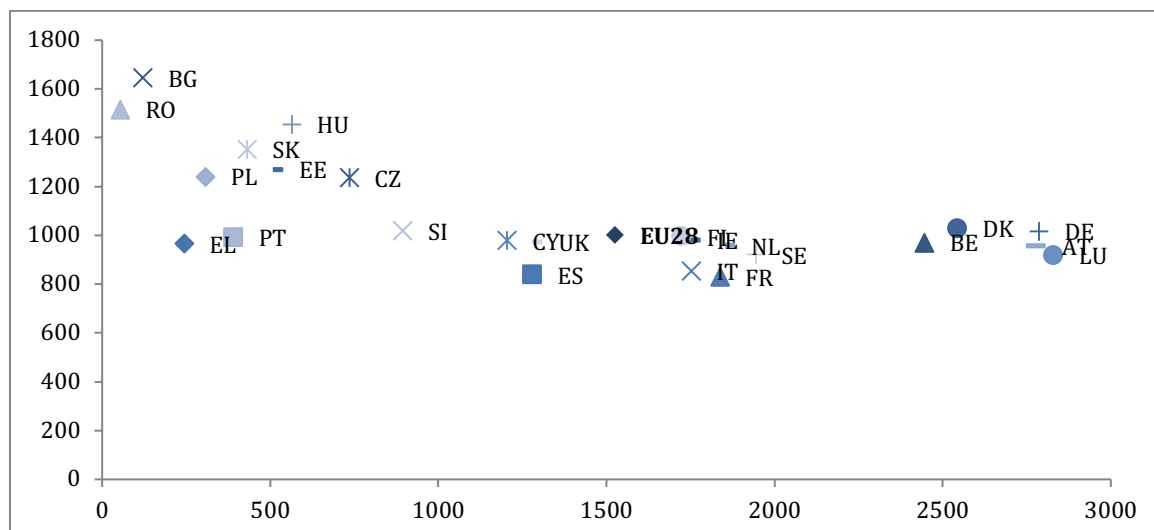


Figure 23: capital stock p. capita (x-axis) vs. standardised death rate by residence (y-axis). Source: Eurostat, own calculations

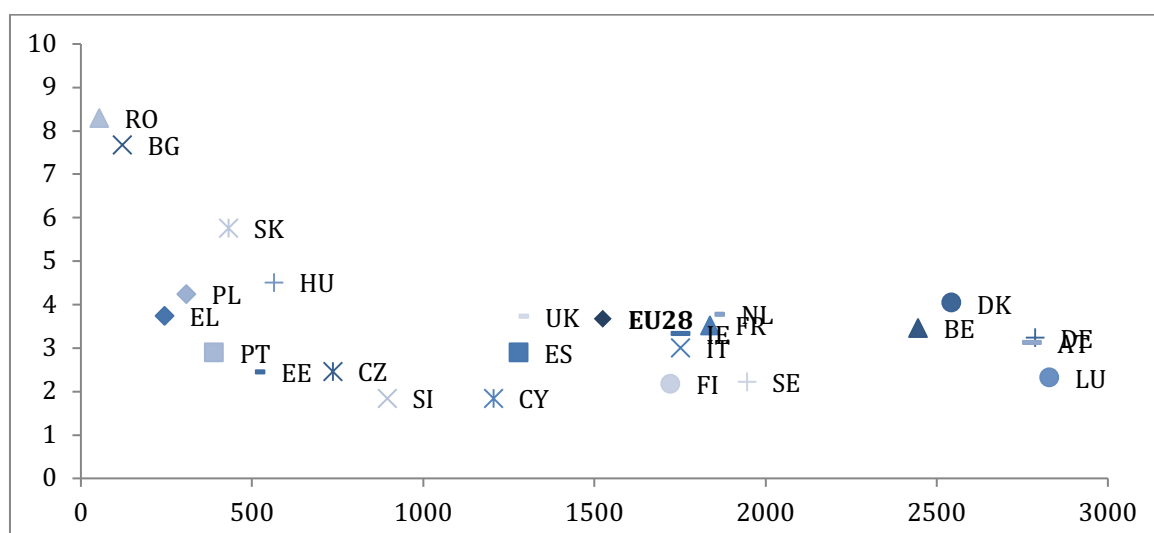


Figure 24: capital stock p. capita (x-axis) vs. infant death rates (y-axis). Source: Eurostat, own calculations.

