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European Federation of Pharmaceutical Industries and Associations

WifOR

Research Report

The Economic Footprint of Selected Pharmaceutical Companies in Europe

Authors:
Nora Albu, Marc Mecke, Dr. Dennis A. Ostwald, Katharina Zubrzycki

WifOR Berlin

Joseph-Haydn-Straße 1
10557 Berlin
Germany

Phone +49 30 232 566 6-50
Telefax +49 30 232 566 6-951
Email kontakt@wifor.com
Web www.wifor.com

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List of Abbreviations and Acronyms

abs	Absolut
avg	Average
bn	Billion
CAGR	Compound annual growth rate
Destatis	Statistisches Bundesamt Deutschland (Federal Office of Statistics Germany)
ECB	European Central Bank
Eurostat	Statistical Office of the European Union
ESA	European System of Accounts
EUR	European Euro
FTE	Full time equivalent
GDP	Gross domestic product
GVA	Gross value added
IOT	Input-output table
n/a	Not available
OECD	Organisation for Economic Co-operation and Development
p.a.	Per annum (per year)
pps	percentage points
PV	Production value
R&D	Research and Development
SNA	System of National Accounts
UN	United Nations
WHO	World Health Organisation

List of Symbols

a_{ij}	Input coefficients of production sector $i \in [1;n]$ and $j \in [1;n]$
A	Matrix of input coefficients
c	Vector of consumption rate
C	Matrix of consumption coefficients
e_d	Direct employment effect
e_{d+i}	Sum of direct and indirect employment effects
e_{indi}	Indirect employment effect
e_{indu}	Induced employment effects
e_j	Coefficients of employment of production sector $j \in [1;n]$
e_t	Total employment effect (sum of direct, indirect and induced production value effects)
E	Matrix of employment coefficients
E_j	Employment of production sector $j \in [1;n]$
g_d	Direct gross value added effect
g_{d+i}	Sum of direct and indirect gross value added effects
g_{indi}	Indirect gross value added effect
g_{indu}	Induced gross value added effects
g_j	Coefficients of the gross value added of production sector $j \in [1;n]$
g_t	Total gross value added effect (sum of direct, indirect and induced production value effects)
G	Matrix of coefficients of the gross value added
G_j	Gross value added of production sector $j \in [1;n]$
i	Production sector, $i \in [1;n]$
I	Identity matrix
j	Production sector, $j \in [1;n]$
L	Leontief inverse matrix
n	Number of homogeneous production sectors
T	Technology matrix
w	Vector of compensation of employees
w_d	Direct effect of compensation of employees
w_{d+i}	Sum of direct and indirect effects of compensation of employees
w_{indi}	Indirect effect of compensation of employees
w_{indu}	Induced effects of compensation of employees
w_j	Coefficients of compensation of employees of production sector $j \in [1;n]$
w_t	Total effect of compensation of employees (sum of direct, indirect and induced production value effects)

W	Matrix of coefficients of compensation of employees
W_j	Compensation of employees of production sector $j \in [1;n]$
x	Vector of gross output / total demand
x_d	Direct production value effect
x_{d+i}	Sum of direct and indirect production value effects
x_{ij}	Input / intermediate consumption that production sector $i \in [1;n]$ demands from production sector $j \in [1;n]$
x_{indi}	Indirect production value effect
x_{indu}	Induced production value effects
x_t	Total production value effect (sum of direct, indirect and induced production value effects)
X_i	Gross output / total demand of production sector $i \in [1;n]$
X_j	Production value of production sector $j \in [1;n]$
y	Vector of final consumption
Y_i	Final consumption of production sector $i \in [1;n]$

Abstract

This research study, conducted by the independent economic research institute WifOR, investigates the direct economic impact of selected companies of the pharmaceutical industry in Europe as well as their contribution to the entire European economy from 2010 to 2014. Thus, the study analyses the European *Economic Footprint* of selected pharmaceutical companies. In addition to direct economic effects, the *Economic Footprint* also accounts for indirect and induced economic effects (so-called spillover effects). Direct effects describe a company's immediate economic impact while indirect effects are a result of inputs or intermediate consumption. Induced economic effects originate in the spending of income by employees working in the pharmaceutical industry and for its suppliers. The economic impact analysis is based on the United Nations' System of National Accounts (SNA). In a first step, a satellite account of the selected pharmaceutical companies is modelled to derive their direct economic effects. In a second step, the indirect and induced economic effects are computed based on the Leontief Inverse. Thus, the economic impact analysis yields direct, indirect and induced gross value added and employment effects in the European economy supported by the selection of European pharmaceutical companies. In addition to these economic impacts, economic key indicators such as R&D intensities are also derived.

1. Introduction

This study, on behalf of the *European Federation of Pharmaceutical Industries and Associations* (efpia), examines the impact of selected pharmaceutical companies on the European economy. Efpia is the voice of the pharmaceutical industry in the European Union (EU), representing 40 leading pharmaceutical companies in Europe. The *Economic Footprint* of the pharmaceutical industry is measured in order to quantify the macroeconomic contribution of seven major pharmaceutical companies to economic growth, employment and innovation in Europe from 2010 to 2014. The results of this study aim to enrich the public discussion with newly derived data substantiating how the pharmaceutical industry in Europe is powering growth in Europe, how the pharmaceutical industry in Europe is driving employment and how the pharmaceutical industry in Europe is investing in innovation. These three core aspects affirm the pharmaceutical industry's importance for the European economy.

The objective of the study is to supplement the present and on-going dialogue about the perception of the healthcare sector. As stated in *Figure 1*, perception changes are occurring in several areas. For example, while previously being understood as a separate system for the provision of health related services, the healthcare sector is now perceived as an economic sector. In light of the emerging secondary health market, it has also become a playing field for new methods of financing and compensating providers. Another key development is the focus on high-quality outcomes rather than on inputs that are needed to achieve them.

These shifts are all driven and reinforced by the fact that the healthcare sector is perceived as a reliable contributor to stable economic growth and a guarantor of employment. As such, the healthcare sector no longer represents a cost factor that is accountable for huge public and private expenditures. Instead, it constitutes an investment in health that can promote growth through the activities of Research and Development and labour productivity. One prominent example in this regard is a recent statement by the Director-General of the World Health Organisation (WHO), Dr. Margaret Chan, concerning the first meeting of the high-level commission on health employment and economic growth: *"The Commission calls for a change in the way policy-makers look at the health sector, not as a drain on resources but as a source of opportunities […]. Employment in the health sector can operate as a counterforce to the world's growing inequalities in income levels and opportunities."*[1]

The economic impact analysis, conducted by the independent economic research institute WifOR, encompasses the calculation of the European *Economic Footprint* of a selected group of European Pharmaceutical companies, i.e. *Abbvie*, *AstraZeneca*, *Boehringer Ingelheim*, *Ipsen*, *Janssen* (a *Johnson & Johnson* subsidiary), *Novartis* and *Sanofi*. In addition to direct economic effects, the *Economic Footprint* also accounts for indirect and induced economic effects. Direct effects describe the seven participating companies' immediate economic impact while indirect effects arise due to demand for inputs or intermediate consumption and their usage by the companies' business activities. Induced economic effects originate in the spending of income by employees working both for the selected companies in the pharmaceutical industry and their suppliers.

[1] Cf. (WHO, 2016).

The computation of these economic impacts is based on the System of National Accounts (SNA) and input-output analysis. In order to provide efpia with evidence-based data on the economic impacts of the European pharmaceutical industry, WifOR computed the group-specific European direct effects and, based on the company-specific European analyses, the calculation of the selected companies' indirect and induced effects.[2]

The study begins with a summary of important key data regarding the European pharmaceutical industry and its importance for global economic performance and employment. The next chapter describes the stand-alone characteristics of the project and outlines its specific set-up. Subsequently, the results of the calculation, i.e. direct, indirect and induced economic effects as well as further economic indicators, are illustrated and interpreted. The study concludes with a summary of pivotal results and recommendations that emphasise the importance of the pharmaceutical industry for the European economy. In addition, further research areas related to the *Economic Footprint* are introduced. The final chapter describes the methodology of the analysis and examines the data used.

Figure 1: Summary of the Worldwide Paradigm Shift in the Healthcare Sector

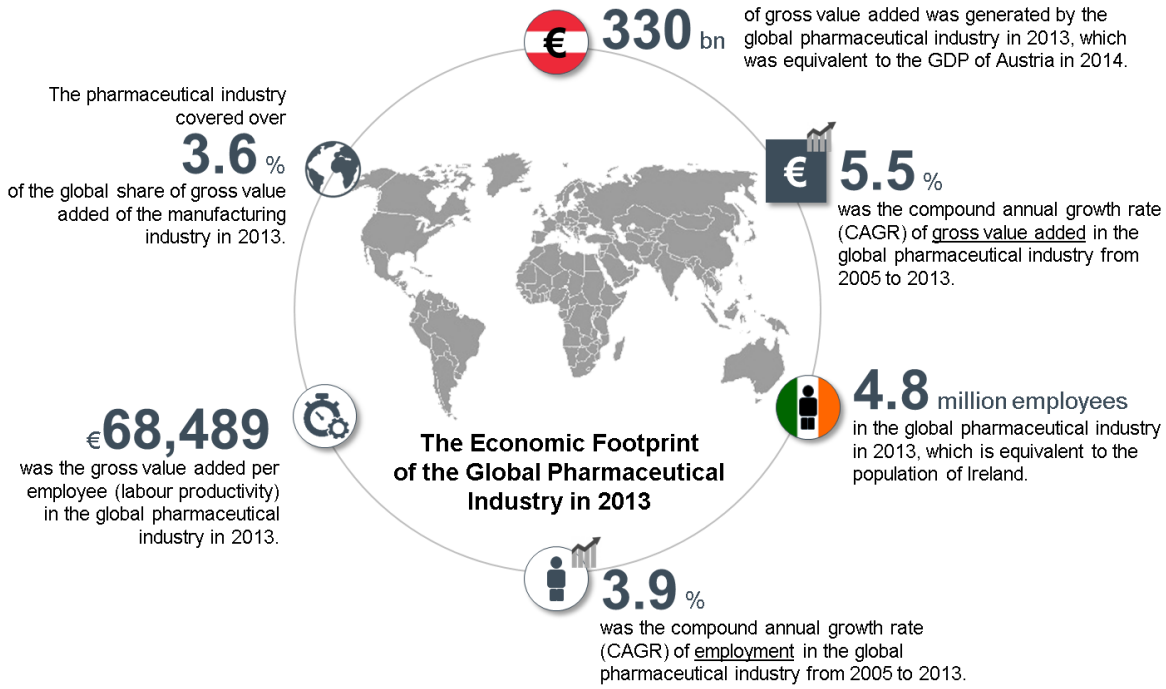
Source: Henke, Neumann, & Schneider, 2010 ; WifOR illustration.

[2] Nevertheless, positive effects of the pharmaceutical companies on improvements of employee health and thus increased labour productivity were not accounted for in this study.

2. Data and Facts about the European Pharmaceutical Industry

As shown in *Figure 2*, the pharmaceutical industry contributes a considerable amount to the global economy. In 2013, the pharmaceutical industry generated €330 bn of gross value added (GVA), which corresponds to 3.6% of the GVA generated by the global manufacturing industry. Furthermore, the compound annual growth rate (CAGR) of the global pharmaceutical industry was 5.5% between 2005 and 2013. On a global scale, the pharmaceutical industry employed over 4.8 million people in 2013. In addition, the sector's average labour productivity, i.e. an indicator of gross value added generated per employee, reached €68,489.

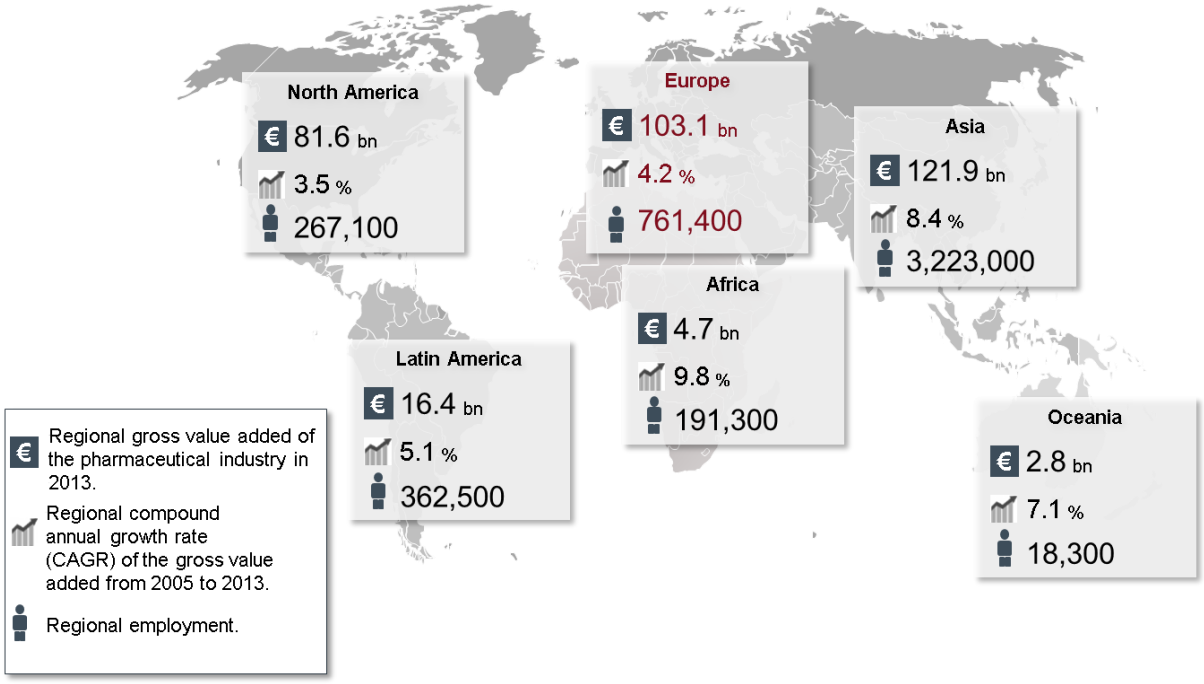
Figure 2: Key Facts about the Global Pharmaceutical Industry in 2013



Source: The World Bank Group, 2015 ; WifOR calculation; WifOR illustration.

On a regional level, *Figure 3* shows that the pharmaceutical industry in Europe represents the second largest region in terms of gross value added generated. The same holds true for employment effects, where again, only Asia has higher figures. Nevertheless, the pharmaceutical industry in Europe in terms of GVA is substantially larger than the industry in North America. In 2013, at 4.2%, the pharmaceutical industry's compound annual growth rate (CAGR) in Europe also exceeded the North American pharmaceutical industry's growth rate.

Figure 3: Gross Value Added and Employment of the Pharmaceutical Industry by Continent, 2013, in billion Euro and number of persons



Source: The World Bank Group, 2015 ; WifOR calculation; WifOR illustration.

