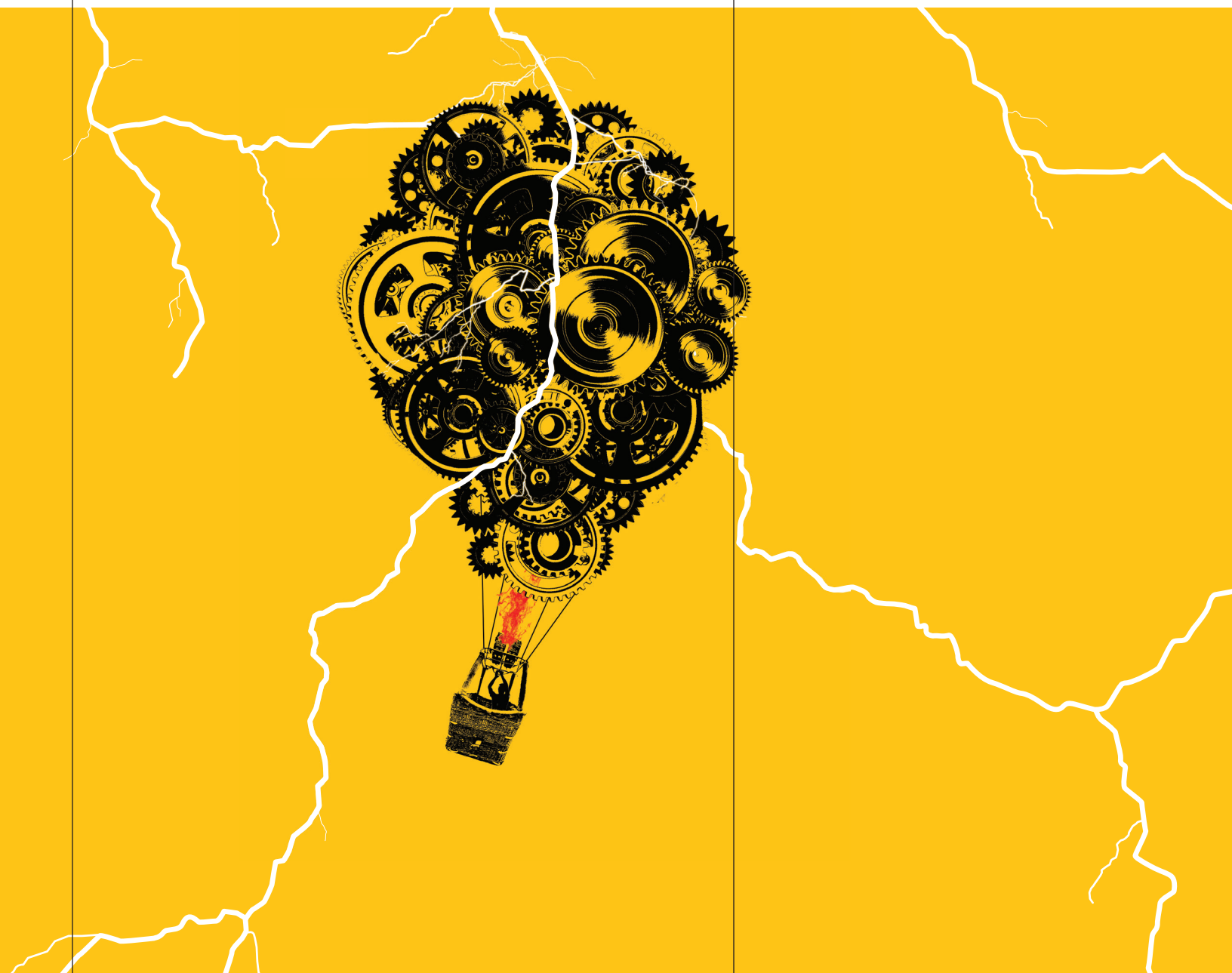
William Blair

Investment Management

The Perpetual Growth Machine



The recent shifts in the global economy have left many people feeling shaken. Will artificial intelligence take our jobs? Will large budget deficits and high interest rates erode our standard of living? Will deglobalization lead to nations that are poorer, inefficient, and isolated? Will climate change disrupt our economies and uproot us from our homes? Underlying each of these questions is a quest for economic growth, a quest for improving one's lot in life, an ongoing process as old as humanity.

We call humanity's quest for improvement—to ensure better harvests, more comfortable homes, easier ways to make a living—the Perpetual Growth Machine, or PGM for short. More than a set of economic principles, the PGM is a mechanism that alchemizes needs into opportunity. We put resources toward building tools to address our needs, thereby producing innovation—which creates new needs, which then drive further innovation. In short, a perpetual cycle.

