THE EFFECT OF MONOPOLIZATION OF PHARMACEUTICAL INDUSTRY ON HEALTH CARE IN THE OECD COUNTRIES

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Submitted to
Central European University
Department of Economics

In partial fulfilment of the requirements for the degree of Master of Arts

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Budapest, Hungary
2009

Abstract

The present thesis addresses the subject of monopoly in pharmaceutical industry, the sources and consequences of its presence for health care. According to Schumpeter hypothesis (1942) high concentration in the industry leads to higher innovation, because company-monopolist uses its monopoly surplus for costly Research and Development. This can be very efficient in the pharmaceutical industry, because of great importance of innovation and new drugs' development. However, in practice through last decades the process of concentration in the pharmaceutical industry goes together with the decreasing number of major innovation and increasing prices of drugs. In this thesis I analyze this question of the effect of the presence of monopoly power empirically using the OECD Heath Dataset by panel data econometric methods OLS and fixed effect. My analysis shows that higher number of big companies originated in the country is associated with significantly higher expenses on pharmaceuticals. In the same time I do not estimate the significant effect of the higher number of big pharmaceutical companies on the consumption of pharmaceuticals in real term (daily dosage), sales and R&D activity of pharmaceutical sector.

Acknowledgement

First and the most important, I want to express my gratitude to Professor Peter Mihalyi for his advice, consideration and priceless support through all period of writing my thesis. I am also very grateful to Professor Gabor Korosi and John Harbord for their help in elaboration of this thesis. I would like to thank all my friends in CEU, especially Ecaterina Boboc, for their support and recommendation, and my family for their constant encouragement.

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INTRODUCTION

Nowadays the pharmaceutical industry is a considerable part of the health care system, which is important for every person because of the fundamental value of the health. The discovery and development of new drugs save people's lives and increase its' quality. An average child born in 1900 had life expectancy of 45 years, which is now 78 and increasing. The consumption of drugs is continuously increasing and often can replace other more stressful methods of health treatment, for example, surgical intervention. According to Lichtenberg (2007) even if we control for life style, income and other factors, two-thirds (63 percent) of the potential increase in longevity can be attributed to the use of newer drugs.

Due to the dependence of the pharmaceutical industry on discovery of new successful drugs it is one of the most R&D intensive industries. In the United States major pharmaceutical companies invest about 17 percent of sales in R&D activity. The topic of the presence and sources of size advantages in intensive R&D industries is highly discussed in the literature. Schumpeter (1942) was the first, who argued that large companies are better in innovation because they can invest more in R&D activity using their monopoly surplus. Therefore in industries where innovation are highly important, one of which is the pharmaceutical industry, concentration is natural. However, results of empirical testing of this hypothesis in the pharmaceutical industry and in other industries are very controversial: some authors found positive effects of concentration and others argued that concentration destroys the incentives to innovate. Huge R&D expenses together with costly drug development because of strict regulation make it difficult for small companies to operate. As the result, the development of the industry in the last two decades shows significant consolidation and orientation on the market, because only companies with high sales can afford R&D costs. Nowadays the world top

10 pharmaceutical companies account for more that 40 percent of sales and the major part of their cost is not discovering and producing new drugs, but marketing.

The aim of this thesis is to answer the question is the monopoly the most efficient structure in the pharmaceutical industry that serves the heaths care in the best possible way. It is very possible that without patent protection and concentration caused by it, the industry would not achieve current level of development. Even in current situation of decreasing innovation rate and number of major discoveries, the role of big pharmaceutical companies in developing and bringing to the market new drugs is essential. The profits of big pharmaceutical companies are rather high in comparison with other manufacturing industries, which are partially explained by high risk of investment in R&D and huge marketing costs. Interestingly, notwithstanding the high R&D investment, big pharmaceutical companies do not rely a lot on their own research, but rather on academia and small enterprises. Bobulescu and Soulas (2006) reported that 50 per cent of new drugs originated in small enterprises, including insulin, vaccines, human growth hormones, monoclonal antibodies for treatment of infections and cancer. However, the increasing concentration in the industry strengthens the pressure on small enterprises, whose role is significant

For my analysis I use OECD health dataset for 30 countries and estimate the effect of being the country of origin for a company from the top 50 worldwide by sales on drug consumption, expenses on pharmaceuticals, sales of pharmaceutical companies and R&D activity of pharmaceutical companies.

The remaining part of the thesis is organized in the following way. In the first chapter I discuss the previous research related to the topic of my thesis and the present situation in the industry, and describe the sources of market power of big pharmaceutical

companies. In the second chapter I present my econometric model and the results of estimation. Last section concludes.

CHAPTER 1: THE PHARMACEUTICAL INDUSTRY

1.1 Firm size and innovation

The relationship between firm size and innovation activity is a subject of particular interest for economists because despite the well-known arguments against monopoly, the presence of concentrated market in industries with high innovation rate can be seen as welfare improving. Schumpeter (1942) argued that *large firms*, which operate in concentrated industry, are the main *generators of innovations* because they can use the monopoly surplus to invest more in Research and Development (R&D). However, there seem to be problems with empirical support of his hypothesis. Some authors did not find any relationship, some found inverted-U relationship and others found positive relationship up to a certain point and no significant effect for large companies (Syrneonidis, 1996). There are also considerable differences across industries. The same problems were met in empirical testing the Schumpeter's hypothesis about the positive effect of concentration in the industry on innovation activity: some found positive effect and others did not find any significant effect. General and significant problem in data analysis is measurement of innovative input and output: the results of innovation are often informal and does not covered by statistics; the return of R&D investment is hard to measure.

Innovation by itself is *not homogeneous* process and there is a distinction between *product innovation* and *process innovation* (Vaona and Pianta, 2006). Product innovation is related to search for competitive advantages or radical innovations, for example, market-oriented innovations and patents. In that case small firms are expected to innovate more dynamically, and large firms should rely more on market power. Process innovation is the search for efficiency in production and innovation of machinery, where small firms depend on production flexibility and large firm should invest more in machinery and search for larger markets. Considering the industry life-

cycle, small companies are more prosperous in the new industries, while higher concentration is more often in mature ones. As we can see, the process of innovation is complicated and affected by the variety of factors, so there is no unique clear way to succeed.

The main advantages of big firms in innovation activity are summarized by Syrneonidis (1996). First, projects with high R&D expenses are risky and needed in *large sunk costs*, which can be covered only if sales are sufficiently large. Second, there are *economies of scale and scope*. Researchers tend to produce more in cooperation with others and the output of the big diversified team is often higher than if researchers work by themselves. Another advantage of scope is that the discovery made in one program can stimulate the development in another. For example, “several important central nervous system therapies … were discovered as the result of search for drugs active in the cardiovascular system” (Henderson and Cockburn, 1996). Next, large firms can better hedge risk, because they are involved in many projects in the same time and even if one of them will be unprofitable the company still can survive. And last, large firms still have *better access to external finance*. However, the situation with financing of risky R&D projects improved during last years with the growth of venture capital, but still the interest rates of bank loans are higher for small companies in many countries. It can be the result of lower bargaining power of such companies or their evaluation as risky investment. Syrneonidis (1996) also defined two reasons why innovation activity can be higher in concentrated industry. Both come from possibility of companies with monopoly power to have high profits. First, companies can spend part of their profits to finance large R&D expenses, and second, they have *more incentives to innovate*, because they can better appropriate the return from innovation. A number of empirical works studied the relationship between concentration and patents as the measure of innovation

output. Scherer (1984) found no significant relationship and Mansfield (1986) found positive relationship in the number of industries one of which is the pharmaceutical.