On a European level, the macroeconomic development of the pharmaceutical industry was of mixed nature between 2010 and 2014. This was mainly due to the aftermath of the global financial crisis of 2008/09 and the subsequent Eurozone crisis. Key economic indicators show negative effects on the EU's economy in the first three years of the time period analysed. This, however, changed by the end of the time period under review in that the economic indicators partly stabilized at a higher level compared to pre-crisis years. For example, GDP growth decreased and was negative (-0.4%) in 2012[3], but reached +1.5% in 2014[4]. Furthermore, a similar development can be seen in unemployment figures. Once below 10%, the unemployment rate peaked in 2013 at 10.9% with a slight decrease in 2014[5]. However, not all economic indicators show a reversal of the negative trend. For example, inflation decreased from more than 3% in 2011 to only 0.4% in 2014, with deflation risks rising, and gross government debt steadily increasing from 90.8% of GDP to 107.6% between 2011 and 2014.[6] Additionally, between 2010 and 2014, extensive monetary policy with decreasing interest rates in the EU, mainly supported by very low ECB policy rates, almost reached the zero lower bound.[7]

In 2010, the European Commission formulated a strategy that defined targets on where the EU strives to be by the year 2020. The *EU 2020 Strategy* proposes to achieve important goals that inter alia include a share of 3% of the EU's GDP invested in Research and Devel-

[3] Cf. (OECD, 2014a).
[4] Cf. (OECD, 2016).
[5] Cf. (OECD, 2016).
[6] Cf. (OECD, 2014a, 2016).
[7] Cf. (ECB, 2014).

opment (R&D).[8] The R&D target is of particular importance in the context of analysing the pharmaceutical industry as it serves as a benchmark for meaningful comparison. As pharmaceutical companies generally invest heavily into R&D, it can be assumed that the seven selected companies' internal R&D intensity rate is substantially higher than 3% of the GDP.

Furthermore, the EU pharmaceutical industry was in part also negatively affected by economic shocks in recent years. For example, direct gross value added generated by the European pharmaceutical industry decreased from €85.8 bn in 2011 to €79.5 bn in 2014. The GVA rate, i.e. the gross value added share of output, dropped from 41.0% in 2011 to 37.8% in 2014. Also, labour productivity, i.e. the gross value added per employee, decreased from 158,239 in 2011 to 142,630 in 2013. On the other hand, the number of directly employed persons in the industry increased 2.8% from 542,500 to 557,700 in the same time period.[9]

On another note, health-related government spending affected the pharmaceutical industry. While growing at 4.7% per year between 2000 and 2009, health spending in EU countries decreased on average by 0.6% each year between 2009 and 2012. Despite this development, most EU members were able to maintain universal health coverage and thus protected access to health care in the EU.[10]

[8] Cf. (European Commission Communication, 2010).
[9] Data from Eurostat; WifOR calculations.
[10] Cf. (OECD, 2014b).

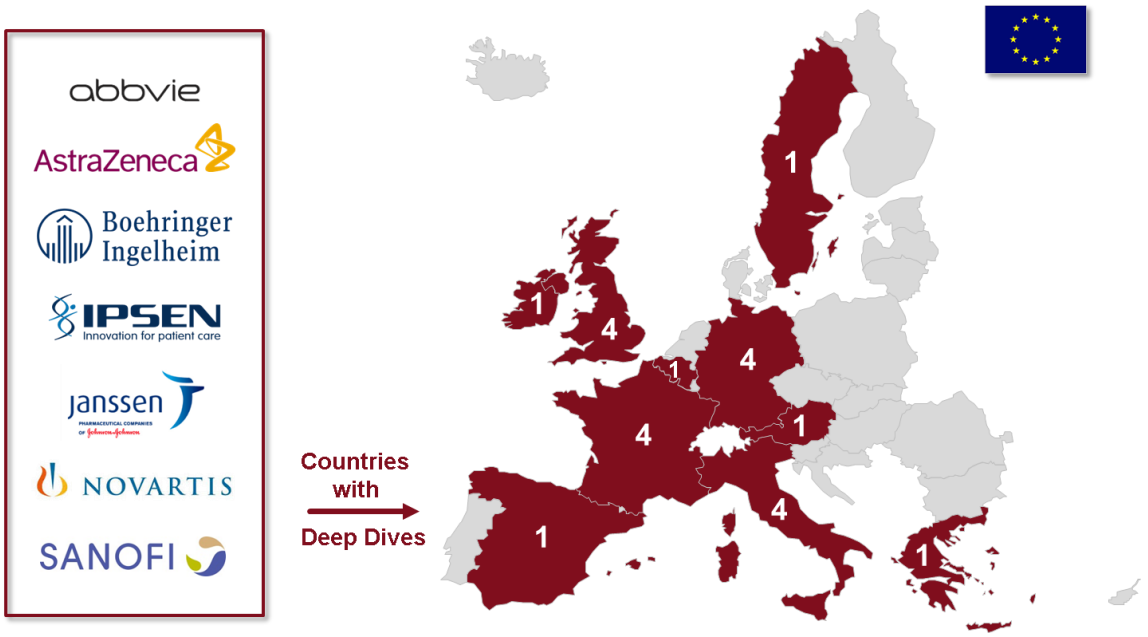
3. Study Design

This unique study provides an in-depth analysis of the selected pharmaceutical companies' economic impacts within the European Union. It marks the first time that direct effects, spillover effects and contributions to the EU single market's GDP were calculated using company-specific data provided by multinational pharmaceutical companies in the EU.

3.1 Project Scope

In order to calculate the European *Economic Footprint* of the selected pharmaceutical companies, each company's key management data was retrieved, transformed into macroeconomic data and aggregated to form the basis for the European calculations. The participating efpia members are the multinational companies *Abbvie, AstraZeneca, Boehringer Ingelheim, Ipsen, Janssen* (a *Johnson & Johnson* subsidiary), *Novartis* and *Sanofi*. WifOR calculated a company-specific European *Economic Footprint* for each participating member and, depending on the individual contracting, conducted up to 5 country deep-dive analyses.
Figure 4 shows the number of deep-dive analyses carried out in each European country as commissioned by the selected companies. As expected, individual deep dive analyses were most frequently conducted for the prominent economies in the EU, i.e. France, Germany, Italy and the UK. In total, 22 individual deep-dive analyses were completed by calculating the *Economic Footprint* of a specific company in a certain country.[11]

Figure 4: Regional Allocation of Commissioned Deep Dives in the EU

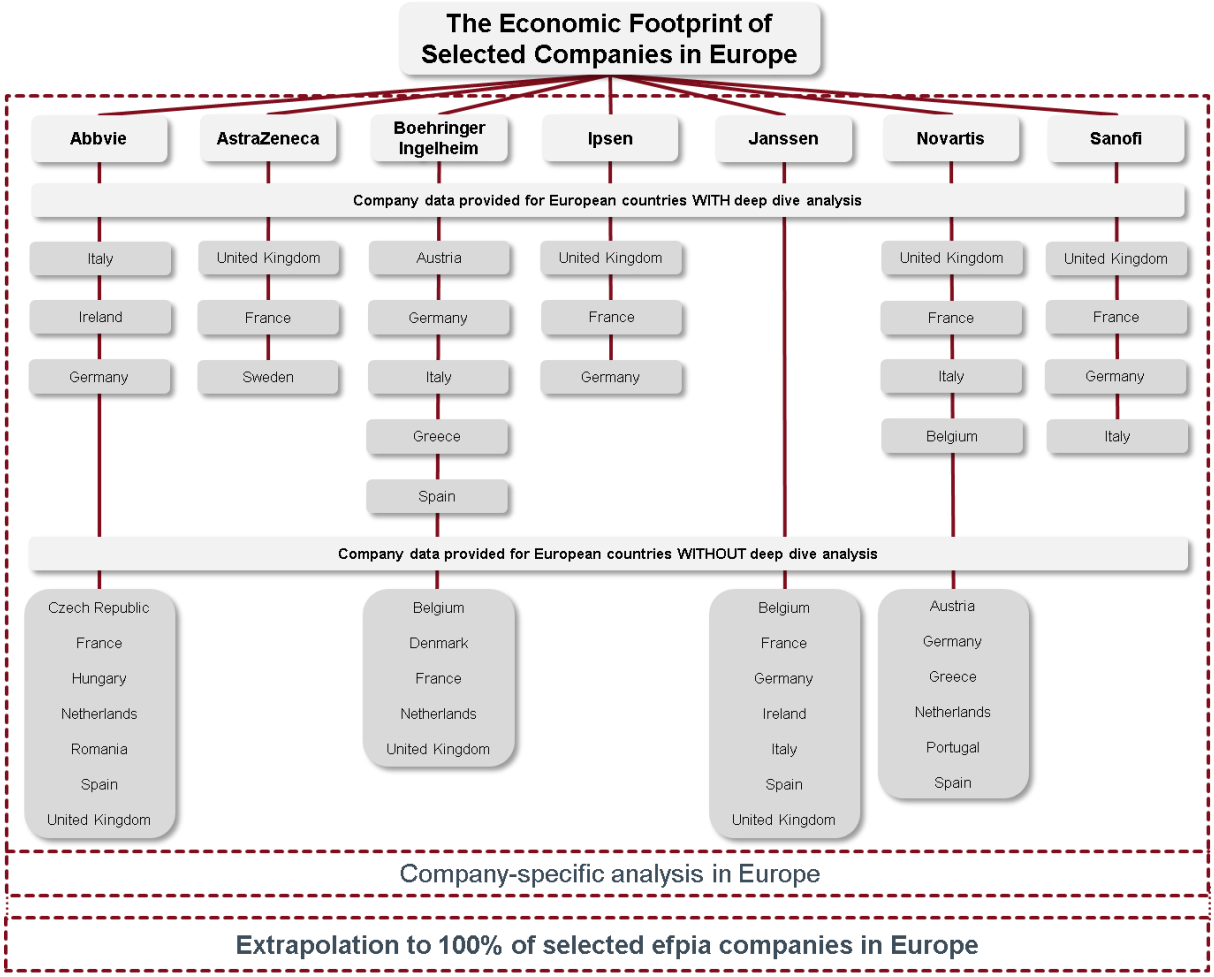


Source: Data from selected efpia companies; Data from Eurostat; WifOR calculation; WifOR illustration.

[11] This number only counts deep dive analyses that were also part of the European analysis. Other 'non-EU' deep dive analyses, e.g. in Switzerland, were not part of the European *Economic Footprint* and were thus not included here.

In addition, *Figure 5* displays the specific distribution of deep-dives for each of the selected companies, a schematic explanation of the calculation of the European *Economic Footprint* of selected companies, and information on additional country-specific data provided by each company. In order to increase the quality of the European analysis 80% of a company's European business activities was targeted. Thereby, country-specific characteristics, e.g. legal entity based supplier patterns or import quotas, were used for the calculation and the analysis was thus able to maintain a high standard of accuracy. Finally, all company-specific European satellite accounts were combined to form an aggregate based on which the selected companies' European *Economic Footprint* was calculated.[12]

Figure 5: Allocation of Deep Dives and Countries with Further Data Deliveries on the Selected Companies



Source: Data from selected efpia companies; WifOR illustration; countries without deep dive analysis in alphabetical order.

[12] For a more detailed description of the methodology, see chapter 6.

3.2 Stand Alone Characteristics

The primary standalone characteristic of the study is the selected companies' significant share of the pharmaceutical industry in the EU. In 2014, the seven selected companies together generated 41.3% of the direct gross value added generated by the European pharmaceutical industry (see *Figure 6*). The prominent share makes the study one-of-a-kind, since it is the first to include multinational companies that represent such a large share of its industry.

The results presented in the next chapter are of high significance and importance for all stakeholders involved in the business activities of the pharmaceutical industry in the EU, i.e. participating companies, non-participating pharmaceutical companies, shareholders, politicians and policy advisors. Since the selected companies are important drivers of growth, employment and Research and Development efforts in the EU economy, the wider population is positively affected by their business activities. In addition, the companies also accelerate the achievement of the EU 2020 targets.

Figure 6: Share of Selected Companies on EU28 Pharmaceutical Industry's Direct GVA

Source: Data from selected efpia companies (in 2014); Data from Eurostat (EU28 pharmaceutical industry in 2012); WifOR calculation; WifOR illustration.

The secondary standalone characteristic is the high coverage of the base aggregate of the selected European pharmaceutical companies. The deep-dive data together with the additional company-specific data yield a total coverage of 79.3% of overall business activities in the EU28 of the selected European pharmaceutical companies. Thus, the initial 80% target is quasi met. Furthermore, the additional data provided by the selected companies allowed a very accurate representation of the national structure for the European aggregate. The resulting precision of the computations can be traced back to high standards of quality data delivery for all the national legal entities that entered the company-specific European *Economic Footprint*.

4. Results of the Economic Footprint Analysis in Europe

Despite a declining direct GVA between 2010 and 2014, the increase in total intermediate consumption shows that more gross value added was generated along the supply chain. The linkages between the selected companies' intermediate consumption and the EU economy result in rising indirect and induced effects and high multipliers. Especially, the very high internal R&D expenditures of the selected companies point to a source of competitiveness through innovation.

In the midst of the very competitive European sales market for pharmaceutical goods (resulting from the price cutting war of generic products flooding the market), the selected companies' direct gross value added decreased by €2.8 bn from 2010 to 2014, which is equivalent to a 7.5% decline. However, the drop in direct GVA occurred despite a slight increase in turnover by €0.6 bn in the same time period (see*Table 1*). On a regional level, the selected companies generated a 41.3% share of direct gross value added of the EU pharmaceutical industry (see *Figure 8*).

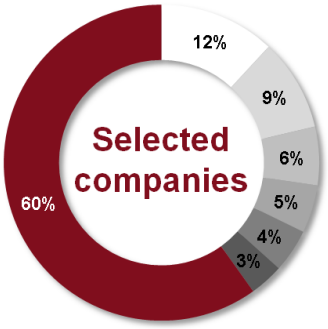
Table 1: Key Results of Selected Pharmaceutical Companies in Europe

efpia-Aggregate in Europe	Unit	2010	2011	2012	2013	2014	Growth (abs)	Growth (%)
Turnover	**bn€**	**97.9**	**96.2**	**98.1**	**95.4**	**98.5**	**0.6**	**0.6%**
+ Value of stock of goods of own production	bn€							
+ Self-produced equipment	bn€							
- Use of merchandise	bn€							
= Output	**bn€**	**71.1**	**70.2**	**70.9**	**67.8**	**69.3**	**-1.8**	**-2.6%**
Intermediate consumption	bn€							
+ Other consumption	bn€							
= Total intermediate consumption	**bn€**	**33.8**	**34.4**	**35.5**	**34.0**	**34.7**	**1.0**	**2.8%**
Output	bn€	71.1	70.2	70.9	67.8	69.3	-1.8	-2.6%
- Total intermediate consumption	bn€	33.8	34.4	35.5	34.0	34.7	1.0	2.8%
= Gross value added (GVA)	**bn€**	**37.4**	**35.7**	**35.4**	**33.8**	**34.6**	**-2.8**	**-7.5%**
GVA rate (GVA / output)	%	52.5%	50.9%	50.0%	49.9%	49.9%	-2.6	-5.0%
GVA multiplier	-	2.1	2.1	2.2	2.3	2.3	0.2	8.2%
Employees (EMP)	**'000**	**165.676**	**163.440**	**158.976**	**153.021**	**153.027**	**-12.650**	**-7.6%**
Labour productivity (GVA / EMP)	€	225,521	218,480	222,969	220,982	225,946	425	0.2%
Employment multiplier	-	5.2	5.2	5.5	5.6	5.7	0.5	9.1%
Internal R&D expenditures	**bn€**	**6.2**	**6.3**	**6.0**	**6.0**	**6.0**	**-0.2**	**-2.7%**
Internal R&D intensity (R&D / GVA)	%	16.6%	17.6%	17.0%	17.7%	17.4%	0.8	5.1%
Total R&D expenditures (internal + external)	**bn€**	**9.8**	**10.1**	**10.8**	**10.2**	**10.8**	**1.0**	**10.7%**
Total R&D intensity (R&D / GVA)	%	26.2%	28.2%	30.3%	30.1%	31.3%	5.1	19.6%

Source: Data from selected efpia companies; Data from Eurostat; WifOR calculation; WifOR illustration.

