Superabundance Unbound: Limitless Possibilities in a Finite World

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Introduction

This paper revisits an old question. Does population growth lead to greater resource scarcity? The 18th century English cleric Thomas Malthus certainly thought so. His ideas were immensely influential, especially in the second half of the 20th century, and continue to impact the public discourse today. As Malthus' disciple, American biologist Paul Ehrlich, noted in 2017, "You can't go on growing forever on a finite planet. The biggest problem we face is the continued expansion of the human enterprise… Perpetual growth is the creed of a cancer cell."[1]

The alternative viewpoint, best exemplified by the American economist Julian Simon, holds that population growth leads to knowledge creation or innovation, which makes resources more abundant. Instead of the widespread famine that Malthus foresaw, Simon predicted in the mid-1990s that, "The material conditions of life will continue to get better for most people in most countries most of the time, indefinitely. Within a century or two, all nations and most of humanity will be at or above today's Western living standards."[2] Who was correct?

In our recent book, *Superabundance: The Story of Population Growth, Innovation, and Human Flourishing on an Infinitely Bountiful Planet*, Dr. Gale L. Pooley and I revisited the debate between the two camps. We confirmed that the popular narrative of resource scarcity is false, and the prediction of eventual civilisational collapse is not a foregone conclusion. Far from being a net negative, as Malthusians argue, humans are a net positive. On average, every additional human being creates more than he or she consumes, thus building a world where everyone can thrive.

Between 1850 and 2023 the world's population has grown from 1.2 billion people to over 8 billion people. Yet, we found that over the same period, resources have grown considerably more abundant relative to income. Put simply, people all over the world now work ever fewer hours to meet their basic needs, such as their daily sustenance, thus allowing more time for human flourishing, including learning, playing, travelling, exercising, or relaxing. How is that possible?

Humans, unlike other members of the animal kingdom, are intelligent beings who are uniquely capable of innovating their way out of pressing problems. Unlike other species, we have developed sophisticated forms of cooperation that increase our chances of survival and flourishing. There are, in other words, rational grounds for optimism about our future. And while it is true that past performance is no guide to future performance, in the words of British historian and statesman Thomas Babington Macaulay, "On what principle is it that with nothing but improvement behind us, we are to expect nothing but deterioration before us?"[3,4]

Macaulay wrote those words in 1830, but he may well have been writing about the Western world today. Most of the prevailing cultural narratives are almost designed to demoralise and confuse the public, as well as make us fearful of the future. Superabundance tells a more positive story. Look at it this way: in the Book of Exodus (3:8), God promises to take the Israelites out of slavery in Egypt to "a land flowing with milk and honey." That, apparently, was the best that anyone could hope for back in

the 6th century BC when the Book of Exodus was written. Today, a gallon of milk costs $2.66 and 12 oz of honey costs $3.94 at Walmart. The total of $6.60 is less than an hour of work on a minimum federal wage of $7.25 in the United States.[5]

The superabundance of the modern world is not a consequence of magic. It is a result of new ideas that were born in the human mind. It is those ideas that birthed inventions which—following a market test that separated good ones from bad ones—led to innovations that improved our productivity and raised our standards of living beyond anything that our ancestors dared to dream about. Put differently, humans, far from being a cancer on the planet, are intrinsically valuable.

Whether more value is or is not created, however, depends on a number of factors. Those include an institutional setting that protects life, liberty, and property and a cultural setting that provides hope, meaning, and purpose. In other words, to prevent the Western world from declining, we must continue our commitment to economic and political freedoms and a superabundance mindset that emphasises rational optimism over fatalistic pessimism, knowledge creation over intellectual stagnation, and industriousness over idleness.

Turning the tide against cultural relativism and moral nihilism that infect the public discourse requires that we recognise the superiority of our institutional setup and the value of human life. Simply put, superabundance is an interplay between people and freedom. Or, as Simon put it, "The ultimate resource is people—especially skilled, spirited, and hopeful young people endowed with liberty—who will exert their wills and imaginations for their own benefits, and so inevitably they will benefit the rest of us as well."[6]

Historical Background

Scholars have debated the costs and benefits of population growth since antiquity. In ancient China, Confucius (551–479 BC) and many of his followers saw population growth in a relatively favourable light, but they also believed that population growth needed to be controlled. They theorised that there was an ideal ratio of land to population. They reasoned that when the population grew beyond that ratio, labour productivity and quality of life would diminish, leading to social discord. Therefore, they argued, it was the duty of the government to maintain that ratio by forcing people to migrate to less populated areas.[7]

The Greeks analysed population growth from the perspective of the city-state and focused on the implications of human fecundity for governance and state security. They thought a population should be large enough to be economically self-sufficient but not so large as to make democratic governance impossible. Plato argued that the ideal population—5,040 citizens per city-state—would maximise the well-being of the polity. He advocated reproductive incentives and immigration if the population was too low and birth control and colonisation (i.e., emigration) if the population was too high.[8] Similarly, Aristotle worried that since the rates of land cultivation could not keep pace with population growth, it was necessary to abort or expose (i.e., leave to die) some children.[9]

The Romans analysed population growth from the imperial (i.e., expansionist) perspective and welcomed the contribution of a growing population to Rome's military strength. Under Caesar Augustus (63 BC–14 AD), the state conferred legal privileges on married and child-rearing couples, while unmarried people faced discrimination. The state discouraged celibacy.[10] The Indian philosopher Chanakya (371–283 AD) expressed a similar view, arguing that a large population leads to greater

economic and military power, and acknowledged war, famine, and plague served as checks on rapid population growth.[11]