One of the reasons of the fact that results of empirical testing are not homogenous is that it is difficult to measure innovation, and it is often impossible to separate major innovation and the everyday R&D activity on the aggregate level. There is an opinion that small companies produce more major innovation, while big companies are involved in costly R&D project of product's development. However, Acs and Audretsch (1991) found that large firms also can produce more major innovations in concentrated industries. Cohen and Klepper (1996) argued that R&D projects involve high fixed sunk costs and the bigger the company the more these costs can be spread that demonstrates the higher efficiency of large firms in comparison with small ones.

However, small companies that operate in R&D intensive industries also have advantages. Acs and Audretsch (1990) studied the innovation output and found that *innovation per employee* is higher in small firms than in big ones and innovations increased slower with the firm size. Also Link and Rees (1990) showed that small companies are more innovative and what is even more important the innovation of small companies appear to be more *significant*.

The advantages and disadvantages of big and small companies in the R&D intensive industries considerably define the way the pharmaceutical industry is operating. Process of research and development in pharmaceutical industry has two stagers: *drug discovery* and *drug development*, which require different sets of skills and resources (Henderson and Cockburn, 1996). It is the basis for *unofficial division of labor* in the industry: academics do fundamental research, small companies innovates and big pharma companies do costly development and marketing. (Bobulescu and Soulas, 2006). In recent years after the wave of mergers and acquisition the number of small

companies decreased and that can be one of the reasons of the diminishing number of new drugs. However, the opposite causal relationship is also possible that decreasing number of new innovative drugs leads to increase of competition and intensive struggle for market share (Bertoncelj and Kesic, 2007).

The advantages of big and small companies in the pharmaceutical industry are summarized by Bobulescu and Soulas (2006). The main advantages of large companies are economies of scale and scope. Advantages of small companies are less bureaucratic management, access to Contact Research organization and knowledge spillovers. Henderson and Cockburn (1996) analyzed the data of the research program and concentrated on its output. They found that economy of scope help big companies to develop new drugs as they sustain a lot of diverse projects and can employ a lot of scientists from different areas, in the same time programs and knowledge spillovers are more effective in small companies. Small companies can make decisions more quickly because of better internal communications that can be important in changing environment and they more often take the risk.

The topic of advantages and disadvantages of the high concentration in the R&D intensive industries is highly discussed in the literature. In this section I have outlined the number of opinions on that question. To summarize, according to the existent literature there are advantages of both big and small companies in such industries as pharmaceutical, and both types of companies should operate on the market, which will lead to efficient innovation. However, nowadays industry is very concentrated, which I will illustrate in the next section.

1.2 Concentration in the pharmaceutical industry

Sanjaya Lall defined in his work “Multinational companies and concentration: the case of pharmaceutical industry” two forms of concentration: *geographical and structural*. The

main reasons for geographical concentration are the economy of scales and low transaction cost.

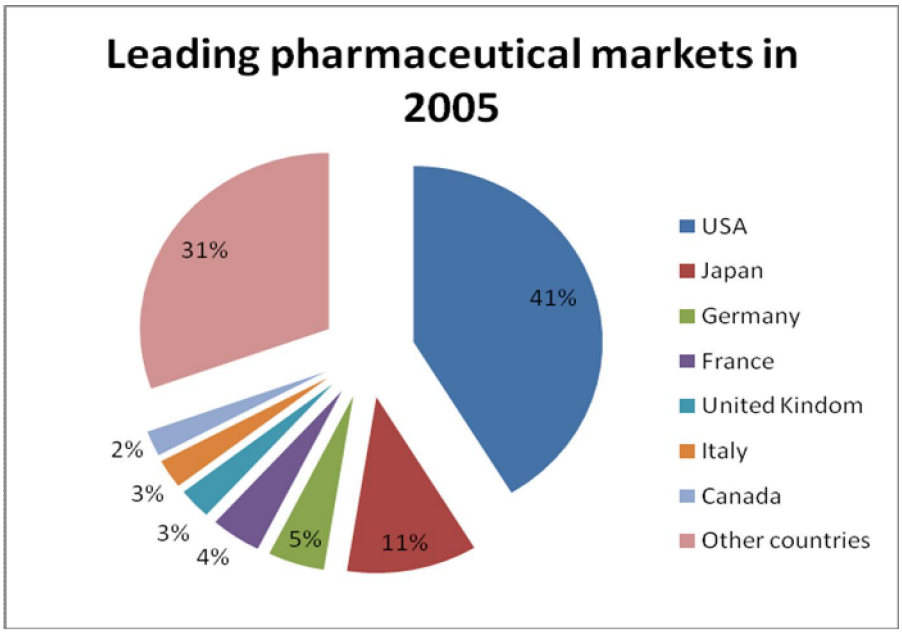
Table 1. Sales of pharmaceutical products

World audited market	Sales (US$B)		
	2005	2006	2007
North America	265.7	289.9	304.5
Europe	169.5	181.8	206.2
Japan	60.3	56.7	62.2
Asia, Africa, Australia	46.4	52	58.5
Latin America	24	27.5	32

Source: IMS Health statistics

Global pharmaceutical sales have continuously grown through last years. The average growth of brand pharmaceutical market is 7 percent and the market of generic products growing even faster by average 10 percent per year. There are number of reasons for it such as the increasing age of population, higher efficiency of drugs, which can be used instead of other types of medical treatment, and increasing consumption of pharmaceutical product by developing countries.

Figure 1. Leading pharmaceutical markets in 2005 (Estimation of Bertincelj and Kesic, 2007)



As can be seen from Figure 1 geographical concentration takes place in North America, Europe and Japan, and the United States along accounts for more than 40 percent of global pharmaceutical market. Developing countries produce and consume comparatively less pharmaceutical products and in that area they are more importers than exporters.

Table 2. Leading innovative pharmaceutical companies in 2005

Position	Company	Country of origin	Sales in million US$	Global market share %
1	Pfizer	USA	44 284	7.4
2	GlaxoSmithKline	UK	33 592	5.6
3	Sanofy-Aventis	France	32 096	5.3
4	Novartis	Switzerland	24 956	4.1
5	AstraZeneca	UK	23 950	4.0
6	Johnson&Johnson	USA	22 300	3.7
7	Merck&Co	USA	22 030	3.7
8	Wyeth	USA	21 470	3.6
9	BMS	USA	15 321	2.5
10	Eli Lilly	USA	15 254	2.5

Estimation of Bertoncelj and Kesic (2007)

If we look at Table 2 it can appear that there is no concentration at all because shares of every company are small. However as Barbara Rosenberg (2004) notes when pharmaceutical sales are properly divided by sub-markets, figures indicating a much higher concentration appear. For example, if we look on the market of global generic prescription, the top eight global markets – the U.S., Germany, France, the U.K., Canada, Italy, Spain and Japan – today account for 84 percent of total generics sales. The top ten generics companies currently hold a 47 percent share of the generics market worldwide. In the pharmaceutical market of prescription drug it is quite common

that one single drug accounts that 50 percent of its relevant market, and, when it is patented drug, this share is usually even higher.

