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How innovation drives health and growth in Europe: Assessing the Return on Investment of innovative medicines

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Foreword

At a time of profound geopolitical, demographic and technological change, the choices Europe makes today will shape its future position in life sciences, access to medicines, competitiveness and economic prosperity for decades to come.

The single, most important question to address is: will Europe continue to view spending on innovative medicines as simply a cost to the system or as an investment in the region's health and economic future?

For Europe, this moment matters. Across the world, countries are implementing ambitious strategies to attract investment in the research, development and manufacturing of innovative medicines. Without the pharmaceutical industry, the EU's overall trade balance would shift from a € 133 bn surplus to a € 93 bn deficit.

This landmark report challenges a persistent misconception in European policy debates: that spending on innovative medicines is primarily a cost to be contained. The evidence points in the opposite direction. Across Europe, the use of innovative medicines has reduced mortality and avoided millions of hospital days for people living with serious and chronic diseases such as cancer, diabetes and Chronic Obstructive Pulmonary Disease. The report also shows that these benefits extend well beyond individual patients and healthcare systems. Better health enables people to remain active and productive participants in the labour force. When more people in working age are healthy, economies grow, which speaks directly to Europe's number one problem today: slow economic growth compared to our global competitors. Investment in innovative medicines delivers returns that extend far beyond the medicines budget itself, generating value through improved health outcomes, reduced pressure on healthcare systems, greater workforce participation and stronger economic productivity.

Yet Europe continues to invest less in innovative medicines than other leading regions. As a result, European patients often wait significantly longer for access to innovative medicines, and many treatments available elsewhere never reach European patients. These delays come at a real cost, not only in terms of patient health outcomes, but also in the form of greater pressure on healthcare systems and missed opportunities for growth and societal resilience.

At a time when Europe is seeking to strengthen its competitiveness and economic security, the findings of this report should prompt a broader reflection on how we value, fund and reward innovation.

If Europe wants to remain a global leader in life sciences, it must create an environment where innovation can thrive and where patients can benefit from scientific breakthroughs without unnecessary delay. The choices made today will determine whether Europe continues to lead in medical innovation or falls further behind in one of the world's most strategically important sectors.

My ambition is that this report contributes constructively to that discussion.

Nathalie Moll

Director General of EFPIA

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List of Abbreviations

ATC	Anatomical Therapeutic Chemical Classification System
EFPIA	European Federation of Pharmaceutical Industries and Associations
EU	European Union
FDA	Food and Drug Administration (United States)
GDP	Gross Domestic Product
GVA	Gross Value Added
HTA	Health Technology Assessment
ICD-10	International Classification of Diseases, 10th Revision
IQVIA	IQVIA (formerly IMS Health and Quintiles)
R&D	Research and Development
ROI	Return on Investment
WHO	World Health Organization
YLL	Years of Life Lost

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Executive Summary

I. Background

While healthcare was once viewed largely as a necessary expense that strained budgets, recent evidence demonstrates a shift in perspective, with healthcare increasingly recognized as a key driver of economic growth and resilience. This shift is supported by strong evidence showing that the health sector contributes significantly to GDP, employment, and long-term economic growth [1].

Economic growth is fundamentally driven by technological progress, which depends on sustained investment in research and development (R&D). Jones [2] presented a model in which long-term growth is driven by the discovery (through research effort) of new ideas throughout the world. His model built upon a large collection of previous research, including Romer [3], Grossman and Helpman [4] , and Aghion and Howitt [5], as well as earlier contributions by Phelps [6] , Shell [7], Nordhaus [8], and Haines [9]. These contributions collectively highlight that innovation is the central engine of sustained economic growth.

Policymakers and economists recognize that better health is a major component of human development, or economic growth, broadly defined. Longevity growth is one of the three components of the Human Development Index (HDI) published by the United Nations Development Programme (2025) [10]. Nordhaus [11] argued that "to a first approximation, the economic value of increases in longevity in the last hundred years is about as large as the value of measured growth in non-health goods and services."

In this context, the pharmaceutical industry plays a central role as one of the most research-intensive sectors of the economy. The development of new therapies is inherently high-risk, complex, costly, and time-consuming, requiring sustained investment in scientific discovery, clinical trials, and regulatory approval processes. As a result, R&D is not a peripheral activity but a core driver of innovation and competitiveness in the industry. This is reflected in the scale of investment: in Europe in 2021, the pharmaceutical industry's ratio of R&D to sales (13.72%) was approximately 3.5 times higher than the average across all industries [12].

The pharmaceutical sector's exceptionally high R&D intensity reflects both the scale of investment required and the inherent risks of medical innovation. As a result, future health gains and associated economic benefits are highly sensitive to the incentives and conditions that support continued R&D.

As emphasized by the Royal Swedish Academy of Sciences, sustained economic growth depends on the continuous replacement of old technologies with new ones. When it awarded the 2025 Nobel Prize in Economic Sciences to three economists, the Royal Swedish Academy of Sciences [13] declared that "sustained economic growth occurs when new technologies replace old ones as part of the process known as creative destruction."

This study examines how pharmaceutical innovation contributes to this process in practice by quantifying its impact on health outcomes and economic performance across Europe. Taken together, these factors position pharmaceutical innovation not only as a health intervention, but as a strategic investment in economic performance and long-term growth.

II. Objectives and methods

This study examines the impact of pharmaceutical innovation on mortality and hospital utilization across 29 European countries over the period 2014–2022. Pharmaceutical innovation is measured by the pace at which newer therapies are actually adopted in clinical practice, specifically, whether patients are increasingly being treated with more recently developed drugs across the three main drug classes relevant to the corresponding diseases. Changes in mortality and hospital utilization are subsequently translated into economic value and compared with the associated pharmaceutical expenditure to estimate a return-on-investment measure.

III. Key Findings

Pharmaceutical innovation significantly reduces mortality and hospital burden across Europe. The use of more recently approved medicines between 2014 and 2022 is associated with a reduction of approximately 1.83 million years of life lost before age 85, and 20.9 million hospital days across 29 European countries. Long-term effects are substantially larger than short-term impacts, indicating that short-term perspectives underestimate the full value of innovation.

Health gains from pharmaceutical innovation generate substantial social and economic value. Reduced mortality and hospitalization lead to fewer productivity losses from the years of life lost avoided. In total, pharmaceutical innovation generated **€ 66.18 billion** in socioeconomic benefit across the 29 European countries, including **€ 38.10 billion** in paid work productivity, **€ 18.96 billion** in unpaid work productivity, and **€ 9.11 billion** in direct hospitalization cost savings.

Every euro invested in innovative medicines generates, on average, € 5.67 in socioeconomic benefit. An additional **€ 11.67 billion** in pharmaceutical expenditure associated with the use of more innovative medicines generated approximately **€ 66.18 billion** in measurable socioeconomic benefit, corresponding to an average return on investment (ROI) of **5.67 times**. Hospitalization costs savings alone offset approximately 80 cents per euro invested.

Policy implications are immediate: improving access to innovative medicines is critical to reducing avoidable health and economic losses. Countries with slower growing drug vintage carry disproportionately large economic costs. Policies on access, reimbursement, and R&D incentives should reflect this complete picture.

IV. Conclusions & Policy recommendations

▶ This study provides robust evidence that investment in pharmaceutical innovation, and the timely availability of innovative medicines to patients across Europe, generates substantial economic and social benefits. The estimated returns on investment are consistently high, reinforcing that spending on medical innovation is not only a health imperative but also a highly efficient use of public resources.

▶ These estimates should be read as conservative. Several methodological features systematically pull the ROI figures downward. Medicine costs are based on gross list prices, not the net prices actually paid after rebates and discounts. The analysis captures only the economic cost of premature mortality, leaving aside productivity losses from morbidity such as absenteeism and reduced working capacity due to chronic illness. Finally, due to limitations in pharmaceutical sales data, disease-specific measures of innovation are subject to some measurement error, as a significant share of relevant drugs fall outside the standard ATC classification groups used in the analysis. A fuller accounting of all these dimensions would yield materially higher returns.

▶ The findings also underscore that pharmaceutical innovation contributes meaningfully to broader economic growth through improvements in population health, increased labour productivity, and reduced pressure on healthcare systems. Declines in hospital utilisation, in particular, can help ease capacity constraints that affect the quality and timeliness of care across the system.

▶ Yet the current geopolitical and policy environment risks undermining Europe's attractiveness as a destination for life sciences investment. A less favourable innovation ecosystem translates, in practice, into delayed or reduced patient access to new therapies with direct consequences for health outcomes and for the economic performance that this report documents.

▶ There is therefore an urgent case for coordinated policy action at the member state and European level. Strengthening the conditions for innovation, ensuring timely and equitable access to new medicines, and preserving Europe's competitiveness in the global life sciences sector must be treated as interconnected priorities, not separate agendas. Inaction has a price: avoidable health losses, lower productivity, and slower economic growth, all of which pharmaceutical innovation could help prevent.

1

1 Introduction

1.1 Background

Healthcare in Europe faces a dual challenge. On one hand, governments face ageing populations, rising chronic disease burdens, and health systems are under sustained fiscal pressure. On the other hand, Europe's share of total R&D investment of pharmaceutical innovation has been declining steadily over the past two decades. EFPIA reports that Europe's share of global pharmaceutical R&D investment across the US, Europe, China, and Japan fell from 41 % in 2001 to 31 % by the mid-2020s, while the absolute R&D spending gap between the US and Europe increased from € 2 billion to € 25 billion over the same period [14]. The rate at which patients in many European member states gain access to newly approved innovative medicines also lags considerably. The EFPIA W.A.I.T. Indicator 2024 estimates the median time from market authorization to medicine availability to patients in the EU to be 532 days, ranging from 56 days in Germany to 1201 days in Romania [15]. When patients wait longer for newer treatments, or when reimbursements are limited to decrease expenditure, these costs reappear elsewhere through avoidable hospitalizations, lost productivity, and premature death.

These dynamics are not independent. The share in global pharmaceutical R&D investment, the pace at which European patients gain access to new medicines, the breadth of that access across member states, and the ecosystem of incentives that sustains pharmaceutical R&D in Europe are all interconnected elements of the same underlying question: what is the economic and social value of pharmaceutical innovation, and how should European policy reflect that value?

This study was commissioned by EFPIA and conducted by WifOR Institute to answer that question. It brings together the findings of three analytical modules that trace the value chain of pharmaceutical innovation from its most proximate health effects through to its ultimate economic returns across three major disease areas for 29 European countries, over the period 2014 to 2022.

This broader perspective is important because the value of better health extends beyond the healthcare sector alone. Nordhaus [11] argued that "to a first approximation, the economic value of increases in longevity in the last hundred years is about as large as the value of measured growth in non-health goods and services."

1.2 Study concept and objectives

This study aims to assess the health and socioeconomic benefits of innovative medicines. It does so by examining how the uptake of newer medicines across three major disease areas in 29 European countries is associated with changes in mortality and hospital utilization, and by monetizing the resulting health gains in socioeconomic terms. The final step is to compare these benefits with the pharmaceutical expenditures associated with these innovations.

The analytical framework of this study relies on a well-established concept in health economics: drug vintage. A drug's vintage is defined as the year in which the drug received its approval from the US Food and Drug Administration (FDA). Consequently, greater utilization of more recently approved drugs corresponds to a higher average drug vintage. As new products often must demonstrate added value to achieve reimbursement and uptake, higher vintage drugs are, on average, more therapeutically effective than older ones. Studies by Lichtenberg [16], [17], [18], [19], [20], [21] consistently find that higher utilization-weighted mean vintage of drugs in a country or disease area predicts lower mortality, fewer hospitalizations, and reduced morbidity.

The measure of pharmaceutical innovation used throughout is the utilization-weighted mean vintage of drugs used to treat a disease sold in a country. This measure is calculated as units sold multiplied by FDA approval year, summed across all substances and divided by units sold. A rise in this measure underscores a shift in prescribing more recently approved medicines in practice.

The study proceeds in three modules *Figure 1*:

- **Module 1** assesses the impact of drug vintage on health outcomes and hospitalizations using a three-way fixed-effects regression model with lags of zero to eight years tested to capture the delayed nature of therapeutic benefits. The model controls for all country-specific and disease-specific confounding factors.

- **Module 2** translates these health benefits into monetary terms using WifOR's Health Footprint methodology. It monetizes the health gains into three distinct categories: paid productivity, unpaid productivity, and hospitalization cost savings.

- **Module 3** calculates the return on investment. It evaluates ROI by comparing socioeconomic benefits, calculated in Module 2, to the incremental pharmaceutical expenditure attributable to the rise in drug vintage.

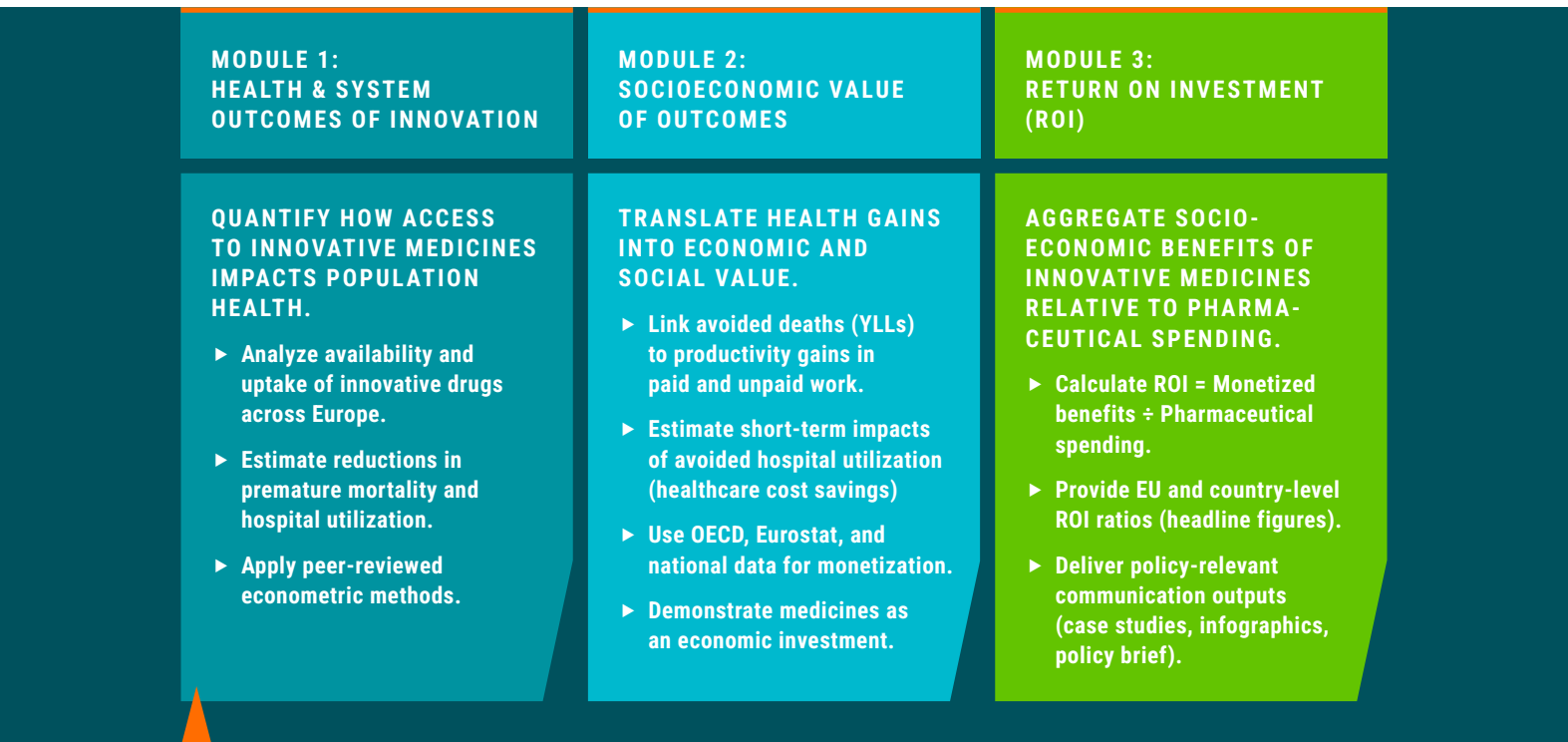


Figure 1: Analytical framework linking pharmaceutical innovation to health and socioeconomic value in Europe.
The figure illustrates the three-module analytical framework used in this study.