The rise in the companies' business activities has caused an increase in their total intermediate consumption by €1 bn from 2010 to 2014. *Figure 7* summarises the industries that were among the most important suppliers of the selected companies. With 12% of all inputs used, the chemicals sector is most prominent in this ranking. Together with the second largest supplier industry, i.e. *basic pharmaceutical products and pharmaceutical preparations*, the top two supplier industries represent almost €7 bn (approximately 20%) of the intermediate consumption and thereby stand out compared to the others. The other top supplier industries ranked from 3 to 6 only represent individual shares of 3-6%, leaving a remarkably large share of 60% to other industries with smaller shares. The overproportional increase of intermediate goods and services for production purposes is the source for high indirect and induced economic effects in the EU economy.

Figure 7: Most Important Supplier Industries in 2014

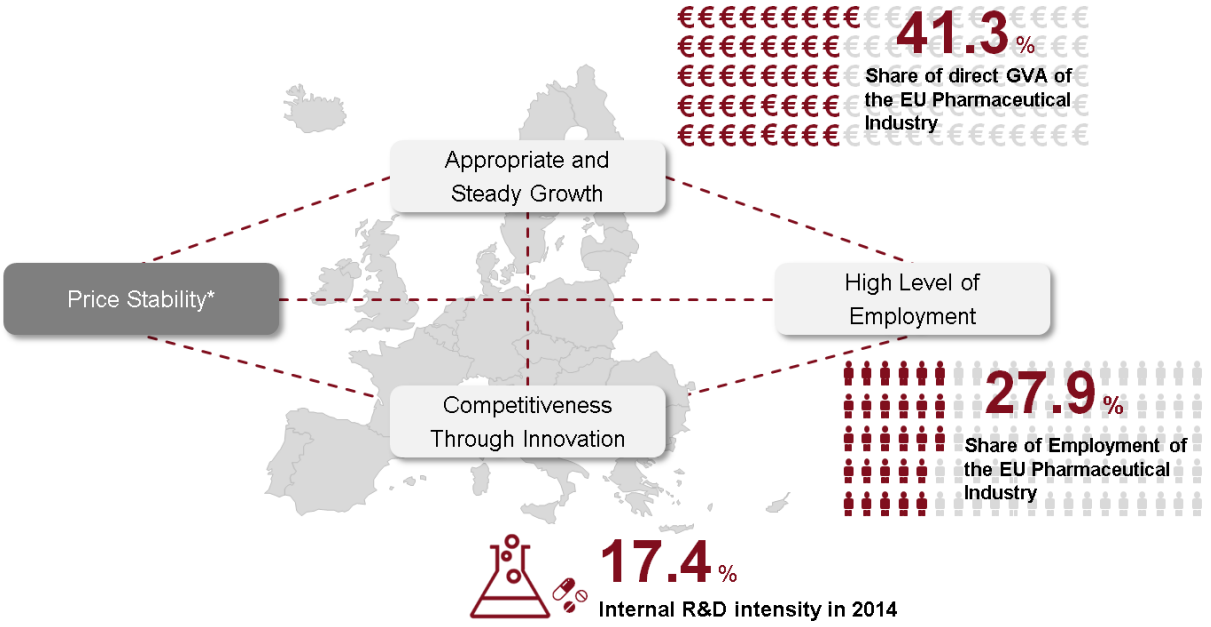


	Ranking of selected companies' suppliers in Europe	bn€	%
1	Chemicals and chemical products	3,662	12%
2	Basic pharmaceutical products and pharmaceutical preparations	2,904	9%
3	Electricity, gas, steam and air-conditioning	1,841	6%
4	Scientific research and development services	1,512	5%
5	Wholesale trade services, except of motor vehicles and motorcycles	1,366	4%
6	Legal, accounting and management consulting services	1,070	3%
	Others	18,434	60%

Source: Data from selected efpia companies; Data from Eurostat; WifOR calculation; WifOR illustration.

Also, rising spillover effects generated by the selected companies translate into higher multipliers for 2014. As an example, the total GVA multiplier was 0.2 percentage points higher in 2014 compared to 2010, which shows the increased importance of the selected companies for the overall European economy. Despite the decrease in direct gross value added, total intermediate consumption increased enough to trigger higher gross value added effects in the supplier industries and the overall economy. This development shows that the selected companies' total intermediate consumption was able to compensate for decreasing direct gross value added effects. The same holds true, and is even stronger in its amplitude, for employment effects, where the number of directly employed persons decreased by 12,650 from 2010 to 2014, which is equivalent to a 7.6% decline. However, the total employment multiplier increased by 0.5 percentage points from 2010 to 2014. The selected companies increased their production specialisation while raising highly qualified personnel for R&D activities. On a regional level, the selected companies' share of direct employment was almost one-third at 27.9% (see *Figure 8*).

Figure 8: Objectives of Economic Policy



Source: Data from selected efpia companies; Data from Eurostat; WifOR calculation; WifOR illustration. * Not of importance in the Economic Footprint analysis due to non-transferability to industry and branches.

Overall, the trends from 2010 to 2014 are a reflection of the concentration of resources in order to increase productivity without a loss of quality, thus remaining competitive in the European pharmaceutical market.

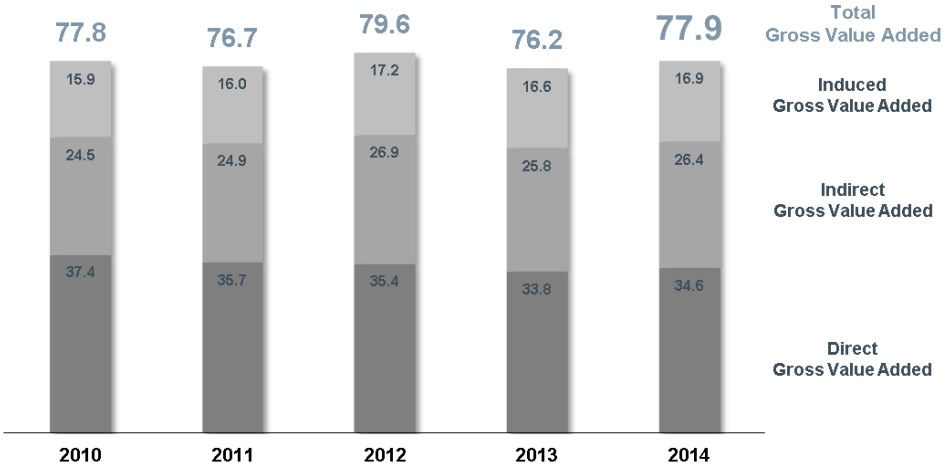
Finally, there is an important development in R&D intensities, which is defined as the share of gross value added spent for Research and Development activities. Despite a slight decline of €0.2 bn in internal R&D expenditures from 2010 to 2014, the internal R&D intensity increased, due to the proportionally larger decrease of direct gross value added. With 17.4% as internal and 31.3% as total R&D intensity in 2014, the selected companies have achieved almost 6 times the EU 2020's as high internal R&D intensity target of 3%. The very high internal R&D expenditures imply a concentration of highly qualified human capital. In order to withstand the competitive climate within the pharmaceutical industry, the European pharmaceutical companies focus on the specialisation of production and the increase of Research and Development activities.

4.1 Powering Growth

Total gross value added effects remain relatively stable with an average of €77.6 bn. This is due to increasing total intermediate consumption that triggered rising spillover effects and a higher GVA multiplier. In 2014, every Euro of direct gross value added generated 1.25 Euro in the EU economy. In comparison, the companies' aggregate spillover effects are higher than the European pharmaceutical industry and the total EU economy.

As illustrated in *Figure 9*, the total contribution to the European GDP in 2014 by the selected efpia companies is €77.9 bn. Thereof, €34.6 bn are direct gross value added effects and €43.3 bn are spillover effects (split between €26.4 bn indirect and €16.9 bn induced effects). Between the years 2010 and 2014 there was no stable trend in total gross value added effects, even though direct effects decreased by €2.8 bn from 2010 to 2014 reaching its lowest level in 2013. At €79.6 bn, total gross value added effects reached a maximum in 2012.

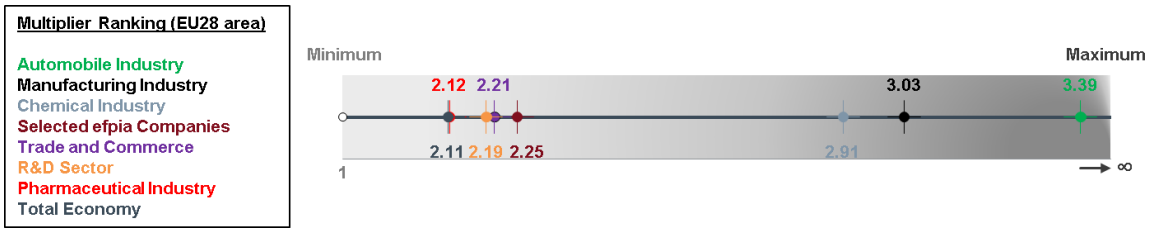
Figure 9: Developments of Gross Value Added Effects of Selected efpia Companies



Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; in bn €.

Furthermore, in 2014, the selected companies' total GVA multiplier is outperforming the European pharmaceutical industry's total GVA multiplier and that of the total EU28 economy. As illustrated in *Figure 10*, the selected companies generated larger economic impacts in Europe through their business activities compared to their own industry. For every Euro of direct gross value added, additional 1.25 Euros were created in the EU economy contributing to European GDP.

Figure 10: Comparison of Total GVA Multipliers in the EU28 Area



Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; benchmark industries' multipliers from 2012; selected efpia companies' multiplier from 2014.

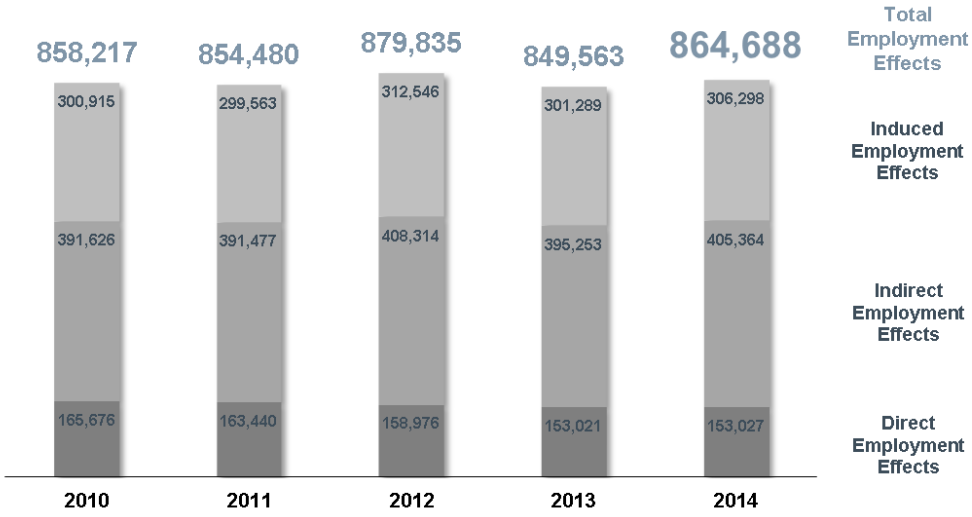
4.2 Driving Employment

Total employment effects of the selected efpia companies' aggregate remained rather stable with an average of 861,357 FTEs (full time equivalents). In 2012, total employment peaked at 879,835 total jobs supported in the EU. The high multiplier of 5.65 in 2014 indicates the importance of the companies for the European economy and their contribution to the EU labour market.

Figure 11 shows the selected companies' aggregate total employment effects from 2010 to 2014, ranging between 850,000 and 880,000 jobs and the split of the employment impacts into direct, indirect and induced employment effects. Despite a decrease in direct employ-

ment from 2010 to 2014, total employment effects in 2014 surpassed those in 2010. The high spillover effects were caused by increased intermediate consumption of materials and services for production purposes. Thus, high intermediate consumption affects employment along the supply chain. As a result, spillover effects made up most of the total impact and can be seen as the main driver for employment effects within the EU labour market. They also account for most of the variation in total effects. Even in 2013, where total employment effects were smallest, the business activities of the selected efpia companies supported more jobs in the EU along the supply chain than the population of Amsterdam.[13] The overall trend indicates that the selected companies reduced their number of direct employees and focused on a higher specialization of tasks that resulted in increased productivity. The specialization of productive activities generated stable turnover in a highly competitive European pharmaceutical industry.

Figure 11: Development of Employment Effects of Selected efpia Companies

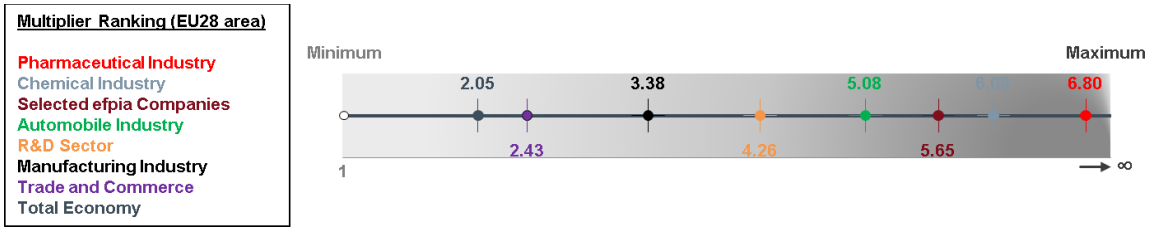


Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; in full-time equivalents.

Furthermore, the sizeable employment spillover effects translate into a high employment multiplier. In 2014, every job created by the selected efpia companies supported 4.65 additional jobs in the EU labour market. This shows how strong the companies are linked to the overall EU economy. Even though the participating efpia members' employment multiplier is not able to match that of the pharmaceutical industry in the EU, it is one of the largest compared to other industries (see *Figure 12*).

[13] Cf. (Amsterdam Population, 2016). Referring to an estimated population of 813,562 within the city limits.

Figure 12: Comparison of Total Employment Multipliers in the EU28 Area



Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; benchmark industries' multipliers from 2012; selected efpia companies' multiplier from 2014.