Even though health services are in general seen as public good, which should be provided by the state, some expenditure need to be made out of pocket, the amount however differ between states. Showing the proportions of total health expenditures (in % of GDP) in comparison with capital stock volumes show that the fraction decreases with increasing capital stock per capita volumes. It can be assumed however, that amounts which have been spend out of pocket for health services might be higher in total numbers, since high levels of capital stocks are related with high economic power in the same countries and therefore high GDP rates.

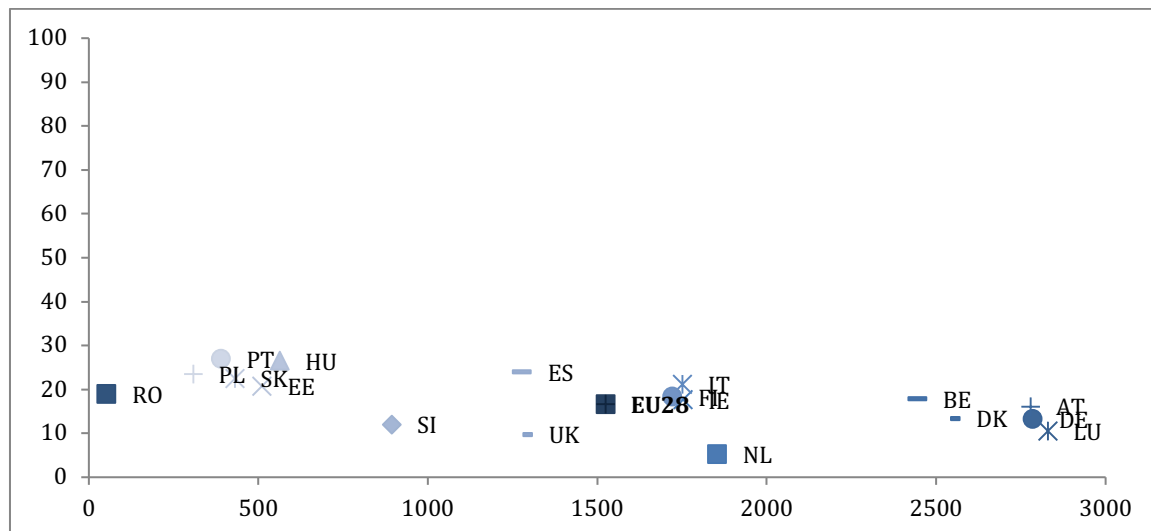


Figure 25: capital stock p. capita (x-axis) vs. Private household out-of-pocket expenditure as a proportion of total health expenditure. Source: WHO (HFA_584 6860), own calculations.

Further information can also be retrieved from performance parameters on infrastructure level. High numbers of available (hospital and day care) beds (per 100,000) are reported for countries with low capital stock volumes (< EUR 1,000) and for countries with more than EUR 1,500. In DE (828) and AT (765) exceptional high numbers of beds are provided, both countries with high capital stock per capita volumes (figure 23). This U-shape regarding availability is also given for the number of hospitals per 100,000 capita. The supply is particularly high for Cyprus (9,6 hospitals), France (5,3), Finland (4,8) and Bulgaria (4,7). The high numbers of hospitals per 100,000 capita in CY are mostly given because of the high numbers of private, for profit hospitals (figure 25) Thus the provision with hospitals and (hospital and day care) beds is rather low in countries with moderate capital stock volumes. The supply with other technical equipment (e.g. CT, MRI, Mammographs, radiation therapy equipment) does not seem to depend on high capital stock volumes either (figure 24). In general, CTs count the highest in most countries, while more Mammographs than CTs are available in FI, CY, SI, EL, HR and MT.

Regarding human resources two observations can be made. The number of physicians per 100,000 capita varies regardless of the capital stock per capita volumes between 73 physicians (Belgium) and 279 (Austria), whereas the number of nurses and midwives (in hospital) per 100,000 capita is rather high if countries' capital stock volumes are high as well.