2

2 Methodology

2.1 Module 1: Health & System Outcomes of Innovation

Module 1 investigates the effect of pharmaceutical innovation on mortality and hospital utilization across 29 European countries over the period 2014–2022. It provides the empirical foundation for the entire analysis: the causal relationship between pharmaceutical innovation and health outcomes including reduced mortality and hospital utilization. This relationship has also been investigated in prior literature, such as Lichtenberg [16], [17], [18], [19], [20], [21].

The analysis in Module 1 is based on a 3-way fixed effects regression model, estimated separately for each health outcome. This approach controls for all determinants of mortality and hospital utilization that are invariant across diseases within a country (e.g., mean income, education, and quality of medical care) during a year, and for all determinants that are invariant across countries for a given disease during a year.

2.1.1 ECONOMETRIC MODEL OF MORTALITY AND HOSPITAL UTILIZATION

The estimates of the effect of (current or lagged) attributes of drugs sold on mortality and hospital utilization were based on the following model:[1]

- $$\ln(\text{outcome}_{dct}) = \beta_k \, \text{vint\_drug}_{dct-k} + \alpha_{dt} + \sigma_{ct} + \varepsilon_{dct} \quad (1)$$

The dependent variable is the natural logarithm of one of the eight health outcomes; years of life lost before ages 85, 75, and 65 (yll85, yll75, yll65); the equivalent productive life-years measures that exclude deaths before age 20 (prod75, prod65); and three hospital utilization measures (discharges, average length of stay, and total hospital days). The subscripts d, c, and t index disease group, country, and year.

The key explanatory variable is the utilization-weighted mean vintage of chemical substances sold to treat disease d in country c in year t−k. $\text{vint\_drug}_{dc,t-k}$ is the only disease-specific, time-varying regressor in Eq. (1). Drug vintage is constructed as a weighted average of the FDA approval years of all substances within the relevant ATC group, with weights proportional to the number of standard units sold. A higher value of this variable reflects a shift toward more recently approved chemical entities.

The fixed effects α_{dt} captures all factors that affect a disease outcome in a given year uniformly across countries (i.e. a fixed effect for disease d in year t) and σ_{ct} captures all country-specific factors that affect all diseases in a given year (i.e. a fixed effect for country c in year t), whereas ε_{dct} captures any disturbances, which were clustered within each country and year. The model is estimated by weighted least squares.

1 Eq. (1) may be considered a "health production function." It is standard for the dependent variable of a health production function to be the logarithm of a health outcome, to incorporate the assumption of diminishing marginal productivity of inputs. See Baltagi, Moscone, and Tosetti (2012) [22].

Figure 2: Geographic scope of the analysis in Europe.* Countries included in scope: Austria, Belgium, Bulgaria, Croatia, Czechia, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Türkiye, United Kingdom.

2.1.2 STUDY SCOPE AND DATA SOURCES

The study covers 29 European countries over the period 2014–2022 for mortality outcomes and 2014–2021 for hospital utilization outcomes. Scope includes these 29 European countries, illustrated in *Figure 2*.

Pharmaceutical annual sales data on the quantity of and expenditure on each (ATC 5th-level) chemical substance within three (ATC 1st-level) anatomical or pharmacological groups sold in each country during 2014–2024 is included in the scope of this study and were obtained from IQVIA. Module 1 of this study analyzes the correlation between pharmaceutical innovation data within each ATC 1st-level group and its corresponding ICD-10 disease group mortality and hospital utilization data. The three ATC 1st-level groups and corresponding ICD-10 disease groups are illustrated in *Table 1*.

Corresponding to the ICD-10 disease areas, data on mortality ($yll85_{dct}$, $yll75_{dct}$, $prod75_{dct}$, $yll65_{dct}$, $prod65_{dct}$), by disease, country, and year (2014–2022) along with their causes and data on hospital utilization ($discharges_{dct}$, $alos_{dct}$, $days_{dct}$), by disease, country, and year (2014–2021) and data on hospital expenditure in 2014, by country were obtained from Eurostat [23], [24], [25], [26].

Data on year_FDAs (the FDA approval year of chemical substance s) were obtained from the Approval and Struct2atc tables of the DrugCentral Database [27].

* Denmark was not included in the scope of this analysis, as the corresponding data was not available in the IQVIA dataset.

ATC 1ST-LEVEL GROUP	ICD-10 DISEASE(S)
A (Alimentary tract and metabolism)	Endocrine, nutritional and metabolic diseases (E00-E90) and diseases of the digestive system (K00-K93)
L (Antineoplastic and immunomodulating agents)	Malignant neoplasms (C00-C97)
R (Respiratory system)	Diseases of the respiratory system (J00-J99)

Table 1: ATC therapeutic groups and corresponding ICD-10 disease classifications

2.1.3 LIMITATIONS

Missing data availability is the most important limitation. 52 % of drugs indicated for malignant neoplasms, 62 % for endocrine, nutritional and metabolic diseases and 72 % for diseases of the digestive system are not represented in ATC groups A, L, and R respectively. This missing proportion of mapping makes our estimates of the impact of pharmaceutical innovation on mortality and hospital utilization conservative, i.e., biasing downwards. Similarly, mortality data for all 29 countries were available for 2014–2018; United Kingdom mortality data were not available after 2018. The hospital expenditure inputs from Eurostat for the following countries were missing: Ireland, Italy, Sweden, Türkiye, and United Kingdom. WHO-CHOICE was sourced for these missing inputs on cost per inpatient bed day [28].

2.2 Module 2: Socioeconomic Value of Outcomes

Module 2 builds directly on the health outcomes estimated in Module 1. In this module, the health gains attributed to pharmaceutical innovation are translated into economic value, with minor adjustments to ensure consistency with the requirements of Modules 2 and 3.

Whereas Module 1 relies on the average increase in drug vintage to estimate the overall impact across all countries, Modules 2 and 3 require country-specific estimates. Accordingly, the analysis in these modules is based on per-country increases in drug vintage *(Table 13)*, rather than the aggregate weighted mean used in Module 1.

The approach adopted in this module is well-established and used in prior WifOR socioeconomic benefit studies [29], [30], [31], [32] and translates health gains into socioeconomic value to showcase productivity gains in both paid and unpaid work. The methodological choices and steps are explained below.

The entire analysis was conducted in U.S. dollars and subsequently converted to euros using the 2014 exchange rate published by the European Central Bank.

2.2.1 WIFOR'S HEALTH FOOTPRINT FRAMEWORK

WifOR's Health Footprint methodology in this study, classifies economic value of health gains into three distinct but related categories: the value of paid productivity that is recovered or preserved because of health improvements, the value of unpaid productivity (including informal care, household chores, and social participation), and the value of avoided hospitalization costs.

Figure 3 shows the effects of having a healthier population on the overall economy based on the input-output (IO) model perspective [33], [34].

The paid productivity component applies a human capital approach [35] and aims to capture the effects of not only the direct Gross Value Added (GVA) contribution of an individual in employment, but also the indirect economic activity through supply chains and induced consumption through direct and indirect generated GVA. The paid productivity component is calculated by multiplying the life-years gained or in other words, years of life lost (YLLs) avoided by country-specific annual gross value added. As paid productivity is linked directly to employment status, the cut-off values of productive age are set at 65 and 75 years for paid and unpaid work, respectively.

The unpaid productivity component includes the value added by healthy individuals beyond the GDP and relies on national time-use surveys to estimate the time spent doing unpaid activities such as household activities, social participation, voluntary work and informal care. This component matters particularly in the context of this analysis because a significant share of the life-years saved are attributable to diseases with high prevalence among older adults.

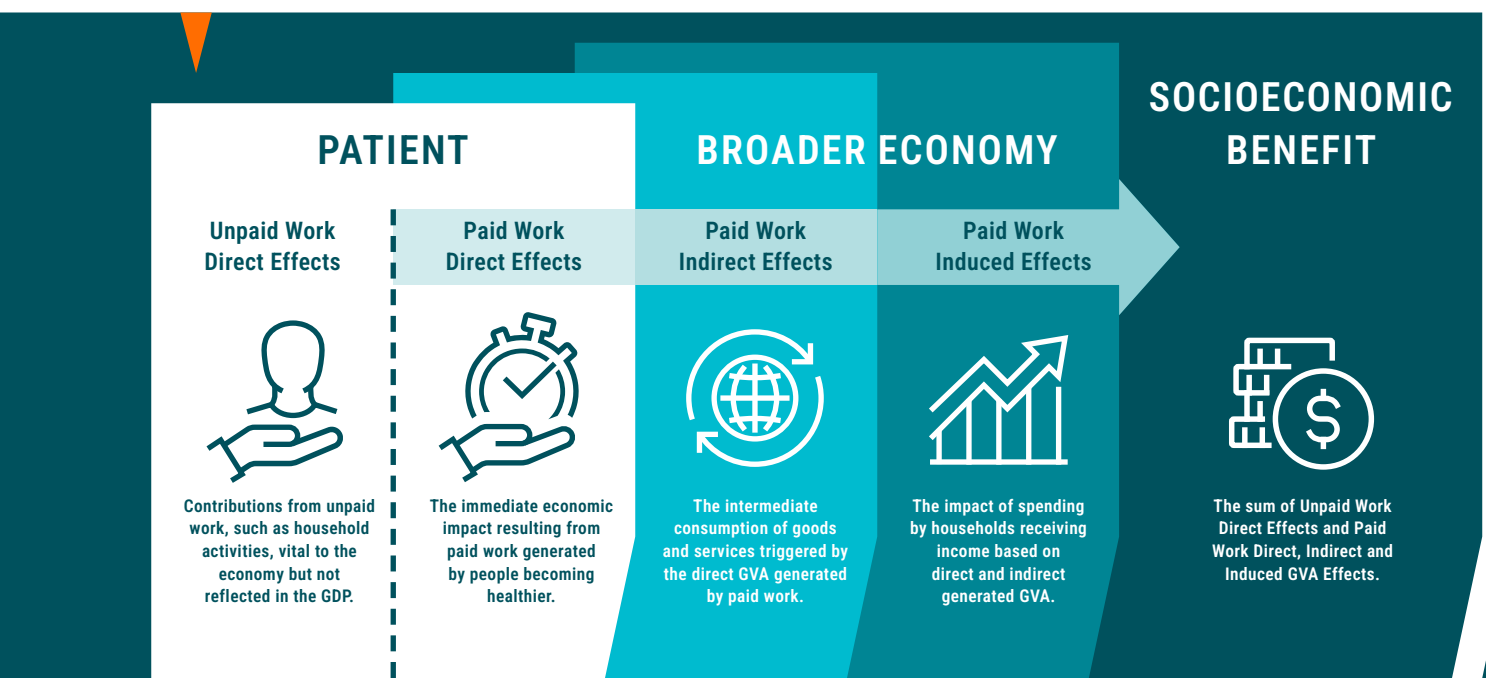
The hospitalization savings component is the most straightforward: it multiplies the reduction in hospital days estimated in Module 1 by a country-specific cost per hospital day, derived from Eurostat data on inpatient curative care expenditure and bed-day utilization.

A detailed explanation of the methodology used to estimate the gains in productivity in paid and unpaid work is available in the appendix 5.1.

2.2.2 DATA SOURCES

The databases used and the variables extracted from these sources to calculate the productivity component are presented in *Table 14*. Likewise, the databases and variables applied for the hospitalization component are summarized in *Table 15*.

Figure 3: Conceptual framework of the socioeconomic benefit pathway, illustrating how patient-level health improvements translate into broader economic effects through unpaid work direct effects, paid work direct effects, paid work indirect effects, and paid work induced effects, which together with constitute the overall socioeconomic benefit from gained productivity.



2.3 Module 3: Return on Investment (ROI)

Modules 1 and 2 examined whether pharmaceutical innovation reduces mortality and hospital utilization, and estimated the socioeconomic value of the associated health gains across the 29 European countries included in the study. Building on these findings, Module 3 addresses the following question: do the benefits of pharmaceutical innovation justify its costs? To this end, Module 3 compares the estimated benefits with the incremental costs arising from the adoption of newer, and typically more expensive, medicines.

2.3.1 DEFINING THE INVESTMENT BASE

There should be clear distinction of what is to be considered as the investment base i.e., the cost of pharmaceutical innovation. Not all pharmaceutical expenditure reflects innovation. A large portion of pharmaceutical expenditure is attributable to the use of older medicines that have been in use for decades. It is only the portion of expenditure attributable to the shift toward newer chemical entities; the vintage premium, that constitutes the cost of pharmaceutical innovation. The incremental cost is estimated using the econometric framework introduced in Module 1 (Eq 1), applied here with pharmaceutical expenditure as the dependent variable. The ROI can be defined as follows:

$$\blacktriangleright \quad \mathbf{ROI_{dc}} = \frac{\mathbf{Benefit_{dc}}}{\mathbf{ln\,(rx\_expend_{dc})}} \qquad (2)$$

Where:

ROI_{dc}	return on investment for disease d in country c
$Benefit_{dc}$	total estimated benefits
$ln(rx\_expend_{dc})$	estimated incremental pharmaceutical expenditure
d	disease
c	country

2.3.2 DIFFERENT ROI WITH DIFFERENT BENEFIT ASPECTS CONSIDERED

The total benefits associated with increased use of newer therapies comprise three components: productivity gains from paid work, productivity gains from unpaid work, and cost savings resulting from reduced hospitalizations. Based on these components, different ROI measures can be calculated. For example, a productivity-only ROI includes only paid and unpaid productivity gains on the benefit side and excludes savings from reduced hospitalizations. The benefit component can therefore be expressed as:

- $\mathbf{Benefit_{dc} = Prod_{dc}^{paid} + Prod_{dc}^{unpaid} + HospSave_{dc}}$ (3)

Where:

$Benefit_{dc}$	total monetized social benefit for disease d in country c
$Prod_{dc}^{paid}$	monetized gains from paid work productivity
$Prod_{dc}^{unpaid}$	monetized gains from unpaid work productivity
$HospSave_{dc}$	hospitalization cost savings

Depending on the scope of the analysis, the benefit term may include all three components (total ROI) or only one or two (e.g., hospitalization-only ROI). In this study, the total ROI uses the sum of all three. The hospitalization ROI uses “HospSavedc” alone as the numerator, holding the investment denominator constant.


3

3 Results

3.1 Module 1: Health & System Outcomes of Innovation

Module 1 used a 3-way (disease by country and year) fixed effects model to quantify how access to innovative medicines impacts population health in 29 European countries.

