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Supplementary information

The significance of blockbusters in the pharmaceutical industry

In the format provided by the authors

Methodology and definitions

We mined and compiled data on new drug approvals issued by the US Food and Drug Administration (FDA) between 2011–2020[1–11]. The dataset includes a listing of all new drugs approved by the Center for Drug Evaluation and Research (CDER), including small-molecule drugs approved under a New Drug Application (NDA) and new biological products approved under a Biologics License Application (BLA). Data on cell and gene therapies were compiled from the FDA Office of Tissues and Advanced Therapies (OTAT; https://www.fda.gov/vaccines-blood-biologics/cellular-gene-therapy-products/approved-cellular-and-gene-therapy-products).

We focused our analysis on the top-20 research-based pharmaceutical companies by total revenues 2020[12]. All FDA-listed applicant companies were mapped to their parent organization to ensure a truthful assessment of company launch performance. The new drugs were classified into their respective (primary) therapeutic area by using information from DrugBank Online (2022) [https://go.drugbank.com/]. Each new drug was assigned to its molecular drug target using information from DrugBank Online (2022), DrugCentral (2021) [https://drugcentral.org/] or the Kyoto Encyclopedia of Genes and Genomes (KEGG) (2022) [https://www.genome.jp/kegg/]. Finally, annual revenue data were derived from annual company reports as per year of approval. Based on the steps described, the sample size amounted to 212 new drugs. Some new drugs were excluded from the analysis if any of the following cases applied: (1) The new drug was approved in 2019/2020 and did not have sufficient commercialization time to generate meaningful revenue data points at the time of our analysis. (2) The new drug license was sold to a competing company, which distorts the purpose of the analysis. (3) The entire business unit related to the new drug was divested to a competitor. Accordingly, our analysis included 168 new drugs, provided in Supplementary Table S1 as an Excel file.

For the completion of the database, certain assumptions related to yearly revenue information had to be made. Through our investigation of 200 annual reports, we observed that the pharmaceutical companies in scope applied certain minimum thresholds for reporting annual revenues of individual product in their financial statements. Most often, drug products generating revenues of <$50 million in a reporting year were not individually stated but grouped into categories such as “other revenue”, “other oncology revenue” or “other virology revenue”. Consequently, if a company did not report annual revenues for an individual NME, we assumed that its revenues were not material and hence, set its revenue to zero for the purpose of our analysis.

We segmented each new drug into one of four revenue categories, which were defined based on the average annual revenue during the commercialization period of the individual new drug. The commercialization period was calculated as the number of years between the new drug launch and the cut-off year of the analysis (2020). With respect to the industry-wide accepted rule, we defined blockbuster drugs as new drugs that generated an annual revenue of more than $1 billion. To ensure that that only drugs were defined as blockbusters that have a provable commercial impact, we allocated only those drugs to the category of blockbusters that had on average an annual revenue of more than $1 billion for the time of commercialization since product launch. Second, the category ‘low-selling drug’ relates to new drugs with annual average revenue below <$100 million, and it also includes all new drugs that did not report any revenue or were grouped together as “other revenue”. Between blockbusters and low-selling drugs, we distinguished amongst high-selling- and medium-selling drugs to derive more granular insights into the new drug performance. Based on this consideration, we defined four product categories: (1) blockbuster drugs (≥$1 billion), (2) high-selling drugs ($0.5–0.999 billion), (3) medium-selling drugs ($0.1–0.499 billion), and (4) low-selling drugs (<$0.1 billion).

For further analyses, we defined ‘R&D profitability’ as the ability of a new drug to provide revenues to compensate for the average pre-approval capitalized cost of new drug development of $2.6 billion (in 2013 dollars) estimated by DiMasi and colleagues[13].