Viewed through the lens of the PGM, economic growth is a highly diffuse, organic, and continuous process. Most people have an innate desire to better their condition in life and that of their loved ones. Our individual and collective appetite for improvement is constantly bumping up against others' vested interest in the status quo, misaligned incentives, or just plain unwillingness to change. The sum of this continuous tug-of-war can be measured as economic growth.

The PGM Is a Tool for Investors

Economic growth is central to investing; even fixed-income investors are preoccupied with growth. After all, if a business does not make more money tomorrow from borrowing today, how can bond investors expect to be repaid for lending?

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The PGM explains why and how economic growth happens. It enables investors of all stripes to identify and estimate investment opportunities accompanying economic growth. It also provides a framework for analyzing conflict between people and businesses that are hungry for improvement and their competitors fighting to maintain the status quo.

The PGM can be applied to virtually all socioeconomic questions, whether historical or current. It can be used to make sense of international conflicts, national and regional policies, political agendas, and more.

As growth investors, we view the PGM as offering a solution to the challenge of understanding and profiting from growth. It is a key to recognizing when and where economic growth will come from next—whether in a new geography or a new industry—and what conditions are necessary to perpetuate this growth.

To illustrate how we, as investors, apply the PGM to our portfolios, we will describe the process in detail, identify the conditions that support growth, respond to objections, and provide examples. After explaining the PGM—how and why economic growth happens—we dwell on the central role of institutions in promoting or stifling the Perpetual Growth Machine and explore why this cycle is indeed perpetual.

Next, we apply the concepts inherent in the PGM toward investing. We will show how the PGM can help formulate the right questions for uncovering the next profitable investment opportunity, demonstrate the role of institutions and financial support in promoting innovation and maximizing investment returns, and, finally, point to the PGM's implications for active versus passive investing strategies.

Happy reading!

The Perpetual Growth Machine Explains the World We See

Why and how economic growth happens

There have been many different models of economic growth over the years, but one idea that keeps reappearing is the notion that growth must eventually bump up against an upper limit. This type of thinking is often represented by the political economist Thomas Malthus, who predicted in 1798 that human populations would inevitably grow until the poorest people suffered famine and widespread death because of fundamental bounds on food production. In the 1970s, "The Limits to Growth" report revived Malthus's ideas, claiming that the world would not be able to harvest enough energy to maintain industrial society.

Instead, innovations in agriculture and energy have allowed us to produce more food with less labor, freeing up millions of people for other activities. At the end of the 19th century, more than half of American workers were employed in farming. A century later, the U.S. population had more than tripled and only 2% were employed in farming.

Human innovation, with each generation of inventions building on the preceding one, has produced such a remarkable increase in economic growth that the world population has increased eightfold in the past 220 years, from around a billion souls at the time of Malthus to 8 billion today. In other words, Malthus's model is well known but wrong. Now, instead of worrying about overpopulation,

policymakers in many wealthy countries are concerned about people having too few children to replace an aging workforce.

How did this happen? What mechanism has managed to defy the predictions of Malthus (and many others) for so long?

The PGM constantly reshapes the economy

We have dubbed the process by which economic growth occurs the Perpetual Growth Machine. It describes a continuous process of channeling individual and collective ingenuity and resourcefulness to address today's needs, always building on existing human knowledge. This process frees up resources, makes something scarce more abundant, and at the same time creates new needs. As growth changes the overall economy, the old limits are no longer meaningful, even as new problems arise.

Let's illustrate with an example. Automobiles made travel much easier and faster, freeing up time—a scarce and valuable resource—for people to pursue other activities. Cars allowed people to live farther from their workplaces. American suburbs, with their large houses and backyards, sprang to life because of the success of automobiles. Cars also created the need for mechanics, who require tools and machines to keep those cars running. Needs produce innovations, which create new needs that must be addressed.

Cars ushered in a new era for mobility, the economic significance of which is impossible to overstate. At the same time, they have contributed heavily to pollution—just look at the air-quality statistics in major cities. They also contribute to climate change, arguably an existential "need" that humanity must address in our lifetime.

In response, companies have commercialized another innovation: electricity as a source of fuel. Electric vehicles (EVs) are simpler, much quieter, and, ultimately, cleaner. As with each new technology before them, they are on their way to becoming cheaper than cars with old-fashioned internal combustion engines.

