RESEARCH REPORT

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The Global Economic Impact of the Pharmaceutical Industry

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EXECUTIVE SUMMARY

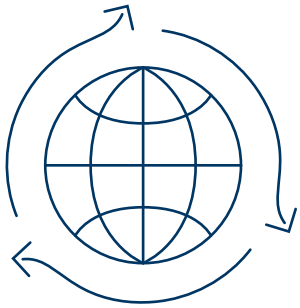
Global GDP contribution of 532 billion U.S. dollars

The global pharmaceutical industry directly **contributed 532 billion U.S. dollars of gross value added to the world's GDP** in 2017. This equals **one percent of global GDP** or about the **GDP of the Netherlands**.

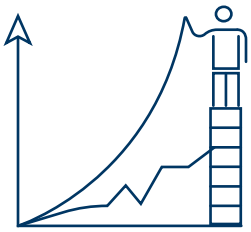
5.5 million jobs created

The global pharmaceutical industry **directly employed over 5.5 million** highly productive persons in 2017. This is equivalent to **Switzerland's total workforce**.

Another 45 million jobs supported along the global supply chain in particularly benefitting Asian and other developing countries due to structural differences in these regions



The global pharmaceutical industry procured direct inputs from other sectors worth over 800 billion U.S. dollars. This triggered effects in global supply chains resulting in **another 791 billion U.S. dollars of GDP contribution and another 45 million supported jobs** in the global work force. Moreover, the private consumption triggered by directly and indirectly generated income resulted in an extra **515 billion U.S. dollars of GDP contribution** and supported an extra **24 million jobs** in the labor market.



Through its economic activity, the global pharmaceutical industry contributes to the **United Nations' Sustainable Development Goal 8: Promote economic growth, employment and work for all.**

INTRODUCTION

In 2017, the global pharmaceutical market was valued at 1,135 billion U.S. dollars.[1] The market has experienced ongoing growth over the last decade and is predicted to continue this trend. For the European Union, a growth rate of 3.1 percent[2] until 2022 is estimated, for North America 5.4 percent[3].

The pharmaceutical industry is part of the global health economy, which in 2014 was responsible for a contribution of 5,600 billion U.S. dollars to the global GDP and supported 183 million people in the labor force.[4] The pharmaceutical industry holds a share of eight percent in the global health economy (in terms of contribution to GDP) and hence plays an important role in addressing modern challenges.

Future large impacts are expected from the widely untapped emerging markets.[5] They offer vast growth potential made visible through an increase in per capita use of medicine and growing consumer income: medicine spending in these regions is expected to grow at five to eight percent through 2023.[6] Therefore, the pharmaceutical industry has and will continue to have a significant economic impact on the global economy both in terms of the creation of contribution to GDP and employment.

The global pharmaceutical industry's economic impact is twofold. First, through the production of pharmaceutical products, the industry contributes directly to world GDP and supports a high number of employees. Second, 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.

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, botanical products.[7] The year of compilation is 2017.

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[1] Statista, 2020. Revenue of the worldwide pharmaceutical market from 2001 to 2019 assembled from several statistics by IQVIA Institute for Human Data Science as published by Pharmaceutical Commerce.
[2] *Statista, 2019. Market growth forecast for certain pharmaceutical markets between 2017 and 2022*.
[3] Statista, 2019. *Projected global pharmaceutical market growth between 2017 and 2022, by region*. 9
[4] WifOR calculations
[5] Including: China, Brazil, India, Russia, Algeria, Argentina, Bangladesh, Chile, Colombia, Egypt, Indonesia, Kazakhstan, Mexico, Nigeria, Pakistan, Philippines, Poland, Saudi Arabia, South Africa, Turkey and Vietnam.
[6] IQVIA Institute, 2019. *The Global Use of Medicine in 2019 and Outlook to 2023.*
[7] United Nations, International Standard Industrial Classification of All Economic Activities, Revision 4, Statistical Papers Series M No.4/Rev.4, 2008, New York.

DESCRIPTIVE ANALYSIS

SUPPLY AND DEMAND STRUCTURE

In 2017, the global pharmaceutical industry had a total intermediate consumption from other sectors, i.e. *goods and services consumed as inputs either transformed or used up by the production process*[8], of 809 billion U.S. dollars. The top ten inputs for the global pharmaceutical sector's industrial production make up over two thirds of the total intermediate consumption (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 17.0 percent, followed by the agricultural sector with a contribution of 13.4 percent.

