RESEARCH REPORT

NOVEMBER 2024

THE ECONOMIC IMPACT OF THE GLOBAL PHARMACEUTI-CAL INDUSTRY

Measurement of the economic impact relating to the pharmaceutical industry's global economic and R&D activities.

Mani Juneja

Lukas Mai

Dr. Nora Albu

Imprint
Version November 2024

Client
International Federation of Pharmaceutical Manufacturers & Associations (IFPMA)

Authors
Mani Juneja | WifOR Institute

Lukas Mai | WifOR Institute

Dr. Nora Albu | WifOR Institute

Contact
Mani Juneja
mani.juneja@wifor.com

WifOR Institute
Rheinstrasse 22
64283 Darmstadt, Germany

Scientific Director of the Institute
Prof. Dr. Dennis A. Ostwald

Head of Impact Analysis
Dr. Richard Scholz

Appreciation
This project was commissioned by IFPMA.

WifOR does not conduct research for advertising, promotion, or to support our clients' interests, including raising investment capital, recommending investment decisions, or for any use in litigation. This report was prepared by WifOR for the *International Federation of Pharmaceutical Manufacturers & Associations (IFPMA)*. WifOR always strives to produce work of the highest quality in accordance with our contractual obligations. Due to the research nature of this work, the Client assumes sole responsibility for the consequences of the use, misuse, or inability to use any information or results received from WifOR.

TABLE OF CONTENTS

FIGURE INDEX

TABLE INDEX

EXECUTIVE SUMMARY

Objective and main results

This report was commissioned by the *International Federation of Pharmaceutical Manufacturers & Associations (IFPMA)*. IFPMA represents the innovative pharmaceutical industry at the international level and in official relations with the United Nations.

The project aims to measure the economic impact relating to the pharmaceutical industry's global economic and R&D activities and follows on the study done in 2020 by the WifOR Institute. The study from 2020 estimated the economic impact of the global pharmaceutical industry for the year 2017. This report now presents updated results using the reference year 2022.

The main aim of this study is to estimate the economic impact of the global pharmaceutical industry. Respectively, the study quantifies the economic value in terms of the gross value added (GVA), i.e., contribution to Gross Domestic Product (GDP), and the jobs supported by the pharmaceutical industry globally due to its economic activity directly and its supply chain. Furthermore, the study details the direct effects in terms of GDP contribution and supported jobs due to research and development (R&D) activities of the business enterprises of the global pharmaceutical sector.

This study is based on public national statistics from statistical offices and other public sources to calculate the direct effects for GDP contribution and employment. In addition to the updated data to estimate the direct effects, the intermediate consumption of the global pharmaceutical industry was also estimated for 2022 using national statistics and other public sources. This data was then used in rationale of the system of national accounts to estimate the economic key figure of GDP contribution and jobs supported along the pharmaceutical industry's global supply chain. For the impact analysis, a widely recognized input-output method for quantifying economic effects in the supply chain was used. Additionally, the study estimated the economic impact of the R&D activities of the global pharmaceutical industry. This report shows the economic impact of the global pharmaceutical industry at a global level only.

MAIN RESULTS

THE PHARMACEUTICAL INDUSTRY CONTRIBUTED A TOTAL GDP OF $2,295 BILLION GLOBALLY IN 2022

THE PHARMACEUTICAL INDUSTRY CREATED A DIRECT GDP CONTRIBUTION OF **$755 BILLION** WORLDWIDE. THE ECONOMIC ACTIVITY OF THE INDUSTRY LED TO INDIRECT EFFECTS OF **$978 BILLION** AND INDUCED EFFECTS OF **$562 BILLION** IN OTHER INDUSTRIES WORLDWIDE.

TOTAL GDP CONTRIBUTION FACTOR OF 2.04

FOR **EVERY DOLLAR** OF GDP CONTRIBUTED BY THE PHARMACEUTICAL INDUSTRY DIRECTLY, AN ADDITIONAL **$2.04** WAS SUPPORTED GLOBALLY BASED ON INTER-INDUSTRY AND INTER-COUNTRY LINKAGES.

THE PHARMACEUTICAL INDUSTRY SUPPORTED A TOTAL EMPLOYMENT OF 75 MILLION GLOBALLY IN 2022

OUT OF THE TOTAL **74.9 MILLION** JOBS SUPPORTED BY THE PHARMACEUTICAL INDUSTRY, **7.8 MILLION** JOBS WERE SUPPORTED DIRECTLY, **44.7 MILLION** JOBS WERE SUPPORTED INDIRECTLY AND **22.4 MILLION** WERE SUPPORTED BECAUSE OF INDUCED EFFECTS IN THE SUPPLY CHAIN.

TOTAL EMPLOYMENT FACTOR OF 8.54

FOR **EVERY JOB** CREATED BY THE PHARMACEUTICAL INDUSTRY DIRECTLY, AN ADDITIONAL **8.54** JOBS WERE SUPPORTED GLOBALLY BASED ON INTER-INDUSTRY AND INTER-COUNTRY LINKAGES.

CHEMICAL INDUSTRY IS THE TOP SUPPLIER AND HUMAN HEALTH SERVICES INDUSTRY IS THE TOP BUYER OF THE PHARMACEUTICAL INDUSTRY

THE CHEMICAL INDUSTRY IS THE PHARMACEUTICAL INDUSTRY'S LARGEST SUPPLIER WITH **19.8%** SHARE. WITH **52.4%** SHARE, THE HUMAN HEALTH SERVICE INDUSTRY IS THE LARGEST BUYER OF THE PHARMACEUTICAL INDUSTRY GLOBALLY.

R&D IS A FUNDAMENTAL PART OF THE PHARMACEUTICAL INDUSTRY

THE GLOBAL PHARMACEUTICAL INDUSTRY'S R&D ACTIVITIES CONTRIBUTED A GDP OF **$227 BILLION** AND EMPLOYED MORE THAN **1.1 MILLION PEOPLE** DIRECTLY IN 2022.

1 Introduction

In 2022, the global pharmaceutical market was valued at $1,607 billion compared to $1,135 billion in 2017[1]. The market has grown at an annual rate of 5.8% since 2017[2] and the R&D expenditures have also increased at an annual rate of 4% until 2022[3].

This study was commissioned by the *International Federation of Pharmaceutical Manufacturers & Associations (IFPMA)*, which represents the innovative pharmaceutical industry at a global level. It works in partnership with governments, intergovernmental organizations, NGOs, civil society, patient groups, , global foundations, and research and academic institutions.

This study was commissioned to estimate the economic impact of the global pharmaceutical industry for the year 2022. The aim of the study is to estimate the economic value added and employment supported by the economic activities of the pharmaceutical industry in the world. The study also comprises the economic impact supported by the research and development (R&D) activities of the industry.

The pharmaceutical sector is an essential sector and proved to be the fastest growing sector in 2021 due to the enormous contribution to the world with the development of tests and vaccines during the COVID-19 pandemic[4]. The sector has experienced rapid growth especially in the recent years and is forecasted to grow at a compound annual growth rate of 12.5% in the next decade[5]. The

---

[1] Statista 2023. Revenue of the worldwide pharmaceutical market from 2001 to 2023. https://www.statista.com/statistics/263102/pharmaceutical-market-worldwide-revenue-since-2001/

[2] Pena et al. (2021). Pharmaceuticals Market, Consumption Trends and Disease Incidence Are Not Driving the Pharmaceutical Research on Water and Wastewater. Int J Environ Res Public Health. 2021 Mar 4;18(5):2532. doi: 10.3390/ijerph18052532.

[3] European Federation of Pharmaceutical Industries and Associations (EFPIA) 2023. The Pharmaceutical Industry in Figures: Key Data 2023. https://www.efpia.eu/media/rm4kzdlx/the-pharmaceutical-industry-in-figures-2023.pdf

[4] Brand Directory 2022. Brand Finance Global 500 2022 Report. https://brandirectory.com/rankings/global/2022

[5] Precedence Research 2023. Pharmaceutical Manufacturing Market. https://www.precedenceresearch.com/pharmaceutical-manufacturing-market

production value[6] of the industry has increased from $127 billion in 2000 to $340 billion in 2022[7]. The industry is further expected to reach a market size of $1,470 billion by 2032[5] with the anticipated rise in chronic diseases, an aging world population, increase in geriatric population, diseases exacerbated by climate change and growing incidence of novel viral diseases and antimicrobial resistance. With the onset of these changes, there is a growing demand for advanced medications, technologies, vaccines and treatment options. The pandemic further strengthened the need for accelerating research activities, digitalization, and expansion of supply chains to have more resilient processes and the adoption of innovative technologies. The pandemic also accelerated vaccine demand and production, thus R&D activities. In response to the increased R&D activities during the pandemic, by the early 2022, 17 vaccines, 68 treatments and 25 antivirals were developed[8]. The global COVID-19 vaccine manufacturing capacity was scaled up from zero to over 11 billion doses per year in 2021, and this excluded vaccines for other diseases. This increased to around 1 billion vaccines every month in the year 2022.

The global pharmaceutical industry's economic impact is twofold. Firstly, through the production of pharmaceutical products, the industry contributes directly to the world's GDP and supports a high number of employees. Secondly, through its economic activity, the global pharmaceutical industry supports additional value creation and employment through its dependence on global supply chains. These indirect economic effects, as well as the economic effects induced by private consumption, are the global pharmaceutical industry's economic spillover effects. This study has covered both above stated effects.

Indirect effects are the effects triggered due to the purchase of materials and services by a business. For example, pharmaceutical company A, purchases chemicals from a local chemical supplier to produce pharmaceuticals. This chemical supplier in turn also makes purchases to manufacture its chemicals. Thus, the demand for chemicals from pharmaceutical company A triggers employment and economic activity at the chemical supplier and its suppliers. This chain of events together will make the indirect impacts of the pharmaceutical company A.

[6] Production value measures the amount produced by a unit, the industry in this case which includes change in stocks and resale of goods and services. Therefore, it represents the value of goods and/or services produced in a year, whether sold or stocked.