Ancient religions celebrated children and ordered procreative arrangements. Hebrew texts emphasised procreation and regarded childlessness as a misfortune.[12] Early and medieval Christians saw population growth in distinctly ethical terms. They condemned population control through abortion, infanticide, and abandonment but praised virginity and sexual restraint. They also discouraged second marriages. Some Christians attributed poverty to overpopulation and believed that war, famine, and plague were God's way of culling humanity. High mortality rates, however, "predisposed most writers towards the maintenance of a high birth rate."[13]

In the 14th century, Arab scholar Ibn Khaldun (1332–1406) developed a fairly comprehensive theory on population. He argued that dense populations were key to raising living standards, as they allowed for a greater division of labour, and he thought that economic expansion and population growth went hand in hand. Ibn Khaldun also maintained, though, that history moved in a cycle of expansion and decline. He wrote that "in the wake of... periods of economic progress came luxury, rising taxes and other changes, which in several generations produced political decline, economic depression, and depopulation."[14]

In 16th century Europe, the ideas of the Italian diplomat and philosopher Niccolò Machiavelli (1469–1527) and Jean Bodin (1529/30–1596) influenced the development of mercantilism, which argued that the goal of national policy should be maximisation of wealth and, consequently, the power of the state. They welcomed population growth, trusting it would swell the government's coffers while depressing wages and the cost of labour. Implicit in mercantilist thought was the notion that population growth, while strengthening the state, also led to the material impoverishment of the populace.[15]

The physiocratic school—an economic theory developed by a group of French economists in the 18th century—arose in opposition to the mercantilists. The physiocrats rejected the mercantilist idea that population growth should be welcomed even if overall living standards fell. The physiocrats believed that agricultural production was key to the overall health of the economy. They accepted the advantages of population growth provided it accompanied increasing agricultural yields and, consequently, higher living standards. Implicit in physiocratic thinking was that agricultural production could keep pace with population growth given the right economic policies.[16]

As the 18th century progressed, some scholars started to view population growth with greater optimism, seeing human life as intrinsically valuable and problems concomitant with population growth as eminently solvable. The French economist Nicolas Baudeau (1730–1792) argued that the "productiveness of nature and the industriousness of man are without known limits" because production "can increase indefinitely." As such, "population numbers and well-being can go on advancing together."[17] English journalist and political philosopher William Godwin (1756–1836) posited that scientific progress would increase food production, thus increasing leisure time. Moreover, he thought human reason would keep the world's population from outrunning the food supply.[18]

Other leading intellectuals of that era went as far as to argue that good government is one that leads to the maximisation of the human population and its well-being. The Scottish philosopher David Hume (1711–1776), for example, noted that "wherever there are most happiness and virtue and the wisest institutions, there will also be most people."[19] Even the French philosopher Jean-Jacques Rousseau (1712–1778) held that "the Government under which... the citizens increase and multiply the most is infallibly the best."[20] These were, to put it mildly, revolutionary ideas, and the almost inevitable backlash against them soon arrived.

Thomas Malthus and the Malthusian Trap

The English population peaked at 4.81 million prior to the outbreak of Black Death in the middle of the 14th century. It was not until 1622 that it had fully recovered. In 1766, when the Reverend Thomas Robert Malthus was born in Westcott, the population of England stood at 6.45 million. By the time he died in 1834, it stood at 13.76 million. Alarmed by the growing number of his countrymen and women, Malthus devised a theory, which claimed to show that whereas population grows at a geometric rate (1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024), subsistence increases at an arithmetic rate (1, 2, 3, 4 or 1, 3, 5, 7).[21] He warned that if,

> "the proportion of births to deaths for a few years indicates an increase of numbers much beyond the proportional increased or acquired produce [i.e., food] of the country, we may be perfectly certain that unless an emigration takes place, the deaths will shortly exceed the births. Were there no other depopulating causes, every country would, without doubt, be subject to periodical pestilences or famine."[22]

Although Malthus recognised there were natural constraints or "positive checks," as he called them, on population growth, such as war, famine, and plague, he declared that these checks would cause "misery" and were therefore undesirable. He thought that "preventative checks" on population growth were more benign. Those included "the sort of intercourse which renders some of the women of large towns unprolific; a general corruption of morals with regard to the sex, which has a similar effect; unnatural passions and improper arts to prevent the consequences of irregular connections."[23]

History validated Malthus' main contention. For thousands of years, the world was stuck in what came to be known as a "Malthusian trap," with the world's population growing during good harvests and peace and collapsing when food was scarce, or war and pestilence reigned. According to the United States Census Bureau, the world's population at the time of Caesar Augustus was between 170 and 400 million. Fourteen centuries later, it was somewhere between 350 and 374 million.

As a predictor of the future, Malthus' theory was an unambiguous failure. In the 18th century alone, the population of England rose by 62.3%.[24] Over the same period, nominal GDP per person per year increased by 93.8%.[25] Finally, the nominal price of a four-pound loaf of bread increased by 42.3%.[26] That means that between 1700 and 1798, the ratio between the nominal price of a loaf of bread and the nominal GDP per person per year decreased by 26.6%, which translates to a 36.2% increase in the abundance of bread. Put differently, as the population of England increased by 62.3%, bread also became 36.2% more abundant.

That was the exact opposite of what Malthus' theory predicted. How did he get it so wrong? By focusing on people as consumers, rather than producers, Malthus completely missed the massive productivity gains taking place during the British Agricultural Revolution (1650–1900), which made food more plentiful and, therefore, more abundant relative to wages.