The last *wave of acquisitions and mergers* started in 1999, as the result such companies as Pfizer with the sales of $44.3 billion in 2005 emerged. Currently leading ten pharmaceutical companies control 42 percent of total pharmaceutical market, but according to Bertoncelj and Kesic (2007) just ten years ago it was only 30 percent. They argue that concentration will grow in following years and companies will perform the *C and C strategy* (cooperation and competition in the same time).

With the growing structural concentration arise the danger of abuse of monopoly power, the sources and indicators of which I will discuss in the following section.

1.3 Sources of market power

I have separated the evidence about the sources of market power, which are exercised by big pharmaceutical companies, by ones that come from technology (patents) and ones that are related to marketing.

1.3.1 Patenting and licensing

The pharmaceutical industry is innovative with high R&D to sales ratio, therefore it needs *strong patent protection* for developing of new products. However, intellectual property rights (IPR) also have drawbacks. They can protect IPR owners from competition, creating market inefficiencies. Protected markets lead to higher prices from one side that maximize profits of companies but also may limit the widespread use of new inventions. If the company has the high market share it might feel less incentive to innovate because it risks decreasing its own market. Strong IPR also might prevent innovation if granted for some fundamental research technology necessary for future improvements. While IPR can be licensed, owners of this type of IPR might refuse to lease for strategic reasons. According to Economic Research Report “Government

Patenting and Technology Transfer" (2006) that problem could be very harmful in areas of rapid and complex research in which many licenses might be necessary for further improvements, because the owner of any one of them could hold up *further research*.

However, there are alternative points of view. For example, Brekke and Straume (2008) argue that patents rarely lead to a complete monopolization of the market. In most cases, a patent just requires that new products must be sufficiently differentiated, implying some degree of competition in the market. The Economic Research Report "Government Patenting and Technology Transfer" (2006) notes an important role of IPR to create a market for innovation. Institutions or individuals with important intellectual property assets do not necessarily posses the complementary assets, commercial skills, or market presence necessary to bring their product on the market. IPR provide investors a negotiating tool with which to license or sell an invention to other firms better positioned to *commercialize* it. It is not a rare case that small flexible companies come out with major innovations, which they sell to big pharmaceutical companies for further commercialization.

Research and development and *technology licensing* are the two main ways to increase technology capability (Arijit Mukherjee, 2002). Economic Research Report "Government Patenting and Technology Transfer" (2006) says that to determine the success of licensing terms and practices is very difficult, because it depends on market size, market characteristics, and technology characteristics, and is subject to both "technology risk" and "appropriation risk". "Technology risk" refers to probability competitors will be able to develop improved product, with which it will be difficult to compete. "Appropriation risk" is the likelihood that a company will be able to earn profits from the new technology and not been acquired. Potential market and technology parameters (e.g. size and characteristics) are often difficult to define in detail before commercialization. Licensing to more than one firm is a good alternative and can be

successful if the market is segmented geographically or by stagers in production process. However, not-exclusive licensing appears not to be popular if firms are competing for the same market niche.

One of the major problems of pharmaceutical industry connected with patenting is the *redundant research* that was noted by Boldrin and Levine (2008). The National Institute of Health Care Management announced that over the period 1989-2000, 54% of FDA-approved drug applications of imitative drugs or drugs, which are close to ones that are already on the market. That can serve as indicator of using patent system as rent-seeking tool by some pharmaceutical companies. However, it can be argued that at the moment industry is on very high level of development and change even in one molecule can be efficient and make drug more effective.

Innovation oriented on the market is not a bad process per se. Acemoglu and Linn (2004) showed that pharmaceutical companies in the United States quickly respond to changes in potential market. According to their empirical results 1 percent growth in potential market leads to 4-6 percent increase in the number of new drug's entrances.

In summary, the pharmaceutical industry is needed in strong IPR protection, despite the problem that it causes there is no other better solution to provide companies the incentive to invest in costly R&D and innovate. The problem of large number of "me-too" patenting can be solved by changing in testing requirements, which is proposed by Angell (2004). I will write about it in details in the conclusion.

1.3.2 Marketing

The role of marketing in defense of market share is well known and such instrument as *product differentiation* and frequent introduction of new products slightly different from old ones are very common in oligopolistic industries. Sanjaya Lall (1979) noted one important characteristic of pharmaceuticals market that is the separation between buyer

(patient or insurance company) and the decision maker (physicians). As the result, marketing that is oriented on physicians can be effective, because for them price is often unimportant. Physicians can be employed by pharmaceutical companies as consultant or drug representatives. According to Report of Transparency International (2006) only in US pharmaceutical companies spend $16 billions annually on marketing to physicians that is $13 000 a year per doctor. There were cases when major pharmaceutical companies were found guilty in *fraud* connected with illegal relationship with physicians. Boldrin and Levine (2006) give information about the volume of fines that were paid by companies for such crimes: in 2004 Pfizer paid $430 million for fraud during marketing campaign of its pain drug Nuerontin, AstraZeneca paid $355 million in 2003 and TAP Pharmaceuticals paid $875 million in 2001.

The pharmaceutical industry is characterized by intensive advertising. According to Brekke and Straume (2008) marketing expenditures in the industry are higher than R&D and typically are 20-40 percent of sales. Socolar and Sager (2001) provided data that between 1995 and 2000 the number of people employed in marketing rose on 59 percent, and in the same time number of people employed in R&D departments even slightly decreased.

1.3.3 Indicators of market power

The main indicator of market power is the concentration itself. Sanjaya Lall (1979) notes three other indicators, which are *price differentiation*, *high profits* of pharmaceutical companies in comparison with other manufacturing companies and *product differentiation*. Also two indicators from previous sections can be added. They are the high number of *irrelevant drug's patenting* and R&D expenditures spent on imitating already existing drugs, and *growing marketing expenditures*.

Pharmaceutical companies have rather high profit. Angell Marcia (2004) argued that in 1990 the worldwide top ten companies have the average profit of 25 percent of sales. In 2001 the top Ten American Companies' net return of sales is 18.5 percent, which is much higher than median net return for all other industries 3.3 percent.

By the price differentiation is implied difference in prices of the same drugs amount regions that is higher that we can expect considering shipping costs. Partially this situation is caused by pharmaceutical companies, but also the price control by governments' contribution is essential. According to Mrazek and Mossialos (2004) amount European countries only Germany and UK (profit control is in place) employ free pricing in pharmaceutical industry, other countries control the prices of drugs. World Health Organization advocates the introduced incentive of pharmaceutical companies to charge lower prices from low income consumers in developed countries or in power countries, for example discounted HIV-AIDS drugs in developing countries. That price differentiation can be helpful for both, for pharmaceutical companies that can increase their revenue targeting people who otherwise would not buy their products, and for society because of increasing availability of drugs. However, Ridley (2005) argued that such differentiation can lead to less innovation and unwillingness of consumers from high-income countries to pay higher prices.