[7] European Federation of Pharmaceutical Industries and Associations (EFPIA) 2023. The Pharmaceutical Industry in Figures: Key Data 2023. https://www.efpia.eu/media/rm4kzdlx/the-pharmaceutical-industry-in-figures-2023.pdf

[8] International Federation of Pharmaceutical Manufacturers and Associations (IFPMA) 2022. Applying Lessons Learned from Covid-19: To Create a Healthier, Safer, More Equitable World. May 2022. https://www.ifpma.org/publications/applying-lessons-learned-from-covid-19-to-create-a-healthier-safer-more-equitable-world/

In addition to the indirect effects, the induced effects are the effects triggered due to the expenditure of the disposable income of the employees of the company and in the supply chain. For example, the employees of pharmaceutical company A, as well as those of the chemical company stated above and its suppliers, receive wages and salaries. The induced effects manifest when these employees spend their income by purchasing goods and services such as food, or clothing. Thus, spending wages and salaries on food or clothing, triggers economic and employment effects which are known as induced effects of the pharmaceutical company A.

The present impact evaluation is based on industry level and utilizes the UN's *International Standard Industrial Classification of All Economic Activities (ISIC) Rev. 4*. In it, class C21 defines the pharmaceutical industry as "Manufacture of basic pharmaceutical products and pharmaceutical preparations" including basic pharmaceutical products, pharmaceutical preparations, medicinal chemical, and botanical products.[9]

The study also includes the direct GDP created in the world by the R&D[10] activities of the global pharmaceutical industry. For the impact of R&D activities, the R&D expenditure by the business enterprises and the R&D personnel engaged in the business enterprises of the pharmaceutical sector was accounted for. The business enterprises include all resident corporations and non-profit institutions (NPIs) and thus, it includes both private business enterprises (both publicly listed and traded, or not) and public business enterprises (i.e. government-controlled enterprises)[11]. This is in-line with the C21 sector classification of the sector. The year of analysis of the study is 2022.

SUPPLY AND DEMAND STRUCTURE

In 2022, the global pharmaceutical industry had a total intermediate consumption[12] from other sectors, i.e. *goods and services consumed as inputs either*

---

[9] United Nations, International Standard Industrial Classification of All Economic Activities, Revision 4, Statistical Papers Series M No.4/Rev.4, 2008, New York.

[10] With the launch of the Frascati Manual by the OECD starting from September 2014, research and development (R&D) services are no longer recorded purely as production inputs. Instead, R&D is treated as contributor to economic performance, and it is seen as a creator of a capital asset and hence a contribution to national wealth. Based on this development, the costs invested in R&D are considered to build intellectual property, which creates value for the economy regardless of its immediate financial return.

[11] Frascati Manual 2015. Guidelines for Collecting and Reporting Data on Research and Experimental Development. The Measurement of Scientific, Technological and Innovation Activities.

[12] Intermediate consumption is a national accounts concept which measures the value of the goods and services consumed as inputs by a process of production. It excludes fixed assets whose consumption is recorded as consumption of fixed capital. The goods and services may be either transformed or used up by the production process. It can also be measured as the difference between gross output and the GDP contribution.

transformed or used up by the production process[13], of $1,301 billion. The top ten suppliers of inputs for the global pharmaceutical sector's industrial production make up over two thirds of the total intermediate consumption of the corresponding sector (see: left column in Table 1). The global pharmaceutical industry's top supplier of goods or services from other sectors is the chemical sector with a share of 19.8%, followed by the agricultural sector with a contribution of 9%.

Vice versa, the global pharmaceutical industry's total intermediate output to other sectors, i.e. *intermediate goods consumed by other sectors for their production of goods and services,* equals $930 billion 2022. The top ten buyers of intermediate pharmaceutical goods consume almost 85% of overall intermediate outputs (see: right column in Table 1). The top buyer of pharmaceutical intermediate goods is the human health and social work activities sector (e.g. hospital supplies and prescription drugs) with a share of 52.4%, followed by 8.8% used by the chemical sector.

Table 1: Top ten industrial suppliers of inputs to the pharmaceutical industry and top ten industrial buyers of intermediate goods from the pharmaceutical industry (in percent for 2022).

Top 10 suppliers to the global pharmaceutical industry	Share
Chemicals	19.8%
Crop and animal production	9.0%
Wholesale trade	7.7%
Legal, accounting and consulting	7.1%
Mining and quarrying	4.8%
Administrative and support services	4.3%
Coke and refined petroleum	4.2%
Land transport services	3.5%
Food, beverages and tobacco	3.4%
Utilities	3.0%

Top 10 buyers of the global pharmaceutical industry	Share
Human health services	52.4%
Chemicals	8.8%
Education	4.0%
Other services activities	3.9%
Public administration and defence	3.2%
Crop and animal production	3.0%
Rubber and plastic products	2.9%
Coke and refined petroleum	2.9%
Food, beverages and tobacco	1.7%
Construction	1.5%

Source: Own estimation using the WifOR model.

[13] United Nations Statistical Division: Glossary of the 1993 System of National Accounts (§ 6.147.).

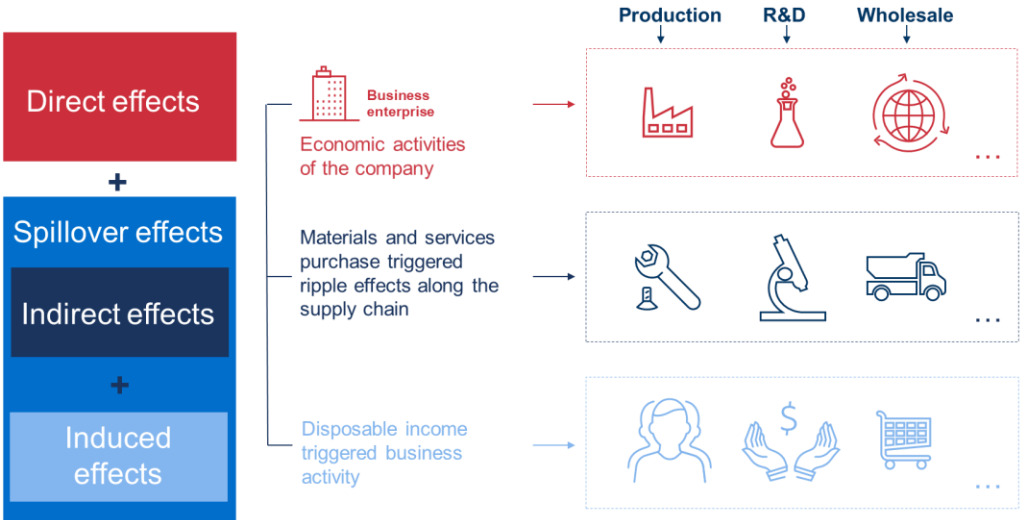
2 Economic impact of the pharmaceutical industry

This chapter presents the key findings from the economic impact assessment of pharmaceutical industry's economic and R&D activities globally. The GDP contribution and the employment supported are the key indicators measured.

2.1 Economic Impact

In addition to the **direct effects**, this analysis includes indirect and induced economic effects that are the immediate economic effects generated by a company or industry. **Indirect effects** are triggered through the procurement of goods and services from suppliers. Due to this stimulus, economic activity is increased along the entire supply chain. This increase is reflected in GDP contribution and other key economic factors. **Induced effects** capture the economic participation of households and their consumption patterns: they quantify the overall effects on the economy that are triggered by the expenditure generated by the direct wages and salaries paid by a company and those which are indirectly generated along supply chains. The combination of indirect and induced effects is called **spillover effects**. **Total economic effects** refer to the sum of all three (direct, indirect, and induced effects) (see Figure 1).

Figure 1: Diagram of the economic impact analysis: direct, indirect and induced effects triggered through economic activities of the global pharmaceutical industry.



Source: Own illustration.

2.1.1 GDP contribution

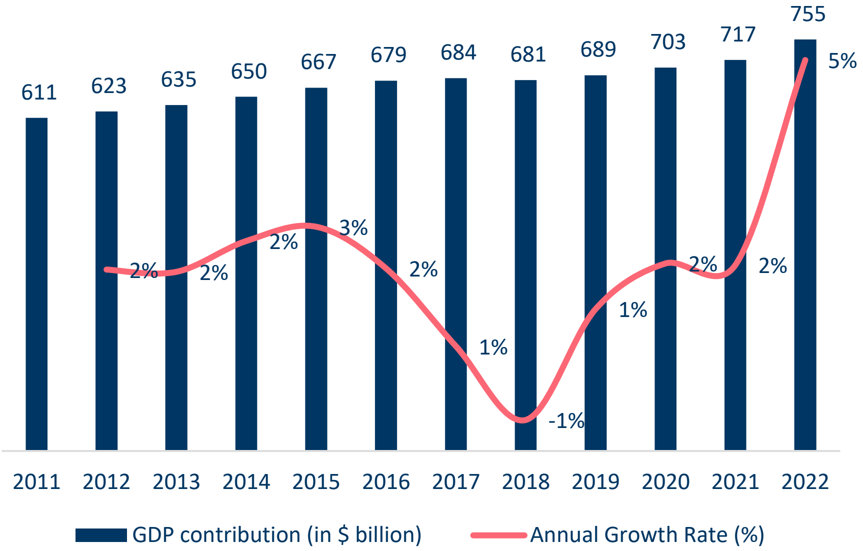
A central figure of the economic impact analysis is the GDP contribution, or the gross value added (GVA). GVA is defined as output (at basic prices) minus intermediate consumption (at purchaser prices). It is a measure of the contribution to the GDP of a country, or the entire world made by an individual producer, industry, or sector. The sum of GVA over all industries or sectors plus taxes on products minus subsidies on products yields the gross domestic product (GDP).[14] In this sense, GVA is the indicator to compare the creation of value among economic actors. Many of the targets in the United Nations' Sustainable Development Goal 8 (SDG 8: Decent work and economic growth) are defined in terms of GDP contribution or GVA.

The pharmaceutical industry created a total GDP contribution of $2,295 billion in 2022 globally through its business activities. Out of this total impact, the pharmaceutical industry has contributed a direct GDP contribution to the world's GDP of $755 billion which equals 0.7% of the global GDP or about the GDP of Switzerland in 2022[15].