Paul Ehrlich and Julian Simon

In 1950, the world's population stood at 2.5 billion. By 1980, it stood at 4.44 billion. It was in that year that one of the most famous wagers of all time commenced between the University of Maryland economist Julian Simon (1932–1998) and three scholars: Stanford University biologist, Paul Ehrlich; University of California, Berkeley ecologist, John Harte; and University of California, Berkeley scientist

and the future director of President Barack Obama's White House Office of Science and Technology, John P. Holdren.

The Ehrlich group bet $1,000 on $200 quantities of five metals: chrome, copper, nickel, tin, and tungsten. Then they signed a futures contract that stipulated that Simon would sell these same quantities of metal to Ehrlich's group for the same price in 10 years' time. Since price reflects scarcity, Simon would pay if population growth made these metals scarcer, but if they became more abundant and therefore cheaper, Ehrlich's group would pay Simon.[27]

When the wager's timeline finally ran out in 1990, all five metals became cheaper, with three prices falling faster than inflation. Ehrlich mailed Simon a spreadsheet of metal prices and a cheque for $576.07, representing a 36% decrease in inflation-adjusted prices. Ehrlich's wife, Anne, signed it. There was no letter accompanying it. Simon sent Ehrlich a thank-you note and an offer to raise the stakes to $20,000 in a future wager, but Ehrlich was not interested.[28]

Simon's triumph was more than a gambling victory. As he had predicted, human ingenuity had made these resources more abundant despite population growth of over 800 million between 1980 and 1990. New nickel mines had been discovered and exploited, ending a Canadian monopoly on the commodity. Glass cables had replaced copper wires, driving down demand for that metal. Aluminium replaced tin in cans, eventually leading to the collapse of the price-setting international tin cartel. Across the board, technological improvements and entrepreneurship made mining and refining so much more efficient, and therefore cheaper, that new supply outpaced the rising demand of a growing population. Yet, Ehrlich regarded his loss as an anomaly. As he wrote,

> "The bet doesn't mean anything. Julian Simon is like the guy who jumps off the Empire State Building and says how great things are going so far as he passes the 10th floor.... I have no doubt that sometime in the next century, food will be scarce enough that prices are really going to be high even in the United States."[29]

Was Ehrlich right? Evidence suggests otherwise.

Simon Abundance Index

Ehrlich and other scholars argued Simon made a fortuitous wager, but the data from 1980 to 2022 confirms Simon's basic insight—as the world's population grew, resources became more abundant. This section discusses the findings of the Simon Abundance Index (the "Index"), which measures whether resources became more or less abundant relative to income. The Index uses time prices or the number of work hours it takes to earn enough money to buy something.

There are several benefits to measuring resource abundance with time rather than money. First, time prices contain more information than money prices, since innovation reduces prices and increases wages. So, time prices more fully capture the benefits of valuable new knowledge and the growth in human capital. Considering only prices without considering wages only tells half the story of growing abundance. Second, time prices transcend the complications of converting nominal to real prices. Inflation adjustments are not necessary.[30] Third, time prices enable comparisons between any product in any currency at any time and place. Fourth, time is an objective and universal constant. Finally, there is perfect equality of time with 24 hours daily. Measuring differences in time inequality instead of

income inequality creates an entirely different picture of the state of the world, as this metric quantifies the time individuals have available to do things other than tend to their subsistence.

As the findings in this section explain, between 1980 (the year the original bet between Simon and Ehrlich began) and 2022 (the last year for which data is available), the Index rose by 420.1%. This implies a compound annual growth rate of global resource abundance of 4% and a doubling of global resource abundance every 17.65 years.

Figure 1: The Simon Abundance Index (1980–2022)[31]

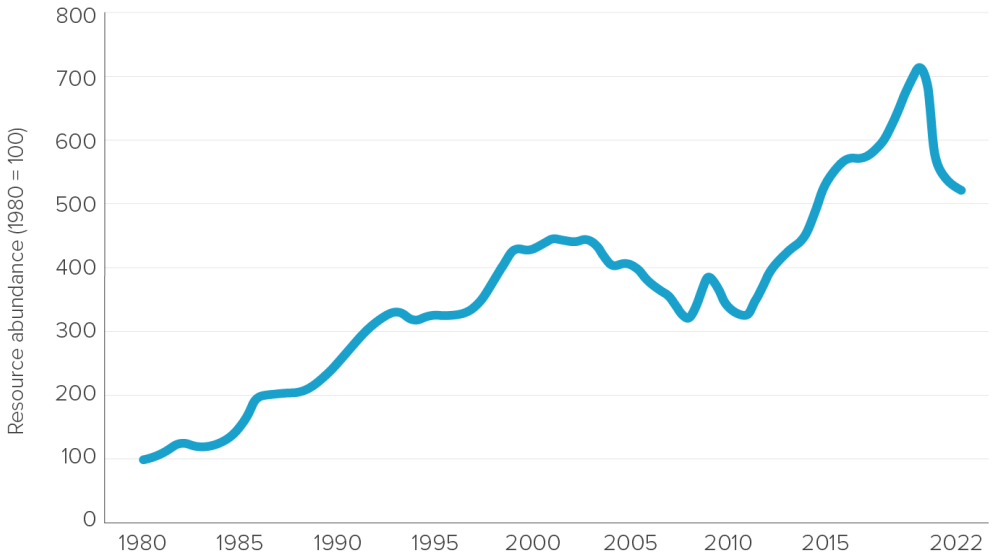


Figure 1 examines the average nominal prices of the Basic 50 commodities (minerals, metals, fuels, and food tracked by the World Bank and the International Monetary Fund) between 1980 and 2022. Over that time, the nominal prices rose by 150% and the average global nominal income per hour worked rose by 439.2%. That means that the time price of the Basic 50 commodities fell by an average of 65.5%. Put differently, over those 42 years, the number of hours of work required to buy those commodities fell by more than half on average.