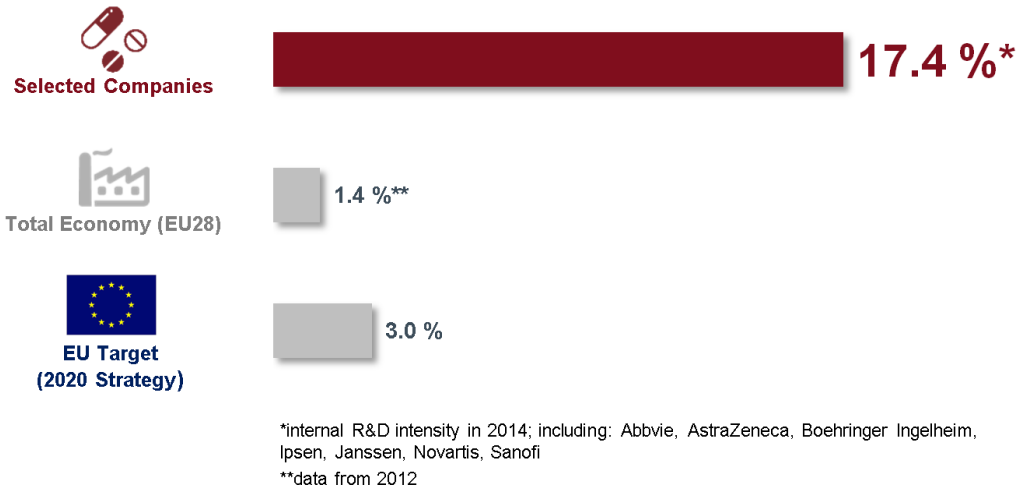
4.3 Investing in Innovation

The selected efpia companies are substantially outperforming the average EU28 pharmaceutical industry in terms of efficiency indicators. The GVA rate of about 50% is almost 10 percentage points higher than the average and labour productivity is more than €73,000 above the pharmaceutical industry's average. In 2014, the selected companies already reinvested almost 6 times the EU target of 3% of GDP in internal Research and Development.

4.3.1 Investment Intensity Measure

A high investment intensity in Research and Development (R&D) activities is seen as one key asset to master the challenges of the future faced by the European Union, such as rising labour cost, lower numbers of direct employees and the relocation of lower specialised tasks and jobs to the European outskirts. The European Commission set a target for internal R&D expenditure to account for 3% of the GDP in 2020. With an internal R&D intensity of 17.4% in 2014, the selected pharmaceutical companies have already surpassed the EU target by a factor of almost six. Thus, their sizeable R&D intensity proves their capacity to drive innovation in the EU economy. In comparison, the selected companies also surpassed the total EU economy's R&D intensity by a factor of 12. In absolute terms, the selected companies invested about €6 bn in 2014 in internal R&D activities and about €10.8 bn in total R&D expenditures. Thus, the total R&D intensity in 2014 is equivalent to 31.3% of direct GVA and increased by 5.1 percentage points from 2010. Increased R&D activities within the selected companies are accelerating an even higher specialisation of human capital and production in the future.

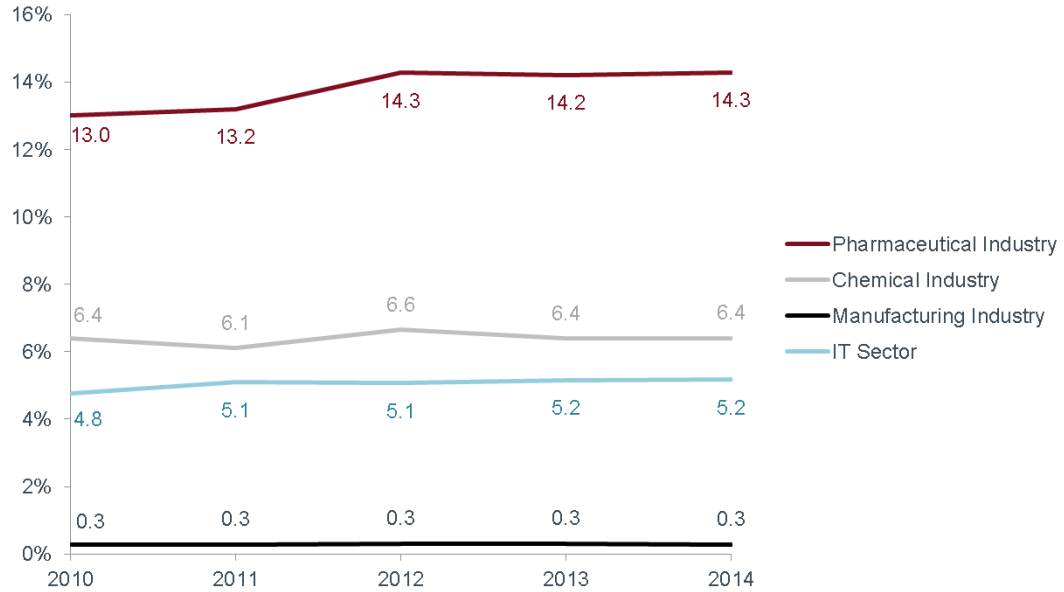
Figure 13: Comparison of Internal R&D Intensities



Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; in %.

As depicted in *Figure 14*, the pharmaceutical industry in the EU28 invests more in internal R&D per generated direct GVA compared to the chemical industry, the manufacturing industry and the IT sector. With 14.3% in 2014 it outperforms the three benchmark industries by a large margin of at least 7.9% (chemical industry).

Figure 14: Comparison of Internal R&D Intensities between Industries

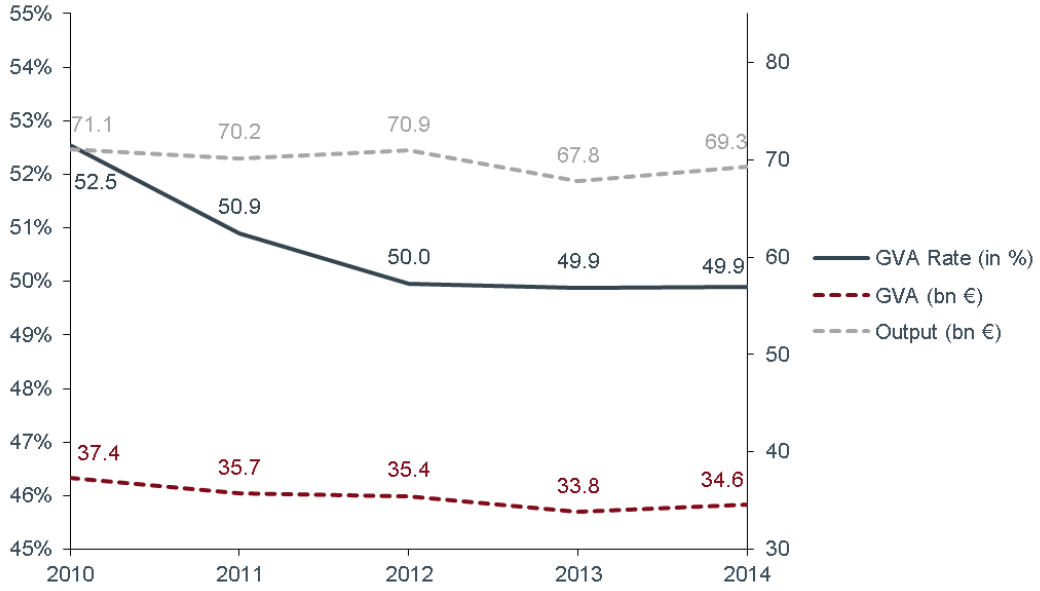


Source: Data from Eurostat for EU28 (aggregated country data); Pharma except for Latvia, Malta and Luxembourg; Chemicals except for Sweden; Manufacturing except for Malta and Luxembourg; IT except for Ireland and Sweden; WifOR illustration; in %.

4.3.2 Efficiency Measure

The gross value added rate (GVA rate) indicates the extent to which upstream gross value added stages are integrated into a company's economic activities. Thus, a high GVA rate means that a company is characterised by strong vertical integration and as a result generates high gross value added through in-house production. Since the GVA rate equals the ratio between direct gross value added and output, the companies' GVA rate of 49.9% means that every additional €100 of output created €49.9 of gross value added in the overall EU economy. The time series of the selected companies' GVA rate is drawn in *Figure 15*. The negative trend line results from declining direct GVA. The flattening trend line of the GVA rate reflects simultaneous variation of direct GVA and output between 2012 and 2014.

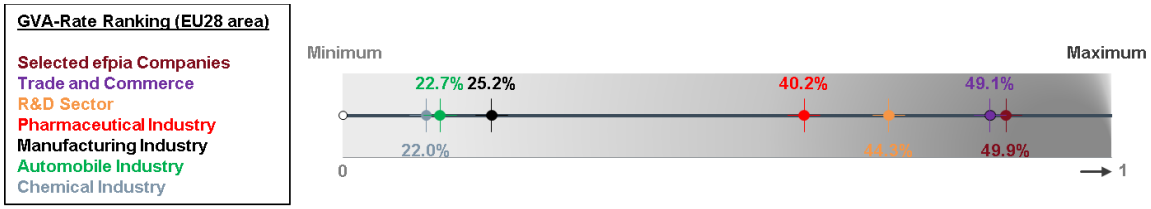
Figure 15: Development of GVA Rate and its Determining Factors



Source: Data from selected efpia companies; WifOR calculations; WifOR illustration; y-axes: GVA Rate (in %) left, GVA and Output (in bn €) right.

As illustrated in *Figure 16*, the selected efpia companies' GVA rate is very high and outperforms all benchmark industries. With almost 50% of integrated upstream gross value added, the selected companies' business activities can be labelled as "Made in the EU". The comparison of GVA rates in the EU28 area reveals that the GVA rate of the selected companies is almost 10 percentage points higher than the EU28 pharmaceutical industry's GVA rate and more than twice the GVA rate of the chemical industry.

Figure 16: Comparison of GVA Rates in the EU28 Area

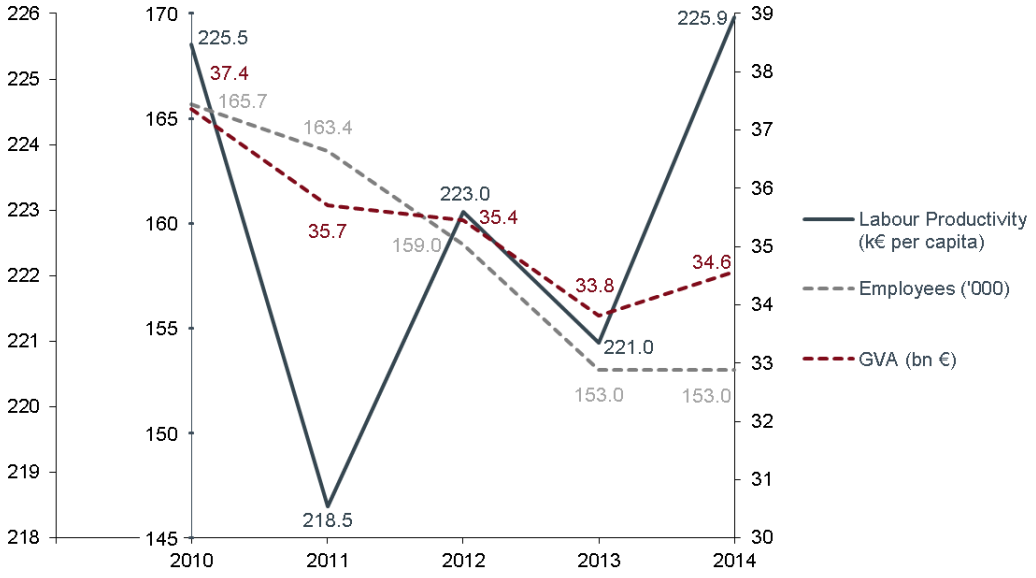


Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; benchmark industries' GVA rates from 2012; selected efpia companies' GVA rate from 2014; in %.

4.3.3 Productivity Measure

Labour productivity indicates a company's efficiency in terms of its labour input to production and can be defined in multiple ways. The one used in this analysis relates the amount of gross value added to the number of employees and states how much gross value added was generated per employee. The higher the labour productivity, the more efficient a company is operating in terms of labour inputs used. In 2014, the selected efpia companies were operating very efficiently and managed to achieve a labour productivity of €225,946. This means that every employee working for one of the selected companies generated almost 226 thousand Euros of gross value added on average in 2014. The time series of the selected companies' labour productivity is drawn in *Figure 17*. In 2011, the direct GVA reaches its minimum. The time series recovers in 2012, due to a lesser variation in the direct GVA compared to the direct employment figure.

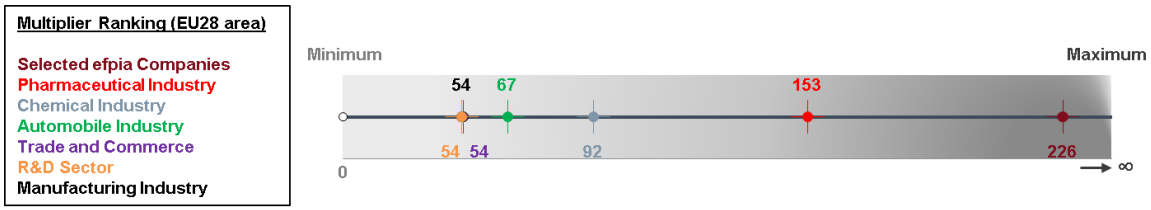
Figure 17: Development of Labour Productivity and its Determining Factors



Source: Data from selected efpia companies; WifOR calculations; WifOR illustration; y-axes from left to right: Labour Productivity (in k€ per capita), Employees (in '000), GVA (in bn €).

To put this number into context, *Figure 18* compares the companies' labour productivity to other industries in the EU. Being by far the largest in terms of productivity, the selected companies' labour productivity exceeded the pharmaceutical industry's figure by €73,000. Also, the selected companies' labour productivity is more than twice that of the chemical industry and more than four times that of the manufacturing industry.

Figure 18: Comparison of Labour Productivities in the EU28 Area



Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration; benchmark industries' labour productivities from 2012; selected efpia companies' labour productivity from 2014; in k€ (and rounded).

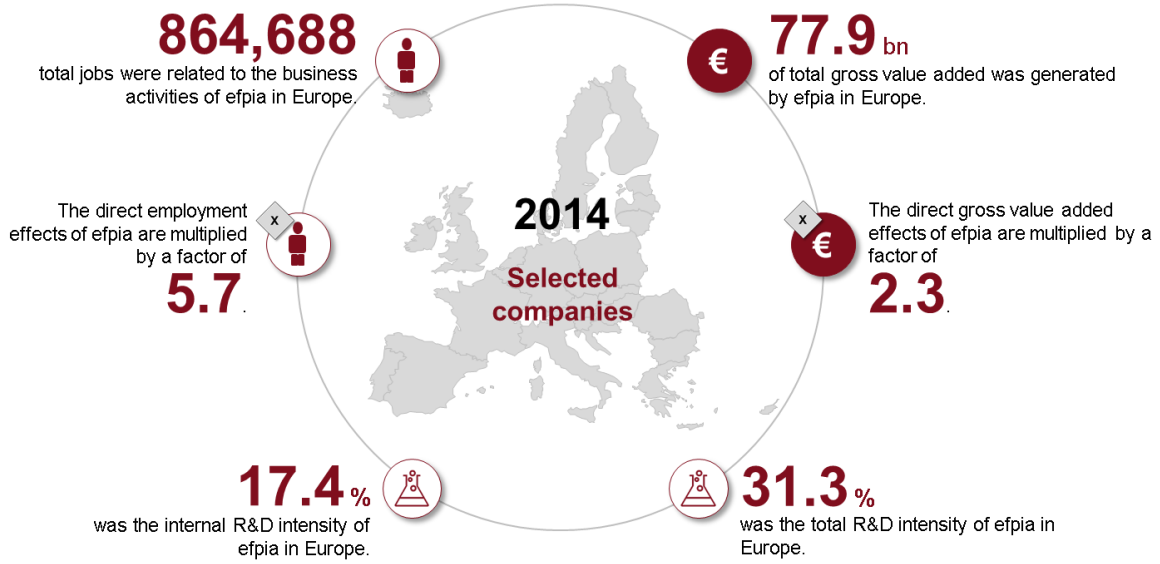
5. Conclusion

The high total GVA impact reflects the selected companies' contribution to powering growth in the European business landscape. The high total employment impact shows the selected companies' share in driving employment in Europe. The high R&D intensities prove that the selected companies are investing in innovation throughout the European economy. In combination with in-depth explanations, the results can be communicated to private and public stakeholders, policy makers and other groups.