[14] United Nations Statistical Division: Glossary of the 1993 System of National Accounts (§ 1.6.; 2.172.; 6.4.; 6.222.).

[15] This pharmaceutical industry is a part of the global Life Sciences industry, which is made up of the pharmaceutical and the MedTech industry together. The life sciences industry contributed $859 billion globally in 2022, which equals 0.9% of global GDP.These results are sourced from the Health Economy Reporting study done for Novartis in 2024. The economic impact of the global industrial health economy was estimated which entails the life sciences industry (i.e., the pharmaceutical industry

Figure 2: Trend of direct GDP contribution (represented by blue bars) and annual growth rate of the global pharmaceutical industry (represented by red line) between 2011 and 2022.



Source: Eurostat, OECD, ADB, WIOD and National Statistics; WifOR calculation.

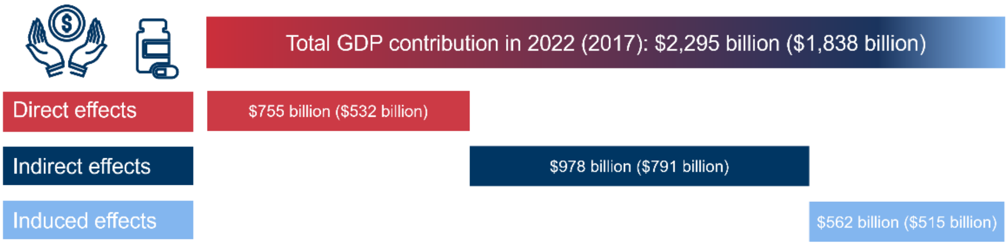
Note: There is a difference in the direct GDP contribution for the past years compared to the last project because of the updating of sources and the resulting level effect of the past estimates.

The direct GDP contribution of the industry has increased by more than 20% in the past decade from $623 billion in 2012 to $755 billion in 2022. The industry also witnessed a markable growth between 2021 and 2022 (see Figure 2), possibly driven by the increased supply of medications and vaccinations during the pandemic period[16].

(C21) and MedTech industry) and the services of industry Q. "Human health and social work activities". Also, please note that the results of these two studies are not comparable as the methodology used by WifOR for the Novartis study is different. Therefore, any type of comparison is to be done discreetly.

[16] Atradius (2022). Industry Trends Pharmaceuticals 2022. https://group.atradius.com/publications/industry-trends/pharmaceuticals-industry-trends-global-overview-2022.html

Figure 3: Direct and spillover GDP contribution effects of the global pharmaceutical industry in 2022.



Source: Data from National accounts, OECD, Eurostat, ADB and AfDB; data from WIOD; WifOR calculation.

The direct GDP contribution[17] created globally is estimated to be of $755 billion and $978 billion in the form of indirect and $562 induced effects. The indirect and induced effects make a total spillover effect[18] of $1,540 billion globally (see Figure 3). Therefore, this makes a total GDP contribution of $2,295 billion or $2.3 trillion in the year 2022. There has been an overall increase of 25% observed in the GDP contribution of the pharmaceutical sector compared to 2017. The total GDP contribution of the pharmaceutical industry in 2017 was $1,838 billion[19]. The increase in 2022 is dominated by the increase in the direct GDP contribution (wherein, the direct effects increased by 42%, the indirect by 24% and induced by 9%) compared to 2017. The moderate increase in the spillover effects compared to the increase in direct effects is due to the resulting inflation from the COVID-19 pandemic and energy crisis. This reduced the purchasing power, and this reduced spending on goods and services, leading to moderate spillover effects.

$2.3 Tn

of total GDP contribution by the pharmaceutical industry globally in 2022.

Additionally, it can be stated that for every dollar of GDP contribution created directly by the pharmaceutical sector, a further $2.04 of value was created along the global supply chain. This can be termed as a GDP contribution factor as well, which is GDP contributed to the global supply chain (spillover effect) for every GDP contributed directly.

$2.04:1

for every dollar of GDP contributed directly, created by pharmaceutical industry's business activities globally, an additional of $2.04 is supported along the global supply chain.

---

[17] The direct GDP contribution or direct GVA describes a company's contribution to the gross domestic product (GDP) because of its own economic activities as well as its production, R&D activities, and wholesale. The value added is the key figure for measuring a country's economic development and it's prospective of growth and economic welfare.

[18] Spillover effects include the indirect and induced effects. The indirect effects are triggered by ripple effects along the global supply chain and the induced effects by the disposable income's triggered business activity.

[19] WifOR Institute 2020. The Global Economic Impact of the Pharmaceutical Industry. https://www.wifor.com/uploads/2021/06/WifOR_Global_Economic_Footprint_Study_September_2020.pdf

Compared to the financial services[20] and utilities[21] industry with a spillover GDP contribution factor of 1.22 and 0.62 respectively, the pharmaceutical industry performed better. In case of the automotive industry with a GDP contribution spillover multiplier of 4.9, there was a smaller effect in the supply chain generated by the economic activity of the pharmaceutical industry.

The GDP contributed effects were triggered mostly in the same geographical region where they occurred. This means that a geographical region received the highest GVA spillover effects by its own region, demonstrating more regional supply chains rather than interregional.

This rationale of the inward regional impacts can be explained by the COVID-19 pandemic. The pandemic brought in major supply chain disruptions globally, because of which the countries tried to establish an invert strategy from importing to production in own country or own economic area to avoid any supply chain disruptions. In addition, an invert strategy can also avoid high transportation costs due to rising inflation which was particularly observed in 2022.

2.1.2 Employment

The global pharmaceutical industry's business activities have supported the world's labor market in addition to the GDP contribution. In 2022, the pharmaceutical industry supported around 75 million jobs.

74.9 million

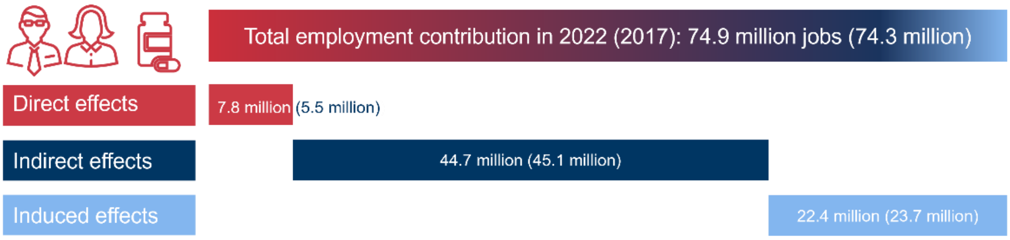
jobs supported by the global pharmaceutical industry's business activities globally in 2022.

The global pharmaceutical industry supported 7.8 million persons directly. In the global supply chain additionally 44.7 million persons were supported indirectly, and 22.4 million persons were supported through induced employment effects. Together, this yielded spillover effects of 67 million persons in 2022. Thus, the global impact of the global pharmaceutical industry including both the direct and the spillover effects on all the countries and along the global supply chain equal to 74.9 million jobs (see Figure 4).

Figure 4: Direct and spillover employment effects of the global pharmaceutical industry in 2022.

[20] The financial services industry includes the financial service activities, including insurance, reinsurance and pension funding activities and activities to support financial services. This also includes the activities of holding assets, such as activities of holding companies and the activities of trusts, funds and similar financial entities.

[21] The utilities industry includes the activity of providing electric power, natural gas, steam, hot water and the like through a permanent infrastructure (network) of lines, mains and pipes.



Source: Data from Labor Force Surveys, ILO, OECD, Eurostat, and AfDB; data from WIOD; WifOR calculation.

There has been an overall 1% increase in employment supported from 2017 to 2022. This increase is dominated by the increase in direct employment (wherein, 42% increase in direct, 1% decrease in indirect and 6% decrease in induced effects). There is a decrease in spillover effects because of inflation and related increased labor costs. Additionally, the spillover employment was affected by the supply chain disruptions in the global supply chain during the pandemic.

The graph above also represents an employment factor[22] of 8.54, which means for every job created directly, a further 8.54 spillover employment were supported along the world's supply chain.

8.54:1

for every job supported directly by the pharmaceutical industry's activities, an additional 8.54 jobs were supported along the global supply chain.

Compared to the automotive and financial services industry with a spillover employment factor of 6.9 and 5.7 respectively, the pharmaceutical industry performs better. In case of the utilities industry with a spillover employment multiplier of 15.9, there is a smaller effect in the supply chain generated by the economic activity of the pharmaceutical industry.

Similar to the GDP contributed spillover effects, the spillover employment was triggered mostly in the same countries where they occurred, i.e., the countries witnessed inward impacts. The rationale behind more inward regional impacts is congruent with the regionalized spillover effects of GDP contribution. Because of this inward regional impact, the spillover jobs supported are located in their own geographical region rather in other parts of the world.

Table 2 shows the growth of labor costs and employee compensation in the global pharmaceutical industry between 2011 and 2022. Thereby the labor costs represent the total labor compensation paid in the whole pharmaceutical industry. This has shown an increasing trend in the last decade, same as the employee compensation (labor compensation per employee in the pharmaceutical industry). Especially within the two years after the COVID-19 pandemic the labor costs have increased rapidly.

[22] Employment or job supported in the global supply chain (indirect and induced) for every job supported directly.

Table 2: Growth of labor costs and employee compensation in the global pharmaceutical industry between 2011 and 2022.

