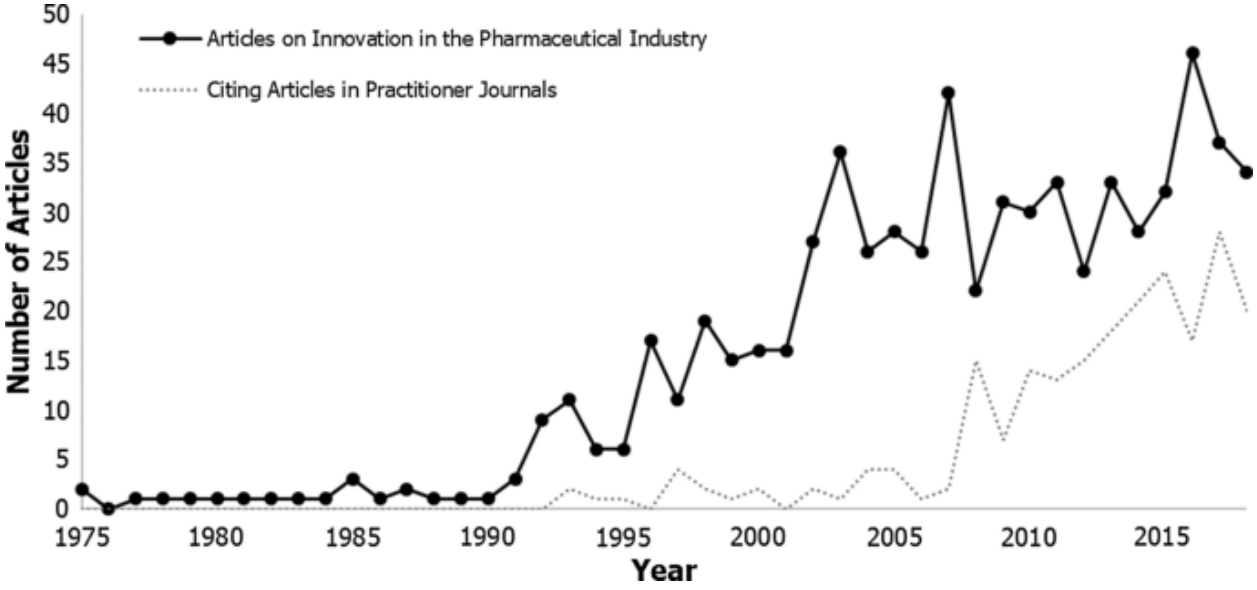
Project Title: The role of external innovation and big pharma business development teams

Team Members (asterisk team Captain): Caroline Sechler*, Steve McCall

Outline Submission Date: 2/4/2025

Introduction

External innovation in the pharmaceutical industry started in the late 1990s and gained steam as a full-fledged trend around the early 2000s. Pharmaceutical Research & Development (R&D) costs had seen steady rise through the 1980s and 1990s (Grabowski, 2004) and companies were searching for a way to reduce costs and also to expand their pipelines for greater likelihood for success in addition to riding the globalization trend in full swing at the time. The adoption curve of [external] innovation in the pharma space can be seen quite clearly in an analysis done on the number of articles published on innovation since 1975 (Romasanta et al., 2020).



“Pharmaceutical leaders confronting a patent cliff look toward innovative biotechnology as a solution. Pharma companies feel an urgency to refresh pipelines as patents expire, engaging in record M&A activity with promising biotechnology producers” (Brocker, 2025). Big Pharma has developed a myriad of external innovation over the years to bridge this gap. This has led to higher numbers of NMEs and higher revenues. However, in this paper we delve deeper into performance metrics (financial and otherwise) to gauge the effectiveness of this ubiquitous strategy.

The guiding hypothesis for our analysis may be stated that: *Over the last 30 years external innovation has become more of an integral part of Pharmaceutical R&D. This has led to gains as measured by # NMEs and revenue by larger Pharma companies. We believe that as competition for external deals (licensing and acquisitions, etc.) has become more competitive, this has increased the value of the deals and reduced the Return on Investment (ROI) thereby increasing the top line revenues (buying market share) but lowering the profitability and measured by EBIT/EBITDA or other return on investment metrics (ROCE, Return on Capital, etc.). External innovation has had other impacts on Big Pharma as well such as talent acquisition and retention strategies.*

The adoption of external innovation within the pharmaceutical industry has seen some wins, some losses, a lot of grey areas and are part of a much more complex story. The trend has also birthed entirely new industries and changed the way Big Pharma operates and measures success. Within our paper we will present definitions, analyze success metrics, test our hypothesis, admit some limitations, discuss some key impacts that external innovation has left

on the industry and finally come up with future prognostications and recommendations for Big Pharma Business Development Teams (BDTs) navigating the complex path to profitability utilizing external innovation as a component of their development work.

Background

Pharma was facing elevated costs in the late 1990s and early 2000s and pipelines that needed diversifying. It's likely that investment dollars were flowing into the tech sector in the late 1990s and then after the Dot.com bubble, investment dollars were harder to come by. The pharma industry turned to external innovation for inspiration and attempts to shore up their pipelines and their bottom lines. There are multiple types of external innovation avenues to be discussed in the pharmaceutical industry (Deloitte, 2018):

Licensing - The licensor firm grants rights to another firm to produce and/or sell a product. The licensee pays compensation to the licensing firm in return for access to intellectual property or technical expertise.

Mergers & Acquisitions - M&A refers to the acquisition or merger of companies or assets. In an acquisition, the acquiring firm can control more than 50 percent of a target firm's equity.

Joint Ventures- In a joint venture, an association of two or more individuals or companies engage in a separate business enterprise for profit.

Open Innovation - Open innovation is a forward-thinking strategy that emphasizes collaboration and external input to drive innovation. This features collaboration and knowledge sharing and can be associated with innovative business models.

Outsourcing - Outsourcing R&D activities to external firms such as universities or government research institutions or CMOs and CROs.

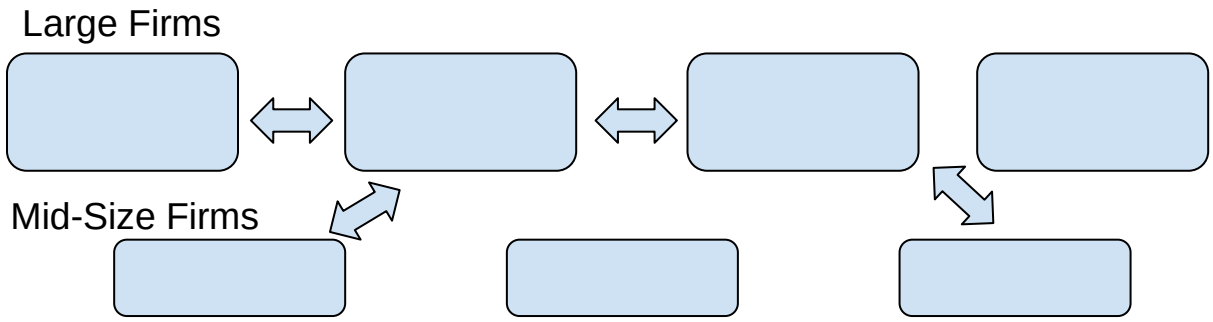
These methods were employed in various forms and magnitudes by all Big Pharma players from the late 1990s until today. En route to our overall recommendation for a path forward for our clients we will dive deep into how success of these external innovations is measured on a Company level as well as Industry level[1].

Historically, pharmaceutical companies had been engaged in research at all stages of the R&D pipeline utilizing internal resources, known as Fully Integrated Pharmaceutical Companies (FIPCOs) (Schumacher et al., 2023). The industry first started implementing external innovation in the form of merger and acquisition (M&A) activity and has seen 3 major waves; from 1988-1991, 1996-2002 and a third wave that began in 2010 and is still ongoing (Feldman, 2021). The M&A waves were driven by the potential for increased market share (and dominance), cost and market synergies, economies of scale and more diversification in their portfolios. The waves may be thought of in a couple of different ways.