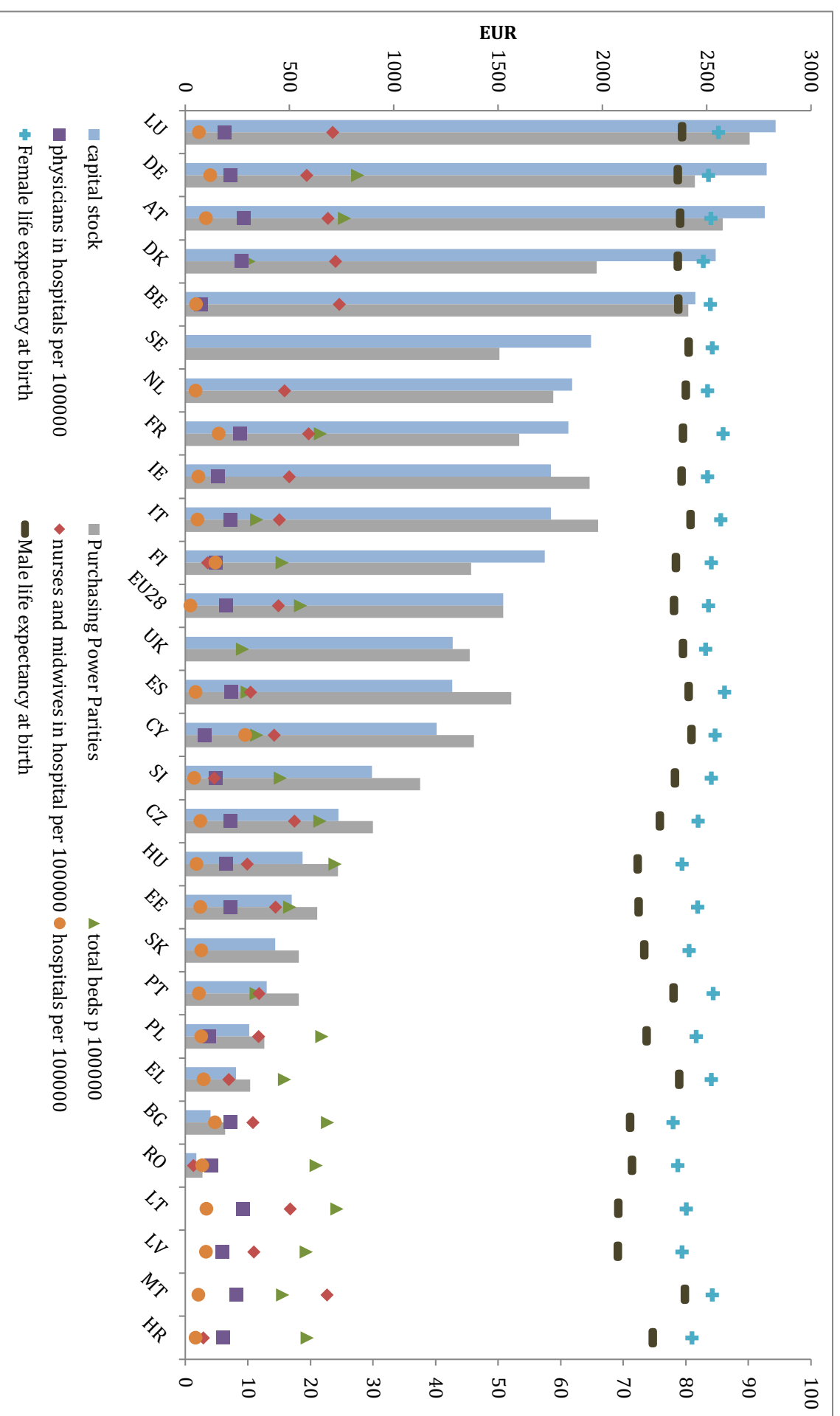


Figure 26: Capital stock and purchasing power parities vs. infrastructure and human recourse parameter. Source: WHO, Eurostat, own calculations.