To summarize, despite the number of advantages of big pharmaceutical companies, which were named earlier, nowadays degree of concentration in the industry has substantial drawbacks. Indicators, which were pointed out in the last section clearly show that big pharmaceutical companies use their high sales not only on R&D, but rather on gaining the monopoly power. This situation can be limited in some degree by introducing number of policies, which I will look at in the conclusion. In the next chapter I will empirically analyze the efficiency of high concentration in the industry.

CHAPTER 2: THE MODEL

2.1 Data and Methodology

For my analysis I use OECD Health data 2008, which is comprehensive dataset of wide number of health related variables for 30 OECD countries. I also use GDP per capita (PPP) and inflation in annual percentage change data reported by the International Monetary Fund.

For the analysis of the effect of monopoly power in the pharmaceutical industry I have estimated the following model using simple pooling cross-section across time and fixed effect method.

Model : $Yit = \alpha + \beta MCit + \gamma Xit + \varepsilon it$ where i=1,30 and t=from 1999 to 2007

The explanatory variable MCit is the measure of market power as the number of pharmaceutical companies founded in the country from the list of top 50 by sales worldwide, which were taken from the annual reports of Pharmaceutical Executive for for all years in the sample excluding 2000 and 2004, which are from the report of arab.medicare.com and European Pharmaceutical executives accordingly. It is constructed in the following way: if there is only one company from the list of top 50, which is originated in the country, then the variable for this particular country in the named year takes the value of 1; if there are two such companies then variable takes the value 2. For example, in 2007 there was only one Australian company, CSL, in the list of top 50 on the 40th place, so in 2007 MC for Australia is equal to 1. In the same year there were three companies from Switzerland, which are Novartis, Roche and Nycomed, on the 4th, 8th and 29th places accordingly, and the MC variable for Switzerland in 2007 is equal to three. If the company in the list is originated in the country, which is not in the sample, then I drop it. For seven years, there are two such

companies: Teva, which is originated in Israel, and in 2006 Chinese Sinopharm. The list of companies for years from 1999 to 2007 can be found in the appendix.

The choice of this variable is explained by hypothesis that if big companies have monopoly power they use it particularly often in the country of their origin. Big companies can easier organize especially aggressive marketing campaigns on the local for them market, exert pressure on government's decisions through good relationship with politicians and build close relationship with people, who influence decision making in health sector (doctors, hospital administration).

I have estimated the effect of MC_{it} on four dependent variables: pharmaceutical consumption, total expenses on pharmaceuticals, sales of pharmaceutical companies and research and development activity of pharmaceutical companies per capita (PPP).

Xit – vector of control factors:

- Health status: total life expectancy at birth measured in years;
- Health employment per 1000 population;
- Economic variables: GDP per capita (PPP) measured in US $ and annual inflation in percentage change to previous year;
- Government coverage is the variable that shows the percentage of population that receive pharmaceutical products through government (social) health insurance, for example in such countries as the United Kingdom and Denmark 100 percent of population have access to medicine through social insurance and 50 percent are covered in Canada, so in the United Kingdom and Denmark the variable equal to 100 and in Canada to 50;
- Private insurance variable is the percentage of population that has private health insurance;
- Non-medical factors:

- Environment variables are the determinants of air quality, as the omissions of sulphur oxide, nitrogen oxide and carbon monoxide that are measured in kilos per capita
- Life style variables are the food consumption: total fat intake that is measured in grammas per capita per day and sugar consumption in kilos per capita per year; alcohol consumption in liters per capita per year and tobacco consumption that is measured in grammas per capita per year (source: the OECD Heath Dataset).

2.2 OLS and Fixed effect estimation

2.2.1 Consumption of pharmaceuticals

First, I have estimated the effect of being the country of origin for the big pharmaceutical company on pharmaceutical consumption of some types of drugs by population. The variable pharmaceutical consumption is the drugs' consumption measured in defined daily dosage per 1000 population per day. I have chosen the log-linear form for the regressions because it shows the most precise results. The results of estimation are reported in Table 3, where we can see the coefficients on the MCit variable and the heteroskedasticity-robust standard errors.

Table 3. The effect of monopoly power on the consumption of pharmaceuticals

Type of drug	The coefficient on MC (the standard error)			
	OLS estimation		Fixed effect estimation	
	without controls	with controls	without controls	with controls
Analgesics	-0.025* (0.013)	0.035 (0.026)	0.003 (0.009)	0.010 (0.010)
Antidepressants	0.004 (0.009)	-1.013* (0.007)	-0.034*** (0.012)	-0.020 (0.047)
Antibacterials for systemic use	-0.058*** (0.014)	-0.036** (0.018)	0.001 (0.004)	-0.008 (0.009)
Drugs used in diabetes	0.055*** (0.014)	0.037*** (0.011)	-0.006 (0.004)	-0.002 (0.007)

Note: Significant with 1% *** Significant with 5% ** Significant with 10% *

The results are not homogeneous: for some types of drugs the MCit variable is insignificant, but for others it is significant positive or negative. According to OLS estimation for consumption of antibacterials for systemic use and drugs used in diabetes the coefficients on the MCit variable is significant and for consumption of analgesics it is significant only at 10 percent level, when I do not include control variables. However, when I control for life style variables, GDP per capita (PPP), health employment and life expectancy at birth, the coefficient on MCit for analgesics becomes insignificant, the significance of coefficient for drugs for antibacterials for systemic use drops, and the coefficient for antidepressants becomes significant only at 10 percent level.

As the result, according to OLS estimation the increase in one big pharmaceutical company originated in the country leads to the increase in consumption of drugs used in diabetes, decrease in consumption of antidepressants and antibacterials and do not affect the consumption of analgetics. Only for the consumption of drugs used in diabetes is a significant result estimated and the coefficient is positive, so the more pharmaceutical companies are in the country the more drugs of that type are consumed.

According to fixed effect estimation the results are more homogeneous. When I included control variables the coefficient on the MCit became insignificant in all regressions. The insignificance possibly shows that there is no relationship between the number of big powerful pharmaceutical companies in the country and consumption of drugs. However, the data for dependent variable is relatively poor: there is no observation for United States, which is important country for my research as the highest number of big pharmaceutical companies is originated there. Another important point is that the control variables for consumption of drugs are measured in number of dosage,

but pharmaceutical companies can use their monopoly power to increase prices even with the same demand.

2.2.2 Expenditures on pharmaceuticals

Second, I analyze the expenditure on pharmaceuticals in the context of my econometric model. The United States, which is the country where the maximum number of companies from top 50 are originated (in different years from 14 to 23), have the highest expenditure per capita among countries included in the sample. I have estimated the effect of being the country of origin for the big pharmaceutical company on the total expenditures of pharmaceuticals in per capita US dollars at 2000 PPP rates. The results of pooled OLS estimation are presented in Table 4.