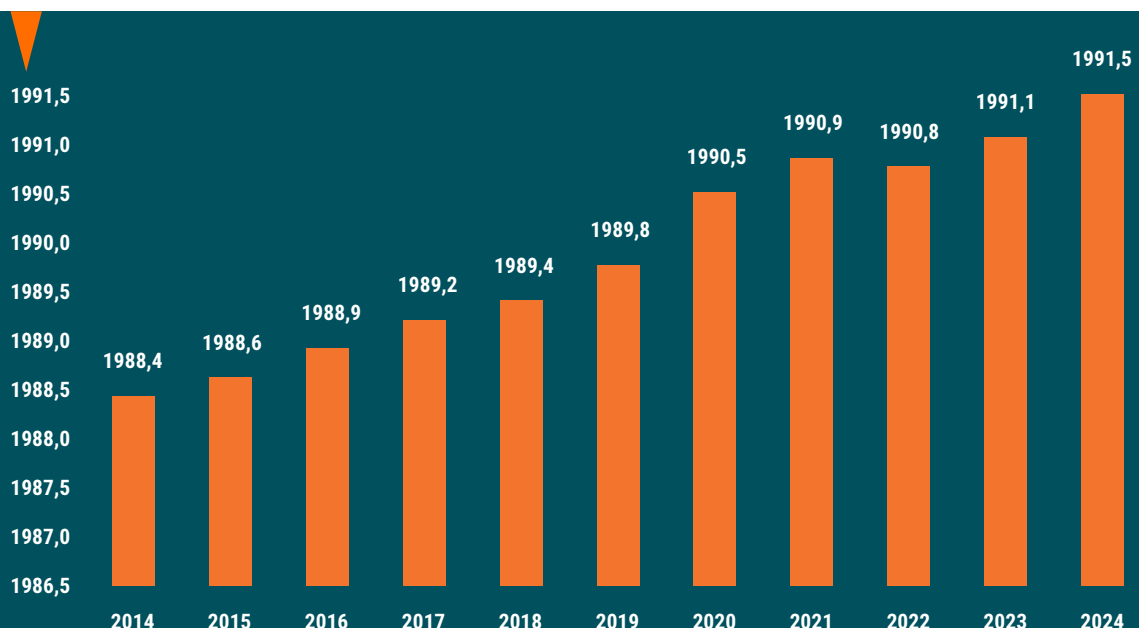
- $\ln(outcome_{dct}) = \beta_k \, vint\_drug_{dct-k} + \alpha_{dt} + \sigma_{ct} + \varepsilon_{dct}$ (1)

The Econometric model as illustrated in Eq. 1 allows for different estimates of β_k, ranging from β_0 to β_8 to represent the lag length, ranging from contemporaneous effects on outcomes to effects after a lag of 8 years.

3.1.1 DRUG VINTAGE TRENDS

According to eq. 1, drug vintage is the only medicine and disease-specific, time-varying regressor. A change in weighted mean vintage directly affects the outcome variable across drugs by disease, country, and year. *Figure 4* shows the trend of weighted mean vintage of drugs in ATC groups A, L, and R sold across the 29 study countries from 2014 to 2024.

Figure 4: Weighted mean vintage of chemical substances in ATC groups A, L, and R sold in 29 countries, 2014–2024



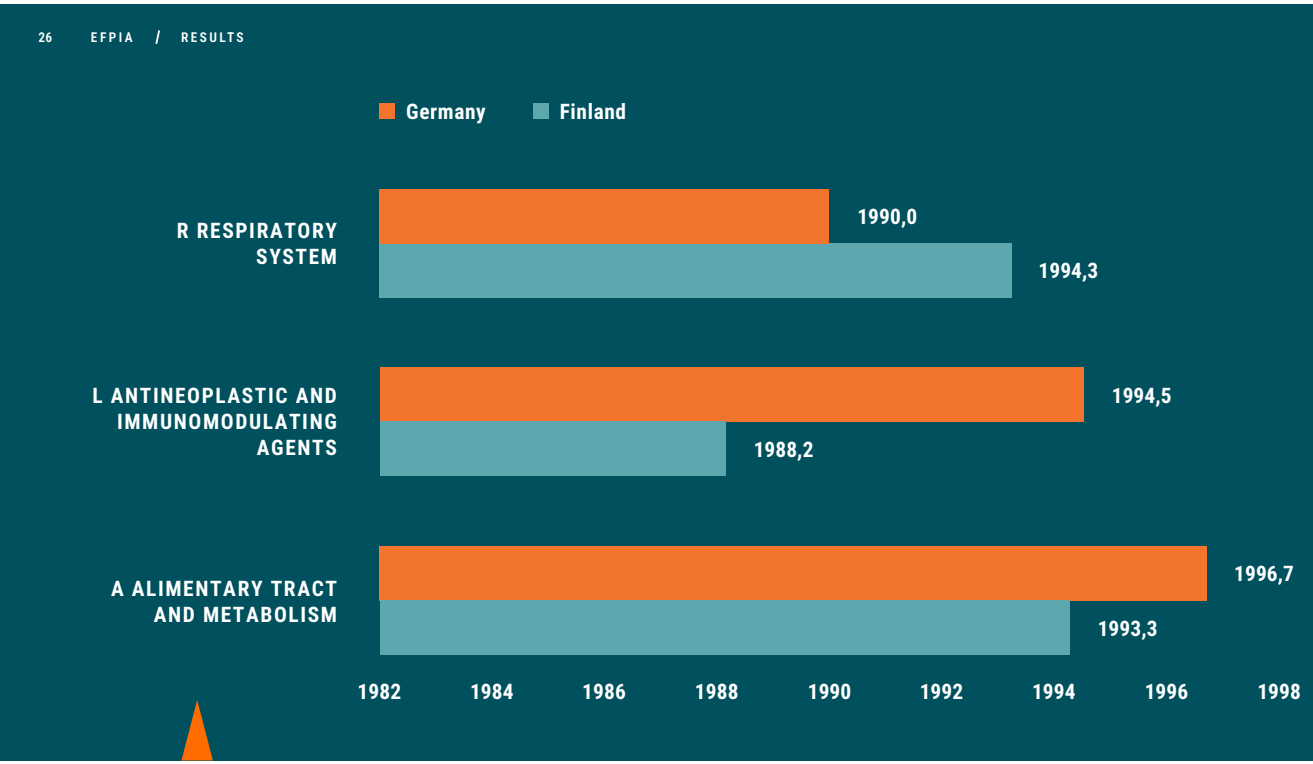


Figure 5: **Mean vintage of drugs in three (ATC 1st-level) anatomical or pharmacological groups sold in Germany and Finland in 2024**

From 2014–2024, the utilization-weighted mean vintage of chemical substances in ATC groups A, L, and R sold in 29 countries increased by 3.1 years, from 1988.4 to 1991.5.

The vintage growth was not uniform across countries or therapeutic groups. *Table 17* shows the weighted mean vintage of chemical substances in ATC groups A, L, and R sold in 2024, by country. *Table 18* instead presents the unweighted mean vintage across countries in 2024.

Variation in drug vintage reflects differences in the speed at which newly approved medicines penetrate different national markets. As shown in *Table 17*, the mean vintage of drugs sold in Finland and Germany were identical: 1993.6. However, as shown in *Figure 5*, the mean vintage of respiratory system drugs was 4.3 years lower in Germany, and the mean vintage of antineoplastic and immunomodulating agents was 6.3 years higher in Germany. This underscores the variation in between-group differences in ATC groups A, L, and R as well and one might expect the ratio of respiratory disease mortality to cancer mortality to be lower in Finland than in Germany.

3.1.2 SUMMARY STATISTICS

To estimate the value of β_k from (*Eq. 1)*, the annual pharmaceutical sales data from IQVIA dataset for years 2014–2024 is first matched to their corresponding drug vintage, and the mortality and hospitalization data from Eurostat 2026. This data serves as the outcome variables in *(Eq. 1)*. Full summary statistics for the matched pharmaceutical, mortality, and hospital utilization data are reported in *Table 8*. The key features of the dataset are summarized here.

The IQVIA dataset covers all 29 countries across the full 2014–2024 period. From 2014 to 2024, the number of standard units sold increased by 24 %, from 125 billion to 154 billion, while total sales expenditure more than doubled from € 61 billion to € 128 billion. The vintage (year of FDA approval) of substances accounting for about 89 % of expenditure could be determined.

Mortality data (yll85, yll75, prod75, yll65, prod65) are available for all 29 countries from 2014 to 2018. After 2018, United Kingdom data are unavailable, reducing coverage to 28 countries for 2019–2022. Hospital utilization data (total days and discharges) are available for all 29 countries only in 2014; coverage varies by year thereafter, as detailed in T*able 8*.

Before detailing the estimates by outcome, the key headline results are presented below as an overview. The sub-sections that follow explain each finding in full.

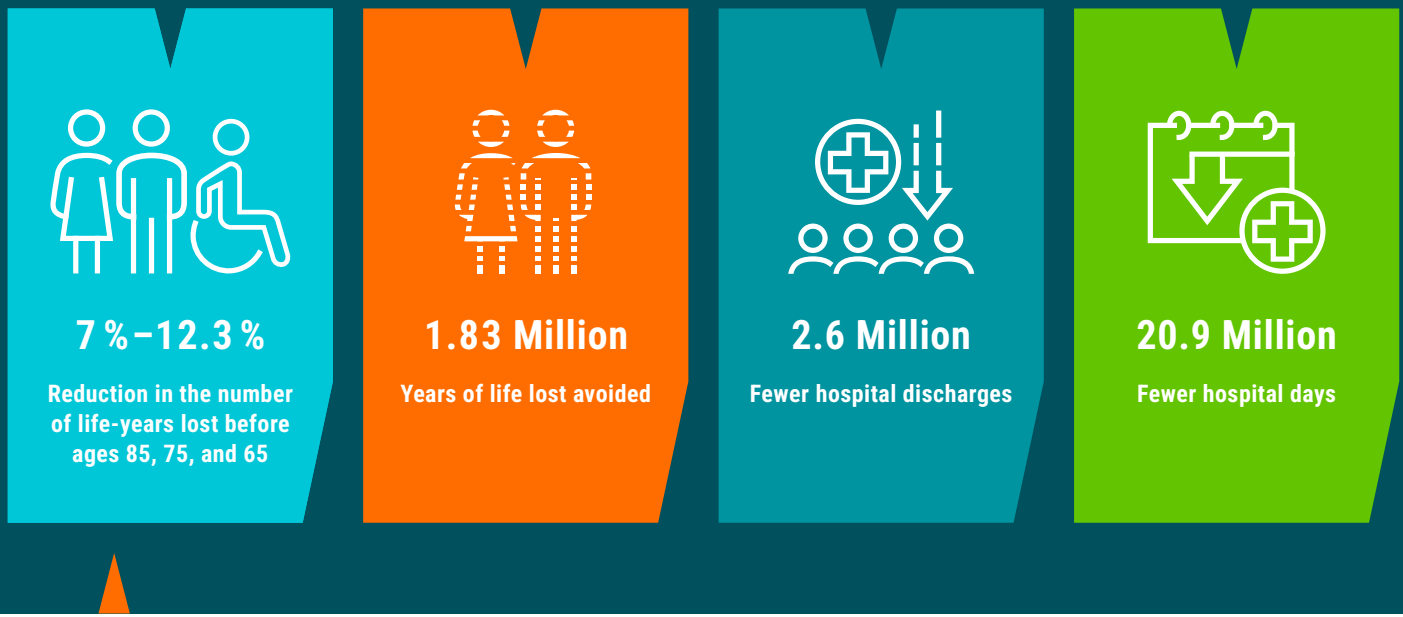


Figure 6: **Summary of estimated health and utilization impacts associated with a 3.1-year increase in drug vintage (2014–2024), showing reductions in life-years lost before ages 85, 75, and 65, as well as decreases in hospital discharges and total hospital days.**

3.1.3 MODULE 1 AT A GLANCE: IMPACT OF THE 2014–2024 VINTAGE INCREASE

From 2014 to 2024, the utilization-weighted mean vintage of medicines sold across the 29 countries increased by an average of 3.1 years. *Figure 6* and *Table 2* show what that shift implies for health outcomes, over a seven-year horizon (lagged estimates, β_7).

The seven-year lagged estimates imply substantially larger impacts compared to contemporaneous estimates: 1.83 million fewer life-years lost before age 85, 1.20 million fewer life-years lost before age 75, and 20.9 million fewer hospital days.

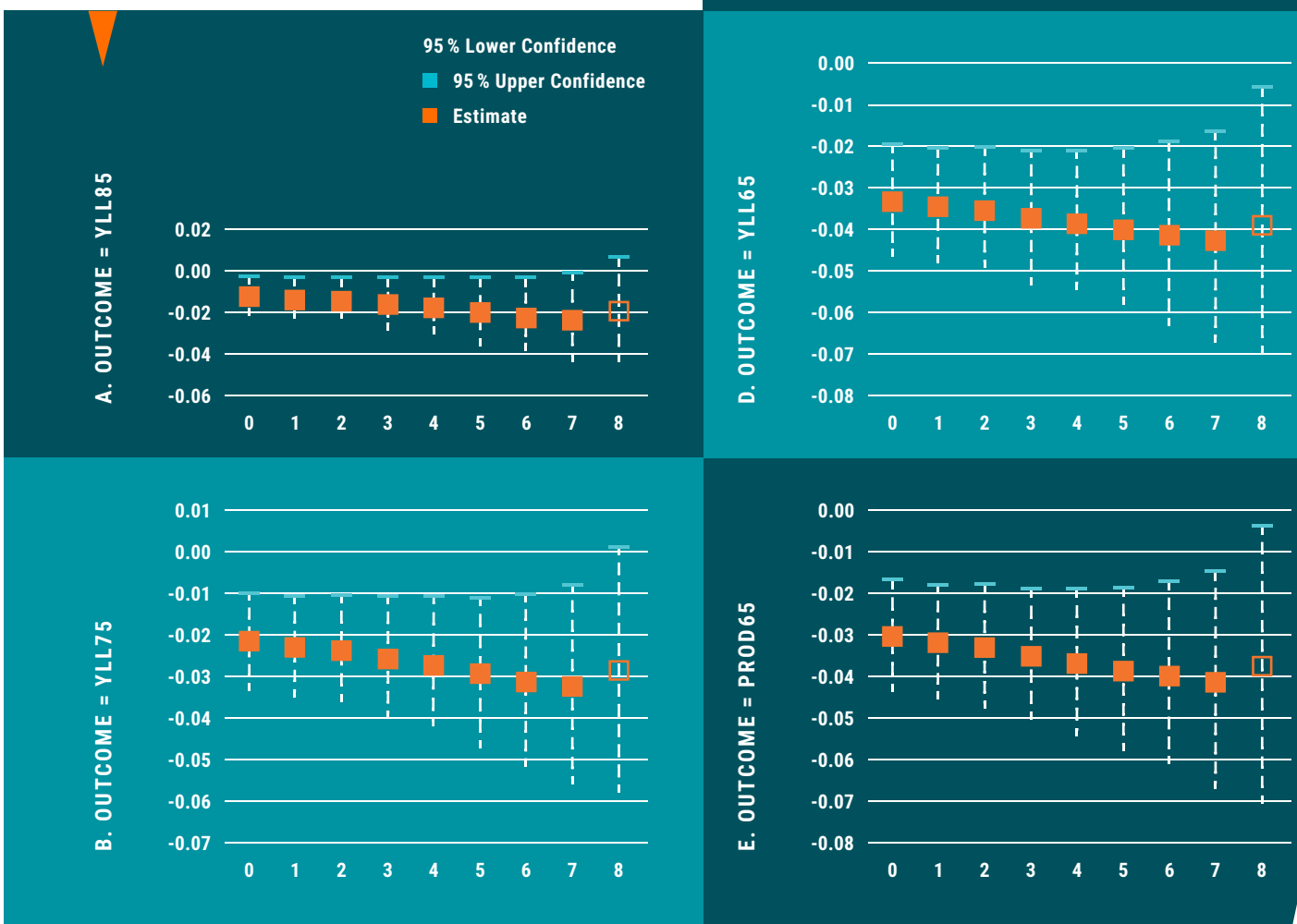
On the expenditure side, the same framework estimates that the 3.1-year vintage increase added approximately € 11.86 billion to pharmaceutical spending between 2014 and 2024.

The sub-sections below detail the underlying regression estimates for mortality and hospital utilization outcomes that produce these aggregate figures.

3.1.4 MORTALITY OUTCOMES

Table 9 and *Figure 7* present the full set of estimates of β_k from Equation 1 across five mortality outcomes and eight lag lengths ranging from contemporaneous effects on outcomes to effects after a lag of 8 years.

Figure 7: Estimates of $ß_k$ from $\ln(outcome_{dct}) = ß_k vint\_drug_{dct-k} + \alpha_{dt} + \sigma_{ct} + \varepsilon_{dct}$: mortality outcomes.