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Labor costs (in $ billion)	135.0	138.3	141.5	146.6	149.8	153.2	154.6	154.1	156.6	160.9	165.8	176.0
Growth rate		2.4%	2.3%	3.6%	2.2%	2.3%	0.9%	-0.3%	1.6%	2.7%	3.1%	6.1%
Employee compensation (in $)	16,415	16,886	17,358	18,278	18,339	18,678	19,385	19,532	19,688	20,150	20,998	22,369
Growth rate		2.9%	2.8%	5.3%	0.3%	1.8%	3.8%	0.8%	0.8%	2.3%	4.2%	6.5%

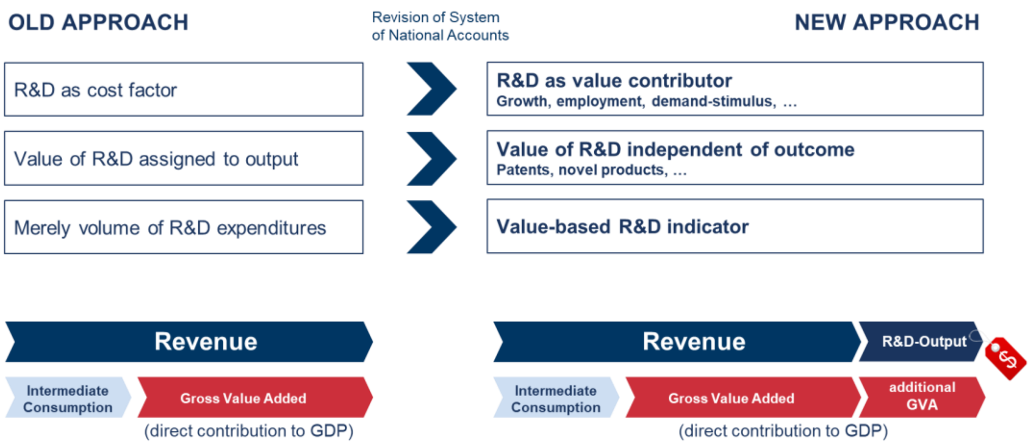
Source: Eurostat, OECD, ADB, WIOD and National Statistics; WifOR calculation.

Note: There is a difference in the figures above for the past years compared to the last project because of the updating of sources and the resulting level effect of the past estimates.

2.2 Impact of R&D activities

Research and development (R&D) enable an infinite number of new combinations of existing resources and is thus regarded as the origin of knowledge-based qualitative economic growth. The work of 2018 Nobel Prize winner in economics Paul Romer includes such core results and underlines the importance of R&D for long-term economic growth. R&D is crucial for maintaining competitiveness and being consistent with regional strategies like the Europe 2020 and the OECD Innovation strategy that include innovation-policy measures to promote R&D.

Figure 5: Treatment of R&D before and after the revision of the System of National Accounts.



Source: WifOR illustration.

The System of National Accounts provides a binding framework for calculating a country's GDP. A revision implemented in 2014 included the recommendation to treat R&D as contributor to economic growth and creator of a capital asset. The revision fundamentally changed the valuation of R&D: R&D expenditure must now be categorized as intellectual property, which creates an economic value for the economy regardless of its possible return. In this way, R&D can be assigned a “virtual” market value. This change in definition alone led to an upward correction of the GDP of several countries in 2014.

R&D comprises “creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge” (Frascati Manual 2015). This covers three types of activities: basic research, applied research and experimental development. Thus, any type of research activity that undertakes ‘pure’ basic research or aims at solving a ‘specific problem’ through product development and or planning to design a new or substantially improved product or process, whether intended for sale or own use is included in R&D activities.

2.2.1 GDP contribution

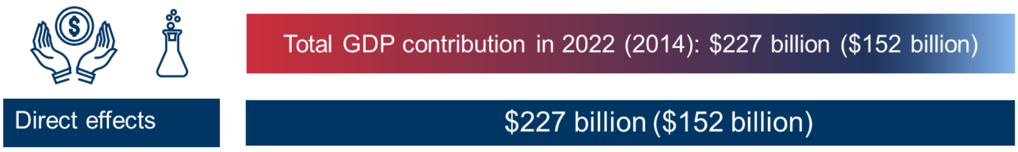
The GDP contribution of R&D activities is equally important as the GDP contribution of business activities because with the launch of the Frascati Manual by the OECD starting from September 2014, R&D services are no longer recorded purely as production inputs. Instead, R&D is treated as contributor to economic performance, and it is seen as a creator of a capital asset and hence a contribution to national wealth. The revision fundamentally changed the valuation of R&D. Based on this development, the costs invested in R&D are considered to build intellectual property, which creates value for the economy regardless of its immediate financial return. Therefore, using this approach it is necessary to assess the contribution of a company´s R&D activities to national economic gains i.e., to national wealth. Prior to the adoption of the Frascati Manual, R&D was treated as a cost factor and hence diminishing national wealth. However, now using this approach the direct economic impact i.e., the direct contribution of R&D activities to global GDP can be measured. This paradigm assumes that R&D activities contribute as value components to the total GDP contribution estimated above. This impact measurement is also imperative as it is in congruity with the EU 2030 sustainability and growth strategy which has a target of achieving an R&D intensity of 3%.

In order to estimate the GDP contribution of R&D activities, the technique used estimates this GDP contribution as a part of the total GDP contribution of the industry. This implies that the direct GDP contribution of the R&D activities of the pharmaceutical sector are already included in the direct GDP contribution of the whole pharmaceutical sector i.e., $755 billion and similar for the direct employment. This is based on the national accounts wherein R&D activities are not separately accounted for.

To measure the economic impacts of the R&D activities, the virtual gross markup (VGM) approach was used. The virtual gross mark-up (VGM) method is used to estimate the direct GDP contribution of Research and Development activities. The VGM ratio is both country and industry specific and reflects the national differences in personnel cost, capital intensity and profitability of the industry with regards to industry personnel cost. The R&D personnel cost for the R&D activities of the pharmaceutical industry by country was either obtained from OECD or estimated using the WifOR model. The region-wise share of R&D compensation paid in the pharmaceutical sector out of the total compensation paid in the sector was estimated using the available data from OECD. This share was multiplied with the compensation paid in the sector by country originated from the WifOR model. The direct GDP contribution was then estimated using these country-wise R&D specific personnel costs and the VGM.

The direct GDP contributed by R&D activities of the pharmaceutical industry was $227 billion in 2022. There has been a 49% increase witnessed in the direct GDP contributed by the R&D activities of the sector compared to 2014. The directly generated GDP contribution by the R&D activities of the sector was $152 billion in 2014[23]. This can also be interpreted as follows: out of the total direct GDP contribution of $755 billion in 2022 by the pharmaceutical industry, the R&D activities contributed a GDP of $227 billion (or 30%). These R&D effects can be triggered from any direct expenditure by a business enterprise on research and experimental development which is of considerable interest to national and international policymakers.

Figure 6: Direct GDP contribution effects of the R&D activities of the global pharmaceutical industry in 2022.



Source: WifOR's own calculations.

2.2.2 Employment

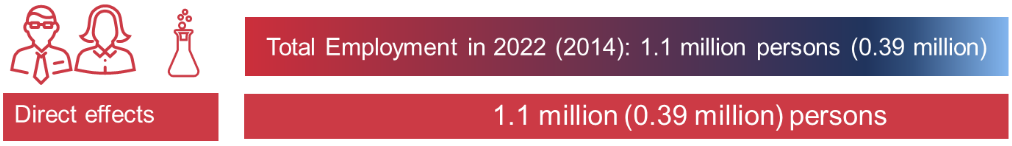
To arrive at the direct employment supported by the R&D activities of the pharmaceutical sector, the data was either collected from OECD or was estimated using R&D specific personnel costs by country, similar to GDP contribution. These R&D personnel costs were then multiplied by a country specific employment ratio of the pharmaceutical industry to arrive at the direct employment supported.

The direct employment supported by the R&D activities of the pharmaceutical sector were 1.1 million persons in 2022. The direct employment supported has witnessed a huge increase in 2022 compared to 2014. In 2014, the employment supported directly by the R&D activities of the pharmaceutical sector were 0.39 million persons[23]. This shows a 175% increase in 2022 compared to 2014. Similar to the GDP contribution above, out of the direct employment of 7.8 million supported by the pharmaceutical industry in 2022, 1.1 million (or 14%) is contributed by the R&D activities of the sector. The persons engaged in R&D activ-

[23] WifOR Institute 2018. Understanding Public and Private Funding for Pharmaceutical R&D: Does Society Really Pay Twice? https://www.wifor.com/uploads/2019/02/WifOR_IFPMA_Research_Report_Global_Pharma_RD-1.pdf

ities can be considered as highly trained researchers, specialists with high levels of technical experience and training, and other supporting staff who contribute directly to carrying out R&D projects and activities. These include all persons engaged directly in R&D, whether they are employed by the statistical unit or are external contributors fully integrated into the statistical unit's R&D activities, as well as those providing direct services for the R&D activities (such as R&D managers, administrators, technicians and clerical staff) by a business enterprise[24].

Figure 7: Direct employment effects of the R&D activities of the global pharmaceutical industry in 2022.



Source: OECD and WifOR's own calculations.

[24] OECD (2015), "Introduction to R&D statistics and the Frascati Manual", in Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development, OECD Publishing, Paris. DOI: https://doi.org/10.1787/9789264239012-3-en

3 Conclusion

The pharmaceutical industry plays a very critical role in the global economy not just due to its contribution to research, innovation, patient well-being, and development of medicines and vaccines but also in terms of value added to the global economy and employment supported.

This report estimates the global pharmaceutical industry's economic impact in terms of GDP contribution and jobs of the industry's own operations based on up-to-date national accounts datasets and the industry's sectoral and country interlinkages using input output analysis.

The pharmaceutical manufacturing activities add value to the economy due to its direct operations and has cross-sectional industry spillover effects on other sectors and countries in the global economy. The direct effects generated by the industry were $755 billion in 2022, compared to $532 billion in 2017, witnessing a 42% increase in terms of GDP contribution. Employment showed similar trends as it increased from 5.5 million to 7.8 million in 2022 compared to 2017. The spillover effects of the industry have also seen an increase in the past few years, as the GDP contribution increased from $1,306 billion in 2017 to $1,540 billion in 2022, however spillover effects for employment decreased slightly from 68 million in 2017 to 67 million 2022 due to inflation, increased labor costs and the supply chain disruptions in the world during the pandemic.

However, it is to note that the global pharmaceutical's GDP contribution constitutes not only from business activities' value added, but also from value added created by the global pharmaceutical's R&D activities. The R&D activities of the sector created a direct GDP contribution of $227 billion in 2022 and supported employment of 1.1 million persons globally.