5.1 Key Results

Figure 19 displays the six key results from the European *Economic Footprint* analysis of selected pharmaceutical companies in 2014, namely total GVA and employment impacts, their respective multipliers and the R&D-intensities of the selected companies' aggregate.

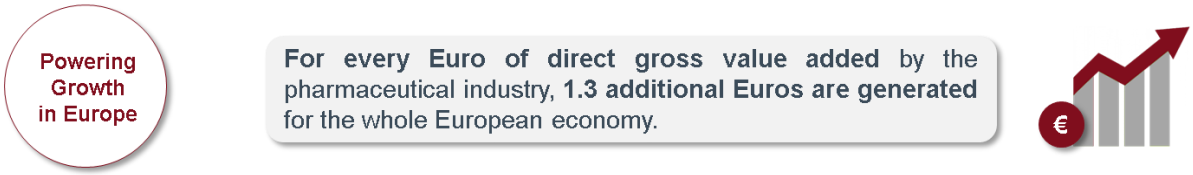
Figure 19: Key Results at a Glance



Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration.

Subsequently, the following three central messages have been formulated:

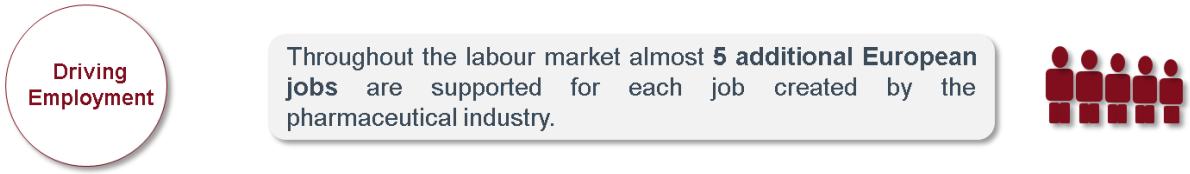
1. **Powering Growth:**



The growth message states that the selected pharmaceutical companies not only contributed €34.6 bn to European GDP by generating direct gross value added, but were able to multiply

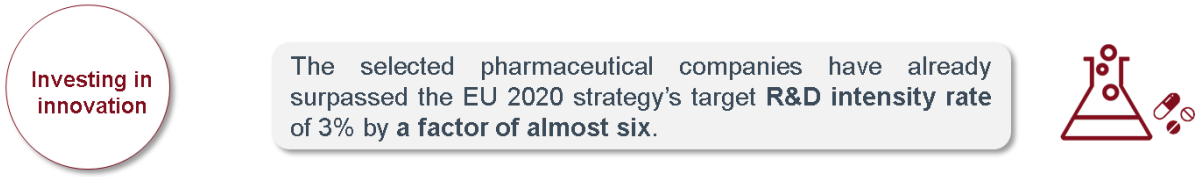
this effect by a factor of 2.3. Thus, direct effects and spillover effects in total contributed €77.9 bn to European GDP.

2. Driving Employment:



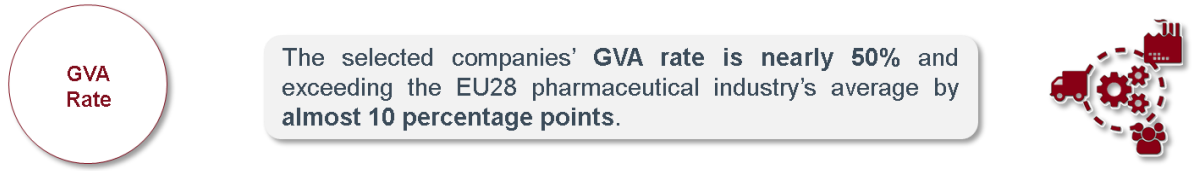
The employment message states that with a multiplier of 5.7, the selected pharmaceutical companies support nearly 865,000 jobs in the European labour market making them a strong driver of employment.

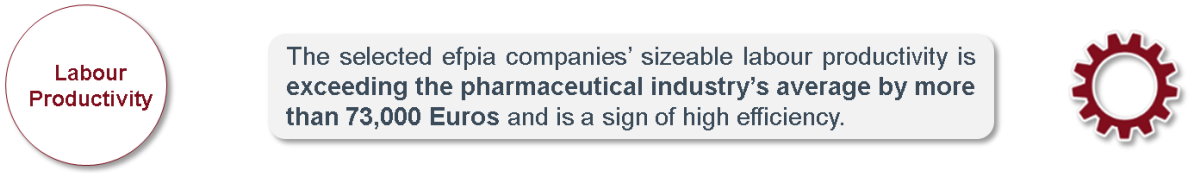
3. Investing in Innovation:



The innovation message stresses the significance of the selected companies' Research and Development efforts for the Europe business landscape and that the companies make an important contribution to achieving the EU target of 3% internal R&D spending of GDP.

In addition to those powerful key results, the selected companies were able to sustain a very high level of productivity and efficiency. In comparison to the pharmaceutical industry in the EU28 area, the selected companies achieved higher and above average levels in terms of labour productivity and GVA rates. With a GVA rate of nearly 50%, the selected companies' GVA rate is almost 10 percentage points higher than the pharmaceutical industry's GVA rate. Also, the selected companies' labour productivity is more than €73,000 higher than the pharmaceutical industry's labour productivity.





All outlined results and interpretations highlight the importance of the pharmaceutical industry, and in particular of the selected efpia companies, for the European economy. The select-

ed companies' strong linkages to the European economy have enabled them to be a catalyst for both growth and employment in the aftermath of the economic crises.

5.2 Further Research

WifOR's expertise covers an array of research fields that can be used to quantify and understand the specific impact of a variety of developments in the industry having, for example, socio-economic, fiscal, sustainability and environmental effects. Our reference book shows both completed and future, potential analyses that can provide the pharmaceutical industry with meaningful insight beyond the *Economic Footprint.*

Figure 20: WifOR's Reference Book on Additional Fields of Research

Source: WifOR illustration.

6. Methodology and Database of the Economic Footprint

The Economic Footprint traces the direct, indirect and induced economic impact of an object of investigation and illustrates linkages to other industries. The System of National Accounts serves as its database while the input-output analysis is the foundation of the calculation method.

6.1 The company-specific European Satellite Account

6.1.1 Participating Companies

For the efpia-project, seven European pharmaceutical companies were requested to provide representative data amounting to about 80% of their respective European revenue. The participating pharmaceutical companies in the efpia study are *Abbvie, AstraZeneca, Boehringer Ingelheim, Ipsen, Janssen, Novartis and Sanofi*. For *Janssen*, deep dive analyses were not performed in the EU area, only the European analysis.

6.1.2 Types of Business Entities

Every type of business entity that contributes gross value added to the national Gross Domestic Product (GDP) was included, e.g.

- Private Limited Company (Ltd.)
- Limited Partnership,
- Statutory Company,
- Holding Company

  and more.

6.1.3 Time Period

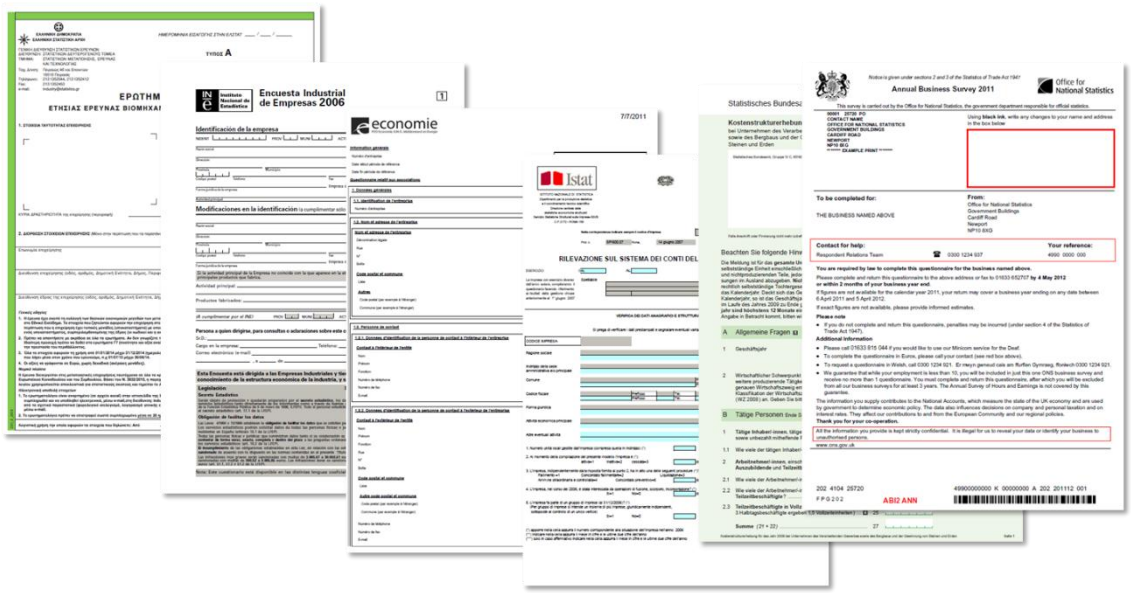
The calculations are made for the time period reaching from 2010 until 2014. The company-specific European satellite accounts from 2010 until 2014 are compiled for *AstraZeneca*, *Sanofi*, *Ispen*, *Boehringer Ingelheim* and *Janssen*. In the case of *Novartis*, the data was only provided for 2014 and for *Abbvie* the data was only available for 2013. This fact leads to level effects for the other years, since the identical company-specific European satellite account has been added throughout the period of interest for *Novartis* and *Abbvie*.

6.1.4 Data Collection Process

The data collection process was complex and time consuming. The best practice was to use official national questionnaires that have already been filled out by the relevant companies in connection with obligatory annual official surveys (see below *Figure 21*) from the national

statistical authorities in the EU. However, as the quantity of extractable data from the questionnaires varied from one country to another, some companies were asked to provide an Excel spreadsheet following the same rationale as the official statistical surveys in the manufacturing trade (e.g. the cost structure survey, the investment survey, the production survey and the materials and incoming goods survey). Another, although somewhat restrictive possibility to obtain company-specific data, is to access the statutory accounts of the legal entities. However, the data reported has to be in accordance with the nature of cost method. For a more detailed analysis on the economic effects created within the Member States of the EU, additional data with regard to the import-ratios of purchased materials and services had to be retrieved. Besides the official national questionnaires, further data was obtained through a variety of sources, such as the selected companies' Annual Business Surveys, financial reports, statutory accounts, SAP data and spend data.

Figure 21: Subset of Official National Questionnaires



Source: National Statistical Authorities in Europe; WifOR illustration.

Most of the information provided in official statistical questionnaires matches the Classifications of Productivity by Activity (CPA) of the European System of Accounts (ESA), which provides information about the activities of an economy. The ESA is the European equivalent to the System of National Accounts (SNA) released in 2008 by the United Nations, which is a comprehensive accounting framework, subdivided according to 64 economic sectors, that depicts the characteristics and performance of an economy. Hereby, an international standard of macroeconomic accounts as well as definitions, classifications and accounting rules was agreed upon.[14] However, as the data was collected from a variety of sources, it had to

[14] Cf. (UN, 2009).

be validated prior to being assigned to homogeneous sectors of the CPA, i.e. the production of unique goods or services identified by their unique production structure. In addition, at a later stage of the compilation, the collected data was transformed from purchasers' prices into basic prices, i.e. excluding the use of imported products and taxes less subsidies.

6.1.5 Input-Output Table

For the calculation of the group-specific *Economic Footprint* in the EU area, EU-28 symmetric input-output tables (SIOT) for domestic output with a breakdown of 64 activities/products provided by Eurostat according to the ESA 2010 methodology were used. The necessary tables were downloaded from the Eurostat website for the years 2010, 2011 and 2012. The SIOTs are product-by-product or industry-by-industry matrices combining both supply and use into a single table with identical classification of products or industries, applied to both rows and columns. The product-by-product input-output table is compiled by converting the supply and use tables, both at basic prices. This involves a change in format, i.e. from two asymmetric tables into one symmetric table. The conversion can be divided into three steps: first, the allocation of secondary products in the supply table to the industries of which they are the principal products; second, the rearrangement of columns of the use table from inputs into industries to inputs into homogeneous sectors (without aggregation of the rows), and third, the aggregation of detailed products (rows) of the new use table to the homogeneous sectors shown in the columns, if appropriate.[15]

6.1.6 Compilation of the Company-Specific European Satellite Account

The data collection exercise allowed for the aggregation of seven company-specific European satellite accounts, each of which is made up of numerous company-specific national satellite accounts. The compilation of a company-specific European satellite account was conducted in four steps: first, the allocation and distribution of company-specific cost positions; second, the aggregation to numerous company-specific European homogenous sectors; third, the purchasers' price conversion into basic prices; fourth, the aggregation to one company-specific European satellite account; fifth, the extrapolation to 100% of the company-specific European Satellite Account.

i. Allocation and Distribution of Company-Specific Cost Positions

The company's business activities that can differ from one legal entity to another are split in accordance with CPA-units of homogenous sectors. The distinction between the company's national output shares of goods and services is decisive for the split into homogenous sectors. In the case of the selected companies, the business activities were spread across the

[15] Cf. (Eurostat, 2016).

following homogenous sectors*: basic pharmaceutical products and pharmaceutical preparations (CPA_C21)*; *wholesale trade services, except of motor vehicles and motorcycles (CPA_G46)*; *scientific research and development activities (CPA_M72)*; *legal and accounting services, services of head offices, management consulting (PA_M69_M70)*; *chemical and chemical products (CPA_C20)*. Furthermore, the company data was used to derive the company-specific national satellite accounts either by directly allocating the cost positions that are clearly assignable to CPA units, or, for cost positions that are not clearly allocable to one specific CPA unit, by distributing the cost across the remaining CPA units by means of intermediate consumption distribution of their respective homogenous national sectors. Both allocation and distribution occurs in purchasers' prices using national Input-Output Tables (IOT) provided by Eurostat. Company-specific national accounts purposefully resort to national IOTs in order to preserve the national economic structure of the linkages with the economy when distributing cost positions that are not clearly allocable to one particular CPA unit.

ii. Aggregation to Numerous Company-Specific European Homogenous Sectors

The company-specific homogeneous national sectors from every company-specific national satellite account are then aggregated to inter-company-specific homogeneous European sectors, respectively. This is done by summing up all company-specific French, Swedish, German, Italian, etc. homogenous national sectors such as "basic pharmaceutical products and pharmaceutical preparations", "wholesale trade services, except of motor vehicles and motorcycles", etc. Thus, every company is represented by up to five inter-company-specific homogenous European sectors.