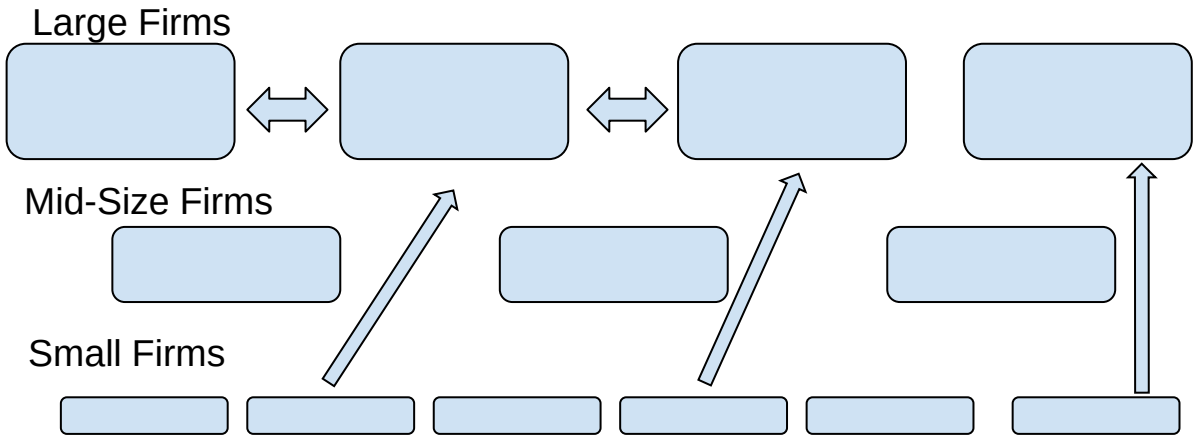
The first and second Waves may be thought of as consolidation amongst large and mid-size players mostly targeting market share gains and cost synergies undergoing mergers and/or acquisitions.

[1] With limited time and resources, we are at the behest of existing literature and source material. Mostly this impacts the time horizon for analysis in that they won't always match up perfectly. We feel that conclusions are evident regardless.

Waves 1&2

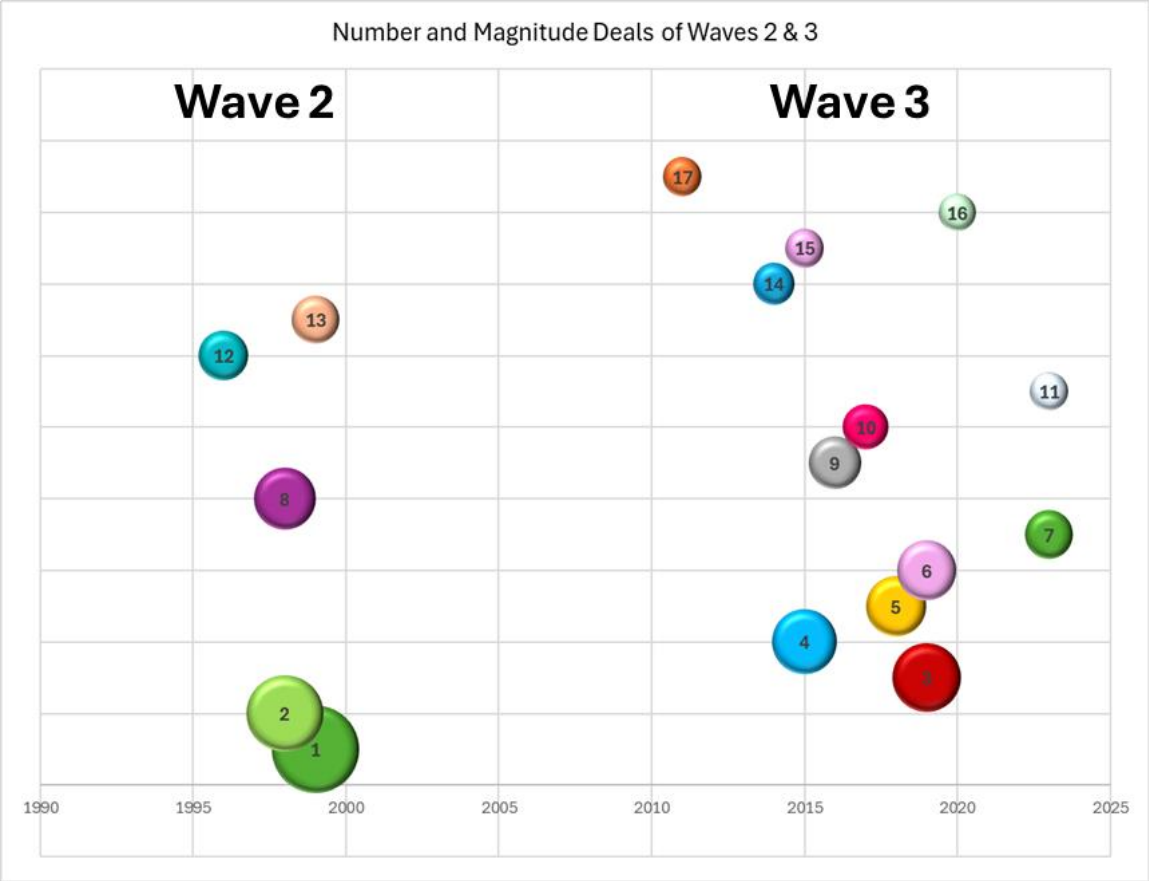


Wave 3



Wave 3 saw the larger pharma players acquiring smaller players to fill specific gaps in their portfolio but also involved “killer acquisitions” in which the goal is simply to remove an innovative drug from the marketplace and thereby lessen competition for an existing or soon to be marketed therapeutic. Before Wave One, the top eight drug companies held 36% market share. After Wave Two this had grown to 42% and by 2012 this had risen to 53%. From 1995 to 2015 the top 60 pharmaceutical companies had merged to a mere 10 (Feldman, 2021). While

this structural shift had wide ranging implications for the consumer and pharma marketplace, we will focus on the implications of this wave on Big Pharma and the major players that make up the sector.



1	Pfizer	Warner-Lambert
2	Zeneca	Astra AB
3	Bristol-Myers Squibb	Celgene
4	Actavis	Allergan, Inc
5	Takeda Pharmaceutical	Shire plc
6	Abbvie	Allergan plc
7	Pfizer	Seagen
8	Hoechst AG	Rhône-Poulenc
9	Teva Pharmaceutical Industries	Actavis Generics
10	Johnson & Johnson	Actelion
11	Amgen	Horizon Therapeutics
12	Ciba-Geigy	Sandoz
13	Monsanto	Pharmacia & Upjohn
14	Actavis	Forest Laboratories
15	Abbvie	Pharmacyclics
16	Gilead Sciences	Immunomedics
17	Sanofi	Genzyme

Another way to look at the waves and to further reinforce this concept is by looking at the frequency and size of the M&A activity since 1999 (Buntz, 2024). Bubble size corresponds to USD in Billions corrected for inflation to 2024 dollars.

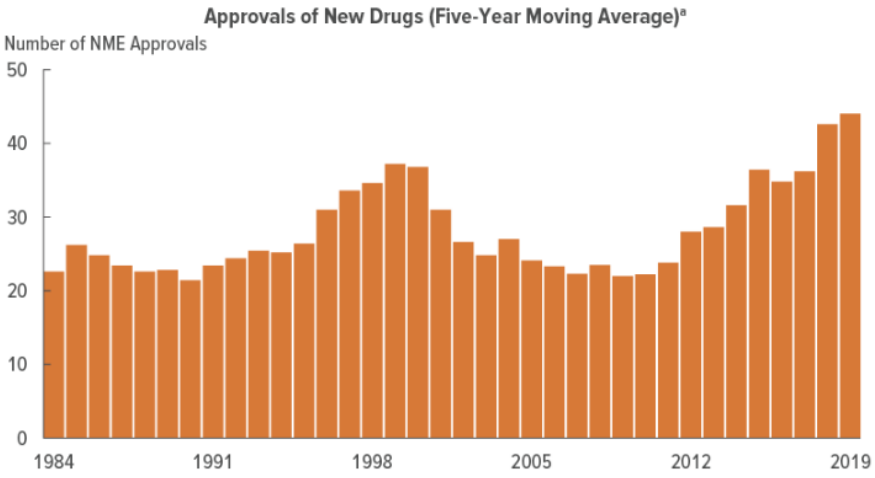
You can see the size and frequency of the deals in Wave 2 corresponding to the merger activity and the average size go down and frequency go up, representing more acquisitions in Wave 3.