Problem solved? Not entirely. Today's EV batteries are still limited by range and charging times. Some of the raw materials used to make them are scarce. To address these issues, automakers are racing to manufacture solid-state EV batteries, which would reduce or remove these limits. A century-old industry is still innovating and contributing to a cleaner world in which it is easier and cheaper to get around.

Our automotive example shows just one way that economic growth is a highly diffuse, organic, and continuous process. With our model of the Perpetual Growth Machine, we are not claiming to have discovered something new. Rather, we offer an explicit and—we believe—accurate description of how and why economic growth occurs. In fact, this is how it has always occurred since the time of the earliest humans.

Conflict is inherent in economic growth

Humanity has an insatiable appetite and, over time, an increasing ability to improve our lot in life. Yet life obviously is not a constant upward spiral toward greater safety and efficiency. Our individual and collective appetite is bumping up against other people's vested interests in the status quo, misaligned incentives, or just plain unwillingness to change.

In this way, economic growth is more like a tug-of-war between people. One person's need to improve her life might lead to a new business that threatens another person who already has a comfortable income. When Amazon founder Jeff Bezos says, "Your margin is my opportunity," he is describing this inherent friction between upstart and established companies. Innovating to stay a step ahead of the competition is devilishly difficult and highly uncertain; this is why many companies prefer to buy out their competition. The first impulse of those with an existing advantage is to fight back.

So who mediates? Governments and other institutions are responsible for setting and enforcing the conditions that allow a large group of people to produce—and benefit from—growth.

Why Do Some Places Rocket Ahead?

The need to improve vs. the means to improve: The central role of institutions

Individuals' needs and desire for progress can take them only so far. If they can't access the resources they need, or if the fruits of their labor can easily be taken by others who have not put in the same effort, there is little momentum for future growth and less incentive to innovate.

This is why institutions are necessary to support the Perpetual Growth Machine. In the book Why Nations Fail, Daron Acemoglu of MIT and James A. Robinson of Harvard—recipients, along with Simon Johnson, of the 2024 Nobel Prize in economics for their research on institutions—conclude that the vast difference in living standards we observe today boils down to what they call inclusive and extractive institutions. Put simply, inclusive institutions promote the interests of a large majority, and extractive ones benefit a small group, to the exclusion of everyone else.

We see how these different choices in institutions affect growth rates in the wide range of global living standards. The average American is 10 times as prosperous as the average Peruvian and 40 times as prosperous as the average citizen of the least developed African countries.

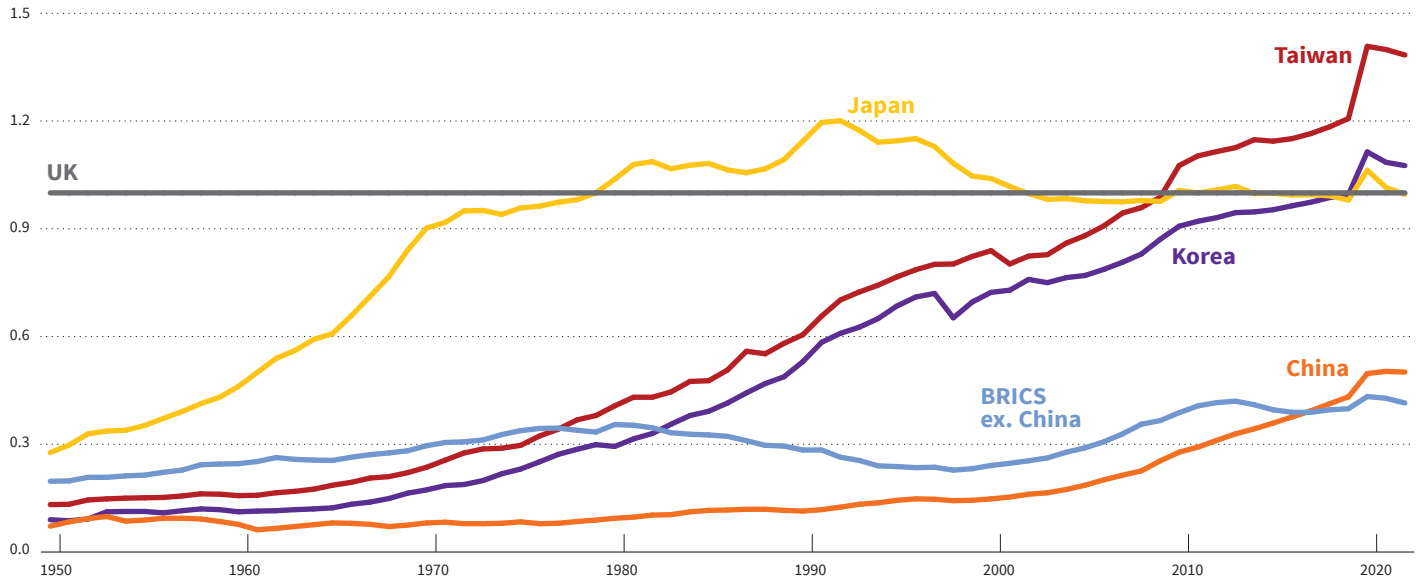
If growth is the sum of all innovations undertaken simultaneously by millions of people, then growth-supporting institutions must be inclusive, addressing the needs of a large majority. Ensuring that people are able to keep the gains they have produced encourages innovation. Policies that protect the majority, not just a select few, and carefully enforce property rights boost the confidence of entrepreneurs and investors.