iii. Purchasers' Price Conversion into Basic Prices

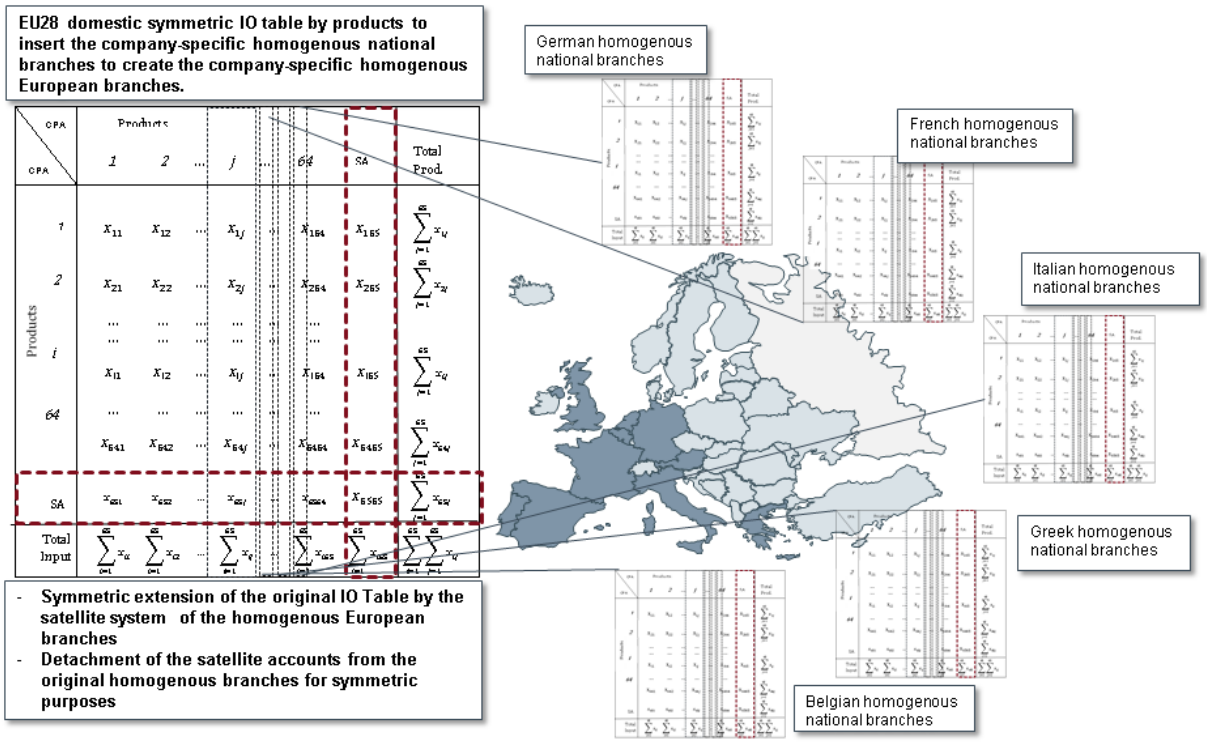
Next, the intercompany-specific homogenous European sectors' purchasers' prices are converted into basic prices. The prices are converted based on the respective sectors' share of imports and taxes less subsidies provided by the EU-28 domestic symmetric IOT (ESA 2010 methodology). This procedure is based on the assumption that the selected companies' extra-EU-28 gross imports of intermediate goods and services is small compared to their intra-EU-28 imports of intermediate consumption. This assumption is supported by 2011 figures made available by the OECD, stating that the EU-28 gross import share of intermediate goods and services from the "World" equals 10.11%, the EU-28 gross import share of intermediate goods and services of the *Chemical Industry*, which includes the *Pharmaceutical industry*, equals 15.53% and the EU-28 gross import share of intermediate goods and services of the *Wholesale industry* equals 11.46%. Thus, the EU-28 intra-European market is more important to the European businesses than the rest of the world.[16]

[16] Cf. (OECD, 2016b). Data from: Trade in Value Added (TiVA) Database.

iv. Aggregation to one Company-Specific European Satellite Account

The numerous company-specific homogenous European sectors are then aggregated into one company-specific European satellite account (see below *Figure 22*).

Figure 22: Illustration of the Company-Specific European Satellite Account

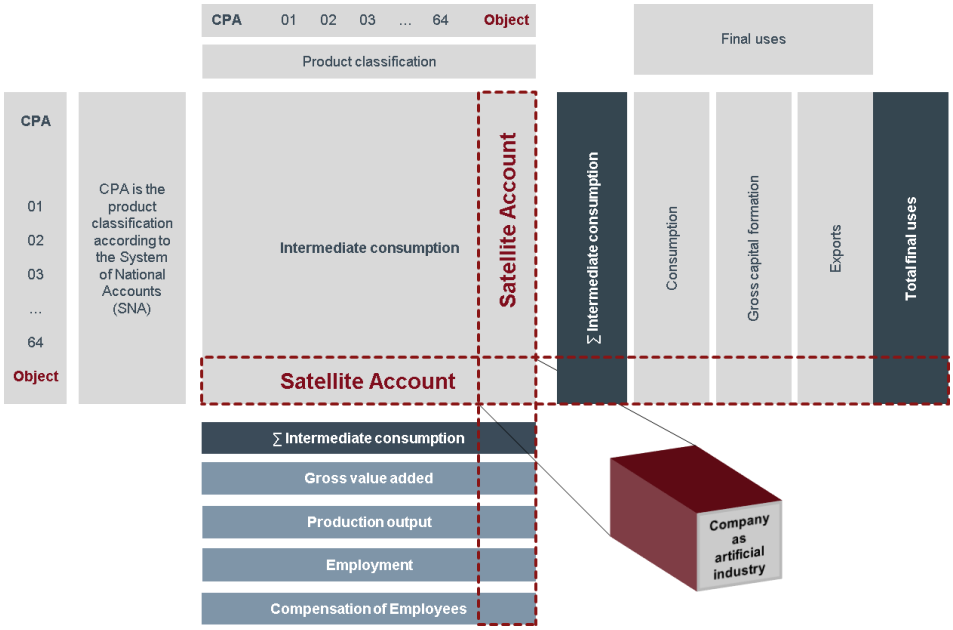


Source: WifOR illustration.

v. Extrapolation to 100% of the Company-Specific European Satellite Account

In the final step, the company-specific European satellite account, covering about 80% of the European company activity, is extrapolated to 100%. The extrapolation factor equals the fraction of the company-specific European total revenue divided by the company-specific European base revenue. Then, every cost position of the company-specific European satellite account is multiplied with that factor. Now, the 100% company-specific European satellite account can be detached from the *Intermediate Consumption Matrix* of the respective EU-28 symmetric IOT. The European satellite account comprises the company's key figures of the direct Economic Footprint (see *Figure 23*).

Figure 23: Schematic Illustration of the Satellite Account



Source: WifOR illustration.

6.2 The Group-Specific European Satellite Account

6.2.1 Database for the Group-Specific European Satellite Account

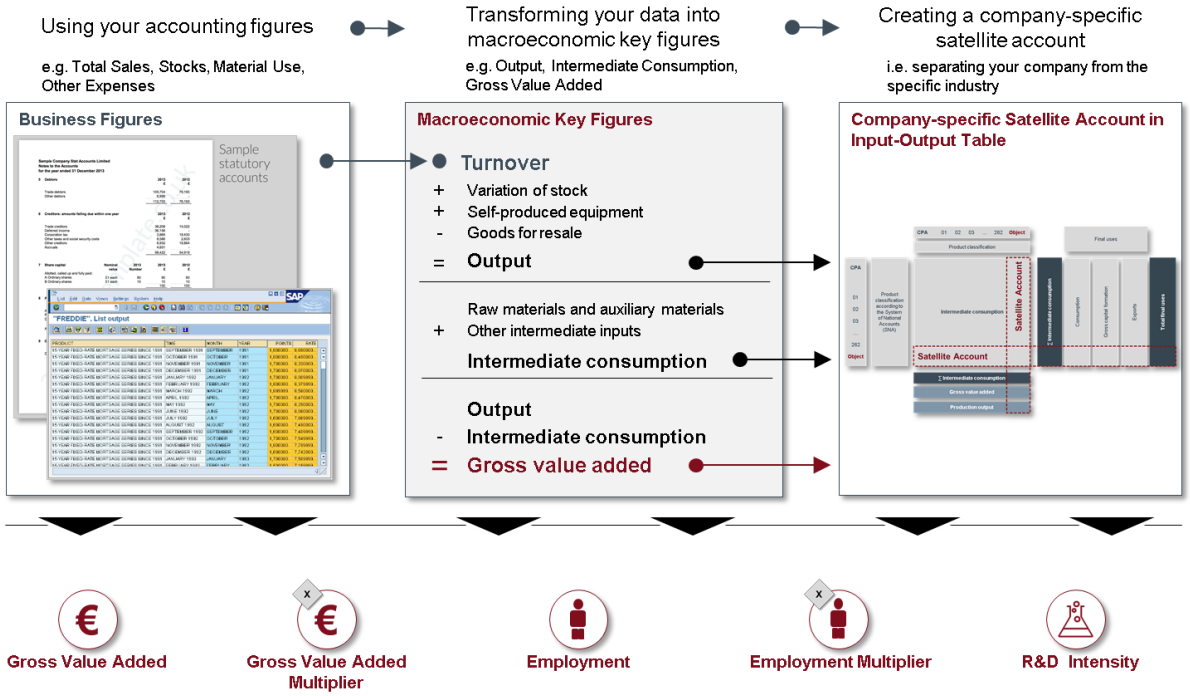
The aggregation of the seven company-specific European satellite accounts into one group-specific European satellite account includes the major business units and legal entities of the seven pharmaceutical companies within the EU 28 area. This group-specific European satellite account shows the economic interrelationships of the group's activity in the European economy and the linked sectors. Prior to the aggregation of the company-specific European satellite accounts, the compilation of the group-specific European satellite account was based on a number of important steps, such as the delivery of a database of about 80% of the European business by every participating company, the transformation of the delivered data into the categories of the *System of National Accounts* (SNA) and the compilation of 100% of the company-specific European satellite accounts.

6.2.2 Direct Economic Effects

The direct economic effects of the efpia-group are derived from the group-specific European satellite account. Direct O*utput* is calculated from sales plus the change in inventory of finished and unfinished products from the company's own production and self-produced equip-

ment less merchandise.[17] The central figure is the *gross value added* (GVA), which is determined by subtracting intermediate inputs from output (see below *Figure 24*).

Figure 24: Calculation of Direct Economic Effects



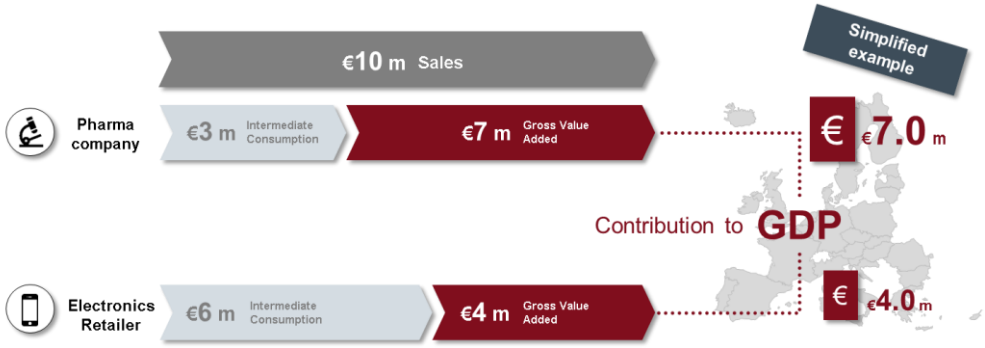
Source: WifOR illustration.

The GVA is more than a simple residuum - it represents any company's share of the Gross Domestic Product (GDP). The direct GVA is used to assess the size as well as the performance of a company, an industry, a sector and even an economy. Thus, the direct GVA indicates the company's contribution to the GDP of the national economy. In order to illustrate the significance of the direct GVA,

Figure 25 shows two direct GVAs of different companies that produce the same amount of sales. In contrast to revenue, the amount of intermediate consumption used in the production process determines the level of direct GVA. In our example, the pharmaceutical company contributes more to GDP (per employee) than the electronics retailer. Following the argumentation above, the direct GVA is better suited to state a company's economic performance.

[17] For a detailed treatment of the topic cf. (Destatis, 2010), p. 4ff. The entire methodological representation has been highly simplified in this section.

Figure 25: Illustration of the Significance of Gross Value Added and Revenue



Source: WifOR illustration.

In addition to *direct GVA*, the Economic Footprint comprises further economic key figures that describe the immediate economic effects, such as:

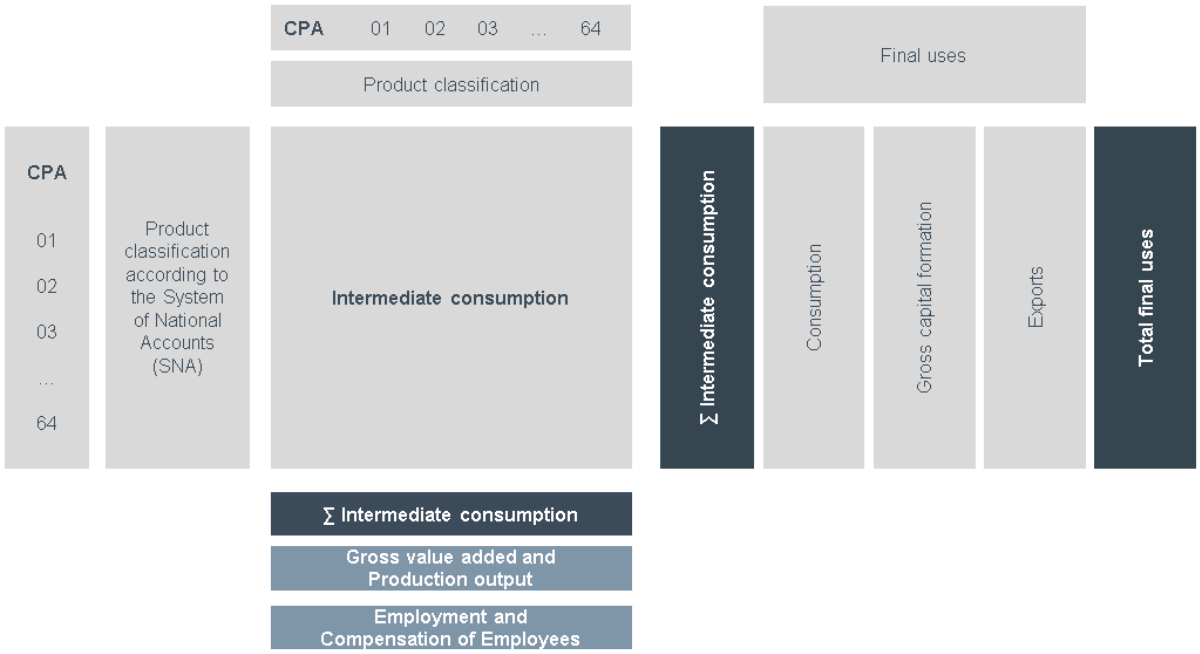
- *Production value or output:* The production value, also referred to as output, is the total value of products created during the accounting period. Output is to be valued at purchasers' prices, i.e. including taxes less subsidies and imports.
- *Intermediate consumption or input:* The intermediate consumption, also referred to as input, consists of goods and services consumed as inputs by a process of production. The goods and services are either transformed or used up during the production process. Intermediate consumption less imports and production charges, i.e. taxes less subsidies, is to be valued at basic prices.
- *Compensation of employees:* Compensation of employees is defined as the total remuneration payable by an employer to an employee in return for work done by the latter during an accounting period. The compensation of employees is a figure provided by the companies.
- *Employment:* Employment covers all persons engaged in productive activity that falls within the production boundary of the national accounts. The direct employment figure of all European businesses is provided by the companies.
- *Expenditure on Research and Development:* Expenditures on Research and Development are recognized as capital formation of intellectual property. The internal and external R&D figures are also provided by the companies.