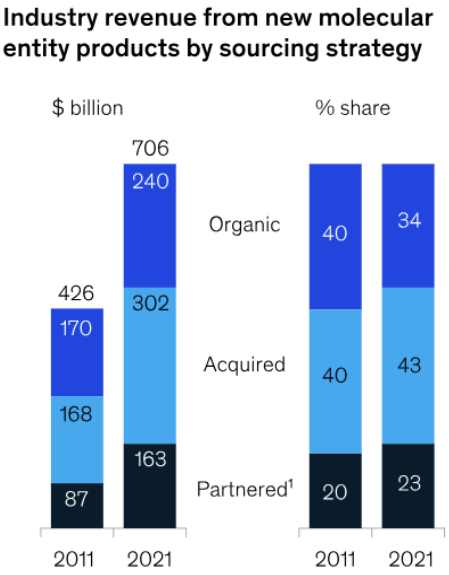
It is Wave 3 that forms the basis of our overriding hypothesis. As the larger pharmaceutical companies became more dependent on external innovation to supply their pipelines, the most attractive targets became hot commodities, allowing them to charge premium prices for acquisition deals, thereby impacting the bottom line of the larger pharma companies.

Here we have been focused mostly on external innovation in the M&A variety. It's worth noting that also during Wave 3 we started to see consolidation of small and mid-level support firms providing Contract services (CRO and CMO) to larger pharmaceutical companies giving them more leverage on the supply side (and higher prices for contract work) and further impacting Big Pharma's bottom lines.

Success Metrics - How do we demonstrate success?

"Success" for these waves of M&A activity can be measured in many ways. Traditionally the industry claims success of the M&A activity by touting the number of new molecules entering the market and obtaining FDA approval. A simple Google search on the "success of external innovation in pharma" will bring up multiple sources that demonstrate the trend of NMEs approved by the FDA (Swagel, 2021). Based on NME approvals it may be argued that Wave 2 had a deleterious impact on innovation, but Wave 3 seems to have yielded clear benefits from a "number of NMEs" perspective.





Additionally, growth in revenue dollars is also often quoted as direct evidence of the fruits of external innovation labor (Pont et al., 2022). Higher revenues have been gained because of external innovation practices as well. But, what of the bottom line? The deals have had impacts on top-line revenue dollars, but have they made the companies more profitable than organically generated therapeutics developed fully internally? Our hypothesis states that, because of increased competition for all external innovation avenues, the costs have increased

commensurately thereby negating efficiency and profitability. Has the adoption of external innovation practices yielded more efficient R&D operations or simply allowed the companies to purchase market share at premium prices? On the road towards our recommendations, we will dive into additional success metrics for R&D output both on an industry-wide level and on a company-by-company basis.

Industry Level Analysis - Has this been productive and profitable for the industry?

There are many ways to analyze the efficiency of R&D operations beyond top line revenues and number of approved NMEs. Financial metrics that are routinely used to measure efficiency are Return on Capital Employed (ROCE), Internal Rate of Return (IRR), and Return on Investment (ROI). This is in addition to the traditional measures of "bottom line" profit of Gross Margin (GM), Earnings Before Income and Taxes (EBIT,) and Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA).

A rudimentary form of investigating is to simply analyze costs relative to output. If output rises more than costs, it is generally a good sign that efficiency gains (and profits) are being realized.

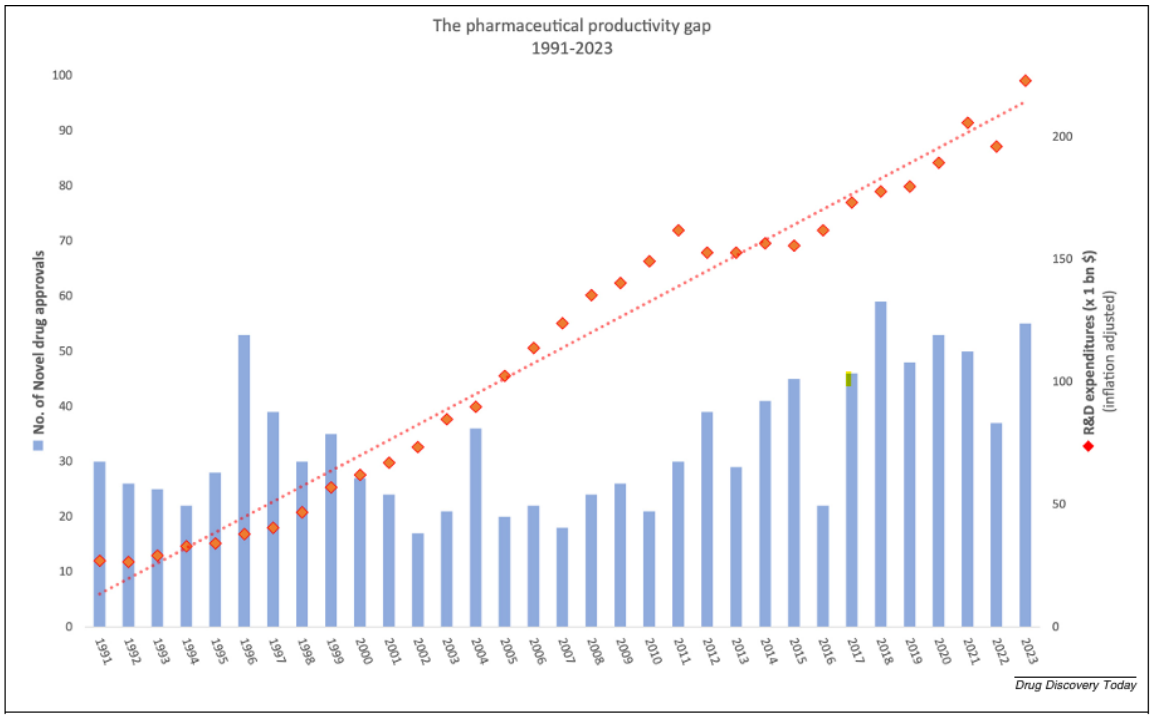


FIGURE 1

The pharmaceutical 'productivity gap', updated from Fernald *et al.*[p13] A steady rise of R&D expenditures compared to a stagnant pattern of novel drug introductions. [Data obtained from fda.gov, Market Data (Datastream) and literature.]

Work published by Fernald, et al. demonstrates that while productivity gains in the number of NMEs launched have clearly been realized, the costs to reach those gains have outpaced the growth. While there may be some accounting nuances between companies and how they allocate these costs, it shows a clear trend of costs to produce therapeutics rising at a higher rate than the output. The same publication gave an even more stark picture of R&D efficiency over the time horizon that we have been concerned with for external innovation. This shows a steady decline in R&D efficiency since 1996.