Table 4. Dependent variable is log of total expenses on pharmaceuticals per capita (OLS)

Variable	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
	5.74*** (0.03)	0.994 (1.77)	0.24 (1.35)
MC	0.031*** (0.003)	0.005 (0.004)	0.012*** (0.003)
Alcohol		-0.010 (0.007)	0.016** (0.007)
Food fat		-0.002 (0.002)	- 0.002 (0.002)
Food sugar		0.013*** (0.004)	0.012*** (0.002)
Tobacco		small number	0.0002*** (small number)
Environment carbon		-0.001* (0.0006)	
Environment nitrogen		0.0002 (0.001)	
Environment sulphur		small number	
Government coverage pharma		small number	
Insurance		0.007*** (0.0008)	0.005*** (0.001)
Health employment		0.012*** (0.002)	0.015*** (0.0003)

Life expectancy		0.051** (0.025)	0.052*** (0.016)

Note 1: Significant with 1% *** Significant with 5% ** Significant with 10% *

Note 2: White standard errors are reported

First, the estimation of the model with only dependent and MCit variable shows significant result, and the coefficient on MCit variable is positive that means the more pharmaceutical companies leads to higher expenses on pharmaceutical products. When I include the whole set of control variables the significance of the coefficient on MCit variable drops. In the last equation I exclude some of control variables. I do not control for air quality because the coefficients on carbon monoxide and sulphur oxide omission are insignificant, and coefficient on nitrogen oxide is significant only with 10% significance level and negative, which is hard to explain. I also exclude from equation variable government insurance, because it is insignificant. The third column shows the result of estimation with remaining control variables. Coefficients on the consumption of sugar, alcohol and tobacco are positive and significant that shows that population with more healthy life style and diet spend less on pharmaceutical products, and the consumption of fat is insignificant. The higher health employment is associated with higher spending on pharmaceuticals. The coefficient on insurance variable is positive and significant, which shows that the higher proportion of population is insured the higher is expenditures on pharmaceuticals. The coefficient on life expectancy variable is also significant and positive that can be explained by higher consumption of drugs by old people.

Next, I estimate using the fixed effect estimation methods, which results are presented in the following Table 5.

Table 5. Dependent variable is log of total expenses on pharmaceuticals per capita (Fixed effect)

Variable	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
	5.74*** (0.006)	2.11 (1.58)	4.51*** (1.19)
MC	0.029*** (0.004)	-0.001 (0.006)	0.007*** (0.002)
Alcohol		0.029 (0.034)	0.001 (0.007)
Food fat		0.001 (0.003)	0.0004 (0.001)
Food sugar		0.005 (0.007)	0.007*** (0.001)
Tobacco		0.0002*** (small number)	0.0001*** (small number)
Environment carbon		-0.0004 (0.0008)	
Environment nitrogen		0.005 (0.003)	
Environment sulphur		-0.001 (0.001)	
Government coverage pharma		-0.0001 (0.002)	
Insurance		0.006*** (0.002)	0.006*** (0.0002)
Health employment		0.018*** (0.005)	0.015*** (0.001)
Life expectancy		0.023 (0.021)	

Note 1: Significant with 1% *** Significant with 5% ** Significant with 10% *

Note 2: White standard errors are reported

According to fixed effect estimation the coefficient on MCit variable is positive and significant when control variables are excluded. However, when the whole set of control variables are included, the significance of MCit variable drops. In the third equation I do not control for air quality variables, the proportion of population which expenses on pharmaceuticals is covered by government and life expectancy because they are insignificant.

According to estimation of final third equation the coefficient on MCit variable is significant and positive that shows that the one more big pharmaceutical company from

the list of top 50 originated in the country leads to 0.7 percent increase of the expenditures on pharmaceutical products holding life style, insurance and life expectancy fixed. That can be an indicator of monopoly power of big companies that leads to higher expenses. However, the reverse causality is also possible: it is easier to be successful for pharmaceutical companies, if population of the country where they perform spends more on their products.

2.2.3 Sales of pharmaceutical companies

Next, I estimate the effect of being the country of origin for the big pharmaceutical company on the sales of pharmaceuticals in per capita US dollars (PPP). The results are presented in Table 6.

Table 6. Dependent variable is log of sales on pharmaceutical companies per capita

Variable	OLS		Fixed effect	
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
	5.60*** (0.04)	2.33 (12.68)	8.14*** (0.01)	-4.08 (35.52)
MC	0.041*** (0.004)	0.054*** (0.020)	-0.019*** (0.006)	0.036 (0.088)
Alcohol		0.033 (0.090)		-0.129 (0.333)
Food fat		0.004 (0.009)		-0.012 (0.022)
Food sugar		-0.009 (0.008)		0.010 (0.044)
Tobacco		0.006*** (0.0001)		-0.0004 (0.001)
Environment carbon		-0.006*** (0.001)		0.0002 (0.014)
Environment nitrogen		0.017*** (0.005)		-0.035 (0.070)
Environment sulphur		small number		0.007 (0.048)
GDP per capita		small number		small number
Inflation		0.008 (0.024)		-0.086** (0.046)
Government coverage pharma		0.056 (0.043)		0.162 (0.168)
Insurance		0.004		0.024

		(0.009)		(0.073)
Health employment		-0.0003 (0.018)		-0.019 (0.120)
Life expectancy		-0.066 (0.085)		0.020 (0.263)

Note 1: Significant with 1% *** Significant with 5% ** Significant with 10% *

Note 2: White standard errors are reported

Estimations of both equations (with control variables and without) by OLS give significant and positive coefficient on MCit variable that means the higher is the number of big companies that are originated in the country the higher is per capita sales of pharmaceutical companies in that country. However, when I estimate by fixed effect the coefficient on MCit variable becomes insignificant. The estimated coefficients on some variables are controversial, for example, coefficient on the inflation variable estimated by fixed effect is significant negative and the coefficient on GDP per capita is very small and insignificant. However, it can be explained by the chosen dataset, as all 30 countries are high or middle income countries, there is no enough variation in GDP per capita amount countries. High inflation is often a sign of weak fundamentals, which means the higher is the inflation the less developed and prosper is the country, which turns to lower use of medicine and sales of pharmaceutical companies.

According to the fixed effect estimation the increase in the number of countries from top 50 originated in the country leads to increase of sales of pharmaceutical companies on 3.6 percent holding other things fixed. It can be interpreted as the indicator of monopoly power. However, we should not forget that the coefficient is insignificant.

2.2.4 Research and Development

Finally, I estimate the effect of number of big pharmaceutical company on expenses on research and development in pharmaceutical industry per capita in US dollars. Results of estimation are presented in Table 7.

Table 7. Dependent variable is the log of expenses on research and development of pharmaceutical companies per capita

Variable	OLS		Fixed effect	
	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)	Coefficient (standard error)
	2.97*** (0.03)	1.79 (4.4)	3.12*** (0.01)	9.67 (7.91)
MC	0.101*** (0.06)	0.037 (0.029)	-0.010 (0.010)	-0.014 (0.013)
GDP per capita		0.0001*** (small number)		-0.0001*** (small number)
Inflation		-0.218*** (0.036)		-0.018 (0.015)
Health employment		-0.022*** (0.004)		0.008*** (0.003)
Life expectancy		-0.009 (0.006)		-0.048 (0.095)

Note 1: Significant with 1% *** Significant with 5% ** Significant with 10% *

Note 2: White standard errors are reported

When I estimate only MCit variable without control variables, both methods show significant and positive coefficients, which means that big companies invest more in research and development activities. However when I control for other factors, coefficient on MCit becomes insignificant and according fixed effect estimation even negative.