Societies must choose their own paths

At this point, it may be difficult to find individuals who would meaningfully dispute the fundamental importance of protecting property rights or allowing citizens to participate in their governance. A critical insight, articulated by Harvard economist Dani Rodrik in the book One Economics, Many Recipes, is that many different policies can further the

From Paddy Fields to PowerhousesSources

Real GDP per capita converging to U.K. living standards



Sources: Maddison Project Database, William Blair Analysis

development of inclusive institutions in a society. These institutions may not look the same in every country or every era. What matters most for the success of a particular policy is the context.

Take China, which produced strong economic growth for decades, even as the specific policies promoted by party leaders shifted. In the 1980s, Chinese leader Deng Xiaoping proclaimed, "Let some people get rich first." He aimed to promote entrepreneurs at a time when the country was experiencing almost universal poverty. His reforms elevated hundreds of millions out of poverty and raised living standards, yet they also contributed to a sharp rise in income inequality.

Today, Xi Jinping talks about a "reasonable adjustment of excessive incomes," as the wealthiest 1% hold nearly a third of China's vast wealth, up from one-fifth a decade ago. Meanwhile, hundreds of millions of Chinese citizens cannot afford basic healthcare or decent education, despite overall improvements.

Looking beyond China, journalist Joe Studwell's book How Asia Works recounts how governments that protected the rights and needs of the majority supported an explosion of growth in certain Asian countries. In Taiwan, for example, land reform—a type of government intervention that may involve legal changes or property redistribution—provided small amounts of capital and income to a broad majority of the population.

Land reform reduced the Gini coefficient, a common measure of inequality, from 0.56 in 1950 to 0.33 in the 1960s. Farmers who cultivated their own land were able to gather savings, which paid for the building of factories—and those same farmers could use their increased income to buy products from early Taiwanese manufacturers.

Similarly, in Japan, the Meiji Restoration abolished feudalism in 1868, which suddenly enabled many people to choose their professions and to move freely around the country. Japan quickly modernized and became more powerful and wealthy, building up its military capabilities and developing an export market.

Not in my backyard

Vested interests and complacency are powerful obstacles to sustained economic growth

By contrast, Studwell explains, countries such as the Philippines, Indonesia, and Thailand never completed land reform, leaving their populations unable to benefit from improvements in small-scale agriculture that would accrue to a majority of households. This failure has curbed economic growth in these places.

To create inclusive institutions, one country may need land reform to allow more of the population to keep more of the wealth it produces, while another may need to prioritize reforms to its education system. In each case, the most important question for investors is: Who is the majority, and who or what is holding back their growth?

The foundations of economic growth

For modern, developed economies that are already technologically advanced, the priorities will look different. In these places, governments must, at a minimum, remove barriers to commercializing scientific breakthroughs. They should develop and constantly upgrade physical and social infrastructure and ensure rational competition in most industries.

On the physical side, types of infrastructure that connect people and goods, like highways and wireless signals, are hugely important for generating productivity gains. On the social side, higher levels of entrepreneurship and individual risk-taking depend on most people completing ever-higher levels of education and having universal access to healthcare and pension provisions. And, of course, any government needs to ensure that most industries have rational competition, or it will be impossible to allocate capital efficiently.

Since our PGM operates continuously, tirelessly creating new winners and losers, the institutions that protect its operation, as well as our policies, need to be highly dynamic and ever-evolving, too. This is the most difficult part to sustain.

If needs drive innovation, what happens when we get to a comfortable living standard, when our immediate needs are broadly met? This state is sometimes described as the middle-income trap, in which people lose their desire to improve after attaining a reasonable level of economic security.

Those who have become complacent exert pressure on the very institutions that enabled their development to refrain from fine-tuning their policies in ways that might disadvantage the incumbents. As a result, institutions that were once inclusive fossilize into bureaucratic machines of obstruction serving only selected interests. Every emerging market economy today, more or less, is foundering in this trap. More recently, many industrialized countries have fallen prey to it as well.