Personal Resource Abundance

The calculations underlying these figures follow a straightforward formula. The personal resource abundance multiplier is calculated by dividing the average time prices of the Basic 50 commodities in 1980 by the average time prices of the Basic 50 commodities in 2022. The multiplier identifies how much more of a resource a person can get for the same number of work hours between two points in time. Given that the average time prices of the Basic 50 commodities fell by 65.5% between 1980 and 2022, the same number of hours of work that bought one unit in the basket of the Basic 50 commodities in 1980 bought 2.9 units in the same basket in 2022.

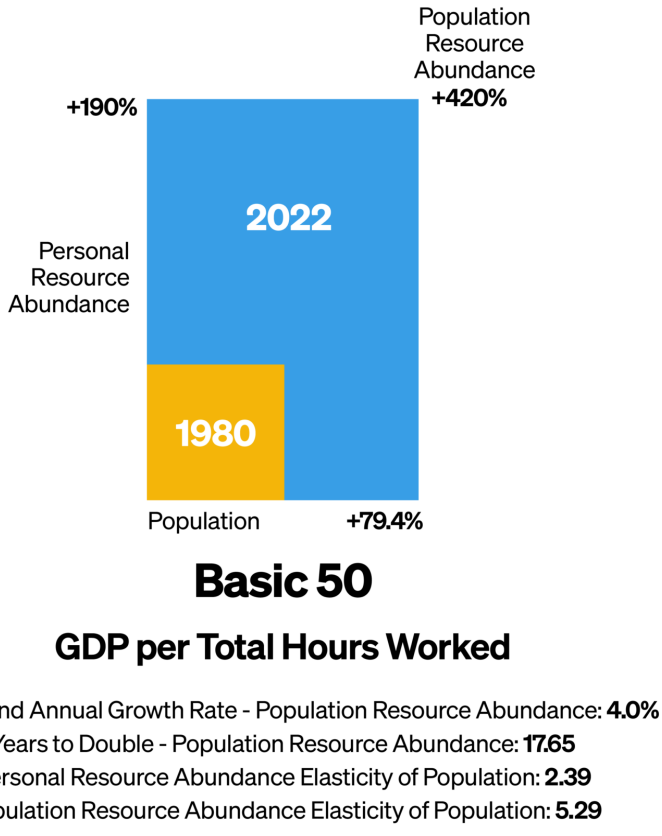
Put differently, the personal resource abundance of the average person rose by 190% between 1980 and 2022. The compound annual growth rate in personal resource abundance amounted to 2.7%, implying that personal resource abundance doubled every 26 years. At the same time as average time prices fell, the world's population grew by 79.4%. So, for every 1% increase in the world's population, the average time prices of the Basic 50 commodities fell by 0.825%.[32]

Population Resource Abundance

While the personal resource abundance analysis looks at resource abundance from the perspective of an individual human being, population resource abundance analysis quantifies the relationship between the overall (or global) resource abundance and the overall (or global) population growth. A pizza analogy can explain the difference between the two levels of analysis. Personal resource abundance measures the size of a slice of pizza per person, while population resource abundance adds up all the slices to measure the size of the entire pizza pie.

Population resource abundance is calculated by multiplying the growth in personal resource abundance by the growth in the global population.[33] In this scenario, the rate of personal resource abundance growth (2.9) multiplied by the rate of the world's population growth (1.794) amounts to a population resource abundance of 520.1.[34] In practical terms, this means that population resource abundance increased at a compound annual growth rate of 4%, thus doubling every 17.65 years.

Figure 2: Visualisation of the Relationship between Global Population Growth and Personal Resource Abundance of the 50 Basic Commodities (1980–2022)[35]



Elasticities of Population

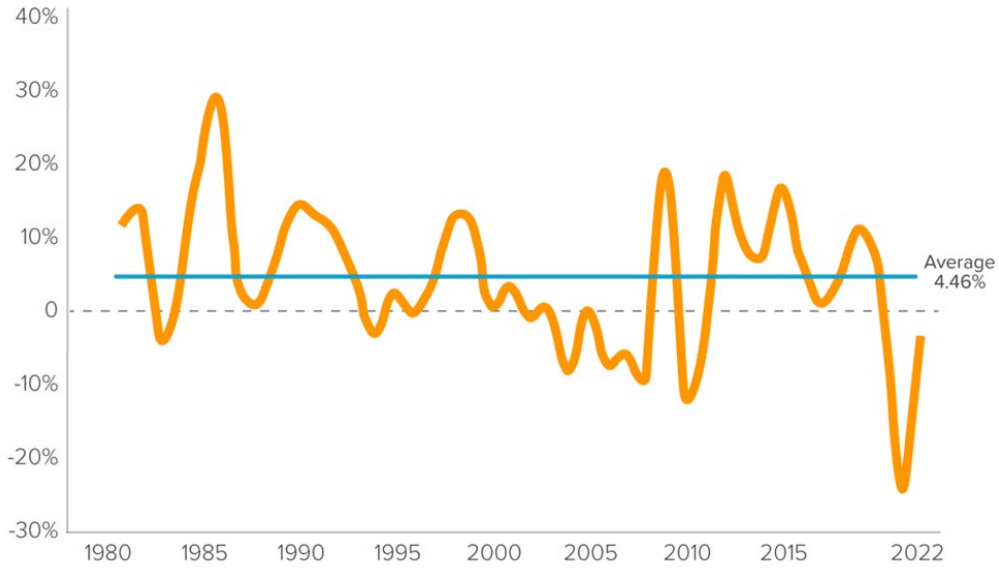
In economics, elasticity measures one variable's sensitivity to a change in another variable. If variable X changes by 10%, while variable Y, because of the change in X, changes by 5%, then the elasticity coefficient of X relative to Y is 2 (10 ÷ 5). A coefficient of 2 can be interpreted as a 2% change in X corresponding to a 1% change in Y.