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 847 billion U.S. dollars in 2017. The top ten buyers of intermediate pharmaceutical goods consume almost 90 percent 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 64.3 percent, followed by 7.8 percent used by the chemical sector.

In addition to industrial buyers of pharmaceutical products, global private household demand of pharmaceutical products, i.e. over the counter retail pharmacy sales, equals 310 billion U.S. dollars. In terms of capital goods, e.g. buildings and machines, intellectual capital and other investments by research and development activities, the global pharmaceutical industry's share is worth 24 billion U.S. dollars.

17.0 % Chemicals	64.3 % Human health services
13.4 % Crop and animal production	7.8 % Chemicals
9.4 % Wholesale trade	3.1 % Compulsory social security
7.9 % Legal, accounting, consulting	2.9 % Rubber and plastic products
4.1 % Food, beverage, tobacco	1.5 % Food, beverage, tobacco
3.9 % Administrative support service	1.5 % Construction
3.5 % Land transport services	0.8 % Coke and refined petroleum
3.2 % Energy	0.8 % Textiles, wearing apparel, leader
2.9 % Financial services	0.7 % Mining and quarrying
2.6 % Coke and refined petroleum	0.7 % Other service activities

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 2017). Source: WIOD, Eurostat, WifOR calculations.

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

ECONOMIC IMPACT

IMPACT ANALYSIS: DIRECT, INDIRECT AND INDUCED EFFECTS

In addition to **direct effects,** which describe the immediate economic effects directly generated by the global pharmaceutical industry, the analysis encompasses indirect and induced economic effects.

Indirect effects are effects arising due to the input the industry demands from other economic sectors. Order placements result in an increase of economic activity at commissioned agents and their suppliers. This stimulus increases gross value added (GVA)and other economic key figures along the supply chain.

Induced effects originate from the expenditure of directly and indirectly generated incomes and the concomitant increase in demand. 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).

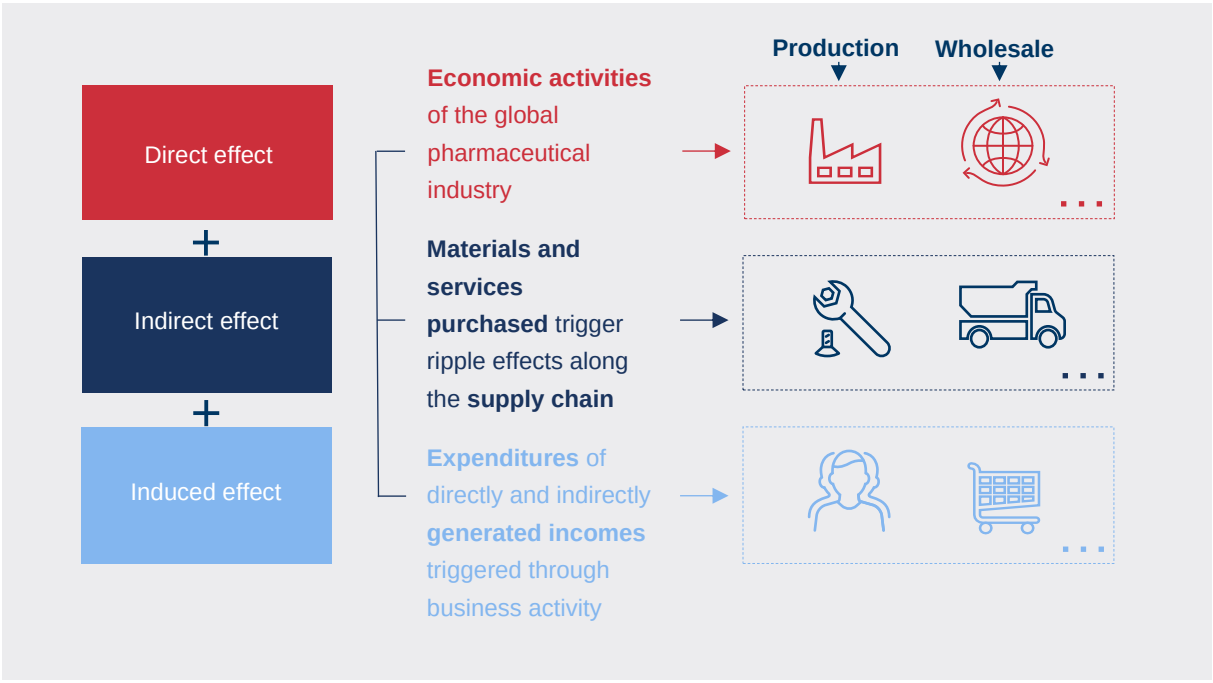

Figure 1: Diagram of the economic impact analysis: direct, indirect and induced effects triggered through economic activities of the global pharmaceutical industry.