The key is to make choices that discourage complacency and allow newcomers who are hungry to improve, to rise to the top. As the billionaire investor Warren Buffett has said, “I want to leave my children enough so that they can do anything, but not so much that they can do nothing.” That is the narrow path that keeps the Perpetual Growth Machine in motion.

Growth is happening all the time, but it is not inevitable in any particular place or era. There can be years, even decades, during which progress stalls without the support of institutions that help to create the right climate for humans to flourish.

But Is the Growth Machine Still Spinning?

More solutions, more problems

Today, the Perpetual Growth Machine spins faster than ever: OpenAI's ChatGPT took just two months to reach 100 million users after its launch in November 2022. But not everyone agrees that the benefits from innovation matter as much as they used to.

Economists such as Northwestern University's Robert J. Gordon have challenged the idea that innovation remains as powerful a driver of economic growth as it once was. Gordon argues that most of the truly transformative inventions, such as electric light and the internal combustion engine, had been created by the mid-20th century. In his view, a society can convert horses to motor power only once. Today's innovations don't have the same ability to jolt the world economy into a new growth phase.

We could not disagree more. The period of innovation that Gordon describes as singular is actually just one burst in a series of explosions of progress, built on a transition to a denser, cheaper, and more abundant source of energy. Britain's first industrial revolution was caused in part by people running out of wood—a problem that urgently required a solution. The solution turned out to be coal, which was cheaper and more abundant than wood and produced more energy.

The transformative period in the 20th century that Gordon highlights was powered by oil, which was cheaper still than coal. Today our progress is bumping up against the limits of commercial fossil-energy sources. Generative AI requires enormous amounts of energy for computation and data storage. Further, our reliance on fossil fuels has contributed to climate change, arguably the greatest challenge in the 21st century.

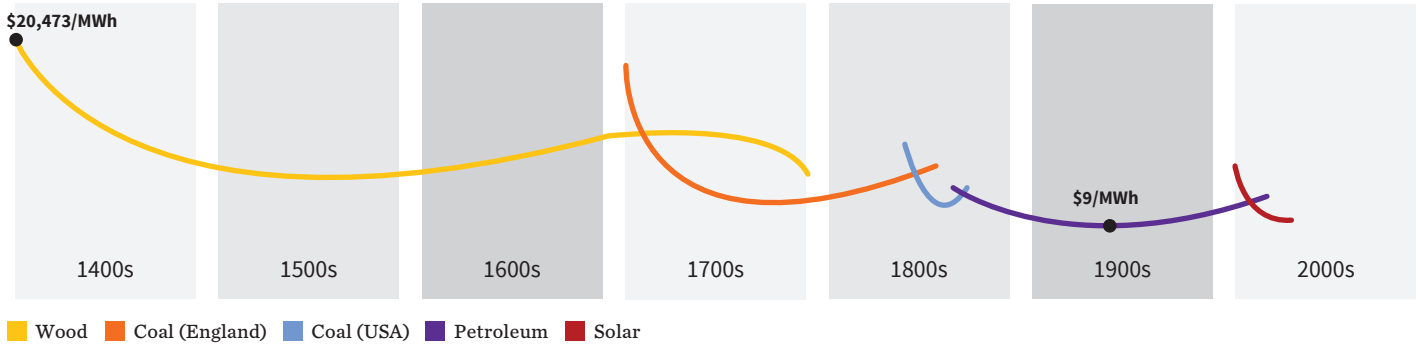
Today's critical challenges will power growth

We need to discover or commercialize new forms of clean, abundant, and cheap energy. One possibility is harnessing the power of the sun and wind. Nuclear is another. While nuclear fusion always seems to be about a decade away, in the past five years scientists have learned to control the fusion reaction and are closer to generating more power than they put in. Technology companies are investing in fusion reactor start-ups. The technological, social, and economic transformation resulting from producing free, clean, and ubiquitous energy will likely lead to productivity gains unseen before.

Other opportunities for major productivity improvements could come from helping people become healthier. Today, wearable devices can check users' temperatures and blood sugar levels. Now imagine if they could also monitor the real-time workings of every organ. Cancers and chronic diseases like arthritis, diabetes, and heart disease might be diagnosed and treated even before the onset of symptoms. Think of the freed-up resources: healthier and more productive citizens who can channel their energy into projects we can't even imagine today. We can envision this future, but we're nowhere close to reaching it. There is still plenty of opportunity for technological transformation. The Perpetual Growth Machine is by no means done.