6.2.3 The Input-Output Analysis

The *Economic Footprint* is based on input-output analysis, which was developed in the 1930s and 1940s by the economist Wassily Leontief who received the Nobel Prize in Economics in 1973. The input-output analysis is an integral component of the SNA and seeks to describe the economic interlacing within an economy as well as the flow of goods with the rest of the world. Furthermore, inputs, i.e. resources in monetary units, are understood as production factors such as labour and capital. Outputs refer to the value of goods and ser-

vices that are produced. Thus, the input-output table is a matrix that combines information about the supply and use of the numerous homogenous units of CPA.[18] A graphic representation of the IOT and its components is given in *Figure 26*.

Figure 26: Architecture of Input-Output Tables



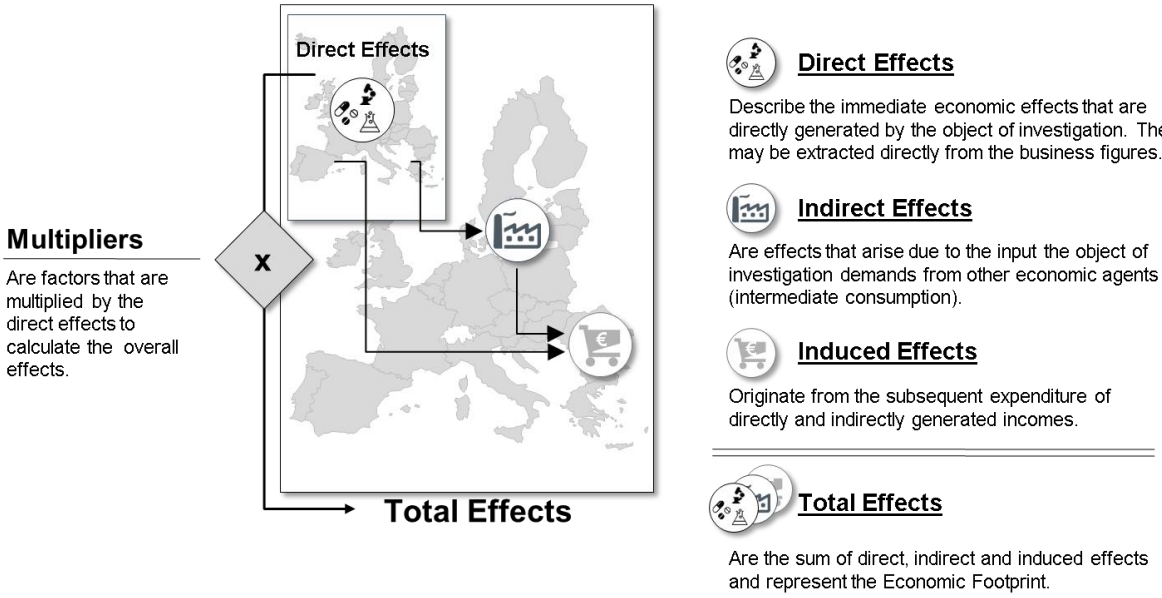
Source: WifOR illustration.

6.2.4 The calculation of Indirect and Induced Economic Effects

Resulting from the input-output analysis, a company's indirect effects can be calculated by means of input demanded by the company from other economic agents. Order placements result in an increase in economic activity among the commissioned agents. This stimulation leads to an enhancement of the supplier's GVA and further economic key figures that are grouped under the term *indirect effect*. Furthermore, induced effects originate from subsequent expenditure of directly and indirectly generated incomes. The compensation of employees that is paid by the company or that arise through the demand of the company leads to further demand in the economy along the supply chain. This demand also triggers GVA and further economic parameters, summed up under the term *induced economic effects*. The sum of indirect and induced economic effects is also called *spillover effects*. Total economic effects refer to the sum of all three effects as shown in *Figure 27* below. Multipliers are factors that get multiplied by the direct effects to calculate the indirect, induced and overall effects. The calculation of indirect and induced economic effects is part of the input-output analysis. For an extensive documentation of the relevant matrix algebra for the computation of indirect and induced effects see the Appendix B.

[18] Cf. (Destatis, 2010).

Figure 27: Schematic Explanation of Direct and Spillover Effects



Source: WifOR illustration.

6.3 Further Economic Indicators of the Economic Footprint

Based on the standardization of direct economic figures such as direct GVA, further indicators of economic performance can be computed and compared with one another despite different aggregation levels. For example, a single economic agent's economic performance can be compared to the economic performance of an economic sector or even the national economy. The following economic indicators are computed:

- *GVA rate:* The GVA rate is the ratio between GVA and output. This rate provides information about the share of processing involved in the production of goods and services. The higher the GVA rate, the more GVA is produced with an identical output.
- *Labour productivity:* Labour productivity is calculated by the ratio between GVA and total employment. This ratio indicates how much GVA is generated by one employee. The higher this ratio, the more productive the labour force.
- *Average compensation of employees:* The average compensation of employees or the compensation per employee is the ratio between total compensation of employees and total employment. It reflects the average annual compensation that employees receive.
- *R&D intensity:* The R&D intensity is the ratio between R&D expenditures and GVA. This ratio indicates future technological change and hence gives an idea about the competitive advantage in the long run.

7. Appendix A: Glossary

Average compensation of employees	The average compensation of employees or the compensation per employee is the ratio of total compensation of employees and total employment. It portends the average annual compensation that employees receive in return for their work.
Basic price	The basic price is the price receivable by the purchasers from the producers.
Compensation of employees	The compensation of employees is defined as the total remuneration payable by an employer to an employee in return for work done by the latter during an accounting period.
Direct (economic) effects	Direct effects describe the immediate economic effects that are directly generated by the object of investigation.
Employment	Employment covers all persons engaged in productive activity that falls within the production boundary of the national accounts
Expenditure on Research and Development (R&D)	Expenditure on R&D is recognised as capital formation of intellectual property.
GVA rate	The GVA rate is the ratio of the GVA and the PV. This rate provides information about the share of PV terminating in GVA. The higher the GVA rate, the more GVA is produced with an identical PV.
Indirect (economic) effects	Indirect effects are effects that arise due to the input the object of investigation demands from other economic agents (intermediate consumption).
Induced (economic) effects	Induced effects originate from subsequent expenditure of directly and indirectly generated incomes.
Input rate	The input rate is computed by the ratio of the intermediate consumption and the output. It denotes the demanded inputs to produce the output. The lower the input rate, the more efficient is the production process regarding its requirements of inputs.
Intermediate consumption	Intermediate consumption, also referred to as input, consists of goods and services consumed as inputs by a process of production. The goods and services are either transformed or used up by/in the production process.
Labour productivity	Labour productivity is calculated by the ratio of the GVA and total employment. This ratio indicates how much GVA is generated by one employee. The higher this ratio, the more productive is the labour force.
Multiplier	Multipliers are factors that get multiplied by the direct effects to calculate the indirect, induced and overall effects.
Production value (PV)	The PV, also referred to as the output, is the total of products created during the accounting period. The output is to be valued at the basic price, which is the price receivable by the producers from the purchaser.
R&D intensity	The R&D intensity is the ratio of R&D expenditure and the GVA. Similar to the investment intensity, this ratio indicates future technological

	change and hence gives an idea about the competitive advantage in the long run.
Spillover effects	Spillover effects are the sum of indirect and induced economic effects.
Total (economic) effects	Total economic effects are the sum of the direct and spillover effects.

8. Appendix B: The Calculation Model of the Direct and Spillover Effects

Since direct effects are effects that are directly generated by the object of investigation, these effects can be investigated by simple data collection. However, to analyse the spillover effects, various types of input-output models exist. These models can be classified into:

- Open and closed models,
- Quantity and price models,
- Statistical and dynamic models.[19]

If the variables of the input-output analysis are mostly independent, the underlying model is an open input-output model. This means that parts of the final demand are exogenous and remain constant throughout the whole analysis. Feedback of e.g. increase of income due to a rise in production are not considered. On the other hand, within closed models, all variables are endogenous and depend on each other.[20] Quantity models analyse the consequences of a change in final demand. Central to these models is how many and which type of intermediate consumption has to be produced to satisfy the final demand for goods. On the other hand, price models investigate the impact of alterations of prices of the intermediate consumption. Statistical and dynamic models differ in terms of the considered time periods. Statistical models do not model changes over time. The models only involve a single time period.[21]

In this research project, the *statistic open quantity model* is applied to investigate the indirect and induced economic effects. The origin of this model is the domestic IOT, which is represented in the following system of equations:

$$\begin{array}{ccccccccc} x_{11} + & \dots & +x_{1j} & \dots & +x_{1n} & +Y_1 & = & X_1 \\ \vdots & & \vdots & & \vdots & \vdots & & \vdots \\ x_{i1} + & \dots & +x_{ij} & \dots & +x_{in} & +Y_i & = & X_i, \\ \vdots & & \vdots & & \vdots & \vdots & & \vdots \\ x_{n1} + & \dots & +x_{nj} & \dots & +x_{nn} & +Y_n & = & X_n \end{array} \tag{1}$$

where X_i represents the gross output or respectively the total demand of a sector i. It is the sum of the intermediate consumption that sector i demands from sector j, denoted by x_{ij}, and the final consumption of sector i, Y_i. To receive a linear correlation between the gross output X_i and the intermediate consumption x_{ij}, the input coefficients,

$$a_{ij} = \frac{x_{ij}}{X_j} \tag{2}$$

are derived. The input coefficient a_{ij} shows the share of contribution of product i to produce product j. The matrix of input coefficients A reads as follows:

$$A = \begin{array}{ccccc} a_{11} & \dots & a_{1j} & \dots & a_{1n} \\ \vdots & & \vdots & & \vdots \\ a_{i1} & \dots & a_{ij} & \dots & a_{in}. \\ \vdots & & \vdots & & \vdots \\ a_{n1} & \dots & a_{nj} & \dots & a_{nn} \end{array} \tag{3}$$

[19] Cf. (Holub & Schnabl, 1997).
[20] Cf. (Ostwald, Henke, & Kim, 2013).
[21] Cf. (Ostwald, Otte, Henke, Strauch, & Löser, 2013).

Equation (2) and (3) can be substituted into Equation (1):

$$\begin{array}{ccccccccc} a_{11}X_1 + & \dots & +a_{1j}X_j & \dots & +a_{1n}X_n & +Y_1 & = & X_1 \\ \vdots & & \vdots & & \vdots & \vdots & & \vdots \\ a_{i1}X_1 + & \dots & +a_{ij}X_j & \dots & +a_{in}X_n & +Y_i & = & X_i, \\ \vdots & & \vdots & & \vdots & \vdots & & \vdots \\ a_{n1}X_1 & \dots & +a_{nj}X_j & \dots & +a_{nn}X_n & +Y_n & = & X_n \end{array} \quad (4)$$

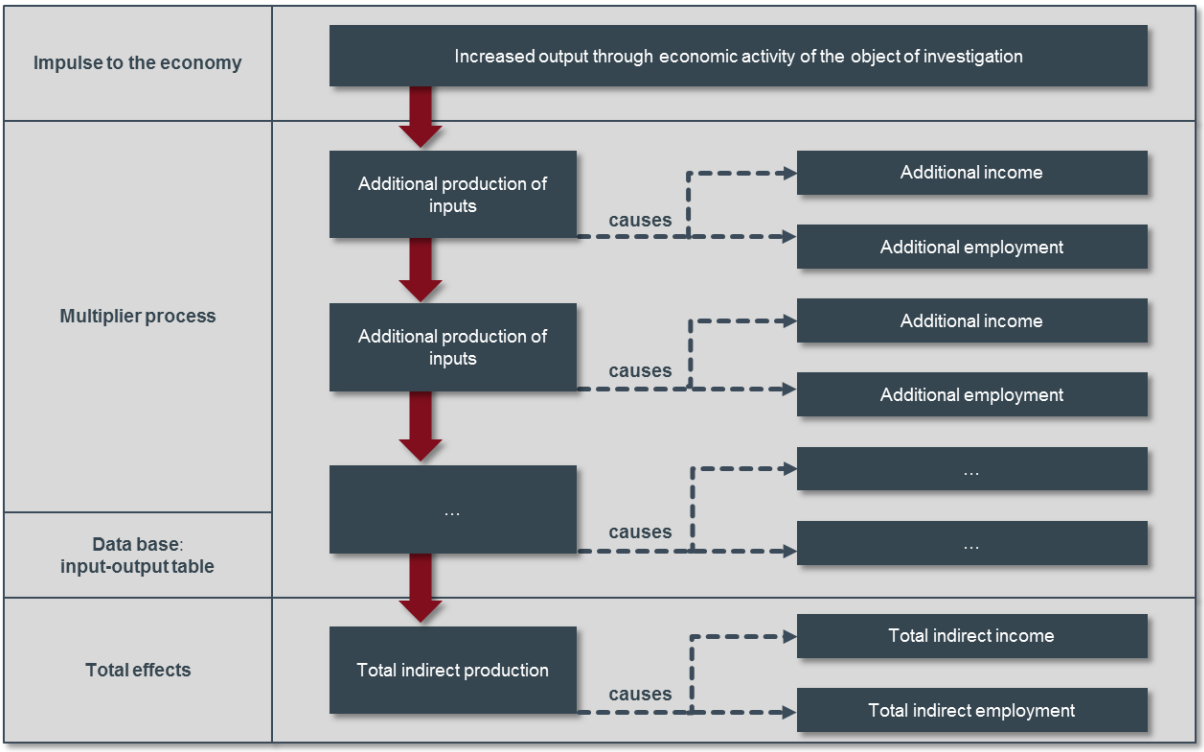
yielding the following equation in matrix notation:

$$Ax + y = x, \quad (5)$$

with x denoting the vector of gross output, y is the vector of final consumption.

In the present model, the economic impulse of the object of investigation towards the rest of the economy is assumed to be the PV. A change in the output leads to a change in the matrix of intermediate consumption. This in turn triggers economic activity in the supplying industries. This effect is the first round of effects. However, if the supplying industries increase their production, they also send out impulses to the economy and so on and so forth. There are infinitely many rounds of indirect economic effects which are mathematically represented by the boundary value of the Leontief inverse matrix. An illustration of the causality of the effect relationship is given in *Figure 28*.

Figure 28: Causality Regarding Investigation of the Indirect Effects



Source: WifOR illustration based on (Ostwald, Otte, Henke, Strauch, & Löser, 2013) and (Ostwald, Henke, & Kim, 2013).