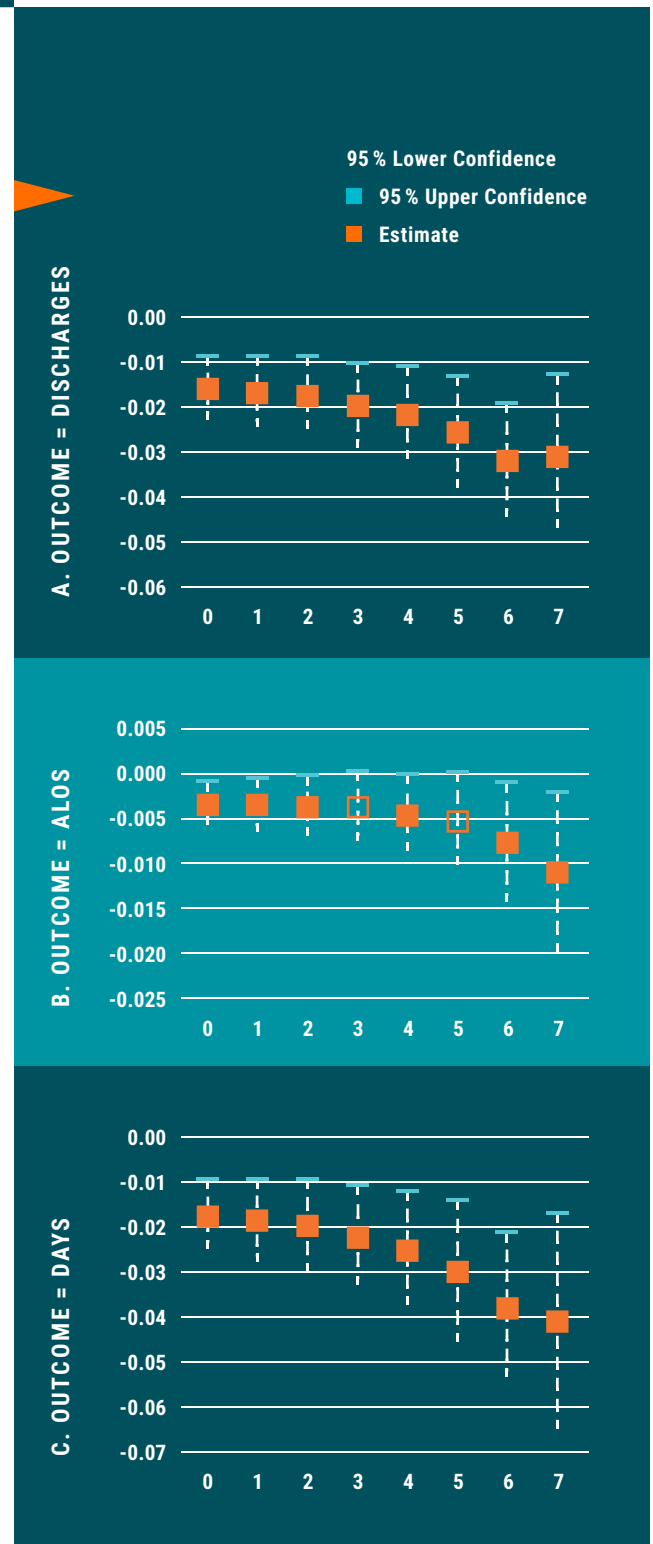


Figure 8: Estimates of $ß_k$ from $\ln(outcome_{dct}) = ß_k vint\_drug_{dct-k} + \alpha_{dt} + \sigma_{ct} + \varepsilon_{dct}$: hospital outcomes.

Across all five mortality measures, the estimates of β_k are negative and statistically significant for lags of zero through seven years. The magnitude of the effect increases steadily with lag length, consistent with the clinical observation that therapeutic improvements often require several years to manifest as measurable reductions in population mortality.

3.1.5 HOSPITAL UTILIZATION OUTCOMES

The results for hospital utilization mirror the mortality outcomes in direction and trend. *Table 10* and *Figure 8* illustrate the estimates of β_k across three hospital utilization outcomes and eight lag lengths ranging from contemporaneous effects on outcomes to effects after a lag of 8 years.

For total hospital discharges, the contemporaneous estimate of -0.0158 implies a 1.6 % reduction per year of vintage increase, growing to -0.0317 (3.2 % reduction) at lag seven. For total hospital days, the product of discharges and average length of stay, the contemporaneous estimate of -0.0179 grows to -0.0411 at lag seven, implying a 4.1 % reduction in hospital days per year of vintage increase over a seven-year horizon.

Key findings from mortality and hospital utilization outcomes (both contemporaneous effects and effects after 7 years of lag) are represented in *Figure 9*.

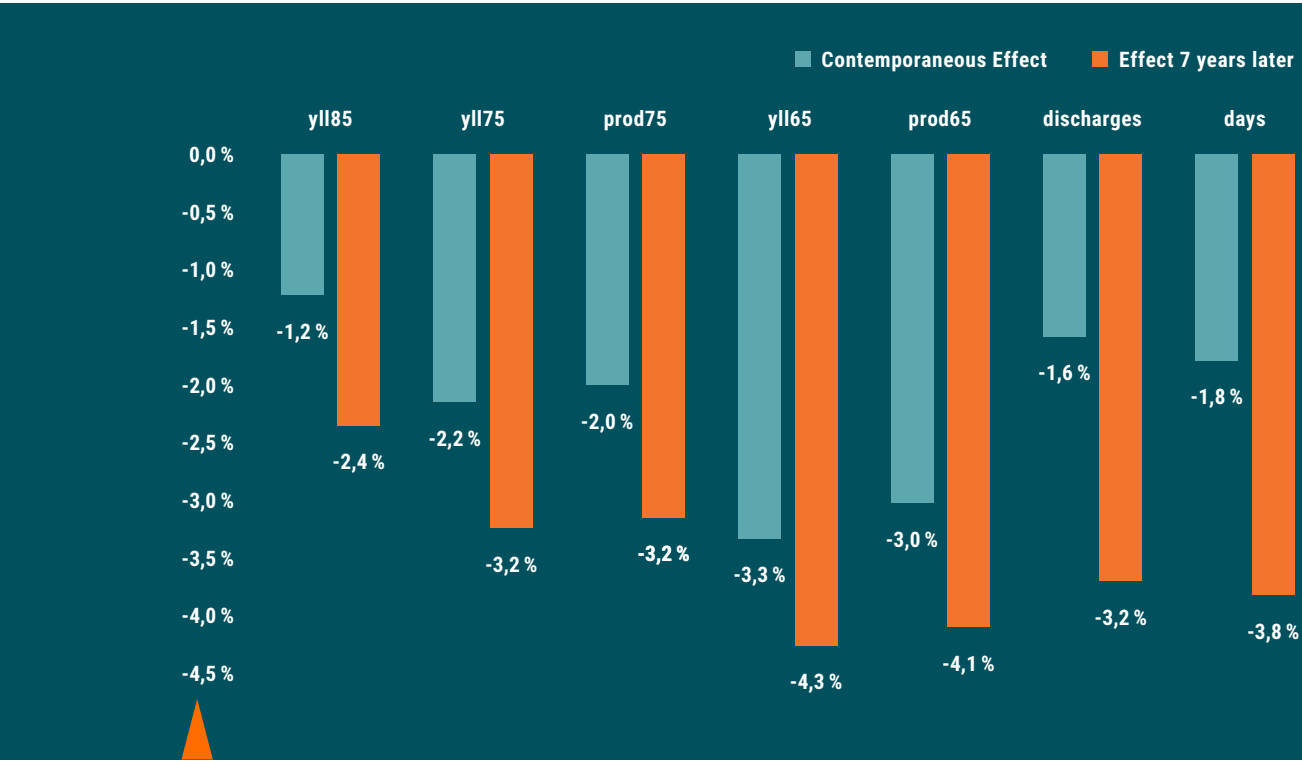


Figure 9: Estimates of ß$_0$ and ß$_7$ from eq. (1) illustrating estimated percentage reduction in health outcomes per one-year increase in drug vintage, comparing contemporaneous and seven-year lagged effects.

From 2014 to 2022, The estimate of β_0 indicates that a one-year increase in vintage is associated with a 1.2 % reduction in contemporaneous yll85. The magnitude of the estimate of β_7 is almost twice as large as the magnitude of the estimate of β_0, with a 2.4 % reduction in yll85 seven years later.

Similarly, estimates of β_0 and β_7 indicate that a one-year increase in vintage is associated with a 2.2 % reduction in contemporaneous yll75, and with a 3.2 % reduction in yll75 seven years later. A one-year increase in vintage is associated with a 3.3 % reduction in contemporaneous yll65, and with a 4.3 % reduction in yll65 seven years later. The estimates of productive years of life lost before 75 and 65 years i.e., prod75 and prod65 also show a reduction of 2.0 and 3.0 %, respectively with a one-year increase in vintage contemporaneously. After a lag of 7 years, estimates show a 3.2 % reduction in prod75 and a 4.1 % reduction in prod65.

3.1.6 EFFECTS OF THE 2014–2024 VINTAGE INCREASE

As shown in *Figure 4*, from 2014 to 2024, the utilization-weighted mean vintage of chemical substances in ATC groups A, L, and R sold in 29 countries increased by 3.1 years, from 1988.4 to 1991.5. The one-year increase in vintage in above calculations, when replaced by a 3.1-year increase in vintage, gives the estimates β_0 and β_7 as shown in *Table 2*. Panel A uses the contemporaneous estimates and Panel B uses the seven-year lagged estimates, which represent the fuller long-run impact.

The contemporaneous estimates (Panel A) suggest that the vintage increase is associated with approximately 964,000 fewer years of life lost before age 85, 811,000 fewer years of life lost before age 75, and roughly 10.1 million fewer hospital days. The seven-year lagged estimates (Panel B) imply substantially larger impacts: 1.83 million fewer life-years lost before age 85, 1.20 million fewer life-years lost before age 75, and 20.9 million fewer hospital days.

On the expenditure side, the same regression framework applied to pharmaceutical spending finds that a one-year increase in drug vintage is associated with a 5.4 to 5.8 percent rise in pharmaceutical expenditure. Applied to the 3.1-year vintage increase and the 2014 expenditure base of € 61 billion, this implies that innovation in medicines added approximately € 11.86 billion to pharmaceutical expenditure between 2014 and 2024. That figure becomes the investment denominator in Module 3.

PANEL A: EFFECT OF 3.1-YEAR INCREASE IN CONTEMPORANEOUS VINTAGE				
Outcome	$ß_0$	$ß_0$ x ΔVintage	2014 Baseline Value	2014–2024 Change due to increase in vintage
YLL before age 85	-0.0122	-0.038	26,063,709	-964,260
YLL before age 75	-0.0215	-0.066	12,616,461	-810,939
Productive YLL < 75	-0.0200	-0.062	12,518,773	-750,239
YLL before age 65	-0.0333	-0.103	5,128,764	-501,491
Productive YLL < 65	-0.0302	-0.093	5,031,075	-448,250
Hospital discharges	-0.0158	-0.049	28,287,893	-1,347,900
Total hospital days	-0.0179	-0.055	188,138,629	-10,123,582

PANEL B: EFFECT OF 3.1-YEAR INCREASE IN VINTAGE 7 YEARS EARLIER				
Outcome	$ß_0$	$ß_0$ x ΔVintage	2014 Baseline Value	2014–2024 Change due to increase in vintage
YLL before age 85	-0.0235	-0.073	26,063,709	-1,825,534
YLL before age 75	-0.0324	-0.100	12,616,461	-1,201,939
Productive YLL < 75	-0.0315	-0.097	12,518,773	-1,161,091
YLL before age 65	-0.0426	-0.132	5,128,764	-632,573
Productive YLL < 65	-0.0410	-0.127	5,031,075	-598,664
Hospital discharges	-0.0317	-0.098	28,287,893	-2,639,500
Total hospital days	-0.0382	-0.118	188,138,629	-20,946,925
Pharmaceutical Expenditure	0.0575	0.178	€ 61,006,858,906	€ 11,861,994,658

Table 2: Estimated effects of the 3.1-year increase in drug vintage (2014–2024) on mortality, hospital utilization, and pharmaceutical expenditure, based on contemporaneous ($ß_0$) and seven-year lagged ($ß_7$) estimates

3.2 Module 2: Socioeconomic Value of Outcomes

Module 2 of this report uses WifOR's Health Footprint methodology to translate the health gains calculated in Module 1 into their economic value for the whole society. This approach constitutes three components of productivity or economic gains: Paid productivity value, unpaid productivity value, and direct hospitalization cost savings.

Table 3 presents the aggregate monetized socioeconomic benefit of pharmaceutical innovation across the 29 countries in scope, decomposed by components. The estimates are based on the seven-year lagged vintage effects from Module 1, which represent the economically relevant horizon over which the full benefits of pharmaceutical innovation are expected to materialize.

The total socioeconomic benefit of € 66.18 billion is dominated by the paid work productivity component, which accounts for roughly 964 million hours of paid activity in productive age, generating an economic growth of € 38.10 billion or approximately 57.6 % of the total. Unpaid work productivity adds a further € 18.96 billion (28.7 %) based on 1.9 million hours of unpaid productivity, and hospitalization savings due to 20.9 million avoided hospital days contribute € 9.11 billion (13.8 %).

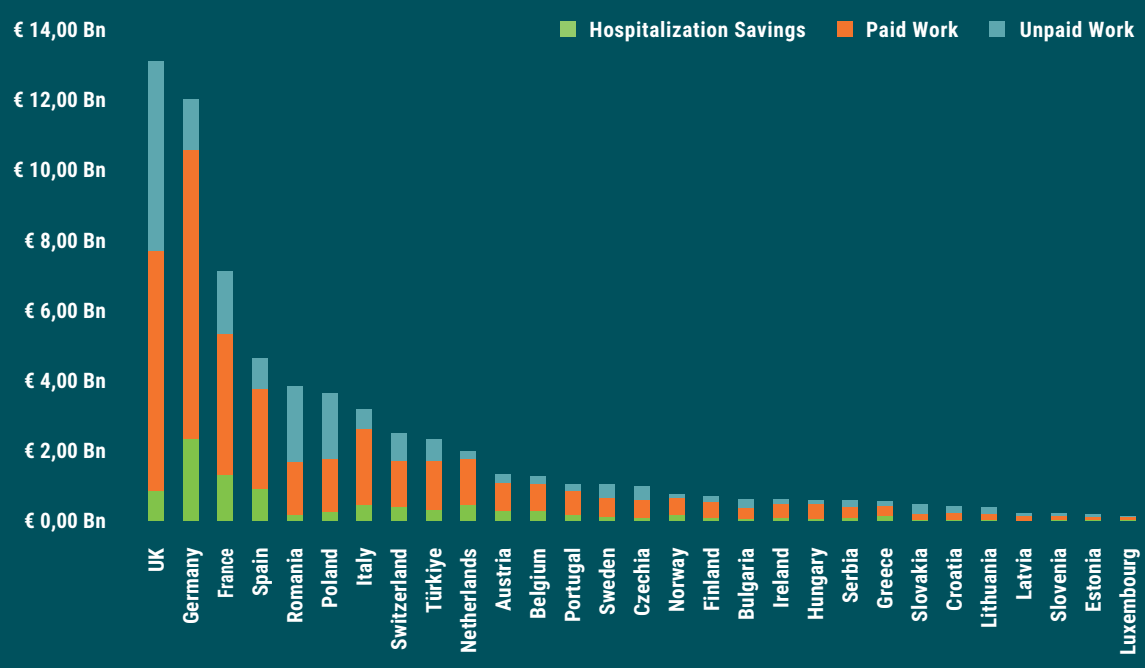
COMPONENT	MONETIZATION BASIS	AGGREGATE VALUE (EUR)
Paid Work Productivity	Country-specific GVA rates × productive life-years gained (direct + indirect + induced effects)	€ 38.10 Bn
Unpaid Work Productivity	Replacement cost of informal / household labor based on time-use surveys	€ 18.96 Bn
Hospitalization Cost Savings	Reduction in hospital days × country-specific inpatient cost per day (2014 Eurostat rates)	€ 9.11 Bn
Total Socioeconomic benefit	Sum of all three components	€ 66.18 Bn

Table 3: Aggregate monetized socioeconomic benefit of pharmaceutical innovation across 29 European countries, by component

3.2.1 COUNTRY-LEVEL RESULTS

The relative weight of each component; paid productivity, unpaid productivity, and hospitalization savings varies considerably across countries, reflecting differences in the size of the economy, demographic structure, and the distribution of disease burden across age groups. In higher-income economies such as Germany, the United Kingdom, Switzerland, France, and Norway, paid work productivity constitutes an even larger share of total value, while in relatively lower-income economies, such as Poland, Romania and Bulgaria, unpaid work and hospitalization savings carry relatively more weight. *Figure 10* shows the results of monetized socioeconomic benefit, by component and country.