How the mighty fall

Historical data show costs of dominant energy sources per megawatt-hour follow a predictable path



Sources: ResearchGate, U.S. Energy Information Administration, officialdata.org, Bank of England

Growth Is Not Enough: Applying the PGM to Growth Investing

How to look for growth? The PGM suggests the right questions

If needs met with resources catalyze innovation, a natural place for a growth investor to start is by asking what needs and challenges a particular sector, company, or market is facing.

Currently, advances in semiconductors are driving rapid developments in computational power, which has the potential to revolutionize every business. But traditional materials such as silicon are facing limits in their capacity to keep up with the ever-decreasing size of next-generation chips. This challenge has made it more costly and complex to push the boundaries of what silicon-based technology can achieve.

A growth investor may benefit from keeping up with scientific and commercial breakthroughs, which can come from unexpected places. Will chemicals or materials companies enable radically new technologies for semiconductors? Or will scientists develop new computational techniques that require something different from existing semiconductor technologies? What research breakthroughs could be commercialized? The answers could profoundly change the structure of industries and supply chains. Existing powerful incumbents may become obsolete—or more powerful than ever.

In healthcare, the bottleneck in drug development presents another opportunity. Currently, it takes more than a decade to evaluate a new drug before it is available for sale, at an average cost of $2.5 billion to $5 billion. With advancements in AI and computing power, solutions such as the ability to simulate a human organ in real time—sometimes called organ-on-a-chip technology—could revolutionize how we test and develop new drugs. The technology aims to mimic the human body environment in a realistic way, potentially speeding up some aspects of drug evaluation.

The PGM Grounded

Monopolies destroy the engine of economic growth

Energy represents a need and an opportunity that is even more fundamental. We have more data and better digital technologies to accelerate growth, but that also means we need more energy to manufacture chips, run computer servers, and cool data warehouses. Recent innovations in natural gas extraction, such as horizontal drilling and hydraulic fracking, have made energy cleaner and cheaper—while producing their own concerns about effects on the environment and human health.

The building and proliferation of AI applications requires enormous amounts of energy. One analysis suggests that if by 2030 we use AI tools the same way we use Google Search today, our electricity needs will grow by 7% per year. Contrast that with a 0.2% annual growth in electricity demand from 2010 to 2019. It is no surprise that large cloud providers are increasingly investing in developing new energy sources, such as nuclear fusion.

Searching for solutions is a messy and uncertain process, in which many fail. We believe great companies are either those able to generate extraordinary profits by transforming entire industries or those that recognize and profit from the emerging opportunities that economic growth presents. In both cases, corporate earnings require economic growth.

The investing process we've outlined above, though complex to implement, is relatively straightforward: cast a wide net and seek companies developing solutions to existing pain points. Applying the PGM can help investors determine which businesses are growing in ways that translate into sustainable earnings increases, which may be underappreciated by financial markets.

The paradox of economic growth and investment returns

An inherent tension exists between sustainable economic growth and near-term investment returns. Sustaining competition-beating innovation is profoundly difficult. One-time innovators and disruptors become the incumbents. It is easier to buy out competition than to out-innovate the hungry, the new kids on the block, the nimbler. This is one reason successful companies may tend to seek political influence and power. Institutions that increasingly serve the needs of the few are one result. So are outsized profits for the incumbents, for some time.

Left to their own devices, businesses tend to set up barriers that protect their own growth by blocking new entrants. As companies establish monopolies or oligopolies, they initially produce predictable revenue streams and high returns for investors, in part because they have squeezed out competition that might threaten their business model.

This is why, in the immediate term, growth investors tend to reward monopolies even as monopolies dampen an economy's innovative capacity—and, therefore, future growth. This is also why vested interests are integral to understanding and applying the PGM.

In the longer term, monopolies can undermine economic growth by preventing healthy change in an industry. Incumbents invest little, as they have less need to stave off competition through innovation. They continue to hold on to customers who are increasingly dissatisfied with the products and services they receive; they squeeze suppliers; they pressure regulators and underpay employees. Upstart companies are held back from promoting transformative innovations with the potential to reduce costs and improve quality, experience, and efficiency. The Perpetual Growth Machine slows, and poor returns follow.

Let's take an example from U.S. economic history. The railway was such a superior form of transportation for all types of cargo that by the late 1880s railway stocks represented more than 60% of the stocks traded in the United States. At the same time, the all-powerful monopolies managed to evade taxes and imposed such "distortions and inequalities of railroad charges" as to cause popular uprisings across the U.S.