GROSS VALUE ADDED EFFECTS

A central figure of the economic impact analysis is 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 GDP 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).[9] 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 (SDG8: Decent work and economic growth) are defined in terms of GDP or GVA.

In 2017, the global pharmaceutical industry generated a direct contribution to the world's GDP of 532 billion U.S. dollars in terms of GVA which equals one percent of the global GDP or about the GDP of the Netherlands. Chart 1 displays the development of the direct gross value added from 2006 to 2017. After a small decrease of 4.9 percent in 2015, the direct GVA has increased 3.9 percent in 2016 and 10.0 percent in 2017, with regards to the previous year.

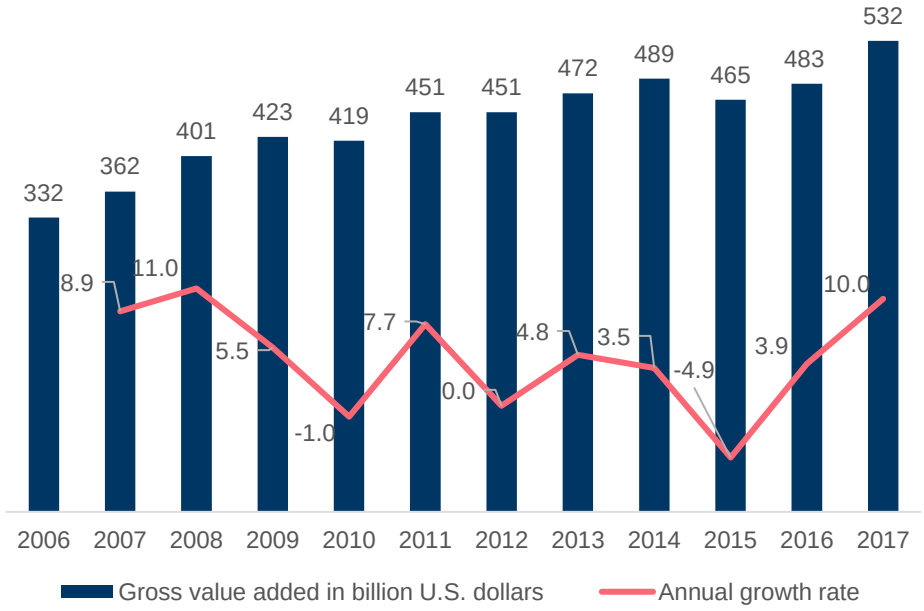

Chart 1: Development of the direct gross valued added (Blue Bar) and the annual growth rate (Red Line) of the global pharmaceutical industry.
Source: Eurostat, OECD, ADB, WIOD and National Statistics; WifOR calculation.

Furthermore, the global pharmaceutical industry supports the global economic activity with 791 billion U.S. dollars triggered by its consumption of intermediate inputs from other sectors along its global supply chains. Another 515 billion U.S. dollars are contributed through induced effects. The total contribution to the world's GDP is 1,838 billion U.S. dollars (see figure 2).[10]

[9] United Nations Statistical Division: Glossary of the 1993 System of National Accounts (§ 1.6.; 2.172.; 6.4.; 6.222.)
[10] Next to the economic impact, the global pharmaceutical acticity also supports the healthcare of workers around the world subsequentially promoting economic productivity.