Figure 10: Monetized socioeconomic benefit of pharmaceutical innovation across 29 European countries, by component and country.
Any difference to the total socioeconomic benefit is due to rounding.



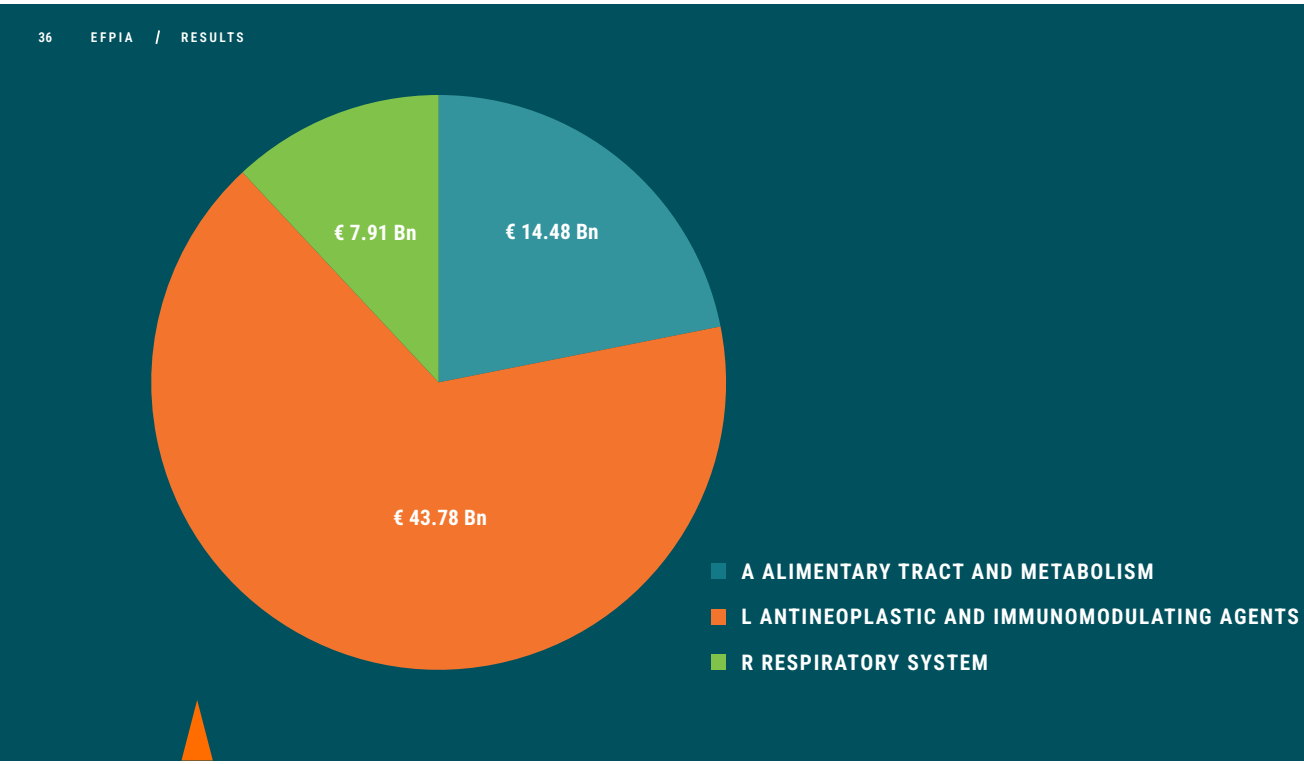


Figure 11: Monetized socioeconomic benefit of pharmaceutical innovation across 29 European countries, by ATC Therapeutic groups; A, L, and R. Any difference to the total socioeconomic benefit is due to rounding.

The five largest contributors to the total socioeconomic benefit are the United Kingdom (€ 13.09 billion), Germany (€ 12.00 billion), France (€ 7.09 billion), and Spain (€ 4.61 billion), and Romania (€ 3.82 billion). Together these five countries account for approximately 61% of the total socioeconomic benefit in scope. The complete results of the individual components of socioeconomic benefit, as well as the overall socioeconomic benefit, stratified by country, are presented in Table 11.

3.2.2 RESULTS BY THERAPEUTIC AREA

The breakdown of socioeconomic benefit by ATC therapeutic group is presented in *Figure 11*. Group L – Antineoplastic and Immunomodulating Agents dominates with the largest share in socioeconomic benefit (€ 43.78 billion). Group A – Alimentary Tract & Metabolism generates € 14.48 billion and Group R – Respiratory System generates € 7.91 billion in socioeconomic benefit. A detailed breakdown of socioeconomic benefit by ATC therapeutic group, per country is given in *Table 12*. The components included are paid work, unpaid work, hospitalization savings, increased pharmaceutical spendings and total socioeconomic benefit.

3.3 Module 3: Return On Investment (ROI)

To address the central question of Module 3, whether the benefits of pharmaceutical innovation justify its costs, we estimate the return on investment (ROI) as the ratio of the socioeconomic benefit calculated in Module 1 to the incremental pharmaceutical expenditure attributable to innovative drugs. As discussed in Section 2.3.2, the benefit component of the ROI may include different elements. In addition, we consider a complementary metric, the hospitalization ROI, defined as the ratio of hospitalization cost savings alone to the incremental pharmaceutical expenditure associated with drug innovations. *Table 4* presents the return on investment for the 29-country sample in aggregate and by ATC therapeutic group, contrasting the total socioeconomic benefit from Module 2 with the incremental pharmaceutical expenditure from Module 1.

ATC GROUP	TOTAL SOCIOECONOMIC BENEFIT	INCREMENTAL PHARMA SALES	HOSPITALIZATION SAVINGS	ROI
A – Alimentary Tract & Metabolism	€ 14.48 Bn	€ 3.11 Bn	€ 3.26 Bn	4.7x
L – Antineoplastic & Immunomodulating Agents	€ 43.78 Bn	€ 6.48 Bn	€ 3.18 Bn	6.8x
R – Respiratory System	€ 7.91 Bn	€ 2.07 Bn	€ 2.67 Bn	3.8x
Grand Total	€ 66.18 Bn	€ 11.67 Bn	€ 9.11 Bn	5.7x

Table 4: Return on investment by ATC therapeutic group. ROI = Total socioeconomic benefit ÷ Incremental Pharmaceutical Expenditure

The aggregate ROI across all countries and therapeutic groups is 5.67, meaning that for every euro of additional pharmaceutical expenditure associated with innovation, European societies received approximately € 5.67 in measurable socioeconomic value.

Across ATC groups, antineoplastic and immunomodulating agents (group L) demonstrate the highest return on investment (ROI), yielding approximately 6.8-fold returns. This is followed by the alimentary tract and metabolism group (A), with a return of 4.7-fold, and the respiratory group (R), with a return of 3.8-fold.

Across all countries combined, hospitalization savings amount to € 9.11 billion relative to an investment of € 11.67 billion, corresponding to a hospitalization return on investment (ROI) of 0.78. In practical terms, this suggests that approximately 78 cents are recovered in reduced hospitalization costs for every euro invested, even before accounting for any productivity-related gains. Notably, in the alimentary tract and metabolism group (A), the ratio exceeds unity, indicating that savings from avoided hospitalizations alone are sufficient to offset the additional costs associated with pharmaceutical innovation. A similar, and even more pronounced pattern is observed in the respiratory group (R), where the hospitalization ROI reaches 1.29. Both Total ROI and hospitalization ROI are arranged in *Table 5* in descending order, making Group L – Antineoplastic & Immunomodulating Agents with the highest Total ROI of 6.6-fold, and Group R – Respiratory System with the highest ROI when only hospitalization savings are considered.

TOTAL ROI CONSIDERING ALL IMPACT CATEGORIES		
RANK	DRUGS ATC GROUP	ROI
1	ANTINEOPLASTIC AND IMMUNOMODULATING AGENTS	6.8
2	ALIMENTARY TRACT AND METABOLISM	4.7
3	RESPIRATORY SYSTEM	3.8

ROI WITH ONLY HOSPITALIZATION SAVINGS CONSIDERED		
RANK	DRUGS ATC GROUP	ROI
1	RESPIRATORY SYSTEM	1.3
2	ALIMENTARY TRACT AND METABOLISM	1.1
3	ANTINEOPLASTIC AND IMMUNOMODULATING AGENTS	0.5

Table 5: ROI by ATC group in different scenarios

3.3.1 COUNTRY-LEVEL RETURN ON INVESTMENT

COUNTRY	TOTAL SOCIOECONOMIC BENEFIT	INCREMENTAL PHARMA SALES	HOSPITAL-IZATION SAVINGS	OVERALL ROI*	HOSPITAL-IZATION ROI**	PAID WORK & HOSPITAL-IZATION ROI
United Kingdom	€ 13.09 Bn	€ 1.45 Bn	€ 862.33 M	9.1x	0.6x	5.3x
Germany	€ 12.00 Bn	€ 2.76 Bn	€ 2.34 Bn	4.3x	0.8x	3.8x
France	€ 7.09 Bn	€ 1.35 Bn	€ 1.32 Bn	5.2x	1.0x	3.9x
Spain	€ 4.61 Bn	€ 1.25 Bn	€ 907.31 M	3.7x	0.7x	3.0x
Romania	€ 3.82 Bn	€ 477.99 M	€ 145.21 M	8.0x	0.3x	3.5x
Poland	€ 3.62 Bn	€ 409.75 M	€ 257.05 M	8.8x	0.6x	4.3x
Italy	€ 3.18 Bn	€ 755.35 M	€ 453.55 M	4.2x	0.6x	3.5x
Switzerland	€ 2.47 Bn	€ 360.07 M	€ 391.61 M	6.9x	1.1x	4.7x
Türkiye	€ 2.32 Bn	€ 290.30 M	€ 302.27 M	8.0x	1.0x	5.9x
Netherlands	€ 1.98 Bn	€ 189.67 M	€ 442.36 M	10.5x	2.3x	9.3x
Austria	€ 1.30 Bn	€ 239.49 M	€ 279.42 M	5.4x	1.2x	4.5x
Belgium	€ 1.26 Bn	€ 276.94 M	€ 280.91 M	4.6x	1.0x	3.8x
Portugal	€ 1.05 Bn	€ 290.55 M	€ 150.00 M	3.6x	0.5x	3.0x
Sweden	€ 1.04 Bn	€ 216.10 M	€ 97.99 M	4.8x	0.5x	3.1x
Czechia	€ 981.94 M	€ 148.54 M	€ 85.97 M	6.6x	0.6x	4.0x

COUNTRY	TOTAL SOCIOECONOMIC BENEFIT	INCREMENTAL PHARMA SALES	HOSPITAL-IZATION SAVINGS	OVERALL ROI*	HOSPITAL-IZATION ROI**	PAID WORK & HOSPITAL-IZATION ROI
Norway	€ 735.36 M	€ 93.55 M	€ 176.65 M	7.9x	1.9x	6.9x
Finland	€ 676.68 M	€ 151.15 M	€ 91.95 M	4.5x	0.6x	3.5x
Bulgaria	€ 613.00 M	€ 182.73 M	€ 49.79 M	3.4x	0.3x	2.0x
Ireland	€ 610.77 M	€ 163.52 M	€ 82.49 M	3.7x	0.5x	2.9x
Hungary	€ 579.28 M	€ 167.02 M	€ 52.46 M	3.5x	0.3x	2.9x
Serbia	€ 572.37 M	€ 83.46 M	€ 72.34 M	6.9x	0.9x	4.7x
Greece	€ 556.97 M	€ 93.11 M	€ 126.55 M	6.0x	1.4x	4.7x
Slovakia	€ 477.91 M	€ 63.16 M	€ 29.30 M	7.6x	0.5x	3.2x
Croatia	€ 421.17 M	€ 74.18 M	€ 26.19 M	5.7x	0.4x	3.0x
Lithuania	€ 388.62 M	€ 34.70 M	€ 21.61 M	11.2x	0.6x	5.7x
Latvia	€ 203.85 M	€ 19.62 M	€ 10.05 M	10.4x	0.5x	6.8x
Slovenia	€ 194.52 M	€ 46.40 M	€ 29.94 M	4.2x	0.6x	2.8x
Estonia	€ 172.31 M	€ 15.56 M	€ 11.24 M	11.1x	0.7x	5.8x
Luxembourg	€ 136.22 M	€ 13.29 M	€ 19.68 M	10.2x	1.5x	8.2x
Grand Total (29 Countries)	€ 66.18 Bn	€ 11.67 Bn	€ 9.11 Bn	5.7x	0.8x	4.0x

Table 6: **Return on investment by country.**

* Overall ROI = Total socioeconomic Benefit ÷ Incremental Pharma Sales
** Hospitalization ROI = Hospitalization savings ÷ Incremental Pharma Sales
Any difference to the total socioeconomic benefit is due to rounding.

The country-level results exhibit substantial heterogeneity in both the absolute magnitude of socioeconomic benefit and the implied ROI. Two patterns stand out. The first pattern is that all 29 countries achieved a total ROI substantially above 1.0. Even the lowest values in Table 6 for Hungary (3.5-times) and Bulgaria (3.4-times) still represent a return of more than three and a half euros return for one euro of incremental pharmaceutical expenditure.

The second pattern that emerges is that ROI is not directly proportional to total socioeconomic benefit. Several large markets with high total socioeconomic benefit, including Germany (€ 12.00 Bn) and Spain (€ 4.61 Bn), show lower ROI ratios than smaller markets such as Lithuania (€ 388.62 M), Estonia (€ 172.31 M), or Luxembourg (€ 136.22 M).

The hospitalization ROI reflects how much of the additional pharmaceutical spending is offset by reduced hospital use. In most countries, the ratio remains below 1.0. This means that hospital savings alone do not fully cover the added costs of treatment. However, there is clear variation across countries. In some cases, such as the Netherlands, Norway, Luxembourg, Greece, and Austria, hospitalization ROI reaches or exceeds 1.0. In these settings, lower hospital use generates substantial and directly measurable savings.

In contrast, countries like Romania, Bulgaria, and Hungary show lower ratios. This suggests more limited short-term savings within hospital systems. Overall, hospitalization ROI captures only part of the economic value. It reflects immediate budget effects, but not the broader gains seen in total socioeconomic benefit and productivity.


4

4 Discussion

Due to the incompleteness of the pharmaceutical sales data, our disease-specific measures of pharmaceutical innovation are subject to measurement error. According to two reliable databases, 52 % of drugs indicated for malignant neoplasms are not in ATC group L; 62 % of drugs indicated for endocrine, nutritional and metabolic diseases and diseases of the digestive system are not in ATC group A; and 72 % of drugs indicated for diseases of the respiratory system are not in ATC group R. This measurement error is likely to make our estimates of the impact of pharmaceutical innovation on mortality and hospital utilization conservative, i.e., to bias them towards zero.

A further reason why the ROI estimates may be considered conservative relates to the difference between net and gross prices. Because net prices are confidential, available sales data are based on gross prices and do not reflect rebates or discounts.

At first glance, *Table 17* may suggest that the impact in the United Kingdom is relatively low, given that it exhibits the lowest drug vintage in 2024. However, the estimated impact is not driven by the level of vintage at a single point in time, but rather by the change in vintage over the period 2014–2022. *Table 13* presents the increase in drug vintage across countries and shows that the United Kingdom does not have the smallest increase over this period.