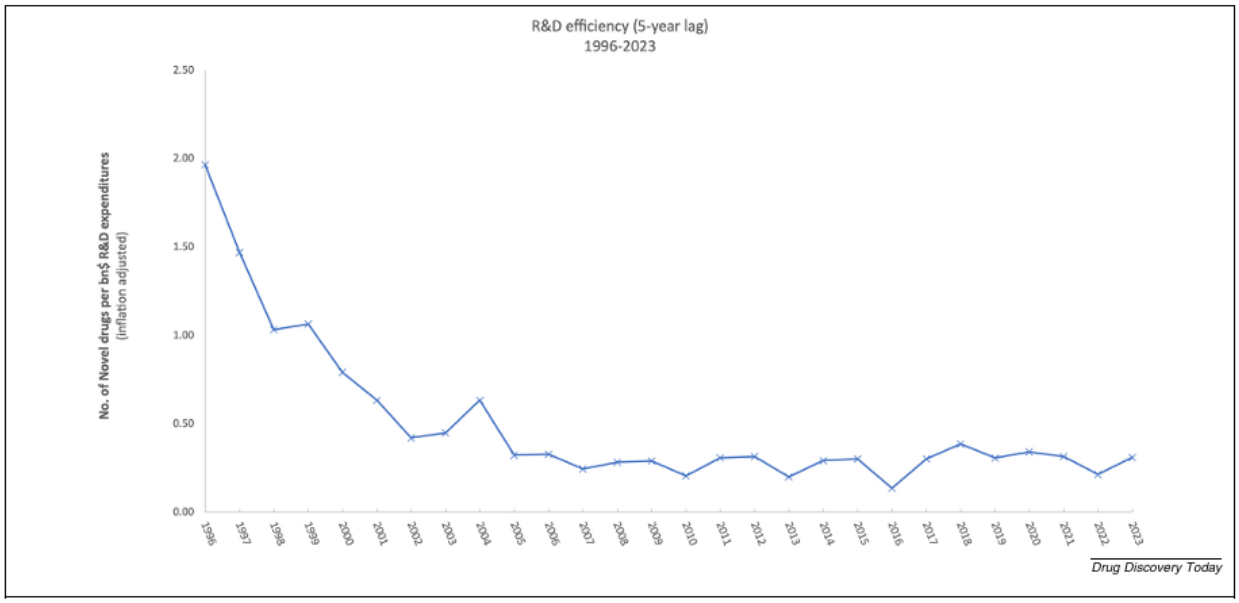
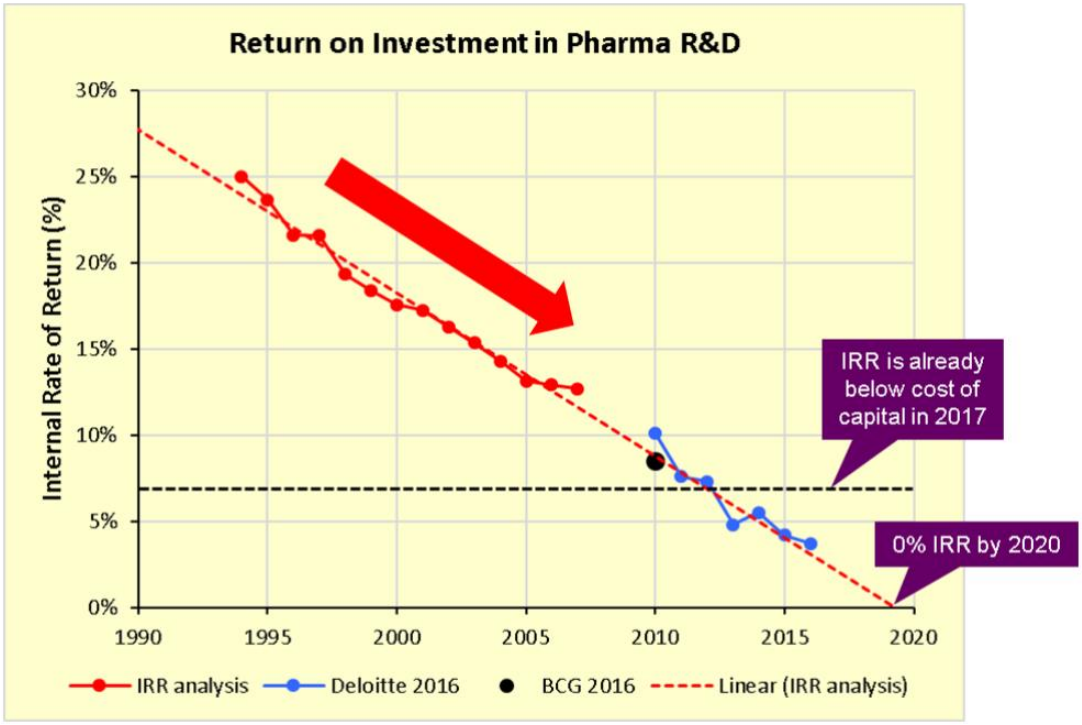


FIGURE 2

R&D efficiency, expressed as the number of novel drug introductions per $1bn of R&D expenditures 5 years prior – adjusted for inflation (in 2023 US$).

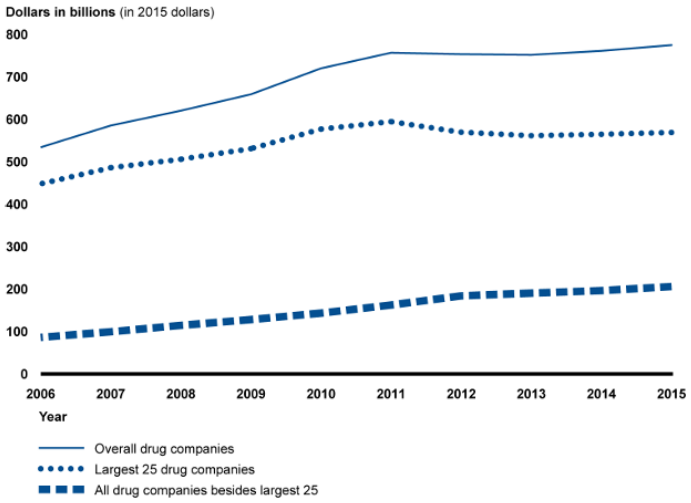
Kelvin Stott also did an analysis that extrapolates recurring work done by Deloitte to give a very clear picture of the financial impacts that the pharmaceutical industry is seeing.



This shows that, over the given time-period since external innovation has been a key focus for Big Pharma, that IRR has consistently gone down.

And lastly, we have a report on profitability in the pharmaceutical industry put out by the Government Accountability Office (GAO) in 2017.

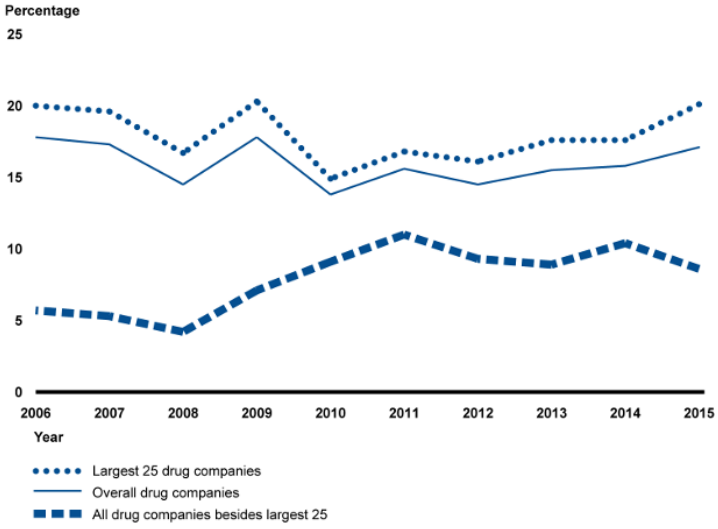
Figure 3: Aggregate Worldwide Pharmaceutical and Biotechnology Sales Revenue for Drug Companies, Overall, Largest 25, and All Others, 2006-2015



Source: GAO analysis of Bloomberg data. | GAO-18-40

Note: The largest 25 drug companies consist of those with the highest pharmaceutical and biotechnology sales revenue in 2015. Data are adjusted to 2015 U.S. dollars using the gross domestic product price index.