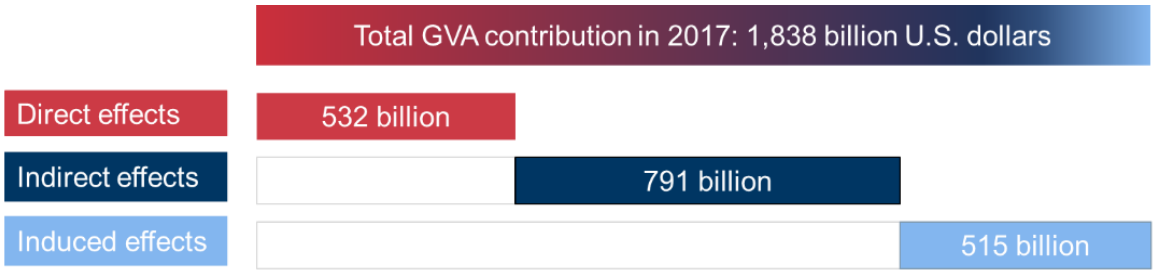

Figure 2: Direct, indirect and induced GVA effects triggered through economic activities of the global pharmaceutical industry.
Source: WifOR calculation; see annex for a detailed description of data sources.

The main GVA upstream spillover effects emanating from the global pharmaceutical industry's production inputs from other sectors are triggered by and occur in the same geographic region than the country of origin. Furthermore, regions also have a significant impact upon each other. The interregional distribution of the spillover effects (indirect and induced GVA) varies. If the global countries are split in four regions, i.e. Asia, North America, Europe and "Other Countries", Asia triggered most GVA spillover effects in "Other Countries". Europe triggered most GVA spillover effects in North America. North America triggered most spillover effects in "Other Countries". And "Other Countries" triggered most GVA spillover effects in Europe.

On the receiving end, "Other Countries" received most of its GVA spillover effects from Asia. North America received most GVA spillover effects from Europe. Europe received most GVA spillover effects from Asia. And Asia received most of its GVA spillover effects from "Other Countries".

EMPLOYMENT EFFECTS

In addition to the creation of value added, the global pharmaceutical industry is also directly responsible for 5.5 million persons engaged. [11]

Through its expenditures on materials and services of other sectors, the global pharmaceutical industry supported an additional 45.1 million indirect jobs in other industries along its supply chains. In addition, the global pharmaceutical industry supported 23.7 million jobs in other sectors induced by private consumption around the world through directly and indirectly generated income. In total, the global pharmaceutical industry supported 74.3 million persons in 2017 (see figure 3).

The pharmaceutical industry has long been a robust employment-generating pillar in industrialized economies and is a major contributor to the prosperity of the world economy. The

[11] The jobs are based on the figure "Persons engaged" (EMP) as provided by the World-Input-Output Database as opposed to persons employed which leaves out self-employed workers.

economic importance of the pharmaceutical industry is not limited to industrialized countries but also includes Asian and other developing countries, among others.

Figure 3: Direct, indirect and induced employment effects triggered through economic activities of the global pharmaceutical industry.[12]
Source: WifOR calculation; see annex for a detailed description of data sources.

Especially the employment spillover effects of the Asian geographical region are strikingly high. This is in part due to the global pharmaceutical industry's interregional effects onto other sectors which is particularly important in Asia as a geographical region – more balanced throughout the different regions with regards to GVA than employment. Asia's structural differences such as higher labor intensity compared to industrialized countries are driving the spillover effects. Also, Asia has more inclusive employment statistics, i.e. the pharmaceutical industry's employment data recognizes workers in traditional medicine contrary to data from industrialized regions.

Estimated employment spillover effects are largely congruent to other existing studies[13][14] covering specific geographical regions. The main difference with regards to the results published by other reports arise from this study's inclusion of interregional spillover effects (e.g. including spillover effects of Country A pharmaceutical sector onto Country B chemical sector). Further methodological differences are explained in the Annex.

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Labor costs (in billion U.S. dollars)	99.0	107.5	119.8	120.5	121.6	133.3	138.0	145.3	150.3	145.8	148.6	153.8
Growth rate		8.6	11.4	0.5	0.9	9.5	3.5	5.2	3.4	-3.0	1.9	3.5
Employee compensation (in U.S. dollars)	27,132	29,233	31,305	30,766	28,713	30,229	29,851	30,143	29,651	26,561	24,489	27,856

Table 2: Labor Costs and Employee Compensation in the global pharmaceutical industry for the years 2006 to 2017.
Source: Eurostat, OECD, ADB, WIOD; WifOR calculations.