The Index found that every 1% increase in population corresponded to a 2.39% increase in personal resource abundance (i.e., the size of a slice of pizza).[36] We also found that every 1% increase in

population corresponded to an increase in population resource abundance (i.e., the size of a pizza pie) of 5.29%.[37]

In 2022, the Index declined from 539.3 to 520.1, or by 3.55%. While regrettable, last year's decline was much smaller than the 22% drop in 2021 caused by the COVID-19 pandemic and pandemic-related policies. The abundance of resources fell further after Russia invaded Ukraine on 24 February 2022. That said, the Index increased by an average of 4.46% per year between 1980 and 2022.

Figure 3: The Simon Abundance Index, Annual Percentage Change (1980–2022)[38]



The Index likely will grow again in 2023, as markets continue their post-COVID recovery and higher prices of resources incentivise greater production. Even if resource uncertainty continues in 2023, we expect the long-term trend of greater resource abundance to continue. After all, humanity has witnessed shocks like those caused by pandemics and wars before. Yet, the Index has always recovered, growing by 28.4% in 1986, 20.0% in 1985, and 19.3% in 2009, respectively.

Figure 4: Changes in the time prices and the abundance of the basic 50 commodities: global commodities perspective (1980–2022). [39]

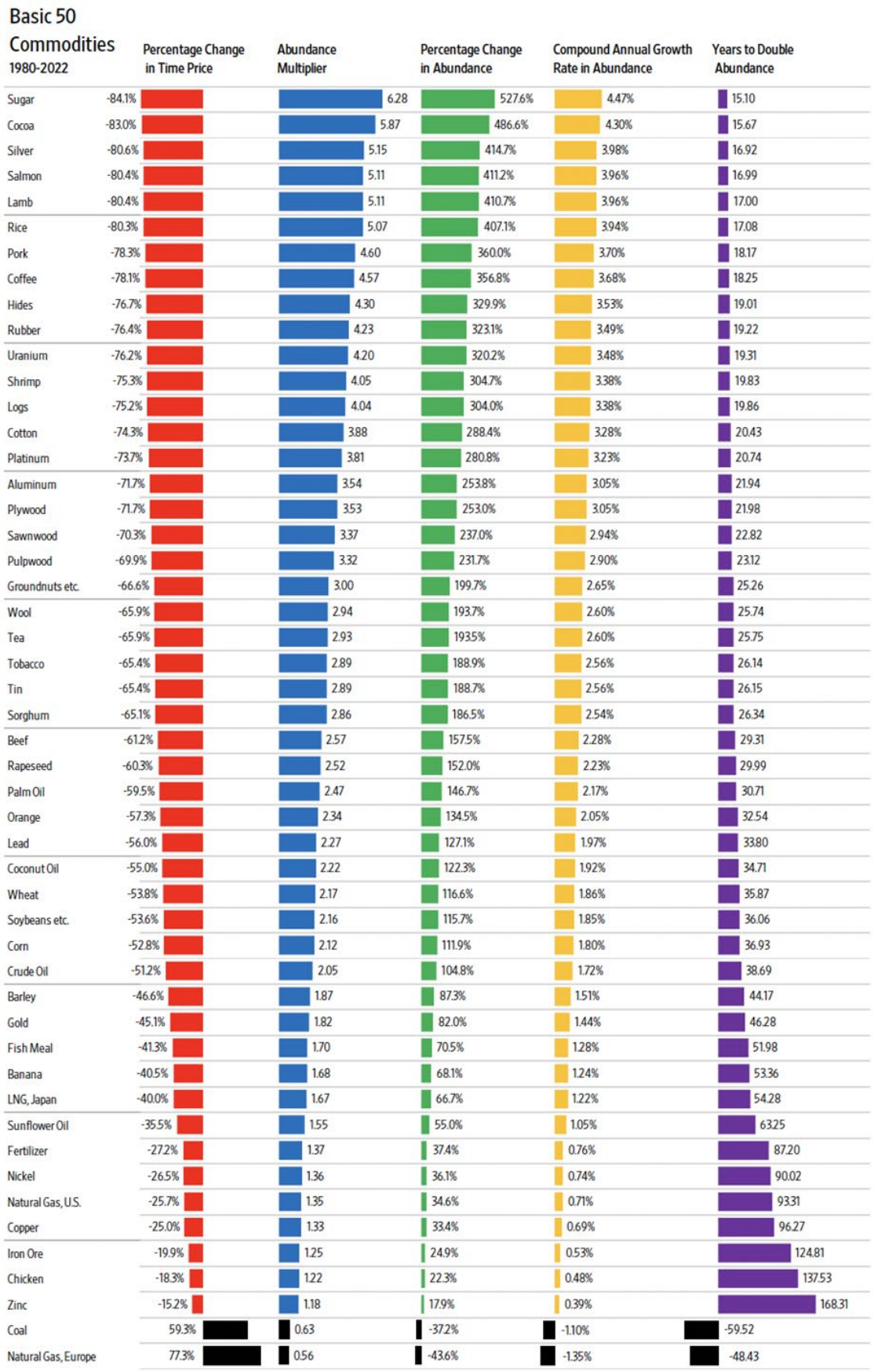


Table 1: Changes in the time prices and the abundance of the basic 50 commodities: global commodities perspective (1980–2022).[40]