Figure 4: Average Profit Margin for Drug Companies, Overall, Largest 25, and All Others, 2006-2015



While the temporal focus of the study comes almost exactly in between Waves 2 & 3, we can still gain insights from the analysis that lend credence to our hypothesis. After Wave 2, the first graph shows revenues for the largest 25 pharma companies steadily climbing and leveling off with a slight decline around the beginning of Wave 3. It also shows that companies outside of the largest 25 still saw steady increases in revenue. This in and of itself may be giving evidence of lackluster performance of the largest companies' external innovation efforts. Even more telling is the second graph showing profitability between the largest pharma companies and the rest of the field. From 2006 to 2011 there was a clear downward trend in profitability for the largest 25 pharma companies and a clear uptrend for the rest of the field. This shows that profitability suffered, and that Wave 2 of M&A had cost Big Pharma on their bottom lines. The smaller companies performed well over the time horizon which likely made them attractive targets heading into Wave 3. It would be interesting to see where this went after 2016 to date as it appears there is an inversion of profitability between the large and small players near the end of the analysis period.

Company Level Analysis - Is anyone getting this right?

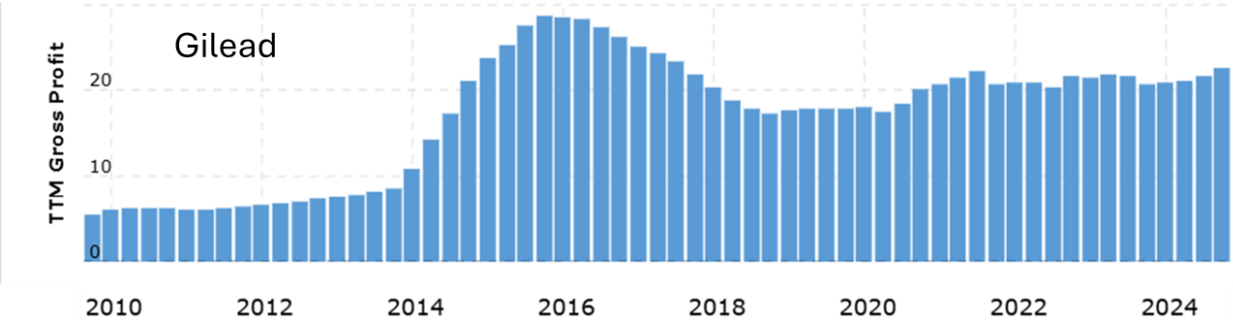
Schumacher et al. conducted an analysis of pharmaceutical industry productivity over the years of 2001 - 2020, encompassing both Waves 2 & 3. They observed a cohort of 16 of the largest pharmaceutical companies over this period. A rudimentary measure of R&D productivity and efficiency is to simply compare the relative growth rates of R&D expenditure to the growth rates of revenue growth. Of the 16 companies involved in the study almost half showed a higher growth rate of R&D spend than revenue growth (diminishing returns), almost a third showed growth of the two measures equal (no added efficiency) and only 25% showed an

actual top line growth outpacing R&D spend. Most were moderate (+1-2%) with one glaring exception of Gilead showing considerable growth in both parameters, but a +8% net positive in revenue growth. Averages for R&D spend and revenue growth were matched at 6%.

Revenue and R&D figures of leading pharmaceutical companies (2001–2020).

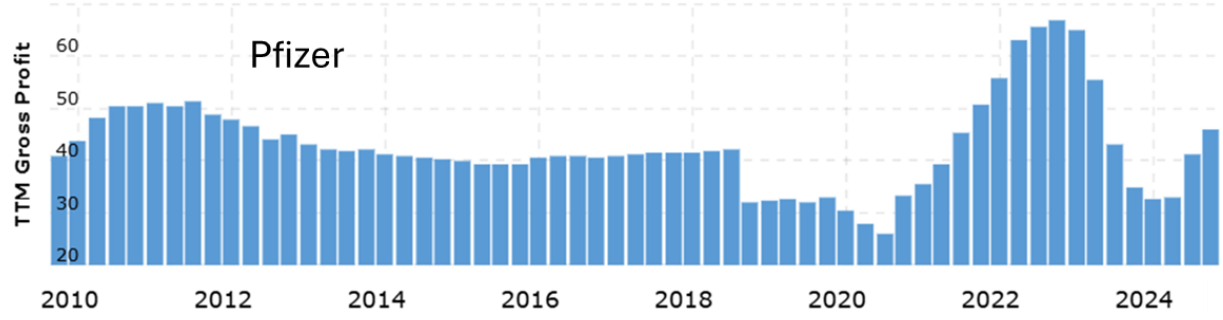
	Total revenue ($ billion)							R&D expenditure ($ billion)							R&D intensity (avg.)				
	Total	Avg. annual	2001–2005	2006–2010	2011–2015	2016–2020	CAGR	Total	Avg. annual	2001–2005	2006–2010	2011–2015	2016–2020	CAGR (%)	Avg. annual	2001–2005	2006–2010	2011–2015	2016–2020
Pfizer	1075.2	53.8	249.1	288.0	286.0	252.2	-1%	166.5	8.3	39.2	45.5	41.9	39.9	1%	16%	16%	16%	15%	16%
GSK	795.9	39.8	213.5	237.6	185.0	159.8	−1%	118.2	5.9	33.1	38.9	25.1	21.2	−1%	15%	15%	16%	13%	13%
Merck & Co.	720.9	36.0	149.7	159.0	213.0	199.2	2%	158.1	7.9	22.0	37.9	42.8	55.6	7%	22%	15%	23%	20%	28%
Sanofi	678.4	33.9	104.6	206.4	189.4	178.0	8%	111.7	5.6	14.0	34.9	33.0	29.8	8%	17%	15%	17%	17%	17%
Roche	649.8	32.5	79.5	159.7	188.4	222.2	8%	146.3	7.3	15.3	33.8	43.2	54.0	10%	22%	19%	21%	23%	24%
J&J	635.9	31.8	130.7	142.8	158.0	204.4	4%	128.2	6.4	22.3	29.6	32.7	43.5	5%	20%	17%	21%	21%	21%
AstraZeneca	589.3	29.5	133.9	186.2	153.7	115.6	-1%	113.4	5.7	21.9	30.5	30.4	30.6	2%	20%	16%	17%	20%	27%
Novartis	549.4	27.5	84.5	130.3	158.5	176.0	6%	112.9	5.6	15.5	26.6	34.2	36.6	6%	20%	18%	20%	22%	21%
BMS	440.9	22.0	104.5	103.5	98.3	134.7	3%	95.7	4.8	15.7	19.5	24.4	36.1	6%	22%	15%	19%	25%	27%
Eli Lilly	415.1	20.8	81.7	113.8	110.1	109.5	2%	89.8	4.5	16.0	22.5	25.4	26.2	4%	22%	20%	20%	23%	24%
Amgen	356.3	17.8	51.8	87.2	100.9	116.4	8%	69.9	3.5	10.8	17.8	21.2	20.1	6%	20%	22%	20%	21%	17%
Bayer	296.3	14.8	32.4	80.4	83.2	100.3	6%	48.2	2.4	6.4	12.5	12.9	16.6	4%	17%	20%	16%	15%	17%
Takeda	293.6	14.7	36.6	62.5	82.6	111.9	9%	56.5	2.8	5.5	14.7	18.2	18.1	9%	19%	15%	23%	22%	17%
Boehringer	272.4	13.6	41.8	75.5	78.0	77.1	5%	48.9	2.4	6.6	13.0	15.1	14.2	6%	18%	16%	17%	19%	18%
Gilead	258.7	12.9	6.0	30.4	93.9	128.3	25%	40.6	2.0	1.4	4.5	12.2	22.6	16%	20%	37%	15%	15%	18%
NovoNordisk	247.0	12.3	26.8	50.6	77.9	91.6	8%	34.9	1.7	4.1	8.3	11.0	11.5	7%	15%	15%	16%	14%	13%
Total	8275.1		1527.1	2113.9	2256.9	2377.2		1539.9		249.7	390.5	423.7	476.6						
Average	517.2		95.4	132.1	141.1	148.6	6%	96.2		15.6	24.4	26.5	29.8	6%	19%	18%	19%	19%	20%
Average annual	25.9		19.1	26.4	28.2	29.7		4.8		3.1	4.9	5.3	6.0						

This performance also shows up significantly on Gilead's bottom line in trailing twelve months (TTM) profits from 2010-2024.