[12] India generates a very high indirect employment effect (indirect multiplier of 23), which reflects a more labor intensive production structure. See Annex for a more detailed analysis.
[13] 'Economic and Societal Footprint of the Pharmaceutical Industry in Europe', EFPIA, PWC, June 2019.
[14] 'The Economic Impact of the U.S. Biopharmaceutical Industry: 2017 National and State Estimates', PhRMA, Teconomy, December 2019.

In addition to persons employed, the study took a deep dive into employee compensation. In 2017, total labor costs, i.e. the sum of all wages paid to employees, as well as the costs of employee benefits and payroll taxes paid by an employer, of the global pharmaceutical industry equals 153.8 billion U.S. dollars. Table 2 shows labor costs and employee compensation in the global pharmaceutical industry. Labor costs have decreased three percent in 2015 compared to 2014, and increased 1.9 percent in 2016 and 3.5 percent in 2017, respective to the previous year. On a different note, employee compensation, i.e. total labor costs per direct employee, equals 27,856 U.S. dollars in 2017.

Annex: Data Sources and Methodology

The economic impact analysis is mainly based on direct GVA and direct employment figures. For the majority of the world data coverage[15] for the global pharmaceutical industry, data classified as C21 *Manufacture of basic pharmaceutical products and pharmaceutical preparations* on industry[16] level has been used. In the case of the direct GVA of the global pharmaceutical industry, the data coverage by National Accounts equals 53.9 percent (see figure 7). The other 39.6 percent of the data coverage are estimates for the Pharmaceutical Industry that rely on data from the World Input-Output Database (WIOD). They are based on country-specific data on the share of C21, extracted from the former aggregate *Manufacture of chemicals and chemical products* (class C20 and C21). Using country GDP as provided by the World Bank as proxy, the total coverage for direct GVA equals 93.5 percent.

In the case of direct employment of the global pharmaceutical industry, the data coverage is also based on C21. The employment data coverage by National Accounts equals 50.7 percent (see table 3). The remaining 28.4 percent of the data coverage are figures for the pharmaceutical industry based on Statistical Yearbooks and other Official National Statistics. The total coverage for direct employment equals 79.1 percent based on World Employment as provided by ILOSTAT as a proxy.

53.9 % GVA coverage by national accounts
39.6 % GVA coverage by other sources (estimation for pharma)
93.5 % GVA total coverage
50.7 % Employment coverage by national accounts
28.4 % Employment coverage by other sources
79.1 % Employment total coverage

Table 3: Data coverage for direct GVA and direct employment of the global pharmaceutical industry for the year of compilation 2017.
Note: GVA total data coverage is estimated using country GDP for 2017 by the World Bank; Employment total data coverage is estimated using country ILOSTAT for 2017.
Source: WifOR calculation; see annex for a detailed description of data sources.

15 The world data coverage for the Global Pharmaceutical Industry calculated based on proxies for GVA and employment: for GVA data for GDP on country level provided by the World Bank has been used; in analogy, the employment data coverage is based on the data for employment on country-level provided by ILOSTAT.
16 Industry level is used on National Accounts and represents an institutional unit as opposed to product level, which is mostly used for analytical purpose and represents a homogeneous unit.

GROSS VALUE ADDED DATA

Table 4 shows data sources used for the calculation of direct GVA of the global pharmaceutical industry for the year of compilation 2017. Data for the European Union was extracted from Eurostat upon availability for 2017. Exceptions are Croatia, Poland, Latvia, the UK and Sweden where the most recent data available is from 2016. The Swedish GVA data is extracted from a national Input-Output-Table. For Malta, Luxembourg and Ireland the pharma share had to be estimated based on Eurostat C20 data with the industry distribution of WIOD as a proxy. The Organisation for Economic Co-operation and Development (OECD) further provided data for the United States of America[17], Brazil, Mexico, Turkey, Saudi Arabia, Argentina, Taiwan, Israel, South Africa, Colombia, Chile, New Zealand, Morocco, Costa Rica and Tunisia, in each case for the latest year available. All Asian countries listed are covered through data of the Asian Development Bank[18] (ADB), available at C20 level for 2017. The pharma share has been estimated following the methodology described above. Data for Australia, Canada, Russia, Norway and Ukraine has been derived from National Accounts and in the case of Peru from a national Input-Output-Table. All data is available for 2017 with the exception of Norway and Peru, where data is from 2016 and 2015, respectively.