Commodity	Units	1980 Nominal Price	2022 Nominal Price	Percentage Change in Nominal Price 1980 - 2022	GDP per Hour Worked 1980 Time Price at $3.24 Per Hour	GDP per Hour Worked 2022 Time Price at $17.45 Per Hour	Percentage Change in Time Price 1980 - 2022	1980 - 2022 Abundance Multiplier 1980 = 1	Percentage Change in Abundance 1980 - 2022	Compound Annual Growth Rate in Abundance	Years to Double Abundance
GDP per Total Hours Worked		$3.24	$17.45	439.2%							
Aluminum	$/mt	$1,774.91	$2,705.02	52.4%	548.49	155.02	-71.7%	3.54	253.8%	3.05%	23.04
Banana	$/lb	$0.17	$0.55	220.7%	0.05	0.03	-40.5%	1.68	68.1%	1.24%	56.03
Barley	$/mt	$78.23	$225.20	187.9%	24.17	12.91	-46.6%	1.87	87.3%	1.51%	46.38
Beef	$/kg	$2.76	$5.78	109.4%	0.85	0.33	-61.2%	2.57	157.5%	2.28%	30.78
Chicken	$/kg	$0.76	$3.35	340.8%	0.23	0.19	-18.3%	1.22	22.3%	0.48%	144.41
Coal	$/mt	$40.14	$344.89	759.2%	12.40	19.76	59.3%	0.63	-37.2%	-1.10%	-62.49
Cocoa	$/kg	$2.60	$2.39	-8.1%	0.80	0.14	-83.0%	5.87	486.6%	4.30%	16.45
Coconut Oil	$/mt	$673.83	$1,634.64	142.6%	208.23	93.68	-55.0%	2.22	122.3%	1.92%	36.44
Coffee	$/kg	$3.35	$3.96	18.0%	1.04	0.23	-78.1%	4.57	356.8%	3.68%	19.16
Copper	$/mt	$2,182.09	$8,822.37	304.3%	674.31	505.58	-25.0%	1.33	33.4%	0.69%	101.09
Corn	$/mt	$125.26	$318.81	154.5%	38.71	18.27	-52.8%	2.12	111.9%	1.80%	38.78
Cotton	$/kg	$2.06	$2.86	38.8%	0.64	0.16	-74.3%	3.88	288.4%	3.28%	21.46
Crude Oil	$/bbl	$36.87	$97.10	163.4%	11.39	5.56	-51.2%	2.05	104.8%	1.72%	40.62
Fertilizer	$/mt	$150.84	$591.84	292.4%	46.61	33.92	-27.2%	1.37	37.4%	0.76%	91.56
Fish Meal	$/mt	$504.43	$1,595.57	216.3%	155.88	91.44	-41.3%	1.70	70.5%	1.28%	54.57
Gold	$/tz	$607.86	$1,800.60	196.2%	187.84	103.19	-45.1%	1.82	82.0%	1.44%	48.60
Groundnuts etc.	$/mt	$2,095.33	$3,770.68	80.0%	647.50	216.08	-66.6%	3.00	199.7%	2.65%	26.53
Hides	¢/lb	$0.46	$0.58	25.4%	0.14	0.03	-76.7%	4.30	329.9%	3.53%	19.96
Iron Ore	$/dmtu	$28.09	$121.30	331.8%	8.68	6.95	-19.9%	1.25	24.9%	0.53%	131.05
Lamb	$/kg	$1.31	$1.39	5.6%	0.41	0.08	-80.4%	5.11	410.7%	3.96%	17.85
Lead	$/mt	$905.75	$2,150.60	137.4%	279.90	123.24	-56.0%	2.27	127.1%	1.97%	35.49
LNG, Japan	$/mmbtu	$5.70	$18.43	223.5%	1.76	1.06	-40.0%	1.67	66.7%	1.22%	56.99
Logs	$/cm	$223.60	$298.47	33.5%	69.10	17.10	-75.2%	4.04	304.0%	3.38%	20.85
Natural Gas, Europe	$/mmbtu	$4.22	$40.34	855.9%	1.30	2.31	77.3%	0.56	-43.6%	-1.35%	-50.85
Natural Gas, U.S.	$/mmbtu	$1.59	$6.37	300.6%	0.49	0.37	-25.7%	1.35	34.6%	0.71%	97.98
Nickel	$/mt	$6,518.68	$25,833.73	296.3%	2,014.42	1,480.44	-26.5%	1.36	36.1%	0.74%	94.52
Orange	$/kg	$0.40	$0.92	130.0%	0.12	0.05	-57.3%	2.34	134.5%	2.05%	34.17
Palm Oil	$/mt	$583.69	$1,275.99	118.6%	180.37	73.12	-59.5%	2.47	146.7%	2.17%	32.24
Platinum	$/tz	$679.10	$961.72	41.6%	209.86	55.11	-73.7%	3.81	280.8%	3.23%	21.77
Plywood	¢/sheet	$273.78	$418.19	52.7%	84.60	23.97	-71.7%	3.53	253.0%	3.05%	23.08
Pork	$/lb	$0.82	$0.96	17.2%	0.25	0.06	-78.3%	4.60	360.0%	3.70%	19.08
Pulpwood	$/mt	$536.54	$872.30	62.6%	165.80	49.99	-69.9%	3.32	231.7%	2.90%	24.28
Rapeseed	$/mt	$572.37	$1,224.60	114.0%	176.87	70.18	-60.3%	2.52	152.0%	2.23%	31.49
Rice	$/mt	$410.74	$436.75	6.3%	126.93	25.03	-80.3%	5.07	407.1%	3.94%	17.93
Rubber	$/kg	$1.42	$1.81	27.5%	0.44	0.10	-76.4%	4.23	323.1%	3.49%	20.18
Salmon	$/kg	$7.98	$8.42	5.5%	2.47	0.48	-80.4%	5.11	411.2%	3.96%	17.84
Sawnwood	$/cm	$396.10	$633.76	60.0%	122.40	36.32	-70.3%	3.37	237.0%	2.94%	23.96
Shrimp	$/kg	$10.14	$13.51	33.2%	3.13	0.77	-75.3%	4.05	304.7%	3.38%	20.82
Silver	$/tz	$20.80	$21.79	4.8%	6.43	1.25	-80.6%	5.15	414.7%	3.98%	17.77
Sorghum	$/mt	$128.86	$242.55	88.2%	39.82	13.90	-65.1%	2.86	186.5%	2.54%	27.66
Soybeans etc.	$/mt	$385.42	$963.35	149.9%	119.10	55.21	-53.6%	2.16	115.7%	1.85%	37.86
Sugar	$/kg	$0.59	$0.51	-14.1%	0.18	0.03	-84.1%	6.28	527.6%	4.47%	15.85
Sunflower Oil	$/mt	$556.01	$1,934.20	247.9%	171.82	110.84	-35.5%	1.55	55.0%	1.05%	66.41
Tea	$/kg	$1.66	$3.05	83.7%	0.51	0.17	-65.9%	2.93	193.5%	2.60%	27.04
Tin	$/mt	$16,774.88	$31,335.41	86.8%	5,183.81	1,795.73	-65.4%	2.89	188.7%	2.56%	27.46
Tobacco	$/mt	$2,275.86	$4,248.52	86.7%	703.29	243.47	-65.4%	2.89	188.9%	2.56%	27.44
Uranium	$/lb	$31.79	$40.80	28.3%	9.82	2.34	-76.2%	4.20	320.2%	3.48%	20.28
Wheat	$/mt	$172.73	$429.97	148.9%	53.38	24.64	-53.8%	2.17	116.6%	1.86%	37.66
Wool	¢/kg	$628.78	$1,154.60	83.6%	194.31	66.17	-65.9%	2.94	193.7%	2.60%	27.02
Zinc	$/mt	$761.22	$3,481.38	357.3%	235.23	199.51	-15.2%	1.18	17.9%	0.39%	176.72
Summary				**150.0%**			**-65.5%**	**2.90**	**189.9%**	**2.57%**	**27.35**