Moreover, the estimated socioeconomic benefit is influenced by additional factors beyond changes in vintage, including the size of the economy and the population. These factors can amplify the overall effect: even a modest increase in vintage may translate into a substantial reduction in years of life lost in larger populations, while relatively small changes in mortality can generate significant economic gains in countries with high gross value added (GVA) per capita. This socioeconomic benefit reflects not only changes in pharmaceutical innovation but also underlying economic and demographic characteristics.


5

5 Appendix

COUNTRY	HOSPITALIZATION COSTS PER DAY IN € (2014)
Austria	536
Belgium	825
Bulgaria	88
Croatia	104
Czechia	151
Estonia	180
Finland	470
France	922
Germany	432
Greece	501
Hungary	98
Ireland	562
Italy	430
Latvia	109
Lithuania	111
Luxembourg	958
Netherlands	1618
Norway	1905
Poland	184
Portugal	430
Romania	62
Serbia	117
Slovakia	179
Slovenia	336
Spain	701
Sweden	538
Switzerland	1234
Türkiye	180
United Kingdom	468

Table 7: Inpatient curative care cost per hospital day in 2014, by country. Calculations based on Eurostat (2026b, 2026c, 2026d).

A. PHARMACEUTICAL SALES DATA				
Year	No. of countries	Total Sales in EUR (millions)	Sales w/Vintage in EUR (millions)	Standard units sold (billions)
2014	29	€ 61,007	€ 54,730	125
2015	29	€ 55,812	€ 49,907	129
2016	29	€ 59,432	€ 53,122	133
2017	29	€ 65,018	€ 58,265	134
2018	29	€ 73,563	€ 66,019	137
2019	29	€ 77,627	€ 69,677	140
2020	29	€ 86,468	€ 77,768	137
2021	29	€ 99,377	€ 89,354	139
2022	29	€ 99,094	€ 88,498	148
2023	29	€ 113,607	€ 100,832	151
2024	29	€ 127,795	€ 112,403	154

B. PHARMACEUTICAL SALES DATA MATCHED TO MORTALITY DATA							
Year	No. of countries	Sales w/Vintage in EUR (millions)	yll85 (millions)	yll75 (millions)	prod75 (millions)	yll65 (millions)	prod65 (millions)
2014	29	€ 54,730	26.06	12.62	12.52	5.13	5.03
2015	29	€ 49,907	26.46	12.71	12.62	5.10	5.00
2016	29	€ 53,122	26.51	12.72	12.63	5.07	4.97
2017	29	€ 58,265	26.30	12.51	12.41	4.93	4.84
2018	29	€ 66,019	26.35	12.47	12.38	4.87	4.79
2019	28	€ 69,677	23.07	10.90	10.82	4.22	4.14
2020	28	€ 77,768	23.47	11.03	10.96	4.24	4.18
2021	28	€ 89,354	23.16	10.87	10.80	4.17	4.10
2022	28	€ 88,498	23.01	10.69	10.62	4.09	4.02

C. PHARMACEUTICAL SALES DATA MATCHED TO HOSPITAL UTILIZATION DATA				
Year	No. of countries	Sales w/Vintage in EUR (millions)	Hospital days (millions)	Discharges (millions)
2014	29	€ 54,730	188.14	28.29
2015	27	€ 49,907	183.85	27.88
2016	26	€ 53,122	181.03	27.70
2017	24	€ 58,265	148.96	21.66
2018	25	€ 66,019	150.58	21.91
2019	23	€ 69,677	145.85	21.46
2020	25	€ 77,768	123.53	17.69
2021	25	€ 89,354	123.23	18.04

Table 8: Summary statistics for pharmaceutical sales, mortality, and hospital utilization data

Table 9: Estimates of $ß_k$ from $\ln(outcome_{dct})$ $= ß_k vint\_drug_{dct-k} + \alpha_{dt} + \sigma_{ct} + \varepsilon_{dct}$: mortality outcomes.

Each estimate is from a separate model.

	lag	Estimate	Std. Err.	Z	Pr > |Z|
A. OUTCOME = YLL85					
	0	-0.0122	0.0048	-2.52	0.0119
	1	-0.0136	0.0051	-2.64	0.0083
	2	-0.0145	0.0057	-2.56	0.0106
	3	-0.0159	0.0064	-2.50	0.0126
	4	-0.0175	0.0072	-2.42	0.0155
	5	-0.0198	0.0082	-2.40	0.0165
	6	-0.0223	0.0095	-2.36	0.0185
	7	-0.0235	0.0114	-2.07	0.0385
	8	-0.0196	0.0133	-1.48	0.1397
B. OUTCOME = YLL75					
	0	-0.0215	0.0058	-3.74	0.0002
	1	-0.0229	0.0060	-3.80	0.0001
	2	-0.0238	0.0066	-3.62	0.0003
	3	-0.0255	0.0072	-3.52	0.0004
	4	-0.0271	0.0080	-3.37	0.0007
	5	-0.0291	0.0090	-3.22	0.0013
	6	-0.0311	0.0103	-3.02	0.0025
	7	-0.0324	0.0122	-2.65	0.0081
	8	-0.0285	0.0149	-1.91	0.0558
D. OUTCOME = YLL65					
	0	-0.0333	0.0069	-4.83	<.0001
	1	-0.0346	0.0071	-4.88	<.0001
	2	-0.0355	0.0076	-4.66	<.0001
	3	-0.0374	0.0082	-4.55	<.0001
	4	-0.0387	0.0089	-4.33	<.0001
	5	-0.0402	0.0100	-4.04	<.0001
	6	-0.0413	0.0113	-3.66	0.0003
	7	-0.0426	0.0133	-3.21	0.0013
	8	-0.0389	0.0169	-2.30	0.0212

lag	Estimate	Std. Err.	Z	Pr > |Z|
C. OUTCOME = PROD75				
0	-0.0200	0.0057	-3.50	0.0005
1	-0.0214	0.0060	-3.57	0.0004
2	-0.0223	0.0065	-3.42	0.0006
3	-0.0242	0.0072	-3.34	0.0008
4	-0.0259	0.0080	-3.23	0.0012
5	-0.0281	0.0091	-3.10	0.0019
6	-0.0301	0.0103	-2.92	0.0035
7	-0.0315	0.0123	-2.57	0.0103
8	-0.0275	0.0149	-1.85	0.0643
E. OUTCOME = PROD65				
0	-0.0302	0.0068	-4.43	<.0001
1	-0.0316	0.0071	-4.48	<.0001
2	-0.0327	0.0076	-4.28	<.0001
3	-0.0349	0.0083	-4.22	<.0001
4	-0.0365	0.0090	-4.06	<.0001
5	-0.0383	0.0100	-3.81	0.0001
6	-0.0395	0.0114	-3.46	0.0005
7	-0.0410	0.0135	-3.04	0.0023
8	-0.0372	0.0171	-2.18	0.0296

	lag	Estimate	Std. Err.	Z	Pr > |Z|
			OUTCOME = DISCHARGES		
	0	-0.0158	0.0036	-4.36	<.0001
	1	-0.0166	0.0039	-4.20	<.0001
	2	-0.0173	0.0044	-3.96	<.0001
	3	-0.0196	0.0048	-4.09	<.0001
	4	-0.0216	0.0054	-4.02	<.0001
	5	-0.0255	0.0063	-4.06	<.0001
	6	-0.0317	0.0064	-4.97	<.0001
	7	-0.0308	0.0091	-3.40	0.0007
			OUTCOME = ALOS		
	0	-0.0035	0.0013	-2.76	0.0058
	1	-0.0035	0.0015	-2.36	0.0181
	2	-0.0037	0.0017	-2.14	0.0321
	3	-0.0037	0.0020	-1.86	0.0622
	4	-0.0046	0.0023	-2.00	0.0453
	5	-0.0054	0.0028	-1.93	0.0542
	6	-0.0076	0.0034	-2.28	0.0225
	7	-0.0109	0.0045	-2.42	0.0157
			OUTCOME = DAYS		
	0	-0.0179	0.0043	-4.20	<.0001
	1	-0.0187	0.0047	-3.99	<.0001
	2	-0.0198	0.0053	-3.77	0.0002
	3	-0.0225	0.0059	-3.78	0.0002
	4	-0.0254	0.0068	-3.75	0.0002
	5	-0.0300	0.0080	-3.76	0.0002
	6	-0.0382	0.0084	-4.53	<.0001
	7	-0.0411	0.0122	-3.38	0.0007

Table 10: Estimates of ßk from model $\ln(\text{outcome}_{dct}) = ß_k \text{vint\_drug}_{dct-k} + \alpha_{dt} + \sigma_{ct} + \varepsilon_{dct}$: hospital outcomes

	COUNTRY	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT
	United Kingdom	€ 6.84 Bn	€ 5.39 Bn	€ 862.33 M	€ 13.09 Bn
	Germany	€ 8.23 Bn	€ 1.43 Bn	€ 2.34 Bn	€ 12.00 Bn
	Metropolitan France	€ 3.99 Bn	€ 1.77 Bn	€ 1.32 Bn	€ 7.09 Bn
	Spain	€ 2.84 Bn	€ 861.87 M	€ 907.31 M	€ 4.61 Bn
	Romania	€ 1.54 Bn	€ 2.14 Bn	€ 145.21 M	€ 3.82 Bn
	Poland	€ 1.50 Bn	€ 1.87 Bn	€ 257.05 M	€ 3.62 Bn
	Italy	€ 2.17 Bn	€ 556.86 M	€ 453.55 M	€ 3.18 Bn
	Switzerland	€ 1.30 Bn	€ 784.57 M	€ 391.61 M	€ 2.47 Bn
	Türkiye	€ 1.39 Bn	€ 622.56 M	€ 302.27 M	€ 2.32 Bn
	Netherlands	€ 1.32 Bn	€ 221.87 M	€ 442.36 M	€ 1.98 Bn
	Austria	€ 795.39 M	€ 229.56 M	€ 279.42 M	€ 1.30 Bn
	Belgium	€ 779.67 M	€ 201.68 M	€ 280.91 M	€ 1.26 Bn
	Portugal	€ 707.51 M	€ 195.09 M	€ 150.00 M	€ 1.05 Bn
	Sweden	€ 565.35 M	€ 376.04 M	€ 97.99 M	€ 1.04 Bn
	Czechia	€ 514.83 M	€ 381.14 M	€ 85.97 M	€ 981.94 M

	COUNTRY	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT
	Norway	€ 465.67 M	€ 93.04 M	€ 176.65 M	€ 735.36 M
	Finland	€ 431.59 M	€ 153.14 M	€ 91.95 M	€ 676.68 M
	Bulgaria	€ 316.79 M	€ 246.42 M	€ 49.79 M	€ 613.00 M
	Ireland	€ 389.07 M	€ 139.22 M	€ 82.49 M	€ 610.77 M
	Hungary	€ 435.30 M	€ 91.52 M	€ 52.46 M	€ 579.28 M
	Serbia	€ 319.13 M	€ 180.90 M	€ 72.34 M	€ 572.37 M
	Greece	€ 311.47 M	€ 118.95 M	€ 126.55 M	€ 556.97 M
	Slovakia	€ 175.43 M	€ 273.18 M	€ 29.30 M	€ 477.91 M
	Croatia	€ 198.13 M	€ 196.85 M	€ 26.19 M	€ 421.17 M
	Lithuania	€ 175.08 M	€ 191.93 M	€ 21.61 M	€ 388.62 M
	Latvia	€ 123.80 M	€ 70.00 M	€ 10.05 M	€ 203.85 M
	Slovenia	€ 99.78 M	€ 64.80 M	€ 29.94 M	€ 194.52 M
	Estonia	€ 78.97 M	€ 82.10 M	€ 11.24 M	€ 172.31 M
	Luxembourg	€ 89.27 M	€ 27.26 M	€ 19.68 M	€ 136.22 M
	Grand Total	€ 38.10 Bn	€ 18.96 Bn	€ 9.11 Bn	€ 66.18 Bn

Table 11: Monetized socioeconomic benefit of pharmaceutical innovation across 29 European countries, by component and country