Country	Coverage	Classification	Description	Year	Source
United States	24,09%	ISIC 4	pharma	2017	OECD
EU 28*	21,45%	NACE 2	pharma	2017	Eurostat
China	15,01%	ISIC 3	pharma estimate	2017	based on ADB
Japan	6,01%	ISIC 3	pharma estimate	2017	based on ADB
India	3,28%	ISIC 3	pharma estimate	2017	based on ADB
Brazil	2,54%	ISIC 4	pharma	2016	OECD
Canada	2,04%	NAICS	pharma	2017	Canadian National Accounts
Russian Federation	1,95%	ISIC 4	pharma	2017	Russian National Accounts
Korea, Rep.	1,89%	ISIC 3	pharma estimate	2017	based on ADB
Australia	1,65%	ANZSIC06	pharma estimate	2017	based on Australian National Accounts
Mexico	1,43%	ISIC 4	pharma	2017	OECD
Indonesia	1,26%	ISIC 3	pharma estimate	2017	based on ADB
Turkey	1,05%	ISIC 4	pharma estimate	2015	based on OECD
Saudi Arabia	0,85%	ISIC 4	pharma estimate	2015	based on OECD
Switzerland	0,84%	NACE 2	pharma	2016	Eurostat
Argentina	0,79%	ISIC 4	pharma estimate	2015	based on OECD
Taiwan	0,66%	ISIC 3	pharma estimate	2017	based on OECD
Thailand	0,56%	ISIC 3	pharma estimate	2017	based on ADB
Norway	0,49%	NACE 2	pharma	2016	Norway Official Statistics
Israel	0,44%	ISIC 4	pharma estimate	2015	based on OECD
South Africa	0,43%	ISIC 4	pharma estimate	2015	based on OECD
Hong Kong SAR, China	0,42%	ISIC 3	pharma estimate	2017	based on ADB

[17] V20 and V21 are adding up to the US Bureau of Economic Analysis' NAICS Chemical products.
[18] ADB's ISIC 3 is converted into ISIC 4 based on WIOD regional GVA.

Singapore	0,42%	ISIC 3	pharma estimate	2017	based on ADB
Malaysia	0,39%	ISIC 3	pharma estimate	2017	based on ADB
Philippines	0,39%	ISIC 3	pharma estimate	2017	based on ADB
Colombia	0,39%	ISIC 4	pharma estimate	2015	based on OECD
Pakistan	0,38%	ISIC 3	pharma estimate	2017	based on ADB
Chile	0,34%	n.a.	pharma estimate	2017	based on OECD
Bangladesh	0,31%	ISIC 3	pharma estimate	2017	based on ADB
Vietnam	0,28%	ISIC 3	pharma estimate	2017	based on ADB
Peru	0,26%	ISIC 4	pharma estimate	2015	based on IOT
New Zealand	0,25%	ISIC 4	pharma estimate	2015	based on OECD
Kazakhstan	0,20%	ISIC 3	pharma estimate	2017	based on ADB
Ukraine	0,14%	ISIC 4	pharma	2017	Ukraine National Accounts
Morocco	0,14%	ISIC 4	pharma estimate	2015	based on OECD
Sri Lanka	0,11%	ISIC 3	pharma estimate	2017	based on ADB
Costa Rica	0,07%	ISIC 4	pharma estimate	2015	based on OECD
Serbia	0,05%	NACE 2	pharma	2017	Eurostat
Tunisia	0,05%	ISIC 4	pharma estimate	2015	based on OECD
Nepal	0,03%	ISIC 3	pharma estimate	2017	based on ADB
Cambodia	0,03%	ISIC 3	pharma estimate	2017	based on ADB
Bosnia and Herzegovina	0,02%	NACE 2	pharma	2017	Eurostat
Lao PDR	0,02%	ISIC 3	pharma estimate	2017	based on ADB
Brunei Darussalam	0,01%	ISIC 3	pharma estimate	2017	based on ADB
Mongolia	0,01%	ISIC 3	pharma estimate	2017	based on ADB
North Macedonia	0,01%	NACE 2	pharma	2017	Eurostat
Kyrgyz Republic	0,01%	ISIC 3	pharma estimate	2017	based on ADB
Fiji	0,01%	ISIC 3	pharma estimate	2017	based on ADB
Bhutan	0,00%	ISIC 3	pharma estimate	2017	based on ADB
World coverage	**93,45%**				

Table 4: Data sources used for the calculation of direct GVA of the global pharmaceutical industry for the year of compilation 2017.
Note: *EU28: Data for Croatia, UK, Latvia, Poland and Sweden are from 2016. Data for Sweden got extracted from national IOT. Malta, Luxembourg and Ireland are pharma estimates based on Eurostat C20 data with the industry distribution of WIOD as a proxy. GVA total data coverage is estimated using country GDP for 2017 by the World Bank.