References

1. Mullard, A. 2011 FDA drug approvals. *Nature Rev. Drug Discov.* **11,** 91–94 (2012). doi:10.1038/nrd3657
2. Mullard, A. 2012 FDA drug approvals. *Nature Rev. Drug Discov.* **12,** 87–90 (2013). doi:10.1038/nrd3946
3. Mullard, A. 2013 FDA approvals. *Nature Rev. Drug Discov.* **13,** 85–89 (2014). doi:10.1038/nrd4239
4. Mullard, A. 2014 FDA drug approvals. *Nature Rev. Drug Discov.* **14,** 77–81 (2015). doi:10.1038/nrd4545
5. Mullard, A. 2015 FDA drug approvals. *Nature Rev. Drug Discov.* **15,** 73–76 (2016). doi:10.1038/nrd.2016.15
6. Mullard, A. 2016 FDA approvals. *Nature Rev. Drug Discov.* **16**, 73–76 (2017). doi:10.1038/nrd.2017.14
7. Mullard, A. 2017 FDA approvals. *Nature Rev. Drug Discov.* **17**, 81–85 (2018). doi:10.1038/nrd.2018.4
8. Mullard, A. 2018 FDA approvals. *Nature Rev. Drug Discov.* **18**, 85–89 (2019). doi:10.1038/d41573-019-00014-x
9. Mullard, A. 2019 FDA approvals. *Nature Rev. Drug Discov.* **19**, 79–84 (2020). doi:10.1038/d41573-020-00001-7
10. Mullard, A. 2020 FDA approvals. *Nature Rev. Drug Discov*. **20**, 85–90 (2021). doi:10.1038/d41573-021-00002-0
11. The Food and Drug Administration (FDA). New Drugs at FDA: CDER's New Molecular Entities and New Therapeutic Biologic Products. Retrieved July 5, 2022, from: https://www.fda.gov/drugs/development-approval-process-drugs/new-drugs-fda-cders-new-molecular-entities-and-new-therapeutic-biological-products
12. Sagonovski, E. Top 20 pharma companies by revenue 2020 (Fierce Pharma, 2021). Retrieved July 5, 2022, from: https://www.fiercepharma.com/special-report/top-20-pharma-companies-by-2020-revenue
13. DiMasi, J. A., Grabowski, H. G. & Hansen, R. W. Innovation in the pharmaceutical industry: new estimates of R&D costs. *J. Health Econ.* **47**, 20–33 (2016). doi:10.1016/j.jhealeco.2016.01.012

Supplementary Table 2 | New drugs of top 20 pharmaceutical companies from 2011–2020 and categorization by therapeutic area, modality and target class

a) Total number of new drugs by therapeutic area; total sales by new drugs and average (av.) sales per new drug; nominal and relative numbers of product category (blockbuster, high-selling, medium-selling or low-selling) per company; all data for the years 2011-2020

b) Total number of new drugs by therapeutic modality; total sales by new drugs and average (av.) sales per new drug; nominal and relative numbers of product category (blockbuster, high-selling, medium-selling or low-selling) per company; all data for the years 2011-2020

c) Total number of new drugs by drug target class; total sales by new drugs and average (av.) sales per new drug; nominal and relative numbers of product category (blockbuster, high-selling, medium-selling or low-selling) per company; all data for the years 2011-2020

a) Therapeutic area:	Total sales (USD billion) by new drugs	Number of new drugs	Av. sales (USD billion) per new drug	Av. years of sales since launch	Av. sales (USD million) per year	Numbers of blockbusters approved (percentage of total new drugs)	Numbers of high-selling drugs approved (percentage of total new drugs)	Numbers of medium-selling drugs approved (percentage of total new drugs)	Numbers of low-selling drugs approved (percentage of total new drugs)
Oncology/hematology	237.9	62	3.8	5.1	752.2	11 (18%)	8 (13%)	21 (34%)	22 (35%)
Infectious Diseases	152.5	22	6.9	5.5	1260.3	9 (41%)	5 (23%)	4 (18%)	4 (18%)
Cardiovascular	100.9	17	5.9	6.4	927.3	5 (29%)	4 (24%)	2 (12%)	6 (35%)
Neurology	75.1	18	4.2	5.3	786.8	4 (22%)	3 (17%)	5 (28%)	6 (33%)
Musculoskeletal	35.2	6	5.9	5.2	1129.5	3 (50%)	0	3 (50%)	0
Metabolic	49.2	17	2.9	5.6	516.7	3 (18%)	3 (18%)	4 (24%)	7 (41%)
Gastrointestinal	15.0	2	7.5	8.0	939.2	1 (50%)	0	1 (50%)	0
Respiratory	21.4	6	3.6	7.2	496.0	0	3 (50%)	3 (50%)	0
Immunology	17.7	9	2.0	4.7	417.4	0	4 (44%)	3 (33%)	2 (22%)
Other	11.3	9	1.3	4.9	256.3	0	1 (11%)	5 (56%)	3 (33%)
Total	716.1	168				36	31	51	50
b) Therapeutic modality:									
Small molecule	467.5	106	4.4	5.8	760.4	22 (21%)	22 (21%)	30 (28%)	32 (30%)
Antibody	208.5	42	5.0	4.5	1103.3	12 (29%)	7 (17%)	15 (36%)	8 (19%)
Protein	29.9	12	2.5	6.6	377.1	1 (8%)	1 (8%)	4 (33%)	6 (50%)
Oligonucleotide therapy	6.8	2	3.4	6.0	563.4	1 (50%)	0	0	1 (50%)
Cell and gene therapy	3.5	6	0.6	3.0	192.7	0	1 (17%)	2 (33%)	3 (50%)
Total	716.1	168				36	31	51	50
c) Drug target class:									
Kinases	150.5	43	3.5	5.3	660.2	7 (16%)	7 (16%)	15 (35%)	14 (33%)
Other Enzymes	179.2	35	5.1	6.1	839.3	9 (26%)	6 (175)	11 (31%)	9 (26%)
Ion Channels	-	2	-	7.0	-	0	0	0	2 (100%)
Receptors	110.1	18	6.2	5.0	1223.5	3 (17%)	6 (33%)	5 (28%)	4 (22%)
Receptors (GPCR)	92.3	30	3.1	5.5	599.3	4 (13%)	3 (10%)	12 (40%)	11 (37%)
Transport Proteins	16.3	4	4.1	4.5	905.8	2 (505)	1 (25%)	0	1 (25%)
Other	167.8	36	4.7	5.1	913.9	11 (31%)	8 (22%)	8 (22%)	9 (25%)
Total	716.1	168				36	31	51	50