It would take another few decades for the railroad monopolies to be curtailed via legislation, but between 1890 and 1900 the U.S. economy shrank by approximately 10%, unemployment reached 25%, and the value of railroad stocks remained stagnant.

Investors are unlikely to limit their own excessive returns in the near term to make a highly uncertain bet on growth from unknown corners, so someone else—often a regulatory agency—needs to step in. Rules like antitrust law can help rein in monopolies so that economic growth is not stifled, but they are unlikely to arise preemptively.

When businesses acting as monopolies start to build up resentment among customers, that should be a signal to investors. Consider how policymakers might respond, but also look for rivals who could disrupt these anticompetitive businesses. Even though established companies will fight to preserve their monopolies, pressure from innovative models or regulators eventually tends to erode their advantages. As the playing field shifts, new or different businesses may be poised to take the lead—a change that could accelerate their earnings growth.

Innovation begins long before private companies get involved

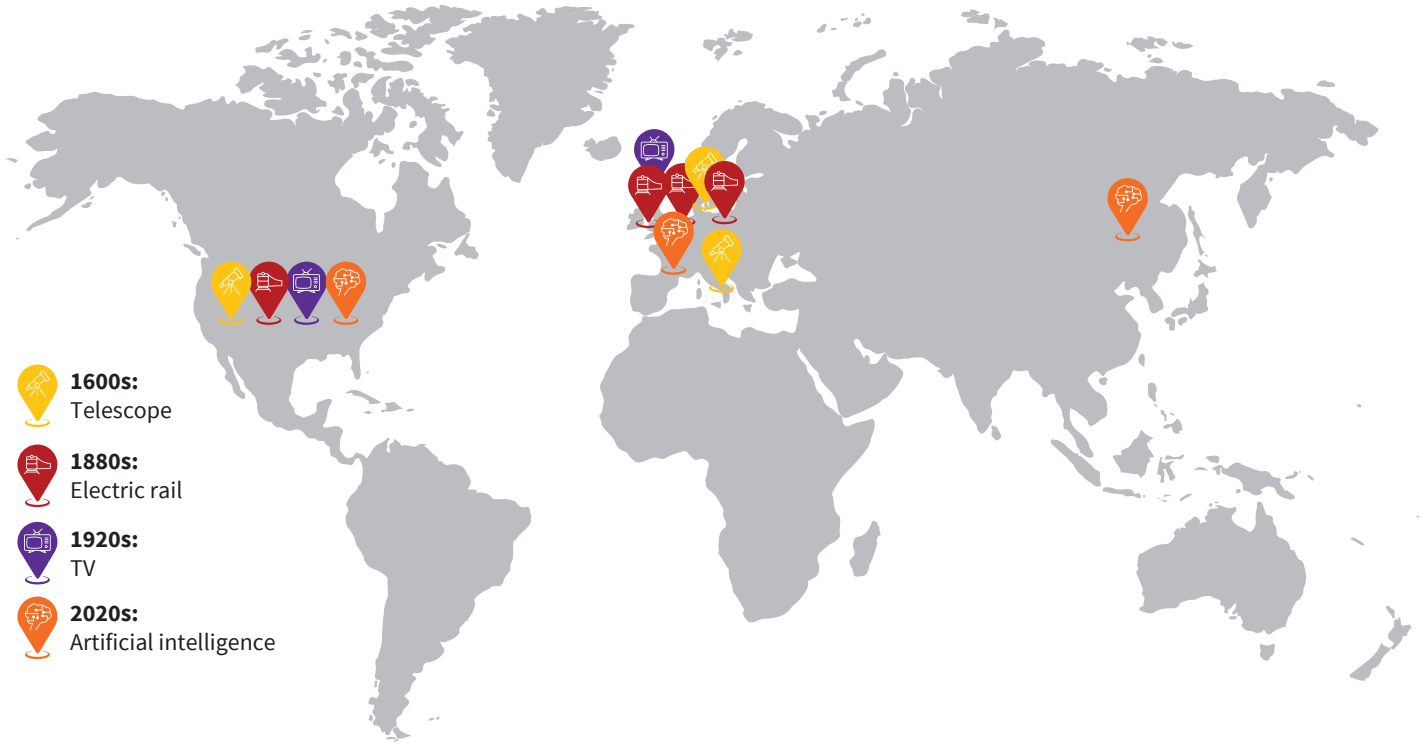
To apply the insights of the Perpetual Growth Machine, investors look for businesses that build new tools and solutions to address important needs and consequently produce underappreciated earnings growth. As this is a highly dynamic process in a highly complex and always changing system, investors constantly evaluate how companies interact with all stakeholders: employees, competitors, suppliers, customers, and regulators.