To examine changes in gross output triggered by changes in demand, Equation (5) is solved for the gross output x:

$$x = (I - A)^{-1}y, \quad (6)$$

with I being the identity matrix. The first term is called the Leontief inverse matrix L:

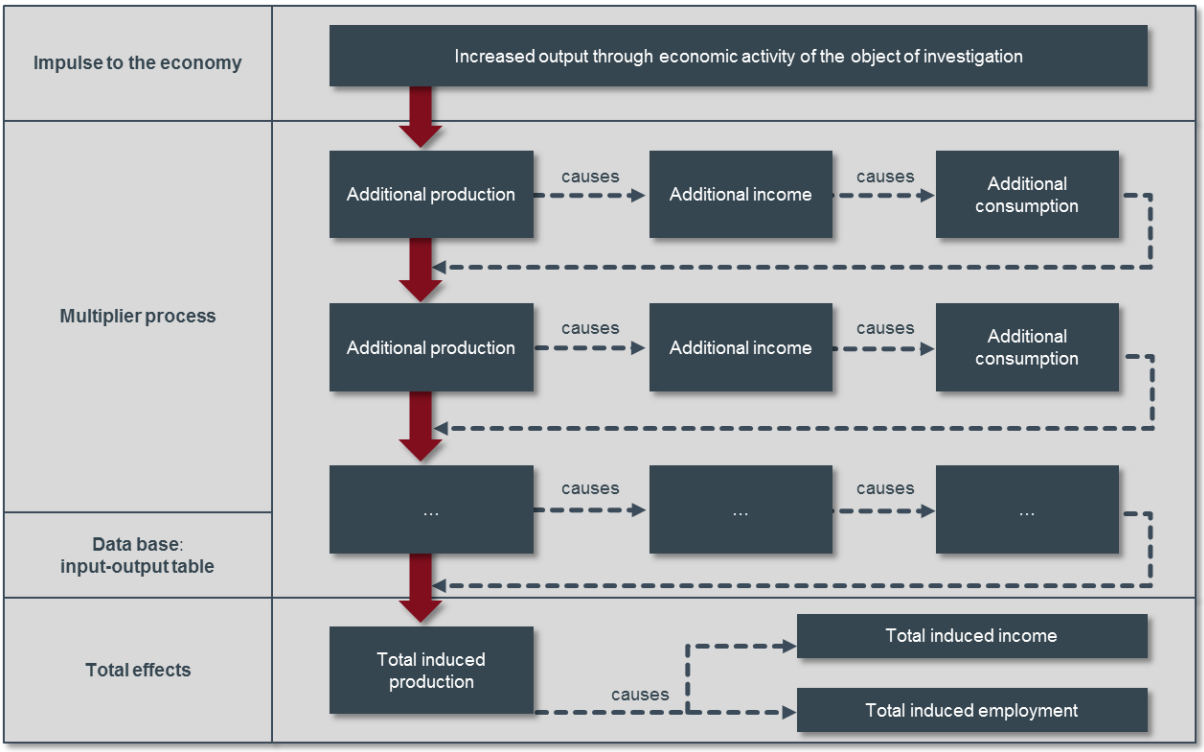
$$L = (I - A)^{-1}.$$ [22] (7)

Furthermore, the Leontief inverse matrix L is standardized, i.e. the main diagonal elements contain the value 1 only. This new matrix T, the technology matrix, is crucial for changes in output given a change in demand, hence it is crucial for calculation of the indirect effects:

$$T = L \times [diag(L)]^{-1}$$ (8)

To quantify the induced economic effects as a consequence of the economic activity of the object of investigation, the consumption demand is endogenised. The compensation of employees leads to an increased demand for goods and services across the economy, for which an enhanced production is needed. The compensation of employees for this enhanced production leads to a further increase in the demand. Theoretically, there are infinitely many rounds that are shown in *Figure 29*. However, the effects become smaller and smaller, since not the full income but only parts of it are spent for consumption.

Figure 29: Causality Regarding Investigation of the Induced Effects



Source: WifOR illustration based on (Ostwald, Otte, Henke, Strauch, & Löser, 2013) and (Ostwald, Henke, & Kim, 2013).

Similar to the indirect effects, a matrix of coefficients has to be derived to calculate the induced effects. However, this matrix C does not contain input coefficients (cf. matrix A), but rather consumption coefficients. These coefficients reveal information about how much is spent in terms of salaries and wages for the generation of a specific output. These coeffi-

[22] Cf. (Ostwald, Henke, & Kim, 2013).

cients are computed by the product of the vector of the consumption rate c and a vector of coefficients of the compensation of employees w:

$$C = c \times w, \tag{9}$$

where w is a vector consisting of the ratio of the compensation of employees in the production sector j, W_j, and the output of the production sector j, X_j:

$$w_j = \frac{W_j}{X_j}.^{23} \tag{10}$$

The standardized technology matrix for calculation of the induced economic effects then reads as follows:

$$T^* = L^* \times [diag(L^*)]^{-1}, \tag{11}$$

with:

$$L^* = (I - C)^{-1}. \tag{12}$$

Production Value Effects

To compute the PV effects, the technology matrices T and T^* are multiplied with the initial impulse, the PV X_j. First, the sum of the direct and indirect PV effect, x_{d+i}, is reached:

$$x_{d+i} = T \cdot X_j, \tag{13}$$

with X_j being equal to the direct PV effect, x_d:

$$X_j = x_d. \tag{14}$$

Subtraction of the direct effect, yields the indirect PV:

$$x_{indi} = x_{d+i} - x_d.^{24} \tag{15}$$

The following equation yields the total production effect:

$$x_t = T^* \cdot X_j, \tag{16}$$

from which the direct and indirect effects are subtracted to achieve the induced PV effect:

$$x_{indu} = x_t - x_{d+i}.^{25} \tag{17}$$

Gross Value Added Effects

To compute the value added effects, the model is expanded by a matrix G with the following elements on the main diagonal:

$$g_j = \frac{G_j}{X_j}. \tag{18}$$

The coefficients g_j result from the GVA of the production areas j, G_j, and the PV of the same production area j, X_j.

With these coefficients, the indirect and induced GVA effects are calculated (cf. Equation (20) and (22)):

$$g_{d+i} = G \cdot T \cdot X_j \tag{19}$$

[23] Cf. (Ostwald, Henke, & Kim, 2013).
[24] Cf. (Ostwald, Henke, & Kim, 2013).
[25] Cf. (Ostwald, Henke, & Kim, 2013).

$$g_{indi} = g_{d+i} - g_d \quad (20)$$

$$g_t = G \cdot T^* \cdot X_j \quad (21)$$

$$g_{indu} = g_t - g_{d+i}. \quad (22)$$

Employment Effects

The calculation of the employment effects operates similar to the calculation of the GVA effects. The model is expanded by a matrix E with the employment coefficients e_j on the main diagonal:

$$e_j = \frac{E_j}{X_j}, \quad (23)$$

where E_j represents the employment of the production area j and X_j being the PV of the production area j.

With these coefficients, the indirect and induced employment effects are calculated:

$$e_{d+i} = E \cdot T \cdot X_j \quad (24)$$

$$e_{indi} = e_{d+i} - e_d \quad (25)$$

$$e_t = E \cdot T^* \cdot X_j \quad (26)$$

$$e_{indu} = e_t - e_{d+i}. \quad (27)$$

9. Appendix C: Results of the Economic Footprint Analysis of Selected Companies

Table 2: Direct, Spillover and Total Economic Effects of Selected Pharmaceutical Companies, from 2010 to 2014

Output effects in EUR million	Unit	2010	2011	2012	2013	2014		Avg.	Growth abs	Growth %	Growth % p.a.
Direct effects	m€	71,121	70,155	70,943	67,792	69,294		69,861	-1,826	-2.6%	-0.6%
Multiplier	-	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*		*1.00*	*0.00*	*0.0%*	*0.0%*
Indirect effects	m€	57,525	59,051	62,298	59,458	60,739		59,814	3,215	5.6%	1.4%
Multiplier	-	*0.81*	*0.84*	*0.88*	*0.88*	*0.88*		*0.86*	*0.07*	*8.4%*	*2.0%*
Induced effects	m€	33,005	33,388	35,090	33,828	34,392		33,941	1,387	4.2%	1.0%
Multiplier	-	*0.46*	*0.48*	*0.49*	*0.50*	*0.50*		*0.49*	*0.03*	*6.9%*	*1.7%*
Spillover effects	m€	90,529	92,439	97,388	93,286	95,131		93,755	4,602	5.1%	1.2%
Multiplier	-	*1.27*	*1.32*	*1.37*	*1.38*	*1.37*		*1.34*	*0.10*	*7.9%*	*1.9%*
Total effects	m€	161,650	162,595	168,331	161,078	164,425		163,616	2,775	1.7%	0.4%
Multiplier	-	*2.27*	*2.32*	*2.37*	*2.38*	*2.37*		*2.34*	*0.10*	*4.4%*	*1.1%*
Value added effects in EUR million	**Unit**	**2010**	**2011**	**2012**	**2013**	**2014**		**Avg.**	**Growth abs**	**Growth %**	**Growth % p.a.**
Direct effects	m€	37,364	35,708	35,447	33,815	34,576		35,382	-2,788	-7.5%	-1.9%
Multiplier	-	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*		*1.00*	*0.00*	*0.0%*	*0.0%*
Indirect effects	m€	24,525	24,914	26,905	25,766	26,414		25,705	1,889	7.7%	1.9%
Multiplier	-	*0.66*	*0.70*	*0.76*	*0.76*	*0.76*		*0.73*	*0.11*	*16.4%*	*3.9%*
Induced effects	m€	15,867	16,029	17,223	16,604	16,881		16,521	1,014	6.4%	1.6%
Multiplier	-	*0.42*	*0.45*	*0.49*	*0.49*	*0.49*		*0.47*	*0.06*	*15.0%*	*3.5%*
Spillover effects	m€	40,392	40,942	44,128	42,371	43,295		42,226	2,903	7.2%	1.8%
Multiplier	-	*1.08*	*1.15*	*1.24*	*1.25*	*1.25*		*1.20*	*0.17*	*15.8%*	*3.7%*
Total effects	m€	77,755	76,651	79,575	76,185	77,871		77,607	116	0.1%	0.0%
Multiplier	-	*2.08*	*2.15*	*2.24*	*2.25*	*2.25*		*2.20*	*0.17*	*8.2%*	*2.0%*

Employment effects in thousand full-time equivalents	Unit	2010	2011	2012	2013	2014		Avg.	Growth abs	Growth %	Growth % p.a.
Direct effects	'000	165.676	163.440	158.976	153.021	153.027		158.828	-12.650	-7.6%	-2.0%
Multiplier	-	*1.0*	*1.0*	*1.0*	*1.0*	*1.0*		*1.0*	*0.0*	*0.0%*	*0.0%*
Indirect effects	'000	391.626	391.477	408.314	395.253	405.364		398.407	13.738	3.5%	0.9%
Multiplier	-	*2.4*	*2.4*	*2.6*	*2.6*	*2.6*		*2.5*	*0.3*	*12.1%*	*2.9%*
Induced effects	'000	300.915	299.563	312.546	301.289	306.298		304.122	5.383	1.8%	0.4%
Multiplier	-	*1.8*	*1.8*	*2.0*	*2.0*	*2.0*		*1.9*	*0.2*	*10.2%*	*2.5%*
Spillover effects	'000	692.541	691.040	720.860	696.542	711.661		702.529	19.121	2.8%	0.7%
Multiplier	-	*4.2*	*4.2*	*4.5*	*4.6*	*4.7*		*4.4*	*0.5*	*11.3%*	*2.7%*
Total effects	'000	858.217	854.480	879.835	849.563	864.688		861.357	6.471	0.8%	0.2%
Multiplier	-	*5.2*	*5.2*	*5.5*	*5.6*	*5.7*		*5.4*	*0.5*	*9.1%*	*2.2%*
Effects of compensation of employees in EUR million	**Unit**	**2010**	**2011**	**2012**	**2013**	**2014**		**Avg.**	**Growth abs**	**Growth %**	**Growth % p.a.**
Direct effects	m€	14,016	14,130	14,419	13,967	14,049		14,116	33	0.2%	0.1%
Multiplier	-	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*		*1.00*	*0.00*	*0.0%*	*0.0%*
Indirect effects	m€	12,484	12,666	13,825	13,262	13,635		13,174	1,151	9.2%	2.2%
Multiplier	-	*0.89*	*0.90*	*0.96*	*0.95*	*0.97*		*0.93*	*0.08*	*9.0%*	*2.2%*
Induced effects	m€	7,129	7,182	7,762	7,482	7,607		7,432	478	6.7%	1.6%
Multiplier	-	*0.51*	*0.51*	*0.54*	*0.54*	*0.54*		*0.53*	*0.03*	*6.5%*	*1.6%*
Spillover effects	m€	19,612	19,848	21,587	20,744	21,242		20,607	1,629	8.3%	2.0%
Multiplier	-	*1.40*	*1.40*	*1.50*	*1.49*	*1.51*		*1.46*	*0.11*	*8.1%*	*2.0%*
Total effects	m€	33,628	33,978	36,006	34,711	35,290		34,723	1,662	4.9%	1.2%
Multiplier	-	*2.40*	*2.40*	*2.50*	*2.49*	*2.51*		*2.46*	*0.11*	*4.7%*	*1.2%*

Source: Data from selected efpia companies; Data from Eurostat; Data from OECD; WifOR calculation; WifOR illustration.

Table 3: Key Results of Selected Pharmaceutical Companies, from 2010 to 2014

	efpia-Aggregate in Europe	Unit	2010	2011	2012	2013	2014	Growth (abs)	Growth (%)
	Turnover	**bn€**	**97.9**	**96.2**	**98.1**	**95.4**	**98.5**	**0.6**	**0.6%**
+	Value of stock of goods of own production	bn€							
+	Self-produced equipment	bn€							
-	Use of merchandise	bn€							
=	**Output**	**bn€**	**71.1**	**70.2**	**70.9**	**67.8**	**69.3**	**-1.8**	**-2.6%**
	Intermediate consumption	bn€							
+	Other consumption	bn€							
=	**Total intermediate consumption**	**bn€**	**33.8**	**34.4**	**35.5**	**34.0**	**34.7**	**1.0**	**2.8%**
	Output	bn€	71.1	70.2	70.9	67.8	69.3	-1.8	-2.6%
-	Total intermediate consumption	bn€	33.8	34.4	35.5	34.0	34.7	1.0	2.8%
=	**Gross value added (GVA)**	**bn€**	**37.4**	**35.7**	**35.4**	**33.8**	**34.6**	**-2.8**	**-7.5%**
	GVA rate (GVA / output)	%	52.5%	50.9%	50.0%	49.9%	49.9%	-2.6	-5.0%
	GVA multiplier	-	2.1	2.1	2.2	2.3	2.3	0.2	8.2%
	Employees (EMP)	**'000**	**165.676**	**163.440**	**158.976**	**153.021**	**153.027**	**-12.650**	**-7.6%**
	Labour productivity (GVA / EMP)	€	225,521	218,480	222,969	220,982	225,946	425	0.2%
	Employment multiplier	-	5.2	5.2	5.5	5.6	5.7	0.5	9.1%
	Internal R&D expenditures	**bn€**	**6.2**	**6.3**	**6.0**	**6.0**	**6.0**	**-0.2**	**-2.7%**
	Internal R&D intensity (R&D / GVA)	%	16.6%	17.6%	17.0%	17.7%	17.4%	0.8	5.1%
	Total R&D expenditures (internal + external)	**bn€**	**9.8**	**10.1**	**10.8**	**10.2**	**10.8**	**1.0**	**10.7%**
	Total R&D intensity (R&D / GVA)	%	26.2%	28.2%	30.3%	30.1%	31.3%	5.1	19.6%

Source: Data from selected efpia companies; Data from Eurostat; WifOR calculation; WifOR illustration.

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