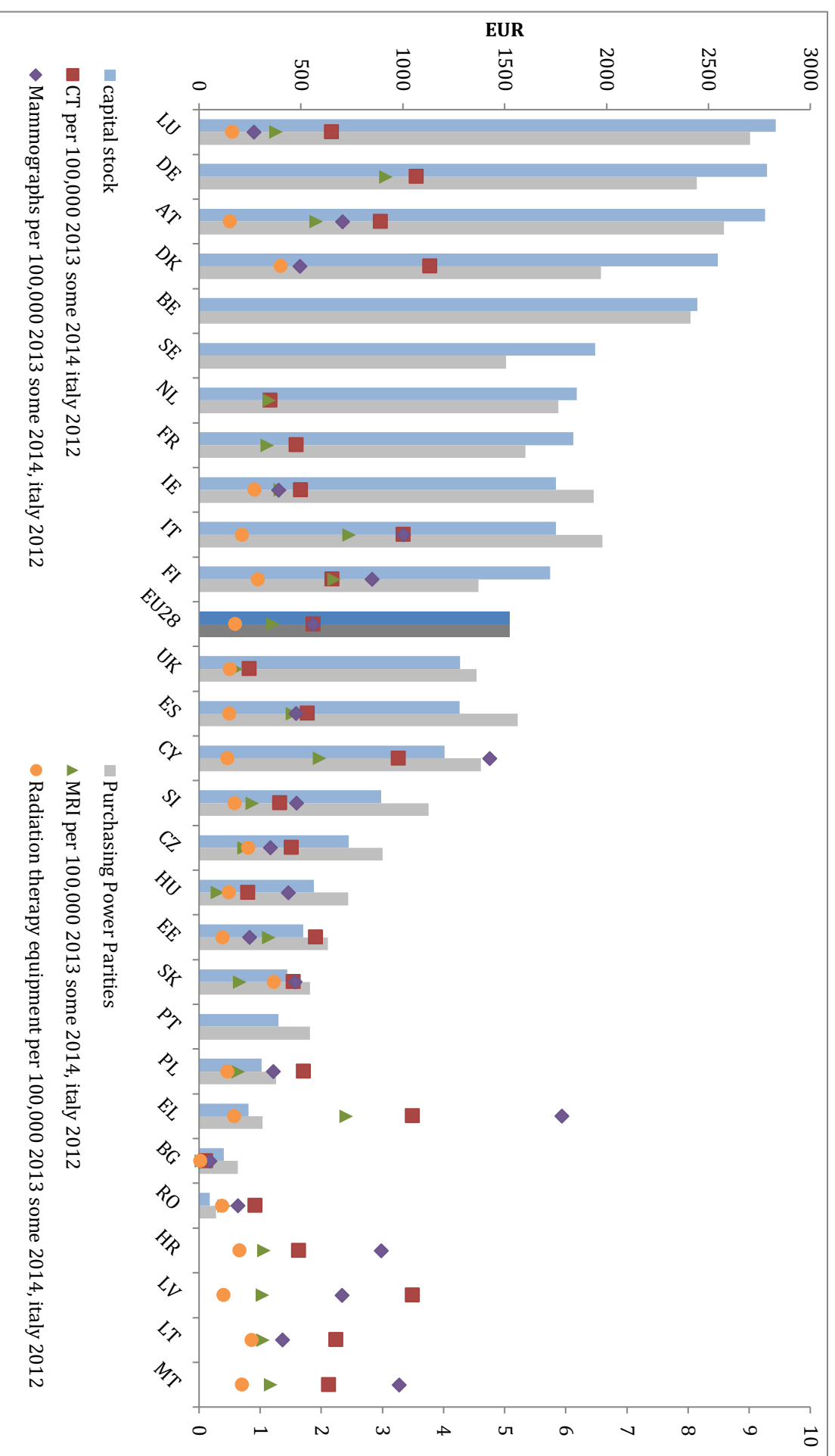


Figure 27: Capital stock and purchasing power parities vs. technical equipment. Source: WHO, Eurostat, own calculations.

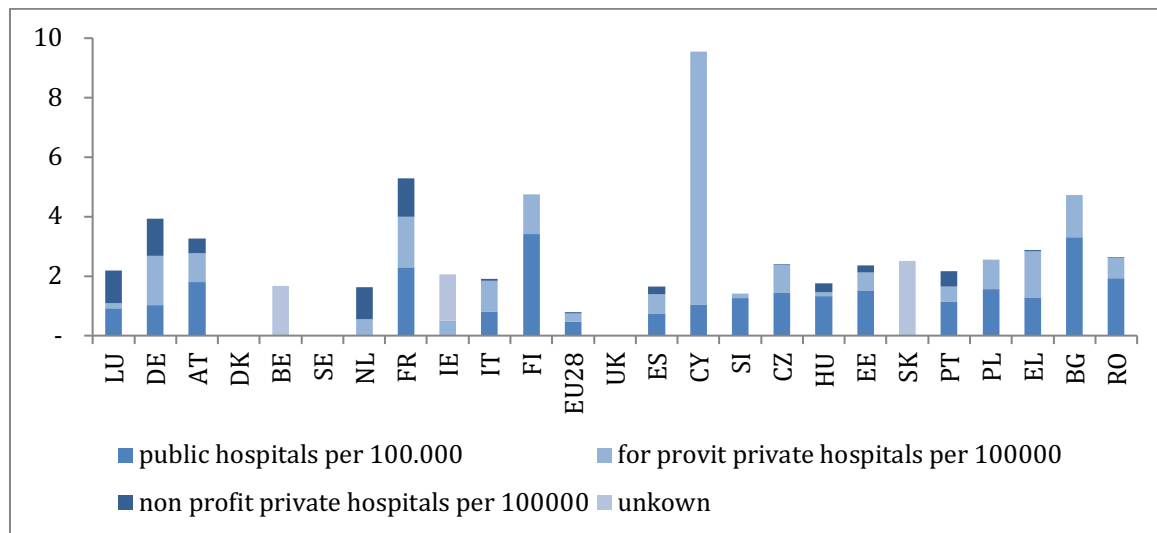


Figure 28: Hospitals in EU28 countries by service provider.