EMPLOYMENT DATA

Table 5 shows data sources used for the calculation of direct employment of the global pharmaceutical industry for the year of compilation 2017. Data for the European Union was extracted from Eurostat, except for Luxembourg and Sweden. Figures for the two latter countries as well as China, Indonesia, Japan, Korea, Mexico, Malta, Norway and Taiwan were derived from WIOD. Brazil's employment figure is based on OECD data. For Argentina, Australia, Bangladesh, Canada, Colombia, Russia and the United States of America, official national statistics were used. Another source of data is the ASEAN Statistical Yearbook that

provides data for Cambodia, Myanmar, Malaysia, the Philippines, Singapore and Vietnam. India is covered by the Statistical Yearbook of India.
Most data is classified as C21 according to ISIC Rev. 4. In the case of Russia and Turkey, the pharmaceutical share was estimated based on the aggregate ISIC Rev. 3 C20 with a WIOD industry split as a proxy. If values were not available for 2017, the most recent year has been used. Employment data is reflected on industry level.

Country	Coverage	Classification	Description	Year	Source
China	25,70%	ISIC Rev 4	pharma	2014	WIOD
India	16,24%	ISIC Rev 4	pharma	2015	India Statistical Yearbook
EU 28*	7,54%	NACE 2	pharma	2017	Eurostat
USA	5,08%	NAICS	pharma	2016	ASM
Indonesia	4,06%	ISIC Rev 4	pharma	2014	WIOD
Brazil	2,96%	ISIC Rev 4	pharma	2014	OECD
Russian Federation	2,39%	NACE 2	pharma estimate	2016	based on Russian National Account
Japan	2,16%	ISIC Rev 4	pharma	2014	WIOD
Bangladesh	2,01%	BSIC	pharma	2012	Official National Statistic
Vietnam	1,78%	n.a.	pharma	2017	Asean Statistical Yearbook 2018
Mexico	1,73%	ISIC Rev 4	pharma	2014	WIOD
Philippines	1,34%	n.a.	pharma	2015	Asean Statistical Yearbook 2018
Turkey	0,93%	ISIC Rev 4	pharma estimate	2014	based on WIOD
Korea	0,89%	ISIC Rev 4	pharma	2014	WIOD
Colombia	0,74%	CIIU Rev 4	pharma	2017	Official National Statistic
Myanmar	0,73%	n.a.	pharma	2017	Asean Statistical Yearbook 2018
Canada	0,61%	NAICS	pharma	2017	Official National Statistic
Malaysia	0,47%	n.a.	pharma	2015	Asean Statistical Yearbook 2018
Australia	0,41%	ANZSIC	pharma	2017	Official National Statistic
Argentina	0,38%	CIIU	pharma	2017	Official National Statistic
Taiwan	0,38%	ISIC Rev 4	pharma	2014	Asean Statistical Yearbook 2018
Cambodia	0,30%	ISIC Rev 4	pharma	2011	Asean Statistical Yearbook 2018
Switzerland	0,15%	NACE 2	pharma	2017	Eurostat
Norway	0,09%	ISIC Rev 4	pharma	2014	WIOD
Singapore	0,07%	n.a.	pharma	2016	Asean Statistical Yearbook 2018
World coverage	**79,14%**				

Table 5: Data sources used for the calculation of direct employment of the global pharmaceutical industry for the year of compilation 2017.
Note: *EU 28: Data of Sweden and Luxembourg got extracted from WIOD 2014.
Employment total data coverage is estimated using country ILOSTAT for 2017.

METHODOLOGY

In addition to direct effects, the present analysis includes indirect and induced economic effects.