2.3 Results

According to my empirical analysis, being the country of origin for a big pharmaceutical company leads to the higher expenditure on pharma products. However, I do not find the same relationship in the consumption of pharmaceuticals in real term, as the result for different drugs are not homogeneous and statistically insignificant, which can be an outcome of not full dataset for the consumption of pharmaceuticals that is not available for the number of countries (for example, the United States). The results show that in the country where big pharmaceutical companies originated the consumption of pharmaceuticals is not statistically significantly higher; however, the expenditures on

pharmaceuticals per capita are higher, which is the sign of monopoly power. The results for expenditures on pharmaceuticals is more revealing in the sense that the variable includes all pharmaceutical products in money term (in US dollars on constant 2000 rates with account for PPP) and the data is more complete than for consumption of pharmaceutical products in real term.

I have estimated that the higher number of companies from the top 50 in the country leads to higher sales of pharmaceutical products per capita. However, the result is insignificant when I include the whole set of control variables and control for unobservables (by estimating by fixed effect method). My results are in the line with the econometric analysis of the relationship between concentration and sales, which was done by Vernon (1971). He analyzed the pharmaceutical industry data of the United States, and also estimated the insignificant coefficient on sales with the concentration ratio as the dependent variable.

Finally, my analysis shows the empirical support for Schumpeter' s hypothesis (1942) that big companies are better innovators, as I have estimated the positive coefficient on the number of big companies in the country with R&D in pharmaceutical industry per capita in US dollars as the dependent variable, but only when I do not include other control variables. When I include economic variables, health employment and life expectancy, the significance of the coefficient on the number of big companies originated in the country drops.

CONCLUSION

My thesis investigates the effect of growing monopoly power of big pharmaceutical companies on the situation in the industry. Current highly monopolized structure of pharmaceutical industry contributed a lot to the discovery of new drugs, their production and worldwide distribution. However, my analysis does not reveal any significant differences in R&D activity between countries with a high number of big pharmaceutical companies and without them, if I control for number of factors including GDP per capita.

According to my analysis a higher number of big pharmaceutical companies in the country leads to higher expenditures on pharmaceuticals. This can be one of the consequences of active advertisement campaigns through which big companies struggle for market share. High advertising leads to overprescription and overconsumption of pharmaceutical products. People consume new products, which are actively advertised, and often even do not know that there are cheaper generic drugs, which have the same effect. The problem is usually solved by insurance companies, which often do not cover the expensive brand drugs that do not add substantial benefits over the cheap ones. State governments also go in the same direction of reducing cost on pharmaceuticals by creating the same type of lists with preferred drugs. However, the information is not available for those who pay for pharmaceuticals out-of-pocket, in spite of the fact that in many developing countries it is a substantial part of population. That is why it is important to continue work in that direction and make the information more accessible.

Advertising campaigns are targeting not only to consumers but in the case of prescription drugs – to community of physicians, and within this community to so-called opinion leaders. The problem of fraud in the industry is very important in virtually all countries in the world. Government investigations in recent years detected cases where very well-known and established companies were found to be involved in illegal

relationship with physicians. This situation needs attention from government and public. All gifts from pharmaceutical companies to physicians should be prohibited.

The problem of the high volume of redundant research and “me-too” drugs, which was discussed in the first chapter, can be solved by changing the method of testing of drug efficiency. The FDA approves drug if it is better than placebo. Companies do not test the drugs weather its better in any aspect than ones that are already on the market (Angell, 2004). However, such tests will be very useful, in spite the costs of such testing is high, it can decrease the amount of redundant research in the industry and “me-too” drugs.

Support of local pharmaceutical companies in developing countries is important. It can decreases prices of drugs in that countries and help to refer recourses on fighting with diseases which are typical for particular region but not as significant in developed countries, for example malaria. However, control for quality and safety of drugs in developing countries is often weak. In spite, the experience of India, China and Brazil in that direction is promising.

Pharmaceutical industry is one of the most secretive. The reform, which will require pharmaceutical companies to open their books, is in the first necessity. Angell (2004) emphasized that public do not know even essential things about the operations of big pharmaceutical companies. Public does not know how much it is actually cost to bring each drug to the market and the prices companies charge from various customer. And, finally, the revealing of results of clinical trials is very important.

To sum up, it is very unlikely that pharmaceutical industry will become less concentrated in following years, the opposite is probable: the concentration will further grow. However, public awareness of the danger that monopoly in pharmaceutical industry leads to is very important. The evidence that is provided in my thesis has important

implications for research in health and pharmaceutical industry. The reforms which I named are practicable and many of them are already being put into practice.

APPENDIX

Top 50 pharmaceutical companies worldwide in 1999

Place	Company	Country
1	Merck	The United States
2	Pfizer	The United States
3	AstraZeneca	The United Kingdom
4	Bristol-Myers Squibb	The United States
5	Glaxo Wellcome	The United Kingdom
6	Aventis	France
7	SmithKline Beecham	The United Kingdom
8	Novartis	Switzerland
9	Johnson & Johnson	The United States
10	Eli Lilly	The United States
11	Roche	Switzerland
12	American Home Products	The United States
13	Warner-Lambert	The United States
14	Schering-plough	The United States
15	Pharmacia & Upjohn	Sweden
16	Takeda	Japan
17	Bayer	Germany
18	BASF	Germany
19	Sanofi-Synthelabo	France
20	Sankyo	Japan
21	Boehringer Ingelheim	Germany
22	Monsanto (Searle)	The United States
23	Shionogi	Japan
24	Schering AG	Germany
25	Amgen	The United States
26	Yamanouchi	Japan
27	Eisai	Japan
28	Akzo Nobel	Netherland
29	Merch KGaA	Germany
30	Novo Nordisk	Denmark
31	Abott Laboratories	The United States
32	Daiichi	Japan
33	Fujisawa	Japan
34	Kyowa	Japan
35	DuPont	The United States
36	Banyu	Japan
37	Tanabe Seiyaki	Japan
38	Chugai	Japan
39	Solvay	Belgium
40	Purdue	The United States
41	Ares-Serono	Sweden
42	Genentech	The United States
43	Teva	Israel
44	Alza	The United States
45	Genzyme	The United States

46	3M	The United States
47	Schwarz Pharma	Belgium
48	ICN	The United States
49	Biogen	The United States
50	Elan	Ireland

"Top 50 Pharmaceutical Companies of 1999," L.J. Sellers, Associate Editor Pharmaceutical Executive, April 2000, 62.