Regarding the innovation capacity, the sector commits considerable resources to combat a myriad of diseases affecting the world, thus increasing productivity and longevity of humans globally. The sector has already improved in terms of GDP contribution and employment supported by the R&D activities, as evidenced by increases of 49% and 175% respectively over the last decade which was stated by the WifOR study that estimated the economic footprint of R&D activities of the sector for the year 2014.

The global pharmaceutical impact results can be used for policy making, steering investments for health, R&D, employment, and sustainable growth. These can be used for various purposes like communication with the policy stakeholders or government affairs, making strategic decisions including holistic steering and decision making. These results can therefore comprehensibly state the value added of an industry to the global economy.

Furthermore, with 52.4%, the global health sector is the primary buyer of pharmaceutical goods and services, and the rest comprises of all the other sectors[25] . This further strengthens the whole argument of perceiving health expenditures as investments and drivers of economic growth and societal well-being[26]. The recent pandemic has further reassured this argument that there is a greater need to place value on health globally and planning health investments strategically. Therefore, better health leads to economic growth and helps to relieve the burden on global health systems. Health investments create value through positive returns for the health sector, the economy, employment, and, overall, for the wealth of society.

[25] Please refer to Table 1 for the complete list of buyers of the pharmaceutical sector in 2022.

[26] WifOR Institute 2022. COVID-19 Policy Environment and the Importance of Health Economy in Latin America. https://www.wifor.com/en/roi-of-health-investments/

4 Appendix

I. Methodology

GDP contribution and Employment

The following section explains the methodology used for determining the direct, indirect and induced effects.

To begin with the GDP contribution and employment estimates, the basic data on direct GDP contribution and employment supported by the sector classification 'Manufacturing of pharmaceutical products and pharmaceutical preparations' or 'C21' by country was collected from public sources like OECD, Eurostat, National Accounts, ADB, AfDB and the UNSD for the year 2022 (refer to sources listed in Figure 8 and Figure 9). This collected data covered 59 countries or 70% by total volume already (Figure 9) for GDP contribution indicator. In case of employment, the data from public sources covered 81 countries or 48% of the volume (Figure 10). The main sources used to update the direct employment data included Official National Labor Force surveys, OECD, Eurostat, ILO, ASEAN and AfDB (refer to sources listed in Figure 8 and Figure 10).

Figure 8 provides the definition of the included pharmaceutical industry based on ISIC Rev. 4. It offers an overview of the geographical coverage by year and by sources that were used to estimate the direct effects of GDP contribution and employment.

Figure 8: Technical approach and coverage for updating the direct impact of the global pharmaceutical industry for the year 2022.

Definition of the Pharmaceutical Industry (ISIC Rev. 4)		
Class 21 "Manufacture of basic pharmaceutical products and pharmaceutical preparations" as part of section C "Manufacture" includes ▪ basic pharmaceutical products, ▪ pharmaceutical preparations,		
Details	**GDP contribution**	**Employment**
Coverage by number of countries	94% of countries (184 out of 195)	93% of countries (181 out of 195)
Coverage by volume	77% of volume covered by National Accounts; 23% by other databases	57% of volume covered by National Accounts; 43% by other databases
Coverage by sources	Volume covered by National Accounts ▪ Official National Statistics ▪ OECD STAN ▪ Eurostat Volume covered by other databases ▪ United Nations Statistical Division (UNSD) ▪ Asian Development Bank (ADB) ▪ African Development Bank Group (AfDB) ▪ Input-Output-Tables, WIOD and EORA	Volume covered by National Accounts ▪ Official National Labour Force Surveys ▪ OECD STAN ▪ Eurostat ▪ ILO (Labor Force Surveys) Volume covered by other databases ▪ ILO Modelled estimates ▪ ASEAN Statistical Yearbook and African Development Bank Group (AfDB)
Range of years	2020-22 (91% of volume); 2018-19 (9% of volume); 2008 (0.001% of volume)	2020-22 (97% of volume); 2017-19 (3% of volume); 2007-16 (0.01% of volume)

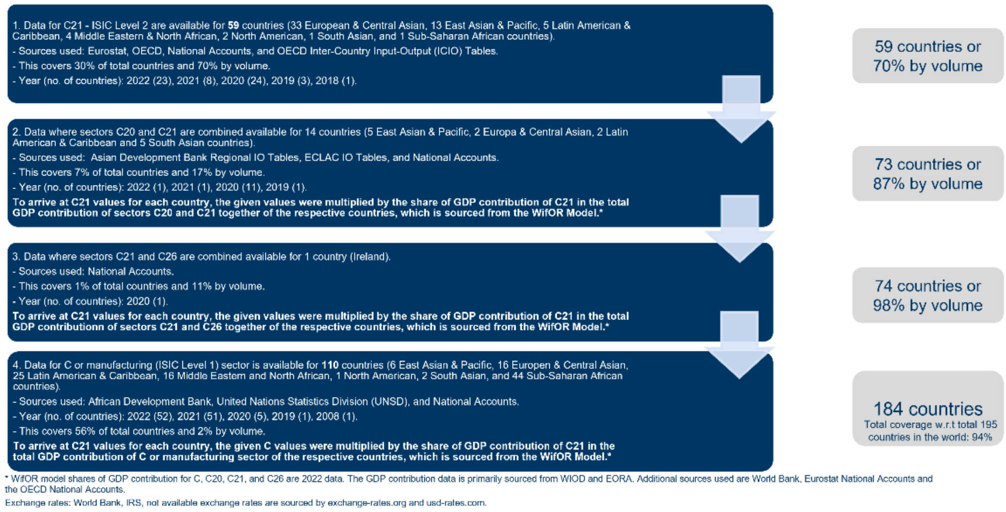
Source: WifOR illustration.

Figure 9 points out the technical approach for the direct GDP contribution. Depending on the availability of data, appropriate approaches were chosen to determine the direct GDP contribution of the respective countries. As mentioned above, the official data on the GDP contribution of the pharmaceutical industry was compiled for 59 countries. This accounted for 70% of the pharmaceutical industry's total direct GDP contribution.

The next method of collecting data for the pharmaceutical sector (C21) used combined data of itself and of the chemical industry (C20). To arrive at the C21 values for each country, the given values were multiplied by the share of GDP contribution of C21 in the total GDP contribution of both industries together of the respective countries. That share was sourced from the WifOR model. The appropriate survey methodology was used for 14 countries or 17% by volume. For one country (Ireland) the same approach was used for, but with a share of C21 and the manufacturing sector of computers and peripheral equipment (C26). The GDP contribution of Ireland's pharmaceutical industry was equal to 11% of the total worldwide GDP contribution of C21.

For 110 countries (resp. 2% by volume) data for the manufacturing sector (ISIC level 1) for each country was multiplied by the share of GDP contribution of C21 in the total GDP contribution of the manufacturing sector of the respective countries. The share was sourced from the WifOR model. In total the project covers 94% of the world's total 195 countries to estimate the direct GDP contribution of the pharmaceutical industry.

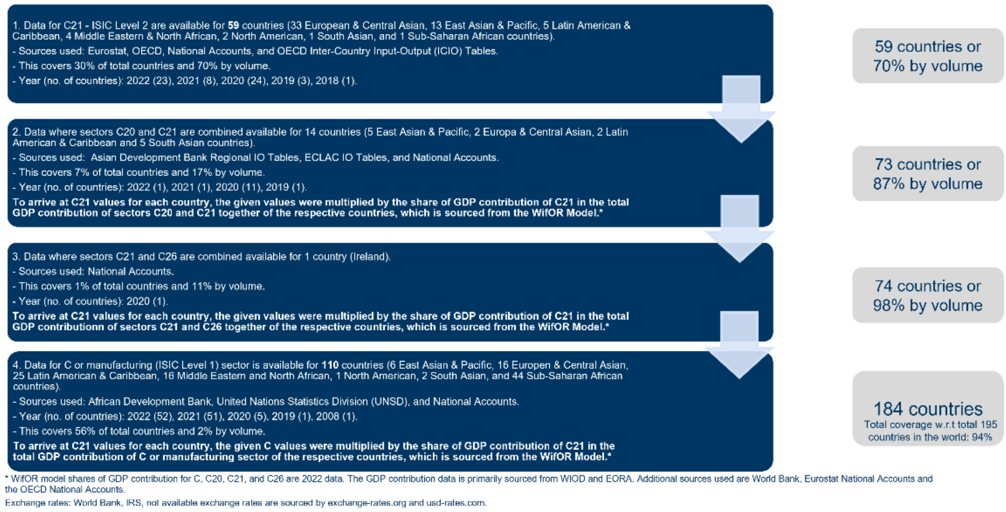
Figure 9: Technical approach for the direct GDP contribution.



Source: WifOR illustration.

Similar approaches were used for compiling the direct employment of the pharmaceutical industry. Whereby, the third step wasn't necessary, because the employment of Ireland was caught up by another one. In total 93% of the 195 countries worldwide were covered. Therefore, it is to be noted that this study estimated the global impact of the pharmaceutical industry both at a global and country level. However, in this report only the global level results are shown.

Figure 10: Technical approach for the direct employment.

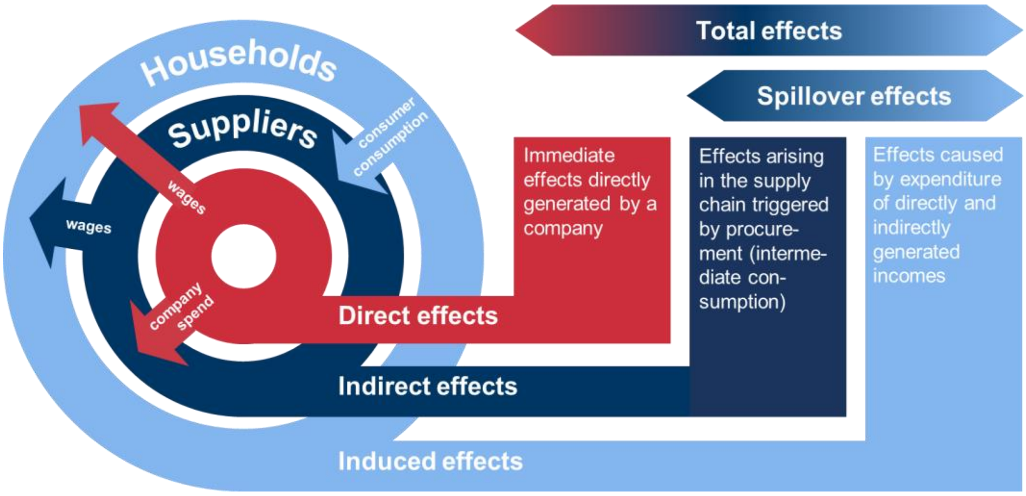


Source: WifOR illustration.