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
United Kingdom	€ 6.84 Bn	€ 5.39 Bn	€ 862.33 M	€ 13.09 Bn	€ 1.45 Bn
A – Alimentary Tract & Metabolism	€ 1.66 Bn	€ 1.03 Bn	€ 283.22 M	€ 2.98 Bn	€ 329.72 M
L – Antineoplastic & Immunomodulating Agents	€ 4.42 Bn	€ 3.65 Bn	€ 225.64 M	€ 8.30 Bn	€ 768.55 M
R – Respiratory System	€ 757.70 M	€ 702.89 M	€ 353.47 M	€ 1.81 Bn	€ 347.32 M
Germany	€ 8.23 Bn	€ 1.43 Bn	€ 2.34 Bn	€ 12.00 Bn	€ 2.76 Bn
A – Alimentary Tract & Metabolism	€ 1.82 Bn	€ 276.64 M	€ 869.03 M	€ 2.96 Bn	€ 629.47 M
L – Antineoplastic & Immunomodulating Agents	€ 5.83 Bn	€ 1.03 Bn	€ 960.44 M	€ 7.82 Bn	€ 1.75 Bn
R – Respiratory System	€ 585.37 M	€ 123.13 M	€ 508.56 M	€ 1.22 Bn	€ 382.18 M
Metropolitan France	€ 3.99 Bn	€ 1.77 Bn	€ 1.32 Bn	€ 7.09 Bn	€ 1.35 Bn
A – Alimentary Tract & Metabolism	€ 657.91 M	€ 267.82 M	€ 526.14 M	€ 1.45 Bn	€ 352.55 M
L – Antineoplastic & Immunomodulating Agents	€ 3.13 Bn	€ 1.41 Bn	€ 433.98 M	€ 4.98 Bn	€ 794.23 M
R – Respiratory System	€ 202.93 M	€ 97.87 M	€ 359.26 M	€ 660.06 M	€ 203.37 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Spain	€ 2.84 Bn	€ 861.87 M	€ 907.31 M	€ 4.61 Bn	€ 1.25 Bn
A – Alimentary Tract & Metabolism	€ 415.14 M	€ 118.88 M	€ 305.91 M	€ 839.93 M	€ 319.43 M
L – Antineoplastic & Immunomodulating Agents	€ 2.18 Bn	€ 665.37 M	€ 301.73 M	€ 3.15 Bn	€ 708.85 M
R – Respiratory System	€ 248.72 M	€ 77.62 M	€ 299.67 M	€ 626.00 M	€ 225.67 M
Romania	€ 1.54 Bn	€ 2.14 Bn	€ 145.21 M	€ 3.82 Bn	€ 477.25 M
A – Alimentary Tract & Metabolism	€ 369.11 M	€ 503.31 M	€ 52.38 M	€ 924.80 M	€ 153.58 M
L – Antineoplastic & Immunomodulating Agents	€ 872.41 M	€ 1.31 Bn	€ 39.93 M	€ 2.22 Bn	€ 251.16 M
R – Respiratory System	€ 295.61 M	€ 330.02 M	€ 52.90 M	€ 678.52 M	€ 72.51 M
Poland	€ 1.50 Bn	€ 1.87 Bn	€ 257.05 M	€ 3.62 Bn	€ 409.67 M
A – Alimentary Tract & Metabolism	€ 345.83 M	€ 361.12 M	€ 98.30 M	€ 805.25 M	€ 129.06 M
L – Antineoplastic & Immunomodulating Agents	€ 1.01 Bn	€ 1.34 Bn	€ 78.20 M	€ 2.43 Bn	€ 166.90 M
R – Respiratory System	€ 144.24 M	€ 167.42 M	€ 80.55 M	€ 392.20 M	€ 113.71 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Italy	€ 2.17 Bn	€ 556.86 M	€ 453.55 M	€ 3.18 Bn	€ 755.53 M
A – Alimentary Tract & Metabolism	€ 332.73 M	€ 80.92 M	€ 147.03 M	€ 560.68 M	€ 218.75 M
L – Antineoplastic & Immunomodulating Agents	€ 1.73 Bn	€ 445.99 M	€ 160.39 M	€ 2.33 Bn	€ 429.11 M
R – Respiratory System	€ 112.23 M	€ 29.95 M	€ 146.12 M	€ 288.30 M	€ 107.67 M
Switzerland	€ 1.30 Bn	€ 784.57 M	€ 391.61 M	€ 2.47 Bn	€ 359.80 M
A – Alimentary Tract & Metabolism	€ 176.76 M	€ 99.71 M	€ 138.59 M	€ 415.06 M	€ 83.36 M
L – Antineoplastic & Immunomodulating Agents	€ 1.04 Bn	€ 631.02 M	€ 164.06 M	€ 1.84 Bn	€ 233.37 M
R – Respiratory System	€ 79.46 M	€ 53.84 M	€ 88.96 M	€ 222.27 M	€ 43.07 M
Türkiye	€ 1.39 Bn	€ 622.56 M	€ 302.27 M	€ 2.32 Bn	€ 289.83 M
A – Alimentary Tract & Metabolism	€ 248.42 M	€ 107.82 M	€ 97.65 M	€ 453.90 M	€ 103.17 M
L – Antineoplastic & Immunomodulating Agents	€ 925.04 M	€ 414.00 M	€ 45.69 M	€ 1.38 Bn	€ 116.91 M
R – Respiratory System	€ 220.62 M	€ 100.75 M	€ 158.93 M	€ 480.30 M	€ 69.75 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Netherlands	€ 1.32 Bn	€ 221.87 M	€ 442.36 M	€ 1.98 Bn	€ 189.47 M
A – Alimentary Tract & Metabolism	€ 172.21 M	€ 24.50 M	€ 157.71 M	€ 354.41 M	€ 71.04 M
L – Antineoplastic & Immunomodulating Agents	€ 1.06 Bn	€ 180.61 M	€ 160.19 M	€ 1.41 Bn	€ 41.45 M
R – Respiratory System	€ 81.78 M	€ 16.76 M	€ 124.47 M	€ 223.01 M	€ 76.98 M
Austria	€ 795.39 M	€ 229.56 M	€ 279.42 M	€ 1.30 Bn	€ 239.47 M
A – Alimentary Tract & Metabolism	€ 203.27 M	€ 52.03 M	€ 105.35 M	€ 360.65 M	€ 53.82 M
L – Antineoplastic & Immunomodulating Agents	€ 562.08 M	€ 164.84 M	€ 105.53 M	€ 832.45 M	€ 152.47 M
R – Respiratory System	€ 30.04 M	€ 12.69 M	€ 68.55 M	€ 111.27 M	€ 33.17 M
Belgium	€ 779.67 M	€ 201.68 M	€ 280.91 M	€ 1.26 Bn	€ 276.94 M
A – Alimentary Tract & Metabolism	€ 150.80 M	€ 33.82 M	€ 108.89 M	€ 293.50 M	€ 61.05 M
L – Antineoplastic & Immunomodulating Agents	€ 559.32 M	€ 147.02 M	€ 83.72 M	€ 790.06 M	€ 167.31 M
R – Respiratory System	€ 69.55 M	€ 20.84 M	€ 88.30 M	€ 178.70 M	€ 48.58 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Portugal	€ 707.51 M	€ 195.09 M	€ 150.00 M	€ 1.05 Bn	€ 290.47 M
A – Alimentary Tract & Metabolism	€ 129.08 M	€ 33.95 M	€ 56.92 M	€ 219.96 M	€ 104.35 M
L – Antineoplastic & Immunomodulating Agents	€ 522.46 M	€ 144.53 M	€ 57.33 M	€ 724.33 M	€ 138.10 M
R – Respiratory System	€ 55.97 M	€ 16.60 M	€ 35.75 M	€ 108.32 M	€ 48.02 M
Sweden	€ 565.35 M	€ 376.04 M	€ 97.99 M	€ 1.04 Bn	€ 216.22 M
A – Alimentary Tract & Metabolism	€ 103.15 M	€ 60.18 M	€ 34.11 M	€ 197.44 M	€ 40.91 M
L – Antineoplastic & Immunomodulating Agents	€ 430.96 M	€ 288.33 M	€ 36.88 M	€ 756.16 M	€ 134.32 M
R – Respiratory System	€ 31.25 M	€ 27.53 M	€ 27.00 M	€ 85.78 M	€ 40.98 M
Czechia	€ 514.83 M	€ 381.14 M	€ 85.97 M	€ 981.94 M	€ 148.68 M
A – Alimentary Tract & Metabolism	€ 133.41 M	€ 83.55 M	€ 34.56 M	€ 251.51 M	€ 44.73 M
L – Antineoplastic & Immunomodulating Agents	€ 333.53 M	€ 260.79 M	€ 26.30 M	€ 620.62 M	€ 70.27 M
R – Respiratory System	€ 47.89 M	€ 36.80 M	€ 25.11 M	€ 109.81 M	€ 33.68 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Norway	€ 465.67 M	€ 93.04 M	€ 176.65 M	€ 735.36 M	€ 93.43 M
A – Alimentary Tract & Metabolism	€ 63.42 M	€ 10.93 M	€ 51.70 M	€ 126.05 M	€ 18.32 M
L – Antineoplastic & Immunomodulating Agents	€ 374.81 M	€ 73.85 M	€ 69.71 M	€ 518.37 M	€ 57.88 M
R – Respiratory System	€ 27.43 M	€ 8.27 M	€ 55.24 M	€ 90.94 M	€ 17.23 M
Finland	€ 431.59 M	€ 153.14 M	€ 91.95 M	€ 676.68 M	€ 150.98 M
A – Alimentary Tract & Metabolism	€ 156.77 M	€ 44.93 M	€ 25.61 M	€ 227.31 M	€ 43.04 M
L – Antineoplastic & Immunomodulating Agents	€ 256.75 M	€ 99.56 M	€ 34.97 M	€ 391.28 M	€ 83.16 M
R – Respiratory System	€ 18.07 M	€ 8.66 M	€ 31.37 M	€ 58.09 M	€ 24.78 M
Bulgaria	€ 316.79 M	€ 246.42 M	€ 49.79 M	€ 613.00 M	€ 182.59 M
A – Alimentary Tract & Metabolism	€ 70.30 M	€ 51.40 M	€ 17.07 M	€ 138.77 M	€ 100.19 M
L – Antineoplastic & Immunomodulating Agents	€ 198.02 M	€ 162.82 M	€ 10.93 M	€ 371.76 M	€ 58.03 M
R – Respiratory System	€ 48.47 M	€ 32.20 M	€ 21.79 M	€ 102.46 M	€ 24.37 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Ireland	€ 389.07 M	€ 139.22 M	€ 82.49 M	€ 610.77 M	€ 163.45 M
A – Alimentary Tract & Metabolism	€ 64.81 M	€ 18.61 M	€ 26.53 M	€ 109.95 M	€ 32.42 M
L – Antineoplastic & Immunomodulating Agents	€ 298.14 M	€ 108.55 M	€ 24.49 M	€ 431.18 M	€ 102.23 M
R – Respiratory System	€ 26.12 M	€ 12.06 M	€ 31.46 M	€ 69.64 M	€ 28.80 M
Hungary	€ 435.30 M	€ 91.52 M	€ 52.46 M	€ 579.28 M	€ 166.90 M
A – Alimentary Tract & Metabolism	€ 95.17 M	€ 18.56 M	€ 15.96 M	€ 129.68 M	€ 50.31 M
L – Antineoplastic & Immunomodulating Agents	€ 299.33 M	€ 63.96 M	€ 20.40 M	€ 383.68 M	€ 88.96 M
R – Respiratory System	€ 40.80 M	€ 9.00 M	€ 16.11 M	€ 65.91 M	€ 27.63 M
Serbia	€ 319.13 M	€ 180.90 M	€ 72.34 M	€ 572.37 M	€ 83.37 M
A – Alimentary Tract & Metabolism	€ 43.39 M	€ 25.00 M	€ 23.76 M	€ 92.15 M	€ 33.24 M
L – Antineoplastic & Immunomodulating Agents	€ 242.17 M	€ 137.36 M	€ 29.84 M	€ 409.37 M	€ 27.91 M
R – Respiratory System	€ 33.57 M	€ 18.54 M	€ 18.74 M	€ 70.85 M	€ 22.23 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Greece	€ 311.47 M	€ 118.95 M	€ 126.55 M	€ 556.97 M	€ 93.18 M
A – Alimentary Tract & Metabolism	€ 40.33 M	€ 13.90 M	€ 39.25 M	€ 93.48 M	€ 54.70 M
L – Antineoplastic & Immunomodulating Agents	€ 240.54 M	€ 93.57 M	€ 51.19 M	€ 385.30 M	€ 9.09 M
R – Respiratory System	€ 30.59 M	€ 11.48 M	€ 36.11 M	€ 78.18 M	€ 29.39 M
Slovakia	€ 175.43 M	€ 273.18 M	€ 29.30 M	€ 477.91 M	€ 63.13 M
A – Alimentary Tract & Metabolism	€ 48.47 M	€ 66.11 M	€ 10.59 M	€ 125.17 M	€ 14.84 M
L – Antineoplastic & Immunomodulating Agents	€ 108.89 M	€ 181.68 M	€ 10.56 M	€ 301.12 M	€ 38.19 M
R – Respiratory System	€ 18.08 M	€ 25.39 M	€ 8.15 M	€ 51.62 M	€ 10.10 M
Croatia	€ 198.13 M	€ 196.85 M	€ 26.19 M	€ 421.17 M	€ 74.15 M
A – Alimentary Tract & Metabolism	€ 38.05 M	€ 34.99 M	€ 8.00 M	€ 81.04 M	€ 25.47 M
L – Antineoplastic & Immunomodulating Agents	€ 151.83 M	€ 152.55 M	€ 12.32 M	€ 316.70 M	€ 35.31 M
R – Respiratory System	€ 8.24 M	€ 9.32 M	€ 5.87 M	€ 23.43 M	€ 13.37 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Lithuania	€ 175.08 M	€ 191.93 M	€ 21.61 M	€ 388.62 M	€ 34.66 M
A – Alimentary Tract & Metabolism	€ 60.50 M	€ 55.64 M	€ 6.68 M	€ 122.82 M	€ 13.14 M
L – Antineoplastic & Immunomodulating Agents	€ 100.59 M	€ 121.23 M	€ 7.61 M	€ 229.43 M	€ 13.11 M
R – Respiratory System	€ 13.99 M	€ 15.06 M	€ 7.31 M	€ 36.37 M	€ 8.41 M
Latvia	€ 123.80 M	€ 70.00 M	€ 10.05 M	€ 203.85 M	€ 19.59 M
A – Alimentary Tract & Metabolism	€ 33.62 M	€ 16.05 M	€ 2.73 M	€ 52.40 M	€ 7.82 M
L – Antineoplastic & Immunomodulating Agents	€ 77.55 M	€ 47.42 M	€ 4.38 M	€ 129.35 M	€ 7.29 M
R – Respiratory System	€ 12.63 M	€ 6.53 M	€ 2.94 M	€ 22.10 M	€ 4.49 M
Slovenia	€ 99.78 M	€ 64.80 M	€ 29.94 M	€ 194.52 M	€ 46.38 M
A – Alimentary Tract & Metabolism	€ 20.12 M	€ 11.77 M	€ 9.05 M	€ 40.94 M	€ 11.80 M
L – Antineoplastic & Immunomodulating Agents	€ 77.37 M	€ 50.86 M	€ 12.02 M	€ 140.24 M	€ 27.92 M
R – Respiratory System	€ 2.30 M	€ 2.16 M	€ 8.87 M	€ 13.34 M	€ 6.66 M

COUNTRY AND THERAPEUTIC AREA	PAID WORK	UNPAID WORK	HOSPITALIZATION SAVINGS	TOTAL SOCIOECONOMIC BENEFIT	INCREASED SALES (€)
Estonia	€ 78.97 M	€ 82.10 M	€ 11.24 M	€ 172.31 M	€ 15.54 M
A – Alimentary Tract & Metabolism	€ 23.12 M	€ 19.19 M	€ 3.30 M	€ 45.60 M	€ 6.74 M
L – Antineoplastic & Immunomodulating Agents	€ 47.60 M	€ 54.92 M	€ 5.29 M	€ 107.80 M	€ 4.44 M
R – Respiratory System	€ 8.25 M	€ 7.99 M	€ 2.66 M	€ 18.90 M	€ 4.35 M
Luxembourg	€ 89.27 M	€ 27.26 M	€ 19.68 M	€ 136.22 M	€ 13.30 M
A – Alimentary Tract & Metabolism	€ 16.21 M	€ 4.39 M	€ 6.30 M	€ 26.91 M	€ 5.04 M
L – Antineoplastic & Immunomodulating Agents	€ 65.55 M	€ 20.46 M	€ 8.54 M	€ 94.55 M	€ 5.37 M
R – Respiratory System	€ 7.51 M	€ 2.41 M	€ 4.85 M	€ 14.77 M	€ 2.88 M
Grand Total	€ 38.10 Bn	€ 18.96 Bn	€ 9.11 Bn	€ 66.18 Bn	€ 11.66 Bn

Table 12: Monetized socioeconomic benefit of pharmaceutical innovation across 29 European countries, by component, country and ATC Therapeutic areas A, L, and R per country

COUNTRY	INCREASE IN VINTAGE BETWEEN 2014–2022
Italy	1.7
Slovakia	2.14
Norway	2.27
Metropolitan France	2.31
Greece	2.43
Sweden	2.55
Belgium	2.71
Türkiye	2.71
Finland	2.97
Netherlands	3
United Kingdom	3.17
Spain	3.35
Austria	3.36
Germany	3.36
Hungary	3.47
Luxembourg	3.5
Ireland	3.59
Czechia	3.61
Poland	3.68
Slovenia	3.73
Switzerland	3.8
Latvia	4.07
Estonia	4.22
Lithuania	4.38
Bulgaria	4.55
Croatia	4.8
Portugal	4.95
Serbia	6.96
Romania	7.42

Table 13: Increase in Vintage by country, indicating the extent of adoption of newer pharmaceutical therapies across study countries.

DATABASE	VARIABLE NAME	EXPLANATIONS	DATA LEVEL
World Bank – World Development Indicators | DataBank	Gross value added at basic prices (GVA) (current US$)	a way of measuring how much value an activity, business, or sector adds to the economy. GVA = the value of what is produced – the value of what was used up to produce it	Country – Year
	Labor force, total	Labor force, total	
	Population, female (% of total population)	Population, female (% of total population)	
	Population, male (% of total population)	Population, male (% of total population)	
	Labor force participation rate, total (% of total population ages 15–64) (modeled ILO estimate)	Labor force participation rate, total (% of total population ages 15–64) (modeled ILO estimate)	
United Nations Statistics (UN) – Indicators | Gender Data Hub	Average number of hours spent on total work (paid and unpaid)	Average number of hours spent on total work (paid and unpaid)	Country – Year – Age group – Sex
WifOR + WIOD/EORA databases	Average number of hours spent on unpaid domestic and care work	Average number of hours spent on unpaid domestic and care work	
	Direct Multipliers per revenue	The immediate economic impact resulting from paid work generated by people becoming healthier.	Country – Year – Sector
	Indirect Multipliers per revenue	Indirect effects are what happens to other industries that supply goods and services to the directly affected sector.	
	Induced Multipliers per revenue	Induced effects come from people earning more income and spending it.	
	Gross Value Added (GVA) per economic sector (million USD)	GVA per sector	
	Employees per economic sector (million of people)	Number of Employees per sector	
Calculated in module 1	Years of Life Lost Avoided (Before the age of 65)	It measures how many years of life are saved because certain deaths do not happen earlier than expected. The focus is only on deaths that occur before age 65.	Country – Year – Disease area
	Years of Life Lost Avoided (Before the age of 75)	It measures how many years of life are saved because certain deaths do not happen earlier than expected. The focus is only on deaths that occur before age 75.	