Benchmarking

In conclusion, only weak to moderate relations between countries' capital stock volumes and performance variables, either subjective (survey), regarding outcome (life expectancy and death rates) or service supply (hospitals, beds, technical and human resources) can be identified. For hospitals and the number of beds a U-shape for the supply can be observed, meaning that high supply is given in countries with high and low capital stock volumes. It can be assumed that the numbers of beds and hospitals are intercorrelated. Additionally, a minimum capacity might be considered when planning new hospitals. Then again population movements can lead to a situation where hospitals (and beds) capacity are available for the population situation of passed times, but infrastructure have not been adapted, e.g. by dismounting or retirement.

It appears from outcome parameters, e.g. life expectancy and death rates, that a capital stock volume of EUR 1,000 might be a minimum for good or at least sufficient health service supply. By visual evaluation life expectancy and death rates are correlated with the existing capital stock volumes below EUR 1,000 per capita, however there might be a mediation effect by lifestyle as well. Whereas after exceeding a threshold of EUR 1,000 per capita, the relationship is less obvious. Variance in the capital stock might depend on different policies.

In a longitudinal, intra-country perspective the recent global financial crisis was highly challenging for most countries in EU28 and globally, such that some countries

experienced a reduction of infrastructure investments, e.g. in the health sector. Some countries responded with a Keynesian financial policy, increasing public investments to stimulate national economy. Beside the fact, that an investment gap can be observed for almost all EU28 countries and therefore also on aggregated level, the capital stocks have been maintained or even improved in most countries. Only in Greece and Cyprus a reduction of capital stock volumes occurred. Investments in Hungary and Italy have been reduced as well, however capital stocks are stable. Given the numbers for existing infrastructure (hospitals, beds and technical resources), the quantity is comparable with the other EU28 countries, while no assertions can be made regarding the quality of existing infrastructure.

The same applies generally to all results in this paper: Even if investments and capital stock volumes appear sufficient from a macro perspective, it might be the case that investments and an increase of capital stock volumes derive from e.g. additional hospital buildings, while existing infrastructure degrade, such that a gap in supplies occur nonetheless. Thus, political choices (pork barrel spending, prestige) and/or business requirements of investors (location factors, return expectations) need to be considered as well.

EU28 future scenarios

In the following we run two future scenarios, based on 2016 capital stock volumes for EU28. The first (ambitious) scenario claims, that investment grow with expected GDP growth rates until 2030 (OECD, 2017), which implies that countries are determined to invest a certain percentage of annual GDP. The second (conservative) scenario intends, that the EU28 capital stock per capita volume of 2016 should be maintained with sufficient future investments. Given the, EU28 capital stock in 2016, increasing investments (with GDP growth rates, which is approx. 2% p.a.) accumulate to an absolute improvement of 28% in 2030. For the maintaining of 2016 capital stock volumes, an immediate reduction of investments by 12,4% could be realized, while the estimated population decline lead to further reduction in the course of time. From a per capita perspective the first scenario implies an increase of 24.2% of the capital stock per capita volumes by 2030, while the second scenario lead to maintained capital stock levels by its assumptions.

Because of future challenges and/or the fulfilment of the SDG, it might be necessary to invest even more than just the given constant proportion of GDP. On the other hand, new technologies, even though they do not come by no cost, could generate alternatives for cost-intensive infrastructure (specially equipped ambulance vehicles vs. hospital buildings in rural areas), such that infrastructure investments in total could be reduced in the long term.