In addition to direct effects, the present analysis includes indirect and induced economic effects. Indirect effects are triggered by the procurement of goods and services from suppliers (other sectors than the pharmaceutical sector). Due to this stimulus, economic activity is increased along the entire supply chain.

This increase is reflected in the GDP contribution and other key economic factors. Induced effects capture the economic participation of households and their consumption patterns. They quantify the overall effects on the economy triggered by the expenditure of wages and salaries which are paid either directly through the pharmaceutical industry or indirectly generated along supply chains. The combination of indirect and induced effects is called spillover effects. Total economic effects refer to the sum of all three (direct, indirect, and induced effects) (see Figure 11).

Figure 11: Economic impact model: direct, indirect and induced effects.



Source: WifOR illustration.

In Input-Output-Modelling, the entire value chain of the company or organization can be accounted for. The estimations are based on primary financial data (a detailed list with region-specific information regarding the amount and type of goods purchased and sold) that are then translated into economic indicators. As both approaches deliver valuable results, efforts were made to match bottom-up and top-down approaches (Beylot, Corrado, and Sala 2019[27]). Integrating results from bottom-up assessments into the top-down Input-Output-framework allows to enhance data quality while not restricting the scope of analysis.

Input-Output analysis was originally developed by Wassily Leontief (Leontief 1936[28]) to describe the industrial structure of an economy and understand how changes in one economic sector may affect other sectors. Leontief is known for his research on IO-Analysis and earned the Nobel Prize in Economics for his

[27] Antoine, B., Corrado, S., and Sala, S. (2019), Environmental Impacts of European Trade: Interpreting Results of Process-Based LCA and Environmentally Extended Input–Output Analysis towards Hotspot Identification. The International Journal of Life Cycle Assessment, July. https://doi.org/10.1007/s11367-019-01649-z.

[28] Leontief, Wassily W. (1936). Quantitative Input and Output Relations in the Economic Systems of the United States. The Review of Economics and Statistics 18 (3): 105. https://doi.org/10.2307/1927837.

development of its associated theory in 1973. Applying the technique of IO-Analysis, it is possible to trace the inputs of production along the entire supply chain. This allows for the calculation of upstream impacts of a company or an organization. In addition to the direct effects, which describe the immediate effects directly generated by a company or an organization, input-output analysis allows for the calculation of (indirect) upstream effects. Upstream effects arise due to the input the company or the organization demands from other economic agents. Order placements result in an increase of economic activity at commissioned agents and their suppliers. This stimulus increases the GDP contribution or gross value added (GVA) and other key figures along the supply chain, which are summarized under the term upstream effects. The model comes with an array of assumptions[29], however it is widely agreed that it is well suitable for impact analysis.

The basis for the calculation of indirect effects can be illustrated by the following equilibrium equation:

$$x = Ax + y \rightarrow x = (I - A)^{-1}\, y \quad (1)$$

where x represents the vector of total gross output of a sector and y represents the vector of final demand and includes domestic consumer spending, assets, changes in inventories and exports. A represents the matrix of intermediate consumption per unit of output.

Equation (1), with $L = (I - A)^{-1}$being the Leontief inverse, can be determined by the following mathematical transformation:

$$x = Ax + y$$

$$y = x - Ax$$

$$y = (I - A)x$$

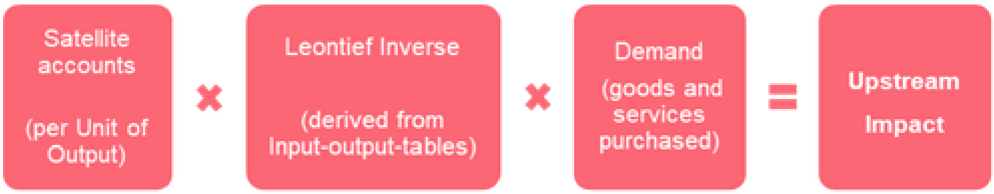
since $(I - A)^{-1} \times (I - A) = 1$, with I being the identity matrix, $x = y\,(I - A)$ equals$x = \ (I - A)^{-1}\, y$.

With $x,$ the output triggered by a given demand y, the corresponding GVA can be derived using country and sector specific ratios of GVA to output. Other effects (e.g., employment) are calculated analogously using respective satellite

[29] The assumptions of the Leontief model are: 1) Constant returns to scale, meaning that regardless of the level of production, the same quantity of inputs is needed per unit of output. 2) No Supply Constraints, meaning there are no restrictions to raw materials, services, or other inputs such as employment. 3) Fixed Input Structure: meaning that there is no input substitution in response to a change in output.

accounts. In simple terms the indirect (upstream) impact of a company or an industry is the result of the multiplication of three components.

Figure 12: Components of upstream calculation.



Source: WifOR illustration.

As shown in Figure 12, the calculation of upstream impacts requires input-output tables to derive the Leontief Inverse, corresponding satellite accounts, and the intermediate consumption of an industry organization under investigation.

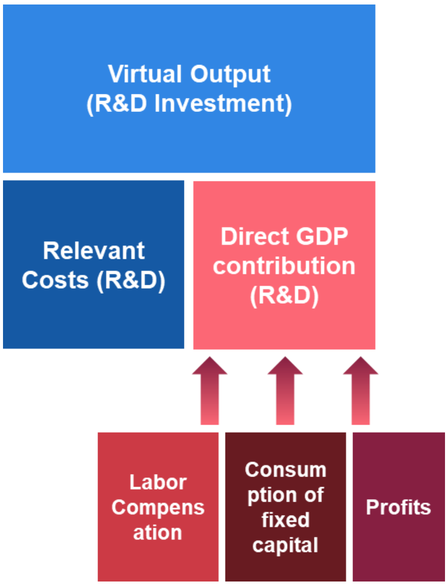
IMPACT OF R&D ACTIVITIES

Income Approach

The system of national accounts (SNA) provides a binding framework for calculating a country's GDP. Starting from September 2014, research, and development (R&D) services are no longer recorded purely production inputs[30]. Instead, a revision implemented in 2014 included the recommendation to treat R&D as contributor to economic growth and creator of a capital asset. The revision fundamentally changed the valuation of R&D: R&D expenditure must now be categorized as intellectual property, which creates an economic value for the economy regardless of its possible return. This change in definition alone led to an upward correction of the GDP of several countries in 2014.

[30] Meaning that R&D is treated as intermediate consumption and is assumed to be completely consumed in the value chains of the users in the current business cycle. For references see: System of National Accounts 2008; European system of accounts ESA 2010; Frascati Manual 2015, OECD; Forschung und Entwicklung in den Volkswirtschaftlichen Gesamtrechnungen, VGR, Destatis; Erhebung für Forschung und Entwicklung, Stifterverband; Identifikation der Unternehmen mit F&E Aufwendungen, Schweizerische Eidgenossenschaft that are completely consumed in the value chains of the users in the current business cycle, but as gross fixed capital formation that are used in several production cycles.

Figure 13: Income approach to estimate GDP contribution.



Source: WifOR-illustration based on the European System of National Accounts 2010 (implemented in 2014).

The income approach to measure the economic impacts of R&D activities is done using the income approach, wherein,

$$GDP\ contribution = Compensation\ of\ employees + Consumption\ of\ fixed\ capital + other\ taxes\ minus\ other\ subsidies\ on\ production + Net\ Operating\ Surplus\ Value$$

This approach measures GDP contribution by adding the incomes that industries need to pay to the different production factors, i.e., labor and capital, that contribute to the output. Additional elements are taxes and subsidies and profits or net operating surplus. However, in case of the capitalization of research and development activities, the income approach is recommended because of the lack of data to estimate using the output approach. This approach follows international guidelines by the OECD and the recommendations of the European system of national accounts, thus is in line and directly comparable to international macroeconomic figures[31].

For this study, the personnel costs were provided from either public source like OECD or estimated using the WifOR model using industry and sector averages, however for the remaining direct GDP of R&D components, the virtual gross mark-up technique (VGM) was used based on country- and industry-specific estimates. For 30 countries or 90% by volume, the R&D specific labor costs

[31] Compare with the European system of national accounts, ESA 2010, Eurostat, European Commission, European Union, 2013 and the Manual on measuring Research and Development in ESA 2010, Eurostat, European Commission, European Union, 2014.

were covered by OECD. Followed by 23 countries or 7% by volume for which the R&D labor costs were arrived at using their R&D expenditures. To arrive at R&D labor cost values for each country, the given R&D expenditure values were multiplied by the share of R&D compensation in total R&D expenditure of their respective regions, which is sourced from the OECD. For the remaining 136 countries that made up 3% of the total volume, the labor costs were estimated using the WifOR model. Firstly, the share of R&D labor costs in the sector C21 sector in the total labor costs of the sector C21 by regions (source of this ratio is the OECD) were estimated. Secondly, these shares were multiplied with labor costs data for the sector C21 derived from the WifOR model for each country. Figure 14 can be referred to for detailed list of approaches and coverage for labor costs related to R&D activities.

Figure 14: Technical approach for estimating data for R&D Labor cost of employees in 2022.

Source: WifOR illustration.

