Eroom's Law

Idea In Short

Pharmaceutical research and development [R&D] has become slower and costlier for seven decades, even as the tools available to scientists have improved beyond recognition. This pattern, known as Eroom's Law, is Moore's Law spelled backward and it describes an innovation system whose output keeps shrinking relative to its input. The lesson for executives outside pharma is direct: better tools do not guarantee better returns if the surrounding system rewards caution, complexity and scale over judgment. Leaders running R&D-intensive units should audit where their own organization has quietly built an Eroom's Law of its own, then fix the incentives and decision gates before adding more technology to a system that is already working against itself.

Gordon Moore's 1965 observation that computing power would double roughly every two years while costs fell became one of the most reliable forecasts in industrial history. Pharmaceutical research and development moved in the opposite direction for most of the following seven decades. Jack Scannell and his coauthors gave this inverse pattern a name in 2012: Eroom's Law, Moore spelled backward, describing how the number of new drugs approved per billion dollars of R&D spending fell by roughly half every nine years from 1950 onward1. The pattern matters well beyond biotech boardrooms. Any executive running an R&D-intensive organization, whether in energy, semiconductors, agriculture or advanced materials, is exposed to the same structural risk:

> technology keeps improving while the system built around it grows slower and more expensive to run

What Eroom's Law actually measures

Eroom's Law is not a claim that science stopped advancing. Genomic sequencing, high-throughput screening, combinatorial chemistry and, more recently, machine learning all

expanded what researchers could see and test. The metric that fell was output per dollar: new molecular entities approved by regulators, divided by inflation-adjusted R&D spending. That ratio dropped roughly 80-fold between 1950 and the early 2010s, even through periods when computing capacity available to researchers grew by many orders of magnitude. The contrast with Moore's Law is precise rather than rhetorical, since both trends compound at a similar rate in opposite directions over similar timeframes. It tells executives that a system can absorb enormous technological improvement and still get structurally worse at converting effort into results.

Four forces behind the decline

Scannell's team proposed four interacting causes rather than a single culprit and each has a direct analog outside pharmaceuticals. The first is the "better than the Beatles" problem: once a category has cheap, safe, effective treatments for common conditions, every new entrant must beat an already excellent standard of care, which raises the bar for clinical and commercial success. The second is the "cautious regulator" effect, in which each safety scandal prompts tighter evidentiary requirements that raise the cost of every subsequent program, including the ones that would have been safe anyway. The third is a "throw money at it" tendency, where large, well-funded organizations substitute headcount and infrastructure for sharper portfolio choices. The fourth is a bias toward basic research and brute-force screening over the translational judgment needed to pick winners early. None of these forces requires bad science. They describe an incentive and governance problem sitting on top of good science.

Cost has kept climbing even with new tools

Deloitte's annual review of large pharmaceutical companies found the average cost of developing a single drug asset reached roughly 2.3 billion dollars and returns on that investment stayed thin for most companies outside a handful of blockbuster categories2. Internal rates of return across the industry improved only when GLP-1 obesity and diabetes drugs were included in the calculation and dropped sharply when they were excluded. That detail matters because it shows the improvement was concentrated in one therapeutic breakthrough rather than distributed across the R&D system. A handful of high-value programs can flatter an average while the underlying discovery engine keeps producing the same low hit rate everywhere else. Executives reviewing their own innovation metrics should ask whether reported gains reflect a systemic fix or one or two outsized wins

carrying the whole portfolio.

Where the same dynamics appear outside pharma

The pattern generalizes wherever three conditions hold together: the cheapest problems were solved first, safety or compliance requirements ratchet upward over time and organizational scale substitutes for selectivity. Semiconductor process R&D shows early signs of this shift as each new node requires exponentially more capital even as Moore's Law itself slows. Oil and gas exploration faced a similar curve as accessible reserves were depleted and remaining prospects required deeper, costlier extraction. Agricultural science has seen crop yield gains per research dollar flatten in mature markets despite genomic tools that would have seemed impossible a generation ago. In each case, the tools got better while the return on using them got worse, because the system around the tools never changed how it selected, funded and killed projects.