Supplementary Table 3 | Top 20 pharmaceutical companies, new drug approvals and blockbuster launches from 2011–2020

	Number of new drugs	Total sales ($ billion) with new drugs	Av. sales years since FDA approval	Nom. and rel. number of blockbuster drugs (% of total new drugs)	Nom. and rel. number of high-selling drugs (% of total new drugs)	Nom. and rel. number of medium-selling drugs (% of total new drugs)	Nom. and rel. number of low-selling drugs (% of total new drugs)
AbbVie	7	37.2	4.3	2 (29%)	3 (43%)	1 (14%)	1 (14%)
Amgen	8	12.4	4.9	0	1 (13%)	5 (63%)	2 (25%)
Astellas Pharma	4	4.6	4.3	0	0	3 (75%)	1 (25%)
AstraZeneca	13	41.0	4.9	3 (23%)	3 (23%)	3 (23%)	4 (31%)
Bayer	5	11.1	7.6	0	0	4 (80%)	1 (20%)
Biogen	4	37.6	6.5	2 (50%)	0	1 (25%)	1 (25%)
Boehringer Ingelheim	6	18.5	6.7	1 (17%)	2 (33%)	0	3 (50%)
Bristol-Myers Squibb	12	103.4	5.7	5 (42%)	1 (8%)	2 (17%)	4 (33%)
Daiichi Sankyo	2	0.4	3.5	0	0	1 (50%)	1 (50%)
Eli Lilly	8	29.0	4.5	1 (13%)	3 (38%)	3 (38%)	1 (13%)
Gilead Sciences	11	102.5	4.8	6 (55%)	1 (9%)	3 (27%)	1 (9%)
GlaxoSmithKline	11	29.4	6.2	1 (9%)	2 (18%)	3 (27%)	5 (45%)
Johnson & Johnson	11	53.6	6.1	2 (18%)	6 (55%)	1 (9%)	2 (18%)
Merck	10	48.9	5.3	1 (10%)	2 (20%)	2 (20%)	5 (50%)
Novartis	14	33.7	4.4	2 (14%)	2 (14%)	6 (43%)	4 (29%)
Novo Nordisk	2	11.2	4.5	1 (50%)	1 (50%)	0	0
Pfizer	10	41.7	5.5	2 (20%)	1 (10%)	3 (30%)	4 (40%)
Roche	12	57.6	5.3	5 (42%)	2 (17%)	2 (17%)	3 (25%)
Sanofi	8	14.8	5.8	1 (13%)	0	3 (38%)	4 (50%)
Takeda	10	28.0	7.1	1 (10%)	1 (10%)	5 (50%)	3 (30%)
Total	168	716.1	5.4	36	31	51	50

Total number of new drugs; total sales by new drugs and average (av.) sales per new drug; nominal (nom.) and relative (rel.) numbers of product categories (blockbuster, high-selling, medium-selling or low-selling) per company; all data for the years 2011–2020