The VGM ratio is an average industry markup ratio based on data published by OECD for each industry per country and reflects the national differences in personnel cost, capital intensity and profitability of an industry with regards to total industry personnel cost per country. The statistical industry VGM ratio per country is multiplied with a company's or an industry's personnel cost for research & development per country to receive the Virtual gross margin (VGM) on country level. Here the VGM was estimated as:

$$VGM_{industry} = \frac{GVA_{(country,industry)} - compensation\ of\ employees_{(country,industry)}}{compensation\ of\ employees_{(country,industry)}}$$

Then, this VGM was multiplied with pharmaceutical industry's personnel cost for R&D activities by country. Consequently, the direct GDP contribution yields:

$$Direct\ GDP\ contribution = R\&D\ Labor\ Cost\ \times (1 + Virtual\ Gross\ Markup)$$

The employment of pharmaceutical industry's R&D activities supported directly by each country were estimated using either the publicly sourced data from OECD or estimated using the employment ratio (from WifOR model), which was then multiplied with the labor costs estimated above, that represents compensation of employees where,

$$Emplyoment\ ratio_{(country\ industry)} = \frac{Number\ of\ employees_{(country\ industry)}}{Compensation\ of\ employees_{(country\ industry)}}$$

$$Direct\ Employment = R\&D\ Labor\ cost\ \times Employment\ ratio$$

The data for 36 countries for R&D supported employment by the pharmaceutical industry was collected from OECD that made up 44% of the total volume. For the rest 152 countries, or 56% by volume, the data was estimated using the WifOR model. To arrive at the number of R&D employees for each country, firstly the share of employment by compensation or labor cost of employees in sector C21 by country (source of this ratio is WifOR model) were estimated. Secondly, these shares were multiplied with the R&D labor data for C21 derived earlier for each country. Figure 15 can be referred to for detailed list of approaches and coverage for labor costs related to R&D activities.

Figure 15: Technical approach for estimating data for R&D employees in 2022.

Source: WifOR illustration.

II. Data Sources and Coverage

Table 3 and Table 4 provide the data sources by region for the direct GDP contribution and the direct employment supported by the pharmaceutical industry.

GDP CONTRIBUTION

Data for European countries was mostly sourced from National accounts or public sources like Eurostat and OECD and the data ranged between 2022 and 2020, in terms of time period and for Class 21. Therefore, for Europe there is both better quality and updated data available. Similarly, for North America which includes the USA and Canada, the data was easily available from their national accounts specifically for Class 21. For Asian countries, the input-output data provided by the Asian Development Bank (ADB) proved to be a crucial source. However, the data provided by the ADB was not specifically at the C21 level but also included the chemical sector along with the pharmaceutical sector. Herein, the C21 sector was separated using shares of C21 in the aggregated chemical and pharmaceutical sector classification provided by the WifOR model by country. The IO data was used only in case of those Asian countries wherein data wasn't available in their national accounts. For rest of the main countries of Asia like Australia, New Zealand, Japan, South Korea, Singapore, Taiwan, Hong Kong, Indonesia, India, Malaysia, Thailand and Vietnam, the data was available in their national accounts. For the rest of the countries like the middle eastern and African countries, estimation of the direct effects was a challenge due to paucity of data. For most of these countries, the data wasn't available at the Class 21 level but only at a higher 'Manufacturing' level which includes all the manufacturing industries. This data was broken down to Class 21 using shares of GDP contribution of C21 in overall GDP contribution of manufacturing sector 'C' from the WifOR model by country for the year 2022. The main source of the manufacturing level data was UNSD, the African Development Bank and the IO table provided by OECD (Table 3).

Table 3: Data sources by region for direct GDP contribution

Region		Coverage (w.r.t. volume)	Approach (1,2,3 or 4) (refer prev. slide)	Sources	Classification	Countries
Europe & Central Asia (including	EU27 (including Malta)	26%	1 (25 countries) 2 (SWE) 3 (IRL)	National Accounts (Official Statistics, Eurostat)	NACE Rev. 2 level 1and 2	Austria, Belgium, Bulgaria, Czech Republic, Estonia, Finland, France, Greece, Croatia, Hungary, Italy, Malta, Netherlands, Romania, Slovakia, Slovenia (2022: Eurostat (NA)); Cyprus, Germany, Spain, Latvia,

						Poland, Portugal (2021: Eurostat (NA)); Denmark (2020: Eurostat (NA)); Sweden (2021: NA Sweden); Lithuania, (2022: NA Lithuania); Ireland (2020: NA Ireland); Luxembourg (2022: NA Luxembourg).
	Other European Countries including Central Asia	10%	1 (9 countries) 4 (8 countries)	National Accounts (Official Statistics, Eurostat, OECD iSTAN, UNSD); IOT (Asian Development Bank); ICIOT (OECD)	NACE Rev. 2 level 1, and 2; ISIC Rev. 3, and 4; ADB MRIOT sector classification	Bosnia and Herzegovina, Switzerland, Serbia (2022: Eurostat (NA)); TFYR Macedonia (2020: Eurostat (NA)); UK (2019: OECD iSTAN (NA)); Tajikistan (2022: UNSD (NA)); Andorra, Azerbaijan, Georgia, Greenland, Liechtenstein, Monaco, Montenegro, San Marino, Turkmenistan, Ukraine, Uzbekistan (2021: UNSD (NA)); Norway (2022: NA Norway); Armenia (2022: NA Armenia); Turkey (2022: NA Turkey); Albania (2021: NA Albania); Belarus (2021: NA Belarus); Russia (2020: NA Russia); Kyrgyzstan (2020: Asian Development Bank (IOT)); Iceland, Kazakhstan (2020: OECD (ICIOT)).
East Asia & Pacific		25%	1 (13 countries) 2 (5 countries) 4 (6 countries)	National Accounts (Official Statistic, OCED iSTAN, UNSD); IOT (Asian Development Bank); ICIOT (OECD)	NACE Rev. 2 level 2; ISIC Rev. 3, and 4; ADB MRIOT sector classification	Japan (2019: OECD iSTAN (NA)); Samoa (2022: UNSD (NA)); Myanmar, New Caledonia, Papua New Guinea, French Polynesia, Vanuatu (2021: UNSD (NA)); Brunei, China, Fiji, Mongolia, Philippines (2020: Asian Development Bank (IOT)); Taiwan (2022: NA Taiwan); Australia, Hong Kong, Indonesia, Cambodia, South Korea , Laos, Malaysia, New Zealand, Singapore, Thailand, Vietnam (2020: OECD (IOCT)).
Latin America & Caribbean		2%	1 (5 countries) 2 (2 countries) 4 (25 countries)	National Accounts (Official Statistics, OECD iSTAN, UNSD); IOT (ECLAC); ICIOT (OECD)	NACE Rev. 2 level 2; ISIC Rev. 3, and 4	Mexico (2018: OECD iSTAN (NA)); Honduras, Nicaragua, Panama, British Virgin Islands (2022: UNSD (NA)); Aruba, Antigua, Bahamas, Belize, Bolivia, Barbados, Cuba, Cayman Islands, Dominican Republic, Guatemala, Guyana, Haiti, Peru, Paraguay, El Salvador, Suriname, Trinidad and Tobago, Uruguay, Venezuela, (2021: UNSD (NA)); Netherlands Antilles (2008: UNSD (NA)); Argentina (2022: NA Argentina); Jamaica (2019: NA Jamaica); Brazil, Chile, Colombia, Costa Rica (2020: OECD (ICIOT)); Ecuador (2019: ECLAC (IOT)).

Middle East & North Africa (excluding Malta)	2%	1 (4 countries9 4 (16 countries)	National Accounts (Official Statistics, UNSD); IOT (African Development Bank); ICIOT (OECD)	NACE Rev. 2 level 2; ISIC Rev. 3, and 4; ISIC 1	UAE, Bahrain, Iran, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Syria, Tunisia, Yemen (2021: UNSD (NA)); Israel (2019: NA Israel); Saudi Arabia (2022: NA Saudi Arabia); Djibouti, Algeria, Libya, (2020: African Development Bank (IOT), Egypt, Morocco (2020: OECD(IOCT)).
North America	31%	1 (2 countries) 4 (BMU)	National Accounts (Official Statistics, UNSD); ICIOT (OECD)	NAICS; ISIC Rev. 3	Canada (2020: OECD (ICIOT), Bermuda (2021: UNSD (NA)); USA (2022: NA USA).
South Asia	3%	1 (IND) 2 (5 countries) 4 (2 countries)	National Accounts (Official Statistics, UNSD); IOT (Asian Development Bank)	ISIC Rev. 3; ADB MRIOT sector classification; NIC-2008	Afghanistan, Maldives (2021: UNSD (NA)); India (2021: NA India); Bangladesh, Bhutan, Sri Lanka, Nepal, Pakistan (2020: Asian Development Bank (IOT)).
Sub-Saharan Africa	1%	1 (Cote d'Ivoire) 4 (44 countries)	National Accounts (African Development Bank); ICIOT (OECD)	ISIC 1; ISIC Rev. 4	Angola, Burundi, Benin, Burkina Faso, Botswana, Central African Republic, Cameroon, DR Congo, Congo, Cape Verde, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Gambia, Kenya, Liberia, Lesotho, Madagascar, Mali, Mozambique, Mauritania, Mauritius, Malawi, Namibia, Niger, Nigeria, Rwanda, South Sudan, Senegal, Sierra Leone, Somalia, Sao Tome and Principe, Sudan, Seychelles, Chad, Togo, Uganda, South Africa, Zambia, Zimbabwe (2022: African Development Bank (NA)); Swaziland, Tanzania (2020: African Development Bank (NA)); Cote d'Ivoire (2020: OECD(ICIOT)).

Note: Classification of geographical regions based on World Bank Country Classification; EU27 includes Malta.