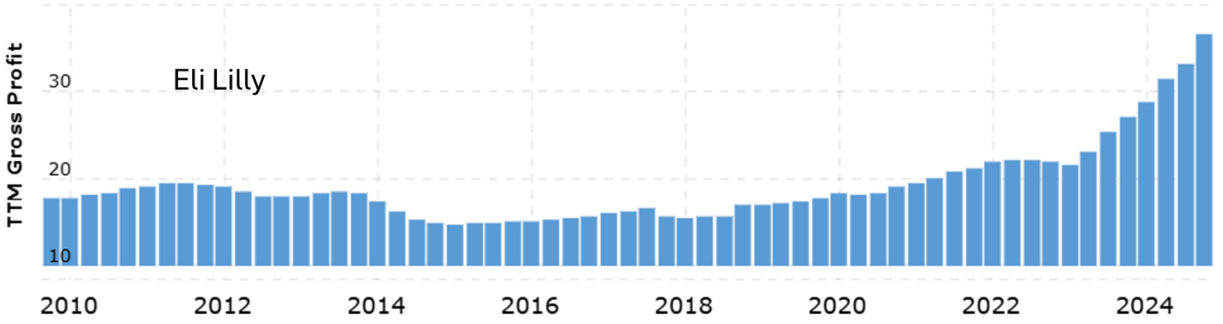


Gilead certainly has engaged in almost all forms of external innovation steadily acquiring targets, partnering and collaborating since the mid-1990s. They used external innovation for therapies as well as platforms. Gilead used M&A activities to boost its pipeline and its research expertise. As best we can tell Gilead was not only masterful at what they acquired and who they partnered with but when and how they went about it.

On a company level though, the results don't always come out quite so neatly. Pfizer, who was an early and big champion of external innovation, saw R&D expenditure match the growth of revenues, so no net gain of efficiency. But they did see a drop in profitability as measured over this time period.



Similarly, Eli Lilly had a negative balance of R&D input to revenue gains and saw profitability basically stable (until a clear bump during/after COVID).

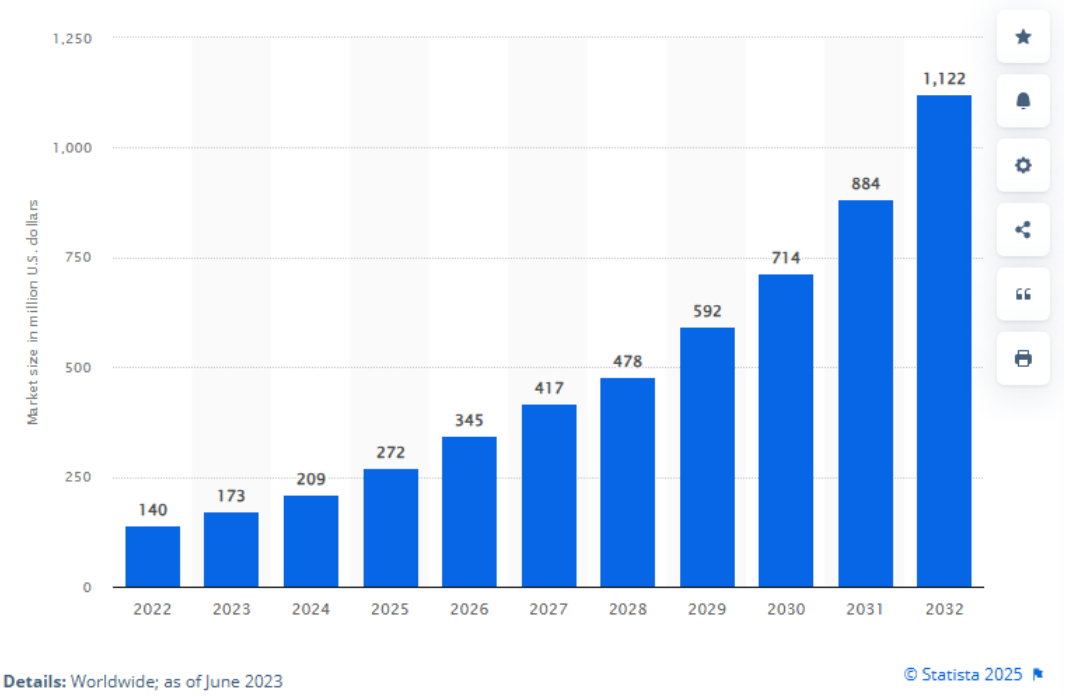


The takeaway from this is that even though we saw strong support for our hypothesis on an industry level, *once we get to the company level the results are much harder to discern*. The reason being that the issue is much more complicated than simply external innovation being more sought after and more expensive to acquire. While we do see evidence of this on a macro level, other factors have played a role. Steve Hall of Lilly Ventures says, he believes “increasing regulatory costs, longer development times, quicker patent expirations and an overarching

strategy towards Blockbuster therapies are all contributing AND the competitive external environment have all contributed to the struggles that Pharma has had with R&D efficiency over the last 30 years even in the face of much adoption of external innovation". While some successes may be claimed from external innovation, it is clear that it has not had an overwhelming impact on the bottom line on an industry level. This may point to the fact that few companies are adept at managing it profitably such as Gilead. As mentioned, Gilead was exceedingly intentional on what assets they sought and for what reasons. One of them was talent and expertise, which we will delve into in our next section.

Talent Acquisition, Retention, and Management

With a growing biopharma industry comes the development of new technologies that need integration into current processes. A technology with significant impact in recent years has been the further development of AI algorithms and platforms (Solverson, 2024). AI has been around for a while already, but it wasn't until recent years (2015-present) that more focus has been placed on its current capability and potential for use in research, discovery, and automation (Devereson et al., 2022; Sovlerson, 2024). Damla Varol, a quality assurance consultant with ample experience in the pharmaceutical industry, provides the statistic that 95% of reporting pharmaceutical companies have invested in AI in 2024, while Thomas, 2024 reports the statistic that about half of both pharmaceutical *and* biotech companies utilize AI. AI can provide benefits such as better digitization, automation, and faster processing of data for companies, making it a highly sought after and valuable tool. Mike Cruski, the VP and GM for the North American API portion of Thermo Fisher, similarly recognizes automation and digitization as a large trend in CMOs in the past 30 years.



Global market for generative AI in clinical trials from 2022 to 2032 (in million U.S. dollars).

Source: Statista 2025

Because of its novelty and high complexity, current talent at some companies may not have the skills to operate or work around AI yet. This is where strategies for filling in the gaps are necessary. Talent acquisition is important for companies as it allows them to diversify their employees, knowledge base, and skill base for greater stability in the market, as reported by Eightfold AI, 2023. A common theme amongst sources is that to fill this gap in AI-digitization skills, biopharmaceutical companies are looking at more communications with colleges and career centers. There is a large focus on marketing pharmaceutical jobs to students to plant the seeds for the next generation of talent in the industry (Mix and De Silva, 2024).

Some sources state that one method of acquisition that is being more frequently adopted is the development of talent intelligence groups, or talent intelligence centers of excellence.

These groups are made up of people whose job it is to identify the gaps in the company's workforce/knowledge/skills, develop a profile for who they need, and recruit. Having a group dedicated to filling in roles has proven to aid in the efficiency of filling jobs (Eightfold AI, 2023).