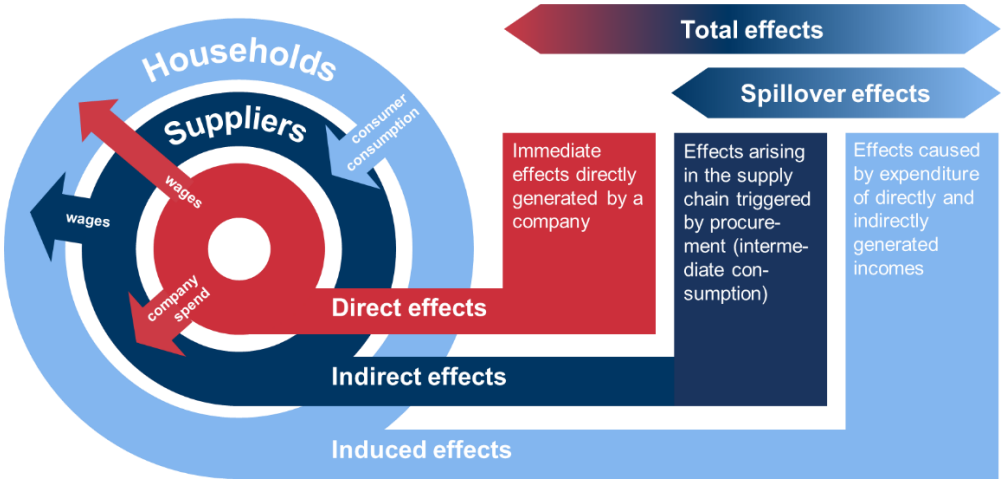

Figure 4: Economic impact model: Direct, indirect, and induced effects.

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 GVA 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 economic impact model in figure 4).

Input-Output analysis is a standard economic tool to measure the economic impact of an industry or company. Applying this technique, it is possible to trace the inputs of production along the entire supply chain from other sectors. While in the traditional model households belong to the final demand sector (are exogenous), their activities are included in the model and thus treated as endogenous.[19] .

The basis for the calculation of the effects is formed by the following equilibrium equation:

$$\boldsymbol{x} = \boldsymbol{A}\boldsymbol{x} + \boldsymbol{y} \leftrightarrow \boldsymbol{x} = (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{y}$$

where $\boldsymbol{x}$ is the vector of total gross output and $\boldsymbol{y}$ is the vector of final demand. $\boldsymbol{A}$ is either the matrix of intermediate consumption coefficients used to calculate the indirect effects, or the matrix of intermediate consumption extended by labor income and corresponding consumption coefficients to calculate spillover effects. The equation relates changes in gross output $\boldsymbol{x}$ to changes in demand $\boldsymbol{d}$.

[19] The model treats the endogenous variables according to the so called “fictitious industrial sector approach”.

Equipped with the output triggered by a given demand (and labor compensation), the corresponding resulting gross value added is derived using country and sector specific ratios of GVA to output. Employment effects are calculated analogously.

METHODOLOGICAL DIFFERENCES WITH SIMILAR STUDIES

The aim of this study is to compute global spillover effects in other economic sectors. 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.

2. The computations for this study's impact results are based on both the WIOD data set as well as the most recent (2017 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.

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. There are two ways of computing multipliers, i.e. indirect plus induced effects as a ratio of direct effects or the sum of direct, indirect and induced effects as a ratio of direct effects. The latter method is based on the idea of a 'Keynesian multiplier' showing the total impact, i.e. including the direct, indirect and induced impacts, of the pharmaceutical industry's direct production. In order to prevent misinterpretation, this report has refrained from presenting multiplier results.

6. This study's induced effects are based on available income, whereas other reports may not explicitly adjust income for savings and taxes.

Deep Dive Employment Impact for India

With regards to the global pharmaceutical industry's employment effects, India is the main outlier driving the global employment impact with 23 times as many persons indirectly engaged in other sectors – along this country's global supply chains – compared to the persons directly engaged. See table 3 for a breakdown of the employment impact.

India's most significant impact occurs in its respective national territory along its country's national supply chains. India's very high national indirect employment impact, with regards to its direct employment figure, depicts a more labor-intensive production structure, compared to a more moderate employment impact ratio, such as the one from industrialized countries, that imply a more capital-intensive production structure.

WifOR is an independent economic research institute that originated from a spin-out of the Department of Public Economics and Economic Policy at the Technical University of Darmstadt, Germany. We see ourselves as an academic partner and think tank on a global scale. WifOR's fields of research include Economic, Environmental and Social Impact Analyses as well as Labor Market and Health Economy research.

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