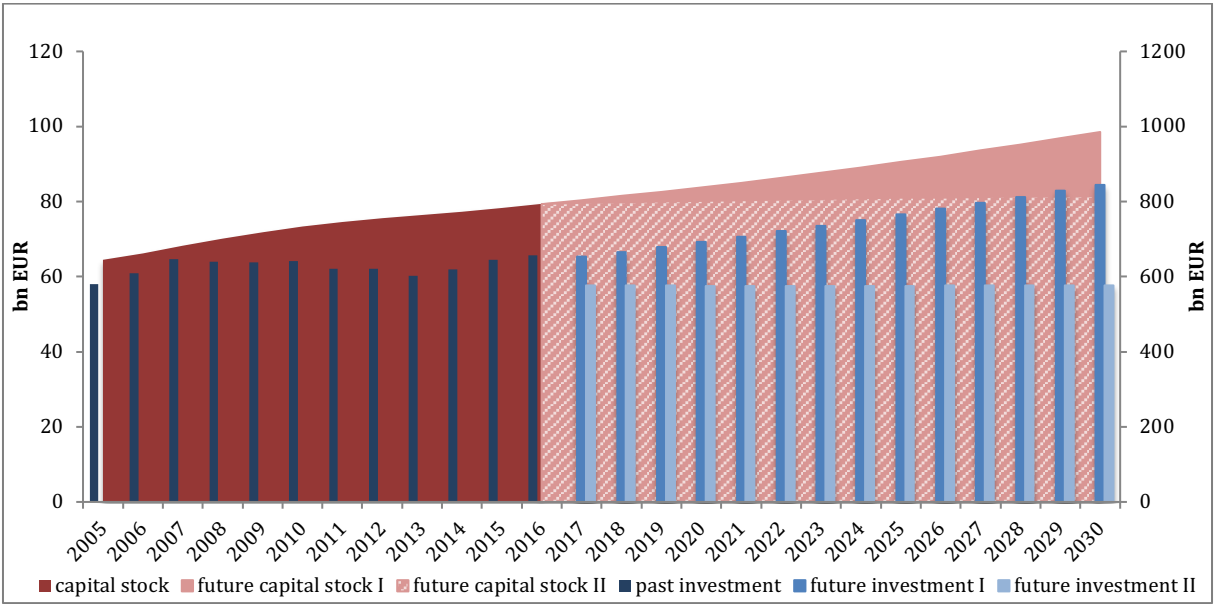


Figure 29: EU28 investment and capital stock (bn €) with future investment scenario I & II. Real volumes EU28 aggregate does not include investment data from Croatia, Latvia, Lithuania, Malta. Average GDP growth rate 2015-2030: 2.23%. Source: Eurostat (nama_10_nfa_fl, demo_pjan, proj_15npms), own calculations.

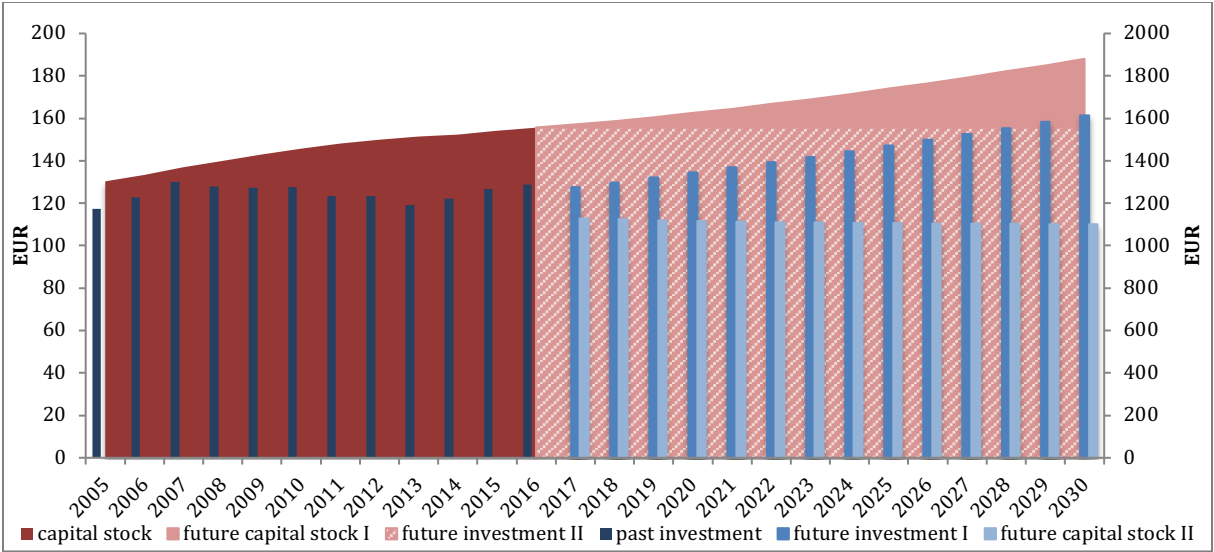


Figure 30: EU28 investment and capital stock per capita (€) with future investment scenario I & II. Real volumes EU28 aggregate does not include investment data from Croatia, Latvia, Lithuania, Malta. Average GDP growth rate 2015-2030: 2.23%. Source: Eurostat (nama_10_nfa_fl, demo_pjan, proj_15npms), own calculations.