Top 50 pharmaceutical companies worldwide in 2000

Place	**Company**	**Country**
1	Glaxo SmithKline	The United Kingdom
2	Pfizer	The United States
3	Merck & Co	The United States
4	AstraZeneca	The United Kingdom
5	Aventis	France
6	Bristol-Myers Squibb	The United States
7	Novartis	Switzerland
8	Pharmacia	Sweden
9	Hoffmann-La Roche	Switzerland
10	Johnson & Johnson	The United States
11	American Home Products	The United States
12	Eli Lilly	The United States
13	Schering-Plough	The United States
14	Takeda	Japan
15	Abbott	The United States
16	Sanofi-Synthelabo	France
17	Bayer	Germany
18	Boehringer Ingelheim	Germany
19	Sankyo	Japan
20	Shionogi	Japan
21	Merck KGaA	Germany
22	Amgen	The United States
23	Yamanouchi	Japan
24	Knoll	The United States
25	Schering AG	Germany
26	Eisai	Japan
27	Novo Nordisk	Denmark
28	Fujisawa	Japan
29	Taisho	Japan
30	Akzo Nobel	Netherland
31	Servier	France
32	Dupont Pharmaceuticals	The United States
33	Chugai	Japan
34	Mitsubishi Pharma Corporation	Japan
35	Otsuka	Japan
36	Solvay	Belgium
37	Tanabe Seiyaki	Japan

38	Kyowa Hakko	Japan
39	Kaneka	Japan
40	Byk Gulden	Germany
41	Teva	Israel
42	Meiji Seika	Japan
43	Serono	Sweden
44	Genentech	The United States
45	Dainippon	Japan
46	UCB	Belgium
47	Sumitomo	Japan
48	Forest Laboratories	The United States
49	ASTA Medica	The United States
50	Asahi Chemical	Japan

"Pharma Ranking: Top 50 Companies in the World - 2000," Report of arab.medicare.com

Top 50 pharmaceutical companies worldwide in 2001

Place	**Company**	**Country**
1	Pfizer	The United States
2	GlaxoSmithKline	The United Kingdom
3	Merck & Co	The United States
4	AstraZeneca	The United Kingdom
5	Bristol-Myers Squibb	The United States
6	Aventis	France
7	Johnson & Johnson	The United States
8	Novartis	Switzerland
9	Pharmacia	Sweden
10	Lilly	The United States
11	Wyeth	The United States
12	Roche	Switzerland
13	Schering-Plough	The United States
14	Abbott Laboratories	The United States
15	Takeda	Japan
16	Sanofi-Synthelabo	France
17	Boehringer Ingelheim	Germany
18	Bayer	Germany
19	Schering AG	Germany
20	Akzo Nobel	Netherland
21	Amgen	The United States
22	Sankyo	Japan
23	Merck KGaA	Germany
24	Novo Nordisk	Denmark
25	Shionogi	Japan
26	Baxter	The United States
27	Daiichi Pharmaceutical	Japan
28	Yamanouchi	Japan
29	Eisai	Japan
30	Fujisawa	Japan
31	Teva	Israel

32	Purdue Pharma	The United States
33	Genentech	The United States
34	Chugai Pharmaceutical	Japan
35	Solvay	Belgium
36	Otsuka	Japan
37	Elan	Ireland
38	Tanabe Seiyaku	Japan
39	Serono	Switzerland
40	Forest Laboratories	The United States
41	Allergan	The United States
42	Altana	Germany
43	Kyowa Hakko Kogyo	Japan
44	Ono Pharmaceutical	Japan
45	Biogen	The United States
46	Immunex	The United States
47	Genzyme	The United States
48	3M Worldwide	The United States
49	ICN Pharmaceuticals	The United States
50	Schwarz Pharma	Belgium

"Top 50 Pharmaceutical Companies of 2001," L.J. Sellers, Associate Editor Pharmaceutical Executive, May 2002, 61.

Top 50 pharmaceutical companies worldwide in 2002

Place	**Company**	**Country**
1	Pfizer	The United States
2	GlaxoSmithKline	The United Kingdom
3	Merck & Co	The United States
4	AstraZeneca	The United Kingdom
5	Aventis	France
6	Johnson & Johnson	The United States
7	Novartis	Switzerland
8	Bristol-Myers Squibb	The United States
9	Pharmacia	Sweden
10	Wyeth	The United States
11	Eli Lilly	The United States
12	Roche	Switzerland
13	Abbott Laboratories	The United States
14	Schering-Plough	The United States
15	Sanofi-Synthelabo	France
16	Boehringer Ingelheim	Germany
17	Takeda	Japan
18	Schering AG	Germany
19	Bayer	Germany
20	Amgen	The United States
21	Sankyo	Japan
22	Akzo Nobel	Netherland
23	Eisai	Japan
24	Yamanouchi	Japan

25	Merck KGaA	Germany
26	Novo Nordisk	Denmark
27	Baxter	The United States
28	Shionogi	Japan
29	Daiichi	Japan
30	Teva	Israel
31	Fujisawa	Japan
32	Genentech	The United States
33	Solvay	Belgium
34	Purdue Pharma	The United States
35	Altana	Germany
36	Otsuka	Japan
37	Tanabe Seiyaku	Japan
38	Forest Labs	The United States
39	Serono	Switzerland
40	Allergan	The United States
41	Watson	The United States
42	Kyowa	Japan
43	King	The United States
44	Biogen	The United States
45	Ono	Japan
46	Elan	Ireland
47	Alcon Labs	Switzerland
48	Schwarz Pharma	Belgium
49	3M	The United States
50	Genzyme	The United States

"Top 50 Pharmaceutical Companies of 2002," L.J. Sellers, Associate Editor Pharmaceutical Executive, May 2003, 43.

Top 50 pharmaceutical companies worldwide in 2003

Place	**Company**	**Country**
1	Pfizer	The United States
2	GlaxoSmithKline	The United Kingdom
3	Merck & Co	The United States
4	Johnson & Johnson	The United States
5	Aventis	France
6	AstraZeneca	The United Kingdom
7	Novartis	Switzerland
8	Bristol-Myers Squibb	The United States
9	Wyeth	The United States
10	Eli Lilly	The United States
11	Abbott Laboratories	The United States
12	Roche	Switzerland
13	Sanofi-Synthelabo	France
14	Boehringer Ingelheim	Germany
15	Amgen	The United States
16	Takeda	Japan
17	Schering-Plough	The United States

18	Schering AG	Germany
19	Bayer	Germany
20	Sankyo	Japan
21	Eisai	Japan
22	Yamanouchi	Japan
23	Novo Nordisk	Denmark
24	Merck KGaA	Germany
25	Teva	Israel
26	Baxter	The United States
27	Akzo Nobel	Netherland
28	Fujisawa	Japan
29	Daiichi	Japan
30	Genentech	The United States
31	Shionogi	Japan
32	Forest Labs	The United States
33	Purdue Pharma	The United States
34	Solvay	Belgium
35	Serono	Switzerland
36	Altana	Germany
37	Allergan	The United States
38	Schwarz Pharma	Belgium
39	King	The United States
40	Otsuka	Japan
41	Genzyme	The United States
42	Watson	The United States
43	Tanabe Seiyaku	Japan
44	Biogen	The United States
45	Alcon Labs	Switzerland
46	Mylan Labs	The United States
47	Shire	The United Kingdom
48	Kyowa	Japan
49	Chiron	The United Kingdom
50	Ono	Japan

"Top 50 Pharmaceutical Companies of 2003," L.J. Sellers, Associate Editor Pharmaceutical Executive, May 2004, 60.