EMPLOYMENT

Data for European countries was mostly sourced from National labor force surveys or public sources like Eurostat and OECD and the data ranged between 2022 and 2019, in terms of time period and for Class 21. Therefore, for Europe there is both better quality and updated data available, similar to GDP contribution. Similarly, for North America which includes the USA and Canada, the data was easily available from their national labor force surveys specifically for Class 21. For Asian countries, the data provided by ILO proved to be a crucial source. The ILO data was used only in case of those Asian countries wherein data wasn't available in their national labor force surveys or OECD. However, for most of the Asian countries, the data was available in their national labor force surveys, which covered a major part of the volume in terms of Asia. For the rest of the countries like the middle eastern and African countries, the data availability was a challenge similar to GDP contribution, due to lack of data. For most of these countries, the data wasn't available at the Class 21 level but only at a higher 'Manufacturing' level which includes all the industries. This data was broken down to Class 21 using shares of employment of C21 in overall employment of the manufacturing sector 'C' from the WifOR model by country. The main source of the manufacturing level data was ILO, the African Development Bank and ASEAN (Table 4).

Table 4: Data sources by region for direct employment

Region		Coverage (w.r.t. volume)	Approach (1,2,3 or 4) (refer prev. slide)	Sources	Classification	Countries
Europe & Central Asia (including Malta)	EU27 (including Malta)	8%	1 (23 countries) 3 (3 countries)	National Accounts (Official Labor Force Surveys, Eurostat and ILO)	NACE Rev. 2 level 2 and ISIC Rev. 4	Austria, Belgium, Bulgaria, Czech Republic, Cyprus, Denmark, Estonia, Finland, Greece, Croatia, Hungary, Ireland, Italy, Malta Netherlands, Slovakia, Slovenia, Sweden (2022: Eurostat); Lithuania, Luxembourg, Romania (2021: National LFS) Germany, Spain, France, Latvia, Poland, Portugal (2021: Eurostat); Denmark (2020: Eurostat).
	Other European Countries	5%	1 (12 countries)	Official Labor Force Surveys; Eurostat and ILO	NACE Rev. 2 level 2, SIC 2007 and	Bosnia and Herzegovina, Belarus, Switzerland, Greenland, Iceland, Monaco, Moldova, Montenegro, Norway, Serbia, Azerbaijan, Kazakhstan, Tajikistan,

including Central Asia		2 (2 countries) 3 (11 countries)	(LFS and Modelled estimates)	ISIC Rev. 4	Turkmenistan, Turkey, Uzbekistan, Kyrgyzstan (2022: Eurostat, ILO and LFS); Albania, Armenia, Liechtenstein, TFYR Macedonia, Russia, Ukraine (2021: ILO (LFS)), Georgia (2020: ILO (LFS)), UK (2019: OECD)
East Asia & Pacific	43%	1 (11 countries) 2 (2 countries) 3 (13 countries)	Official Labor Force Surveys, ILO (LFS and Modelled estimates), ASEAN Statistical Yearbook	NACE Rev. 2 level 2, ANZSIC and ISIC Rev. 4	Australia, China, Fiji, Hong Kong, Japan, Laos, Macao SAR, Myanmar, Mongolia, Malaysia, New Caledonia, Philippines, Papua New Guinea, N. Korea, French Polynesia, Singapore, Thailand, Taiwan, Vietnam, Vanuatu, Samoa (2022: LFS and ILO); Indonesia (2020: ASEAN); Cambodia, S. Korea (2019: ILO); Brunei, New Zealand (2018: ILO and OECD)
Latin America & Caribbean	6%	1 (15 countries) 3 (14 countries)	Official Labor Force Surveys, OECD and ILO (LFS and Modelled estimates)	NACE Rev. 2 level 2 and ISIC Rev. 4	Argentina, Bahamas, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Haiti, Jamaica, Nicaragua, Panama, Paraguay, El Salvador, Trinidad and Tobago, Uruguay, Venezuela, British Virgin Islands (2022: ILO); Guyana, Honduras (2019: ILO); Barbados, Mexico (2018: ILO and OECD); Suriname (2016: ILO); Aruba (2007: National Accounts)
Middle East & North Africa (excluding Malta)	3%	1 (8 countries) 3 (12 countries)	ILO (LFS and Modelled estimates)	NACE Rev. 2 level 2 and ISIC Rev. 4	UAE, Bahrain, Djibouti, Iran, Algeria, Israel, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Yemen (2022: ILO); Egypt, Iraq, Jordon (2021: ILO); Tunisia (2019: ILO)
North America	9%	1 (2 countries)	National Accounts and Offi-	ISIC Rev.4, 2 digit	Canada, USA (2022: LFS and NA)

			cial Labor Force Survey	level, NAICS	
South Asia	18%	1 (2 countries) 3 (6 countries)	Official Labor Force Surveys, ILO (LFS and Modelled estimates)	ISIC Rev. 4	Afghanistan, Bangladesh, Bhutan, India, Sri Lanka, Maldives (2022: LFS and ILO); Pakistan (2021: LFS); Nepal (2018: LFS)
Sub-Saharan Africa	7%	1 (8 countries) 3 (37 countries)	Official Labor Force Surveys, ILO (LFS and Modelled estimates	ISIC Rev. 4	Burundi, Benin, Botswana, Central African Republic, Cameroon, DR Congo, Congo, Cape Verde, Eritrea, Gabon, Ghana, Guinea, Gambia, Liberia, Lesotho, Madagascar, Mozambique, Mauritania, Malawi, Nigeria, Rwanda, South Sudan, Senegal, Sierra Leone, Sao Tome and Principe, Sudan, Swaziland, Chad, Togo, Tanzania, Uganda, South Africa, Zimbabwe (2022: LFS and ILO); Ethiopia, Mauritius (2021: LFS and ILO); Mali, Seychelles, Zambia (2020: LFS and ILO); Angola, Cote d'Ivoire, Kenya, Somalia (2019: LFS and ILO); Burkina Faso, Namibia (2018: LFS and ILO); Niger (2017: ILO)

Note: Classification of geographical regions based on World Bank Country Classification; EU27 includes Malta.

III. Methodological Differences with Similar Studies

The aim of this study is to compute the direct as well as the global spillover effects in other economic sectors of the pharmaceutical industry. Similar reports on the economic and social impact of the pharmaceutical industry for other geographical regions and time frames exist. While those reports tend to have similar results, there are some methodological and scientific research question differences, which explain most of the variations with those results.

The main methodological differences with other studies are described below:

1. The impact results from this study are based on a multiregional input-output database. Thus, they include intercountry linkages (e.g. the impact from the pharmaceutical sector in Germany on the chemical sector in France). Figures from other similar reports may be based on national input-output tables. In consequence, they would exclude intercountry effects (i.e. the results only show the national pharmaceutical impact in its domestic economy). As a result, focusing only on representing the sum of domestic effects, would leave out intercountry effects or the global impacts along the value chain.

2. The computations for this study's impact results are based on both the WIOD data set as well as the most recent (2022 data when available) country-specific intermediate consumption. Also, the data has been adjusted for inflation. The time frame and exact source of data may differ in other studies. This data is also updated for the impacts of the COVID-19 pandemic on the global supply chains.

3. This report's employment effects are based on "persons engaged", i.e. employees as well as self-employed persons, whereas other studies' employment effects may refer only to employees.

4. This study's results are exempt from double counting of the pharmaceutical industry itself because its research aim is to analyze the impact of the pharmaceutical industry onto the other sectors along the global supply chain. Hence, the results show the effect of the global pharmaceutical industry onto the global economy without including the impact onto itself (e.g. the impact from the pharmaceutical sector in Germany on the pharmaceutical sector in France).

5. This study's induced effects are based on available income (which is adjusted for taxes and savings), whereas other reports may not explicitly adjust income for savings and taxes.

Indicators Glossary

Direct (Economic) Effects	Direct effects refer to the direct contribution of a company or sector to the economy. What did the company generate in terms of economic value? These direct effects are reflected in the economic output of a company, or its value added (see below) or the number of employed persons.
Employment factor	Employment (job) supported in the global supply chain (indirect and induced) for every employment (job) supported directly.
Employment supported	Employment supported by a company means the absolute number of jobs supported by the company. This can be both directly and indirectly or along the global supply chain.
GDP contribution factor	GDP contribution created in the global supply chain (indirect and induced) for every GDP contribution created directly.
GDP Contribution or Gross Value Added (GVA)	The GDP Contribution or GVA describes a company's contribution to the gross domestic product (GDP). The value added is the key figure for measuring a country's economic development and it's prospective of growth and economic welfare.
Indirect (Economic) Effects	The production activities of a company or sector require purchased materials and services. Such purchased materials and services in turn result in increased production among suppliers who also require purchased materials and services for their own production process. The cascading effects that develop as a result (e.g. employment, gross value added) are referred to as the indirect economic effects of the enterprise.
Induced (Economic) Effects	Induced effects refer to those economic effects that result from renewed spending of directly and indirectly generated incomes.

Intermediate Consumption	Value of goods used for further processing and/or purchased materials and services for downstream economic sectors.
NACE (Statistical Classification of Economic Activities)	NACE is a classification providing the framework for collecting and presenting a large range of statistical data according to economic activity in the fields of economic statistics (e.g., production, employment, and national accounts) and in other statistical domains developed within the European Statistical System (ESS).
Research and development	Research and development (R&D) comprise of creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge. It is regarded as a decisive factor for long-term economic growth and is particularly important in a resource-poor economy.
Spillover Effects	The sum of indirect economic effects and economic effects induced by private consumption are called economic spillover effects.
Tax Wedge	Tax wedge is defined as the ratio between the amount of taxes paid by an average single worker (a single person at 100% of average earnings) without children and the corresponding total labor cost for the employer.
Virtual Gross Markup (VGM)	VGM ratio is an industry markup ratio published by OECD for each industry per country. The VGM ratio is both country and industry specific and reflects the national differences in personnel cost, capital intensity and profitability of the pharmaceutical industry with regards to total industry personnel cost per country. The statistical industry VGM ratio per country is then multiplied with a company's or organization's personnel cost for research & development / country to receive the Virtual gross margin (VGM) on country level.

WifOR is an independent economic research institute that emerged from a spin-off of the Department of Economics and Economic Policy at the Technical University of Darmstadt. We see ourselves as an academic partner and think tank on a global level. WifOR's research fields include economic, environmental, and social impact analyses as well as labor market and health economic research.

CONTACT
WifOR Institute
Rheinstrasse 22
64283 Darmstadt, Germany
Germany | Greece | Ireland | Latin America | USA
www.wifor.com