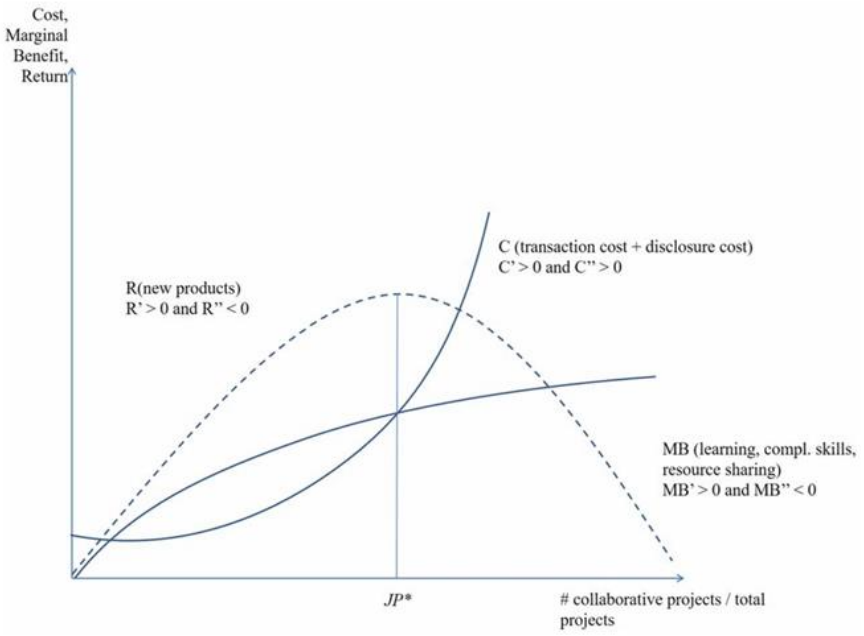
But what about the current talent? Biopharma companies are also seeing an increase in upskilling and reskilling of their workforce so they can keep up with the evolving technology and trends of the industry. Stanford University states that, depending on the current talent, companies can either refine and build upon current skills (upskilling) or shift the focus of talent by introducing new skills (reskilling). By maintaining a workforce educated on the newest technologies, creating more opportunities for internal mobility, and adding flexibility via remote work enables biopharma companies to retain their talent and keep up with the competition (Sykes, 2022).

Collaborations and Strategic Alliances

Biopharma companies make a variety of moves to enhance their capabilities and/or assets. M&As, licensing deals, and strategic alliances are all ways for biopharma companies to attain knowledge (technology, research), lessen the monetary burden by spreading out the cost of R&D, and lessen the ever-present risk that is associated with innovation and developing new technologies (Carboni and Medda, 2021). These connections can be established between companies, between a company and academic institution, or between a company and a government institution (Carboni and Medda, 2021; De Man and Duysters, 2005). All these methods of collaboration/acquisition are considered forms of external innovation, including

collaborations/acquisitions with companies under the same umbrella groups (Carboni and Medda, 2021).

Each of these types of collaborations and acquisitions have their own pros and cons. Companies working with universities or other research facilities have a greater capacity for innovation and a lower risk for negative behaviors caused by underlying competition or ulterior motives. Similarly, companies working with other companies within the same group have a decreased risk of negative competitive behaviors while also boasting more streamlined commercialization pathways (Carboni and Medda, 2021). Companies working with other companies outside their group see an increase in innovation, however, risk being exposed to competition. All forms of external R&D via collaborations and acquisitions come with increased innovation until a certain point, where eventually companies will begin to see negative returns due to so much energy and infrastructure being reallocated from internal development to external (Carboni and Medda, 2021).



Theoretical “U-shaped” curve depicting the benefit that external innovation has on success until a point, *JP** (number of joint projects), where there begins to be excessive outsourcing, leading to negative returns (Hottenrott and Lopes-Bento, 2016).

One study investigated the differences in innovative impacts from M&As and strategic alliances. Both M&As and strategic alliances are known to have high failure rates, with M&As having somewhat higher rates. Despite this close similarity, strategic alliances have been found to exhibit a larger positive impact on a company’s innovation. At best, M&As have neutral effects on innovation while strategic alliances tend to have positive impacts.

Recommendations

The pharmaceutical industry has seen both opportunity and challenges arise from the use of external innovation over the last 30 years. We believe that external innovation still plays a vital role in pharmaceutical development teams, but we recommend using external innovation in a very pointed fashion. Our recommendation will involve both strategic and tactical concerns for companies to lead them to more productive R&D pursuits and greater profitability to return to shareholders.

Strategic

- *Portfolio Focus and Robustness of Business Cases* - companies must be more intentional about what assets they go after and develop. The old pharmaceutical industry model of big, bloated behemoths targeting a broad range of indications and depending on economies of scale is dated and led to many of the inefficiencies pointed out through our research. We saw in Wave 3 that companies started to refine what assets they were targeting. Additionally, the concept of “Blockbuster Only” causes companies to follow-

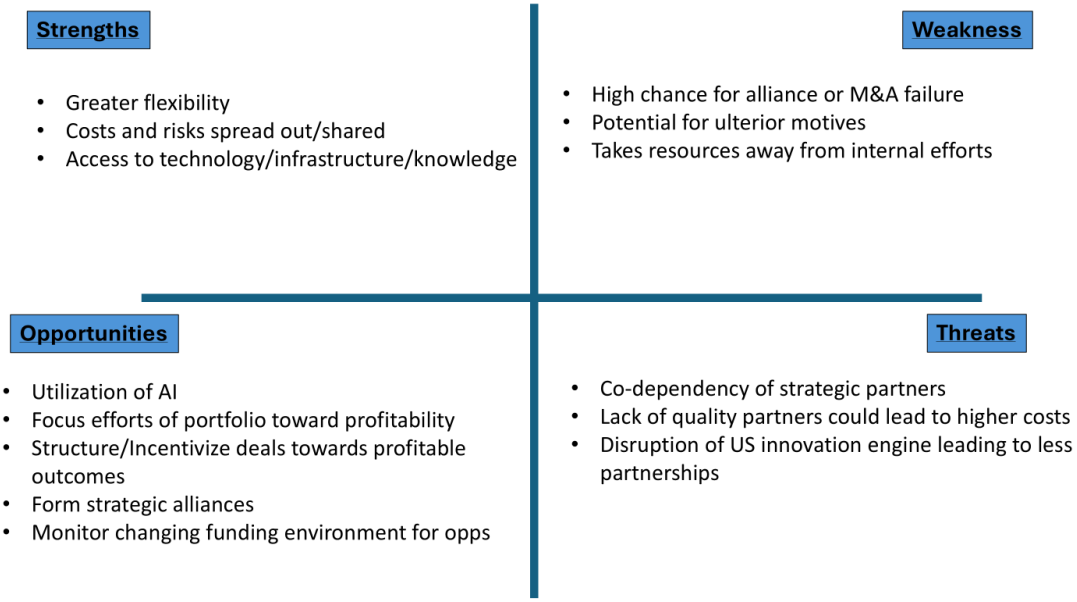
the-leader. While some regulatory risk is minimized with this approach, margins will see significant erosion to all but the very first movers in a space. Pinpointing unique market opportunities should be a clear focus of business development teams. **BDTs should have subject matter experts on their teams that enable identification of external innovations that are laser focused on value capture. They need to not only have capabilities on hand to analyze Bluer Oceans of opportunity for M&A targets, but also the expertise on hand that can speak to operating and integration efficiencies that will impact the bottom line. They need more robust and realistic business cases that focus on profitability.**

- *Strategic Alliances* - Partnerships are frequently sought after by companies who are looking to expand their knowledge and skill base, spread out R&D costs, and spread-out risk. Both M&As and strategic alliances can provide these benefits and even potentially have a net positive impact on innovation. Strategic alliances, however, have been shown to provide more successful impacts on innovation over M&As. The reason behind this could be the potential for M&As to overwhelm a company that is not equipped to manage a full companies' worth of assets and infrastructure, while strategic alliances have the benefit of allowing companies to pick and choose what parts they want to share. **Strategic alliances are recommended over M&As due to being more focused on the needs of the companies rather than a blanket acquisition that may leave you with more than you can handle.**