As mentioned before, the public capital stock in EU28 is approx. 56% of total capital stock. Since public investments are relatively higher compared to total investments, public capital stock accumulated to additional 28.8% of capital stock volume in 2030, which would imply, that ceteris paribus the share of public capital stock volumes in total capital stocks increase a little. The capital stock per capita volume improves with 25%. For the conservative second scenario, 11.4% less investment would be needed immediately to maintain 2016 capital stock per capita level.

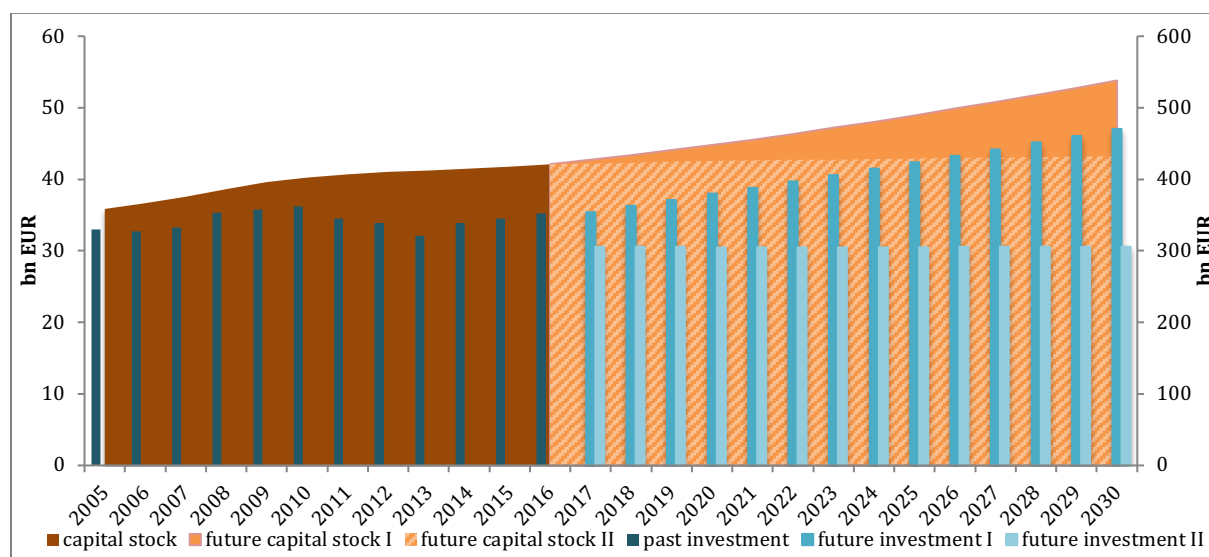


Figure 31: EU28 public investment and public capital stock (bn €) with future investment scenario I & II. Real volumes EU28 aggregate does not include investment data from Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia. Average GDP growth rate 2015-2030: 2.23%. Source: Eurostat (gov_10a_exp, demo_pjan, proj_15npms), own calculations.