Table 14: **Overview of data sources and selected indicators used for Module 2 (productivity components)**

	DATABASE	VARIABLE NAME	EXPLANATIONS	DATA LEVEL
	Eurostat	Number of discharges	The number of hospital discharges due to a disease, in a country in a year.	Country – Year – Disease area
		Average length of stay of each discharge	The average length of stay for discharges due to a disease, in a country, in a year.	
		Healthcare expenditures (Inpatient curative care)	Measure how much is spent on treating patients in hospitals when they are formally admitted, typically involving overnight stays, nursing care, and related services.	
	Calculated in module 1	Days of hospitalization avoided	How many days of hospitalization were avoided due to increase in drug vintage	Country – Year – Disease area

Table 15: Overview of data sources and selected indicators used for Module 2 (hospitalization component)

5.1 Productivity calculation methodology

The socioeconomic input parameters are country specific. They are retrieved from official databases or statistical offices such as the World Bank Development Indicators [36] or the UN National Accounts Database [37]. They may need to be adjusted (e.g. convert the national currency into US dollars) or calculated for every country in the scope of the project. The following six input parameters are finally used to estimate the productivity effects:

- GVA per economically active person
- Labour force participation rate
- Indirect GVA multiplier (Economy average)
- Induced GVA multiplier (Economy average)
- Time adjustment ratio (unpaid/paid)
- GVA adjustment ratio (unpaid/paid)

When searching for inputs, different databases are queried in order of priority to minimize data gaps (missing data). In some cases, if no information is available for a country, proxy countries are used to substitute missing data.

To select the most appropriate proxy country, the data availability of the potential proxy country, geographical distance from the country under investigation, similarity in economic development (GDP per capita), and similarity in the Human Development Index (a measure of achievements in dimensions of human development, such as life expectancy at birth, education, and standard of living) are considered.

Each of the six input parameters is described in the following section and the sources from which they are drawn are specified. These inputs are used to calculate productivity effects mentioned above. Final productivity effects for 2014 may be found in *Table 16*.

5.1.1 GVA PER ECONOMICALLY ACTIVE PERSON

The average annual GVA per economically active person is used as a measure of labour productivity in a given country. To obtain this input, we divide the total GVA at basic prices measured in current USD ($GVA_{c,t}$) by the size of the labour force ($L_{c,t}$) in the respective country (c) and year (t):

- **GVA per economically active person$_{c,t}$** = $\frac{GVA_{c,t}}{L_{c,t}}$

The following sources are used to retrieve total GVA (in descending priority):

- World Bank Development Indicators in t [36]
- World Bank Development Indicators in t-1 [36]
- UN National Accounts Database in t-1 [37]
- National statistical office of a given country c (most recent data)

The following sources are used to retrieve the size of the labour force (in descending priority):

- World Bank Development Indicators in t [36]
- National statistical office of a given country c (most recent data)

5.1.2 LABOUR FORCE PARTICIPATION RATE

The following sources are used to retrieve the labour force participation rate in the respective country (c) and year (t) (in descending priority):

- World Bank Development Indicators in t [36]
- National statistical office of a given country c

The labour force participation rate may be reported separately for different age groups or as one summary measure, e.g., for people aged 15 and older as the working age population. Depending on availability, we select the data that best correspond to the included age groups and, if necessary, adjust the labour force participation rate based on additional information.

5.1.3 TOTAL ECONOMY AVERAGE GVA MULTIPLIER FOR INDIRECT EFFECTS

By means of an input-output analysis indirect GVA and direct GVA effects are determined. The indirect GVA multiplier describes the ratio of indirect to direct GVA and is used to determine average indirect GVA effects associated with paid work.

- $$\textbf{Total Economy Average multiplier indirect}_{c} = \frac{\sum_{j=1}^{n} (\textbf{GVA}_{c,j} * \textbf{indirect multiplier}_{c,j})}{\sum_{j=1}^{n} \textbf{GVA}_{c,j}}$$

Where:

$\textbf{indirect multiplier}_{c,j}$ is the indirect multiplier in sector j and in the corresponding country.

The following sources are used to retrieve the information to calculate the indirect GVA multiplier for the total economy (in descending priority):

- WIOD (World Input-Output Database) country c [38]
- EORA country c [39]
- WIOD proxy country
- EORA proxy country

5.1.4 TOTAL ECONOMY AVERAGE GVA MULTIPLIER FOR INDUCED EFFECTS

Similarly to the economy-wide average GVA multiplier for indirect effects, the induced GVA multiplier describes the ratio of induced to direct GVA and is used to determine the average induced GVA effects in connection with paid labour. Similarly to direct and indirect GVA effects, induced GVA effects are also determined using an input-output analysis.

- **Total Economy Average multiplier induced$_c$** = $$\frac{\sum_{n\,j=1} (GVA_{c,j} * \text{induced multiplier}_{c,j})}{\sum_{j=1}^{n} GVA_{c,j}}$$

Where:

induced multiplier$_{c,j}$ is the induced multiplier in sector j and in the corresponding country.

The following sources are used to retrieve the information to calculate the induced GVA multiplier for the total economy (in descending priority):

- WIOD country c
- EORA country c
- WIOD proxy country
- EORA proxy country

5.1.5 TIME ADJUSTMENT RATIO (UNPAID / PAID WORK)

No statistics or similar on the value contribution of one year of unpaid work exist. Therefore, to approximate a labour productivity value for unpaid work, the paid work productivity is adjusted by the time spent on unpaid work activities relative to paid work activities. This time adjustment ratio is calculated by dividing the gender weighted unpaid working hours by the gender weighted paid working hours:

- $$\textbf{Time use ratio}_{c,t} = \frac{\left[\left(\frac{P_{c,t,m}}{P_{c,t}}\right) * WHU_{c,m}\right] + \left[\left(\frac{P_{c,t,f}}{P_{c,t}}\right) * WHU_{c,f}\right]}{\left[\left(\frac{P_{c,t,m}}{P_{c,t}}\right) * WHP_{c,m}\right] + \left[\left(\frac{P_{c,t,f}}{P_{c,t}}\right) * WHP_{c,f}\right]}$$

Where:

$P_{c,t,m}$ is the male (m) population in the corresponding country and year
$P_{c,t}$ is the population in the corresponding country and year
$P_{c,t,f}$ is the female (f) population in the corresponding country and year
$WHU_{c,m}$ are the unpaid working hours for males in the corresponding country
$WHU_{c,f}$ are the unpaid working hours for females in the corresponding country
$WHP_{c,m}$ are the paid working hours for males in the corresponding country
$WHP_{c,f}$ are the paid working hours for females in the corresponding country

The following sources are used to retrieve the working hours (in descending priority):

- United Nations time use survey country c [40]
- National statistical office of a given country c
- United Nations time use survey proxy country

The following sources are used to retrieve the population sizes (in descending priority):

- World Bank in t
- National statistical office of a given country c in t

Time use statistics may be reported separately for different age groups or as one summary measure, e.g., including all legal adults who do not live in communal accommodation. Depending on availability, we select the data that best correspond to the included age groups.

5.1.6 GVA ADJUSTMENT RATIO (UNPAID / PAID WORK)

If only the time adjustment ratio were used, it would be assumed that one hour of unpaid work is associated with the same average labour productivity as one hour of paid work. However, as unpaid work consists of a specific set of activities that have below average labour productivity in many countries, e.g., because childcare occupations are paid less, this would not correspond to the idea of the replacement cost approach to monetise unpaid work. We thus adjust the average GVA per economically active person by setting the labour productivity of paid work activities which are comparable to unpaid work activities[2] in relation to the average labour productivity in the overall economy. This serves as a proxy of the relative value contribution of unpaid work activities and paid work activities.

We use GVA and employment data for the economic sector "Activities of households as employers" and for the overall economy from the WIOD and EORA databases. These data are available up to the year 2016.

- **GVA per employee sector $HH_{c,t}$ =**

$$\frac{\left(\frac{\text{GVA Sector HH}_c}{\sum_{j=1}^{n} \text{GVA}_{c,j}}\right) * \text{GVA}_{c,t}}{\left(\frac{\text{L Sector HH}_c}{\sum_{j=1}^{n} \text{L}_{c,j}}\right) * \text{L}_{c,t}}$$

Where:

$GVA\ Sector\ HH_c$ is the GVA in the sector representing households as employers in the corresponding country in 2016

$_{j=1n}\mathbf{GVA_{c,j}}$ is the sum of GVA over all sectors (j) in the corresponding country in 2016

$GVA_{c,t}$ is the GVA in the corresponding country and year

$L\ Sector\ HH_c$ is the labour force in the sector representing households as employers in the corresponding country in 2016

$\sum_{j=1}^{n} L_{c,j}$ is the sum of the labour force over all sectors in the corresponding country in 2016

$L_{c,t}$ is the labour force in the corresponding country and year.

2 Defined by the sector of "Activities of Households as Employers; Undifferentiated Goods and Services Producing Activities of Households for Own Use" according to the International Standard Industrial Classification revision 4 (ISIC Rev. 4) used in the WIOD database or the Eora26 sector classification used in the EORA database.

The following sources are used for the inputs to calculate the GVA adjustment ratio (in descending priority):

- WIOD country c
- EORA country c
- WIOD proxy country
- EORA proxy country

Setting this into relation to the average GVA contribution in the overall economy, we calculate a ratio indicating the estimated (hypothetical) GVA contribution of unpaid work activities relative to paid work activities:

- $$\textbf{GVA ratio}_{c,t} = \frac{\textbf{GVA per economically active person HH}_{c,t}}{\textbf{GVA per economically active person}_{c,t}}$$

The socioeconomic benefit stemming from productivity gains, in the scope of this project, comprises four different productivity effects that are linked with the years of life gained:

- Direct effects of paid work
- Indirect effects of paid work
- Induced effects of paid work
- Direct effects of unpaid work

These four different productivity effects are calculated for every country in scope and respective year. An overview of the final values is given in *Table 16*.

To calculate the monetary value of productivity potential in paid work (direct effects of paid work), the YLLs gained are multiplied first with the labour force participation rate. These YLLs gained in economically active persons are then multiplied with the average annual labour productivity (GVA per economically active person):

$$\textbf{Direct paid work effects}_{d,c,t} = \textbf{YLLs gained}_{d,c,t} * \textbf{labor force participation rate}_{c,t} * \textbf{GVA per economically active person}_{c,t}$$

Where:

d = disease, **c** = country, **t** = time

Subsequently, further potential productivity effects within the economy triggered along the value chain by the initial (direct) effects are estimated. These indirect and induced effects associated with paid work productivity potential are calculated by multiplying the direct effects with the respective GVA multiplier from input-output analysis.

To derive the (hypothetical) monetary value of productivity potential in unpaid work, first, the average monetary value equivalent for unpaid work activities is estimated. This is based on the average annual labour productivity of paid work (GVA per economically active person) and then adjusted to reflect differences in terms of time spent and differences in terms of GVA contribution (value creation) between paid and unpaid work activities.

- The time adjustment ratio gives an estimate of how much time is spent for unpaid work activities for each hour of paid work activities.
- The GVA adjustment ratio adjusts for the below average GVA contribution of unpaid work activities.

The estimate of the monetary value equivalent of one year of unpaid work activities is then calculated by multiplying the annual GVA per economically active person by the two adjustment factors:

$$\textbf{Monetary value equivalent of unpaid work}_{c,t}$$
$$= \textbf{GVA per economically active person}_{c,t} * \textbf{Time adjustment ratio}_{c,t} * \textbf{GVA adjustment ratio}_{c,t}$$

Where:

c = country and **t** = time.

Finally, the YLLs gained are multiplied with the estimated monetary value equivalent of one year of unpaid work:

$$\textbf{GVA unpaid}_{m,i,c,t,a} = \textbf{YLLs gained}_{m,i,c,a} * \textbf{Monetary value equivalent of unpaid work}_{c,t}$$

Input data, such as the labour force participation rate or the time spent on unpaid work, are always given for a defined age group and represent an average value.

COUNTRY	PAID DIRECT	PAID INDIRECT	PAID INDUCED	UNPAID
Austria	€ 50,064	€ 26,837	€ 13,745	€ 13,085
Belgium	€ 49,318	€ 25,093	€ 15,028	€ 11,210
Bulgaria	€ 13,171	€ 6,755	€ 4,672	€ 11,749
Croatia	€ 19,934	€ 13,857	€ 4,811	€ 13,186
Czech Republic	€ 49,689	€ 30,578	€ 22,754	€ 17,368
Estonia	€ 48,756	€ 30,396	€ 18,155	€ 8,231
Finland	€ 21,748	€ 10,544	€ 7,366	€ 7,712
France	€ 13,330	€ 5,772	€ 2,677	€ 2,268
Germany	€ 36,667	€ 26,483	€ 16,785	€ 10,069
Greece	€ 14,776	€ 10,387	€ 5,400	€ 9,376
Hungary	€ 16,304	€ 6,203	€ 3,683	€ 16,104
Ireland	€ 96,700	€ 46,762	€ 40,807	€ 17,607
Italy	€ 13,378	€ 8,885	€ 3,123	€ 16,129
Latvia	€ 21,182	€ 11,576	€ 7,692	€ 5,911
Lithuania	€ 9,197	€ 5,876	€ 2,777	€ 13,873
Luxembourg	€ 157,976	€ 63,250	€ 27,432	€ 38,626
Netherlands	€ 17,858	€ 9,475	€ 3,418	€ 25,501
Norway	€ 30,328	€ 19,311	€ 15,494	€ 10,286
Poland	€ 61,288	€ 34,041	€ 19,004	€ 34,501
Portugal	€ 92,576	€ 57,476	€ 50,969	€ 58,416
Romania	€ 11,666	€ 7,829	€ 2,915	€ 6,132
Serbia	€ 47,901	€ 29,986	€ 32,555	€ 44,057
Slovakia	€ 118,909	€ 47,608	€ 20,648	€ 29,074
Slovenia	€ 29,755	€ 15,979	€ 9,857	€ 17,235
Spain	€ 40,293	€ 25,655	€ 20,585	€ 13,666
Sweden	€ 81,424	€ 45,225	€ 25,248	€ 45,837
Switzerland	€ 122,992	€ 76,359	€ 67,715	€ 77,609
Türkiye	€ 15,499	€ 10,401	€ 3,873	€ 8,146
United Kingdom	€ 63,639	€ 39,838	€ 43,252	€ 58,531

Table 16: Country-level socioeconomic productivity components, showing monetized gains from paid work (direct, indirect, and induced effects) and unpaid activities across study countries.

COUNTRY	WEIGHTED MEAN VINTAGE IN 2024
Austria	1992.25
Belgium	1990.88
Bulgaria	1991.18
Croatia	1994.53
Czechia	1991.24
Estonia	1995.15
Finland	1993.61
France	1989.69
Germany	1993.61
Greece	1992.89
Hungary	1991.55
Ireland	1990.87
Italy	1992.52
Latvia	1989.47
Lithuania	1990.51
Luxembourg	1993.74
Netherlands	1995.37
Norway	1993.67
Poland	1991.94
Portugal	1995.16
Romania	1990.34
Serbia	1990.49
Slovakia	1990.38
Slovenia	1994.58
Spain	1992.03
Sweden	1991.8
Switzerland	1994.05
Türkiye	1991.73
United Kingdom	1988.86

Table 17: Weighted mean vintage of chemical substances sold during 2024, by country

COUNTRY	UNWEIGHTED MEAN VINTAGE IN 2024
Austria	2000.32
Belgium	1997.63
Bulgaria	2000.38
Croatia	2000.79
Czechia	1999.52
Estonia	1995.69
Finland	2000.64
France	1997.68
Germany	1992.35
Greece	1999.15
Hungary	1998.39
Ireland	1998.92
Italy	1997.55
Latvia	1995.97
Lithuania	1994.43
Luxembourg	1997.92
Netherlands	1994.78
Norway	1997.09
Poland	1997.98
Portugal	1998.17
Romania	1998.53
Serbia	1998.15
Slovakia	1998.97
Slovenia	2000.8
Spain	1998.49
Sweden	2000.11
Switzerland	1999.11
Türkiye	1996.13
United Kingdom	1997.2

Table 18: Unweighted mean vintage of chemical substances sold during 2024, by country


6

6 References

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