Why more powerful tools alone do not fix the system

A new tool typically raises the volume of options a team can generate or test. It rarely improves the judgment used to choose among those options and judgment is where an innovation system actually creates or destroys value. Machine learning models can screen billions of candidate molecules in the time it once took to test thousands, but that only helps if the model is pointed at biology with a real chance of clinical success. Otherwise the organization runs a much faster search over the same low-probability terrain and spends more money reaching the same conclusion.

> The number of new drugs approved per billion US dollars spent on R&D has halved roughly every nine years since 1950, falling around 80-fold

That sentence, from Scannell's original paper, is the clearest evidence that technology and productivity can move in opposite directions inside the same organization for decades. AI proponents argue the current wave of tools is different in kind, not degree, because it targets the selection problem directly rather than just expanding the search space3. Companies including Exscientia and Insilico Medicine have moved AI-designed candidates

from target discovery into clinical trials faster than historical benchmarks, which is encouraging evidence without yet being proof of an industry-wide reversal.

What separates organizations that bend the curve

McKinsey's review of pharmaceutical productivity efforts found that cost-cutting alone, trimming headcount or shifting manufacturing to lower-cost regions, stopped producing gains once the easy savings were captured4. The organizations that improved output per dollar instead changed how they made portfolio decisions. They set explicit kill criteria and enforced them before a project consumed years of funding on marginal evidence. They rewarded scientists and portfolio leaders for stopping weak programs early rather than only for advancing them. They concentrated capital on targets with the strongest prior biological evidence instead of spreading bets evenly across a large pipeline to manage political risk inside the organization. None of these changes required new laboratory equipment. They required governance willing to say no earlier and more often.

Practical steps for leaders outside pharma

Executives running any R&D-heavy function can borrow the same discipline without waiting for an industry-wide fix. Track cost per successful outcome, whether that is a launched product, an approved patent or a validated technology, on a rolling multi-year basis rather than relying on annual spend as the primary metric. Separate the tools budget from the governance budget, since new software or lab equipment is easy to approve and hard to walk back once sunk cost sets in. Build explicit stage gates with predefined kill criteria tied to evidence thresholds, not political sponsorship inside the company. Reward teams for terminating weak projects on schedule as much as for advancing strong ones, since asymmetric incentives are what let a Scannell-style bias toward "throw money at it" take root. The OECD's review of AI in science reached a similar conclusion: technology adoption raises productivity only when paired with institutional change in how research priorities get set and reviewed5. A faster search engine bolted onto a governance system that avoids hard decisions produces a faster route to the same weak result.

Reading the signal before it becomes a crisis

The most useful application of Eroom's Law for a non-pharma executive is diagnostic rather than historical. Calculate output per dollar for your own innovation function over the last

decade, adjusted for inflation and compare the trend line to the pace of technology adoption over the same period. If the two lines are moving apart, more tools bought in the next budget cycle will not close the gap by themselves. The fix starts with the decision rules governing which projects get funded, which get killed and who is accountable for calling the difference early. Pharmaceutical R&D took decades to recognize its own curve. Leaders in other industries have the benefit of a documented case study and no excuse to wait as long.

- 1Diagnosing The Decline In Pharmaceutical R&D Efficiency
- 2Weight Loss Drugs Boom Drives Pharma R&D Returns, But Industry Could Face A Bubble Effect
- 3When Will AI Beat Eroom's Law In The Pharmaceutical Industry
- 4Rethinking Pharma Productivity
- 5Eroom's Law And The Decline In The Productivity Of Biopharmaceutical R&D

Summary

Eroom's Law shows that technology alone does not fix a broken innovation system. Pharmaceutical R&D has absorbed genomics, high-throughput screening and now Artificial Intelligence, yet the cost of bringing a new drug to market kept climbing for most of the past seventy years. The drag came from regulatory caution, portfolio bias toward incremental targets and a willingness to spend rather than decide. Executives in any R&D-heavy industry should treat this as a warning about their own systems. Adding tools without changing decision rights, kill criteria and risk appetite simply buys a faster route to the same disappointing outcome. The organizations bending their own Eroom's curve are the ones that paired new technology with harder portfolio discipline.