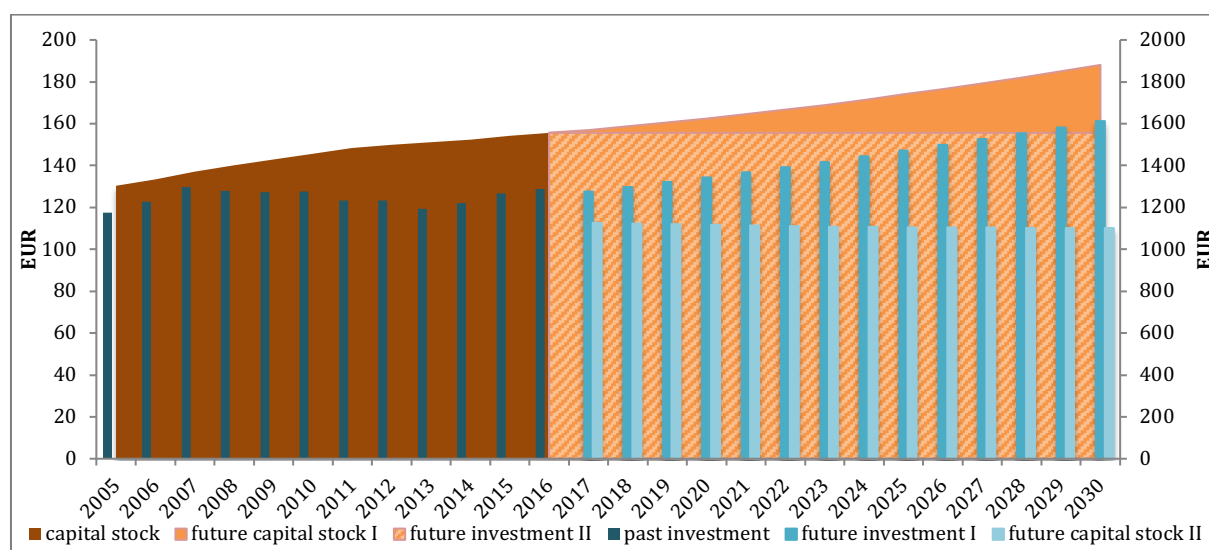


Figure 32: EU28 public investment and public capital stock per capita (€) with future investment scenario I & II. Real volumes EU28 aggregate does not include investment data from Germany, Estonia, Ireland, Spain, Croatia, Cyprus, Latvia, Lithuania, Malta, Poland, Slovenia. Average GDP growth rate 2015-2030: 2.23%. Source: Eurostat (gov_10a_exp, demo_pjan, proj_15npms), own calculations

Discussion and Outlook:

Based on the presented analysis, we can conclude that the proclaimed need for ever increasing investments in infrastructure is partly sound, partly cheap talk. Since health, education and social housing among others are social goods, the actual demand and price cannot be specified the same way as for a normal good. Each state claims its responsibility for the provision of social goods up to a certain amount, because the good should be generally available and a free market supply would not be sufficient or too expensive for the majority of people (cf. Merit goods, Musgrave, 1999). Conversely, since the demand cannot be determined, also the optimal supply is indeterminate. Since social goods and high supply of it are generally considered to be desirable, the call for further investments cannot be contradicted. It would be inopportune for any politics or any other party, dealing with social goods to argue the case for less investment.

The evaluation of past investments and capital stocks, using the perpetual inventory method (OECD, 2009) indicate however, that the investment gap, as it is claimed by e.g. the High level task force (Fransen, del Bufalo & Reviglio, 2017) and which can be indeed identified for the global financial crisis from 2008 onwards, has not lead to a decline of capital stock volumes in EU28. Since some countries have been more affected (program countries) than others, the inter-country perspective lead to differentiated considerations. In general, the situation is not as bad as often proclaimed, at least from a macro perspective.

It is undeniably true and have been reported multiple times, that existing infrastructures decompose, because it has not been sufficiently maintained. At the same time new infrastructure has been build, such that investment and capital stock volumes as an operationalization for existing infrastructure improve favourably on the macro level, even though on the ground poor conditions of infrastructure might be reported by politicians, media and the inhabitants. In the next round, however, beside of the older infrastructure also the new infrastructure is in need of preservation works and corresponding investments.

The analysis also shows, that performance variables are only weakly related to the existing capital stock volumes. That indicates, that 'the more the better' claim does not hold and instead a good or at least sufficient health service can be also provided with lower levels of infrastructure. We identified a capital stock per capita volume of EUR 1,000 as the point, above which life expectancy and (standardised and infant) death rates do not

differ significantly. Also, higher volumes of capital stock do not reduce private out of pocket expenditures for health services, which is somewhat surprising, especially since health services as a social good are already taxed financed to a certain amount.

It can be assumed, that above a certain level of basic endowment further spending are mostly invested for an increase of quality of health services, e.g. advanced technical equipment or specialized care, which formally improve the country's overall health service. Depending on the underlying strategy it might happen in the next round, that by all appearances, the health system performance is high, but the perceived or effective quality, e.g. for standard treatments is low. In this situation, stakeholders, e.g. politicians or institutions would speak up for further investments to remedy the problem with bad health services. This situation would be predestined for a further increase of disparity between talking and action, which is a common behaviour in institutions and politics, since the "hypocrisy" (continual underinvestment) helps to stabilize the institution and justify its existing (Brunsson, 1989).

In summary it is possible to identify countries, regions and segments of service, which are in need for further investments to improve the provision of health services in general, or where less could be invested. A first step could be to increase capital stock volumes up to EUR 1,000 per capita for every European country. At the same time the allocation of investments is crucial as well. It is likely that politicians and other stakeholders would like to allocate investments in prestigious projects, while the general public might be in need for sufficient health services.

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