Tactical Recommendations

- *Monitor changing political and funding environment* - we would be remiss if we didn't mention that much of the foundations and structure that grew to underpin R&D and their external innovation efforts are currently undergoing monumental shifts due to the current administration's domestic and international policies. There may be gaps in foundational scientific research that may give rise to overall slower advancement of science in America. The other side of this coin is that many academic labs and/or start-up companies will now be searching for new sources of funding and partnerships. This may present novel and cheap opportunities should the correct one be identified. **BDTs should investigate how this landscape is changing and look far and wide for new opportunities.**
- *Translate portfolio focus into skill and knowledge development* - Identifying profitable opportunities is the first step. Having the skills on board to maximize the profitability of the assets is the next step. This may be achieved by any of the external innovation techniques and catered to by importance. For example, bridging gaps in Biomanufacturing or Continuous Flow Manufacturing that could have significant impacts on costs and efficiency of assets could be investigated for acquiring SMEs and technologies together whereas expertise in geography specific market penetration tactics could be outsourced. **Prioritizing and customizing the type of innovation leveraged externally as opposed to internal development should be steered by the portfolio prioritization. Additionally, if assets *are* to be acquired, the company should take great care to ensure deep internal knowledge of the space that the technology operates in.**

- *Leverage AI towards multiple aspects of the development pipeline*- accessing expertise in AI and utilizing it across the developmental pipeline will be essential but likely will have more productive areas than others. Smartly leveraging AI capabilities from external sources should be undertaken first to assess where the most impactful areas of application are.
- *Incentivize external Innovations with outcome-based milestones* - Ensure that partnerships and acquisitions have appropriate incentives that ensure success is part of the transaction.



There is still a great deal of value in the concept of external innovation, but it is not a panacea that guarantees results and as we have demonstrated can be mismanaged to deleterious effect. We recommend judicious use of external innovation after prioritization of market opportunities with profitability as a key driver of success. BDTs must be structured accordingly to realize these objectives.

Sources

[1] Institute of Medicine (US) Committee on Technological Innovation in Medicine; Gelijns AC, Halm EA, editors. *The Changing Economics of Medical Technology*. Washington (DC): National Academies Press (US); 1991. (Medical Innovation at the Crossroads, No. 2.) 3, The Changing Economics of Pharmaceutical Research and Development. Available from: https://www.ncbi.nlm.nih.gov/books/NBK234301/

[2] Romasanta, A.S., van der Sijde, P. & van Muijlwijk-Koezen, J. (2020). Innovation in pharmaceutical R&D: mapping the research landscape. *Scientometrics, 125*, 1801–1832. https://doi.org/10.1007/s11192-020-03707-y

[3] Deloitte Insights. (2018). *How biopharma companies are bolstering R&D pipelines through deal-making*. https://www2.deloitte.com/content/dam/Deloitte/tw/Documents/life-sciences-health-care/tw-LSHC-report-external-innovation-en.pdf

[4] Schumacher, A., Hinder, M., Doodle, A., Gassman, O., Hartl, D. (2023). Investigating the origins of recent pharmaceutical innovation. *Nature Review Drug Discovery, 22*, 781-782. https://doi.org/10.1038/d41573-023-00102-z

[5] Feldman, R. (2021, April 6). *Drug companies keep merging. Why that's bad for consumers and innovation*. Washington Post. https://www.washingtonpost.com/outlook/2021/04/06/drug-companies-keep-merging-why-thats-bad-consumers-innovation/

[6] Buntz, B. (2024, June 9). *25-plus years of Big Pharma megadeals*. Drug Discovery & Development. https://www.drugdiscoverytrends.com/25-plus-years-of-big-pharma-megadeals/

[7] Swagel, P. (2021). *Research and Development in the Pharmaceutical Industry*. Congressional Budget Office. https://www.cbo.gov/publication/57126#:~:text=of%20those%20possibilities.-,New%20Drug%20Development,benefit%20from%20the%20new%20drugs

[8] Pont, L. B., Fleming, E., Moss, R., Robke, L., Smietana, K., & Wurzer, S. (2022, May 31). *Innovation sourcing in biopharma: Four practices to maximize success*. McKinsey & Company. https://www.mckinsey.com/industries/life-sciences/our-insights/innovation-sourcing-in-biopharma-four-practices-to-maximize-success

[9] Fernald, K. D. S., Förster, P. C., Claassen, E., & van de Burgwal, L. H. M. (2024). The pharmaceutical productivity gap – Incremental decline in R&D efficiency despite transient improvements. *Drug Discovery Today*, *29*(11), 104160, ISSN 1359-6446. https://doi.org/10.1016/j.drudis.2024.104160

[10] Stott, K. (2017, November 28). *Pharma's broken business model: An industry on the brink of terminal decline*. Endpoints News. https://endpts.com/pharmas-broken-business-model-an-industry-on-the-brink-of-terminal-decline/

[11] Dicken, J., Richard, O. (2017, Nov 17). GAO Report to Congressional Requesters, *Drug Industry Profits, Research and Development, Spending and Merger and Acquisition Deals*. https://www.gao.gov/products/gao-18-40

[12] Solverson, E. (2024, November 12). *Breaking Down Biopharma's Biggest Trends*. Medix. https://www.medixteam.com/blog/breaking-down-biopharmas-biggest-trends/

[13] Devereson, A., Idoux, E., Macak, M., Nagra, N., & Stanzl, E. (2022, October 10). *AI in biopharma research: A time to focus and scale*. McKinsey & Company. https://www.mckinsey.com/industries/life-sciences/our-insights/ai-in-biopharma-research-a-time-to-focus-and-scale

[14] Varol, D. (2025, February 20). *AI in the Pharmaceutical Industry: Innovations and Challenges*. Scilife. https://www.scilife.io/blog/ai-pharma-innovation-challenges#:~:text=95%25%20of%20pharmaceutical%20companies%20reported,years%20to%20just%20one%20year.

[15] Thomas, E. (2024, December 6). *Half of pharma and biotech companies using AI and big data*. Clinical Trials Arena. https://www.clinicaltrialsarena.com/news/half-of-pharma-and-biotech-companies-using-ai-and-big-data/

[16] Mikulic, M. (2023, December 15). *Global market for generative AI in clinical trials from 2022 to 2032*. Statista. https://www-statista-com.prox.lib.ncsu.edu/statistics/1428771/generative-ai-in-clinical-trials-market-worldwide/

[17] Eightfold AI. (2023, December 12). *Josh Bersin research: Why the pharma industry needs a talent acquisition transformation*. Eightfold AI. https://eightfold.ai/blog/josh-bersin-research-pharma-industry-talent-acquisition-transformation/

[18] Mix, G., & De Silva, D. (2024, June 7). *Navigating Great Talent Acquisition in the Pharmaceutical Industry 2023*. Compliance Architects. https://compliancearchitects.com/talent-acquisition-in-the-pharmaceutical-industry/

[19] Stanford. (n.d.). *What is Upskilling and Reskilling?*. Stanford Online. https://online.stanford.edu/what-upskilling-and-reskilling

[20] Sykes, J. (2022, September 23). *6 Best Practices For Biopharma Talent Management In 2023*. Outsourced Pharma. https://www.outsourcedpharma.com/doc/best-practices-for-biopharma-talent-management-in-0001

[21] Carboni, O. A., & Medda, G. (2021). External R&D and product innovation: Is over-outsourcing an issue? *Economic Modelling*, *103*. https://doi.org/10.1016/j.econmod.2021.105601

[22] De Man, A., & Duysters, G. (2005). Collaboration and innovation: a review of the effects of mergers, acquisitions and alliances on innovation. *Technovation*, *25*(12), 1377–1387. https://doi.org/10.1016/j.technovation.2004.07.021

[23] Hottenrott, H., & Lopes-Bento, C. (2016). R&D Partnerships and Innovation Performance: Can There Be too Much of a Good Thing? *Journal of Product Innovation Management*, *33*(6), 773–794. https://doi.org/10.1111/jpim.12311

[24] Brocker, M. (2025.). *Biotechnology in the US*. IBIS World. https://www.ibisworld.com/united-states/industry/biotechnology/2001/

[25] Grabowski, H. (2004). Are the economics of pharmaceutical research and development changing?: productivity, patents and political pressures. *Pharmacoeconomics*, *22*(2 Suppl 2), 15–24. https://doi.org/10.2165/00019053-200422002-00003