Figure 5: Changes in the time prices and the abundance of the basic 50 commodities: country and territory perspective (1980–2022).[41]

Basic 50 1980 - 2022	Percentage Change in Time Price	Personal Abundance Multiplier	Percentage Change in Personal Abundance	Compound Annual Growth Rate in Personal Abundance	Years to Double Personal Abundance
China	-97.1%	33.91	3,291%	8.75%	8.3
South Korea	-90.0%	9.98	898%	5.63%	12.7
Ireland	-87.4%	7.96	696%	5.06%	14.0
Thailand	-84.5%	6.46	546%	4.54%	15.6
Singapore	-82.8%	5.80	480%	4.27%	16.6
Sri Lanka	-82.1%	5.58	458%	4.18%	16.9
Hong Kong	-79.5%	4.88	388%	3.85%	18.4
Bangladesh	-78.9%	4.74	374%	3.78%	18.7
India	-77.5%	4.45	345%	3.62%	19.5
Portugal	-74.6%	3.94	294%	3.32%	21.2
Turkey	-73.4%	3.76	276%	3.20%	22.0
Indonesia	-73.0%	3.71	271%	3.17%	22.2
Norway	-71.9%	3.56	256%	3.07%	22.9
Australia	-70.8%	3.42	242%	2.97%	23.7
New Zealand	-70.4%	3.38	238%	2.94%	23.9
United States	-67.1%	3.04	204%	2.68%	26.2
Austria	-66.7%	3.01	201%	2.66%	26.4
Finland	-66.2%	2.96	196%	2.62%	26.8
AVERAGE	-65.5%	2.90	190%	2.57%	27.3
Iceland	-65.4%	2.89	189%	2.56%	27.4
Switzerland	-63.2%	2.72	172%	2.41%	29.1
Malaysia	-63.0%	2.70	170%	2.40%	29.3
Denmark	-63.0%	2.70	170%	2.39%	29.3
Argentina	-62.5%	2.67	167%	2.36%	29.7
United Kingdom	-61.8%	2.62	162%	2.32%	30.2
Luxembourg	-61.1%	2.57	157%	2.28%	30.8
Germany	-61.1%	2.57	157%	2.27%	30.8
Pakistan	-61.0%	2.57	157%	2.27%	30.9
Canada	-60.8%	2.55	155%	2.25%	31.1
Philippines	-58.5%	2.41	141%	2.12%	33.1
Chile	-57.7%	2.36	136%	2.07%	33.9
Spain	-57.1%	2.33	133%	2.04%	34.4
Colombia	-55.4%	2.24	124%	1.94%	36.0
Japan	-55.2%	2.23	123%	1.93%	36.3
Brazil	-55.0%	2.22	122%	1.92%	36.4
Italy	-52.2%	2.09	109%	1.77%	39.5
Peru	-51.3%	2.05	105%	1.73%	40.4
Belgium	-49.4%	1.98	98%	1.63%	42.8
Sweden	-48.7%	1.95	95%	1.60%	43.7
France	-47.8%	1.92	92%	1.56%	44.7
Mexico	-46.9%	1.88	88%	1.52%	45.9
Netherlands	-44.7%	1.81	81%	1.42%	49.2
Greece	-41.0%	1.69	69%	1.26%	55.2