Top 50 pharmaceutical companies worldwide in 2004

Place	**Company**	**Country**
1	Pfizer	The United States
2	GlaxoSmithKline	The United Kingdom
3	Sanofy-Aventis	France
4	Johnson & Johnson	The United States
5	Merck	The United States
6	AstraZeneca	The United Kingdom
7	Novartis	Switzerland
8	Bristol-Myers Squibb	The United States
9	Wyeth	The United States
10	Abbott Laboratories	The United States

11	Eli Lilly	The United States
12	Roche	Switzerland
13	Amgen	The United States
14	Boehringer Ingelheim	Germany
15	Takeda	Japan
16	Schering-Plough	The United States
17	Schering AG	Germany
18	Bayer	Germany
19	Eisai	Japan
20	Teva	Israel
21	Merck KGaA	Germany
22	Genentech	The United States
23	Yamanouchi	Japan
24	Otsuka	Japan
25	Novo Nordisk	Denmark
26	Baxter	The United States
27	Fujisawa	Japan
28	Sankyo	Japan
29	Forest Labs	The United States
30	Chugai	Japan
31	Akzo Nobel	Netherland
32	Altana	Germany
33	Serono	Switzerland
34	Solvay	Belgium
35	UCB	Belgium
36	Genzyme	The United States
37	Allergan	The United States
38	Mitsubishi Pharmaceuticals	Japan
39	Shionogi Seiyaku	Japan
40	Watson	The United States
41	Ivax Corporation	The United States
42	Alcon Labs	Switzerland
43	Lundbeck	Denmark
44	Biogen	The United States
45	Mylan Labs	The United States
46	Shire	The United Kingdom
47	Purdue Pharma	The United States
48	Ono	Japan
49	King Pharmaceuticals	The United States
50	Tanabe Seiyaku	Japan

"The World Top 50 Pharma companies" European Pharmaceutical Executive's the First Annual Report, July/August 2005

Top 50 pharmaceutical companies worldwide in 2005

Place	**Company**	**Country**
1	Pfizer	The United States
2	GlaxoSmithKline	The United Kingdom
3	Sanofy-Aventis	France

4	Novartis	Switzerland
5	AstraZeneca	The United Kingdom
6	Johnson & Johnson	The United States
7	Merck	The United States
8	Wyeth	The United States
9	Bristol-Myers Squibb	The United States
10	Eli Lilly	The United States
11	Abbott Labs	The United States
12	Roche	Switzerland
13	Amgen	The United States
14	Boehringer Ingelheim	Germany
15	Takeda	Japan
16	Astellas	Japan
17	Schering-Plough	The United States
18	Bayer	Germany
19	Schering AG	Germany
20	Genentech	The United States
21	Novo Nordisk	Denmark
22	Eisai	Japan
23	Teva	Israel
24	Merck KGaA	Germany
25	Sankyo	Japan
26	Otsuka	Japan
27	Forest Labs	The United States
28	Daiichi	Japan
29	Baxter	The United States
30	Akzo Nobel	Netherland
31	Altana	Germany
32	Chugai	Japan
33	Solvay	Belgium
34	UCB	Belgium
35	Genzyme	The United States
36	Serono	Switzerland
37	Allergan	The United States
38	Mitsubishi Pharmaceuticals	Japan
39	Gilead Sciences	The United States
40	Alcon Labs	Switzerland
41	Lundbeck	Denmark
42	Watson	The United States
43	Biogen	The United States
44	Shire	The United Kingdom
45	Shionogi Seiyaku	Japan
46	King	The United States
47	Tanabe Seiyaku	Japan
48	Kyowa Hakko	Japan
49	Mylan Labs	The United States
50	MedImmune	The United States

"Top 50 Pharmaceutical Companies of 2005," Nicole Gray, Associate Editor Pharmaceutical Executive, May 2006, 78.

Top 50 pharmaceutical companies worldwide in 2006

Place	Company	Country
1	Johnson & Johnson	The United States
2	Pfizer	The United States
3	Bayer	Germany
4	GlaxoSmithKline	The United Kingdom
5	Novartis	Switzerland
6	Sanofi-Aventis	France
7	Hoffmann-La Roche	Switzerland
8	AstraZeneca	The United Kingdom
9	Merck & Co.	The United States
10	Abbott Labs	The United States
11	Wyeth	The United States
12	Bristol-Myers Squibb	The United States
13	Eli Lilly and Company	The United States
14	Amgen	The United States
15	Boehringer Ingelheim	Germany
16	Schering-Plough	The United States
17	Baxter	The United States
18	Takeda Pharmaceutical Co.	Japan
19	Genentech	The United States
20	Procter & Gamble	The United States
21	Teva	Israel
22	Astellas Pharma	Japan
23	Daiichi	Japan
24	Novo Nordisk	Denmark
25	Eisai	Japan
26	Merck KGaA	Germany
27	Sinopharm	The United States
28	Akzo Nobel	China
29	UCB	Belgium
30	Nycomed	Switzerland
31	Forest Laboratories	The United States
32	Solvay	Belgium
33	Genzyme	The United States
34	Allergan	The United States
35	Gilead Sciences	The United States
36	CSL	Australia
37	Chugai Pharmaceutical Co.	Japan
38	Biogen	The United States
39	Bausch & Lomb	The United States
40	Taiho Pharmaceutical Co.	Japan
41	King Pharmaceuticals	The United States
42	Watson	The United States
43	Mitsubishi Pharma	Japan
44	Shire	The United Kingdom
45	Cephalon	The United States
46	Dainippon Sumitomo Pharma	Japan

47	Kyowa Hakko	Japan
48	Shionogi	Japan
49	Mylan Labs	The United States
50	H. Lundbeck	Denmark

"Top 50 Pharmaceutical Companies of 2006," Associate Editor Pharmaceutical Executive, May 2007.

Top 50 pharmaceutical companies worldwide in 2007

Place	**Company**	**Country**
1	Pfizer	The United States
2	GlaxoSmithKline	The United Kingdom
3	Sanofi-Aventis	France
4	Novartis	Switzerland
5	AstraZeneca	The United Kingdom
6	Johnson & Johnson	The United States
7	Merck & Co.	The United States
8	Roche	Switzerland
9	Wyeth	The United States
10	Eli Lilly and Company	The United States
11	Bristol-Myers Squibb	The United States
12	Bayer	Germany
13	Abbott	The United States
14	Amgen	The United States
15	Boehringer Ingelheim	Germany
16	Schering-Plough	The United States
17	Takeda	Japan
18	Genentech	The United States
19	Teva	Israel
20	Novo Nordisk	Denmark
21	Astellas Pharma	Japan
22	Daiichi Sankyo	Japan
23	Merck KGaA	Germany
24	Eisai	Japan
25	Otsuka	Japan
26	Servier	France
27	UCB	Belgium
28	Baxter	The United States
29	Nycomed	Switzerland
30	Solvay	Belgium
31	Gilead Sciences	The United States
32	Genzyme	The United States
33	Forest Laboratories	The United States
34	Menarini	Italy
35	Allergan	The United States
36	Mitsubishi Pharma	Japan
37	Chugai Pharmaceutical Co.	Japan
38	Procter & Gamble	The United States
39	Ratiopharm	Germany
40	CSL	Australia

41	Barr Pharmaceuticals	The United States
42	Alcon	The United States
43	Mundipharma	The United Kingdom
44	Shire	The United Kingdom
45	Biogen Idec	The United States
46	Stada	The United States
47	King Pharmaceuticals	The United States
48	H. Lundbeck	Denmark
49	Actavis	The United States
50	Watson	The United States

"Top 50 Pharmaceutical Companies of 2007," Associate Editor Pharmaceutical Executive, 2007.

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