But where does the innovation that drives all these processes come from? One popular notion is that innovation occurs when an inventor is tinkering in his garage, producing a breakthrough that leads him to develop a billion-dollar company.

The reality could not be more different.

Ideas in the air

Parallel invention demonstrates how innovations arise simultaneously



Sources: ResearchGate, U.S. Energy Information Administration, officialdata.org, Bank of England

Innovation, which lies at the heart of the PGM, is often cumulative. Each new scientific and commercial breakthrough rests on the sum total of prior scientific discoveries. This is why many technologies are developed more or less simultaneously by two or more teams working independently. As far back as 1922, researchers William F. Ogburn and Dorothy Thomas listed more than 100 examples of multiple people making the same discovery around the same time.

Accumulation of human knowledge enables the next breakthrough idea or insight.

Inherent in our definition of the Perpetual Growth Machine is the notion that innovation is a highly diffuse, organic process, with countless discoveries being made while looking for something else. In other words, innovation requires a lot of "patient capital": investment that does not require an immediate return. Much of this capital will be wasted, with loads of trial and error—which is terribly inefficient—plus a bit of luck. All of this is why traditional markets do not allocate capital to these foundational, innovation-producing activities. Failure is embedded in the continuous innovation process.

Public companies subject to the demands of the stock market aren't able to put their capital into these risky investments. We believe the best companies commercialize scientific discoveries that have occurred elsewhere, often supported by extensive government subsidies.

In the United States, the federal government continues to be the largest funder of basic research, spending more than $100 billion, or 41% of total U.S. research expenditure, in 2019. Nearly half of this federally funded research is carried out by universities and about 30% by businesses. Groundbreaking innovation requires a great deal of specialized knowledge beyond the scope of any one person. While the outcome of this type of research is highly uncertain, when it succeeds, it can transform industries. Basic research has led to the development of lasers, the modern internet, countless medical advancements, and much more.

Successful growth investors tend to devote some time to learning about the latest research at key academic and technological centers and keep up with DARPA competitions to improve their knowledge of challenges and breakthroughs across as many industries as possible. Even if it is difficult to home in on the disruptors, this ongoing exercise can help identify vulnerabilities within the incumbents.

Often, innovation in the business world refers to commercializing innovation that has arisen outside it. But operationalizing innovation is hardly straightforward. A recent exposé of one U.S. EV manufacturer's employee-safety violations sheds light on the operational and human-resources challenges of setting up a manufacturing facility to produce a rapidly evolving but hardly new product.

If growth reverts to the mean, does the world need professional investors?

Companies can do all the right things to deliver growth: develop innovations that meet new needs or solve new problems, build sustainable advantages over competitors, and translate technological gains into significant earnings increases. Yet the Perpetual Growth Machine is deeply human, and success breeds entrenched interests and complacency. Recognizing these tendencies, Amazon founder Jeff Bezos used to begin his annual letter to shareholders with the line "Every day is Day 1."

Investors recognize that individual businesses eventually slow in their growth patterns. Since no business can outperform indefinitely, they argue that it's wise to become a passive investor and choose index funds that will track the market as particular stocks surge and drop over time. We believe the opposite is true. Investing as a profession—and active investing in particular—exists to evaluate the constant churn in industries, marked by new arrivals and changes in the competitive landscape.

The insights that we draw from the Perpetual Growth Machine, which recognizes growth as a highly diffuse and dynamic process, call for an investment approach that doesn't simply extrapolate from market positions today, but rather embraces turning points, recognizes that growth can bubble up from many different places, and uncovers lesser-known innovators poised to challenge conventional strategies. Put simply, the PGM points to a consistent analytical approach to investing, the outcomes of which are likely to change frequently.

In summary…

When viewed through the lens of human history, people's quest to improve is indeed perpetual, as is our ability to innovate to reach our goals. We call this process the Perpetual Growth Machine, which also encompasses vested interests, political institutions, and general inertia. It may be difficult to spot the PGM's work from week to week, but take a longer time frame—a year, a decade, or a century—and its humming becomes obvious.

We believe the PGM accurately describes the struggles and the achievements of human progress. And it is central to our understanding as growth investors. The PGM points to the need to cast a wide net and look for growth in unexpected places; to keep up with where governments and others are investing and subsidizing; to evaluate a diverse group of stakeholders in all cases; and to keep monopolies on a (relatively) short leash. We believe that all of this requires an active investment approach that uses a consistent framework to uncover different investment opportunities.

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