Table 2: Changes in the time prices and the abundance of the basic 50 commodities: country and territory perspective (1980–2022).[42]

	1980 Nominal GDP per Hour Worked	2022 Nominal GDP per Hour Worked	1980 - 2022 Percentage Change in Hourly Rate	Percentage Change Time Price Basic 50 Index	Basic 50 Commodities Abundance Multiplier	Percentage Change in Abundance 1980 - 2022	Compound Annual Growth Rate in Abundance	Years to Double Abundance
China	$0.16	$10.30	6,207.6%	-97.1%	33.91	3,291%	8.75%	8.3
South Korea	$1.66	$30.79	1,756.5%	-90.0%	9.98	898%	5.63%	12.7
Ireland	$8.47	$125.47	1,380.6%	-87.4%	7.96	696%	5.06%	14.0
Thailand	$0.55	$6.57	1,102.0%	-84.5%	6.46	546%	4.54%	15.6
Singapore	$4.97	$53.55	978.3%	-82.8%	5.80	480%	4.27%	16.6
Sri Lanka	$0.48	$4.98	937.8%	-82.1%	5.58	458%	4.18%	16.9
Hong Kong	$5.21	$47.34	807.9%	-79.5%	4.88	388%	3.85%	18.4
Bangladesh	$0.31	$2.69	782.3%	-78.9%	4.74	374%	3.78%	18.7
India	$0.32	$2.64	728.1%	-77.5%	4.45	345%	3.62%	19.5
Portugal	$4.11	$30.13	632.4%	-74.6%	3.94	294%	3.32%	21.2
Turkey	$2.50	$17.50	599.1%	-73.4%	3.76	276%	3.20%	22.0
Indonesia	$0.70	$4.84	589.6%	-73.0%	3.71	271%	3.17%	22.2
Norway	$20.93	$138.45	561.5%	-71.9%	3.56	256%	3.07%	22.9
Australia	$12.41	$79.01	536.8%	-70.8%	3.42	242%	2.97%	23.7
New Zealand	$8.06	$50.62	528.2%	-70.4%	3.38	238%	2.94%	23.9
United States	$15.51	$87.74	465.8%	-67.1%	3.04	204%	2.68%	26.2
Austria	$12.52	$70.00	459.1%	-66.7%	3.01	201%	2.66%	26.4
Finland	$12.33	$67.93	450.9%	-66.2%	2.96	196%	2.62%	26.8
AVERAGE	$3.24	$17.45	439.2%	-65.5%	2.90	190%	2.57%	27.3
Iceland	$17.02	$91.44	437.3%	-65.4%	2.89	189%	2.56%	27.4
Switzerland	$20.02	$101.22	405.7%	-63.2%	2.72	172%	2.41%	29.1
Malaysia	$2.25	$11.29	402.6%	-63.0%	2.70	170%	2.40%	29.3
Denmark	$17.93	$90.04	402.2%	-63.0%	2.70	170%	2.39%	29.3
Argentina	$3.75	$18.57	395.7%	-62.5%	2.67	167%	2.36%	29.7
United Kingdom	$12.61	$61.42	386.9%	-61.8%	2.62	162%	2.32%	30.2
Luxembourg	$23.24	$111.21	378.5%	-61.1%	2.57	157%	2.28%	30.8
Germany	$13.95	$66.70	378.0%	-61.1%	2.57	157%	2.27%	30.8
Pakistan	$0.46	$2.22	377.3%	-61.0%	2.57	157%	2.27%	30.9
Canada	$13.43	$63.64	373.9%	-60.8%	2.55	155%	2.25%	31.1
Philippines	$0.91	$4.06	348.3%	-58.5%	2.41	141%	2.12%	33.1
Chile	$3.94	$17.32	339.5%	-57.7%	2.36	136%	2.07%	33.9
Spain	$9.58	$41.54	333.8%	-57.1%	2.33	133%	2.04%	34.4
Colombia	$1.90	$7.92	317.3%	-55.4%	2.24	124%	1.94%	36.0
Japan	$9.04	$37.50	314.8%	-55.2%	2.23	123%	1.93%	36.3
Brazil	$2.37	$9.81	313.7%	-55.0%	2.22	122%	1.92%	36.4
Italy	$11.95	$46.49	288.9%	-52.2%	2.09	109%	1.77%	39.5
Peru	$1.56	$5.98	282.2%	-51.3%	2.05	105%	1.73%	40.4
Belgium	$19.81	$72.80	267.4%	-49.4%	1.98	98%	1.63%	42.8
Sweden	$21.60	$78.27	262.3%	-48.7%	1.95	95%	1.60%	43.7
France	$17.39	$62.03	256.6%	-47.8%	1.92	92%	1.56%	44.7
Mexico	$4.36	$15.28	250.5%	-46.9%	1.88	88%	1.52%	45.9
Netherlands	$20.42	$68.63	236.2%	-44.7%	1.81	81%	1.42%	49.2
Greece	$7.41	$23.36	215.1%	-41.0%	1.69	69%	1.26%	55.2

Superabundance Mindset

Clearly, the catastrophe predicted by Malthus and his disciples did not happen. But can superabundance continue? After all, the planet's resources are theoretically finite and most people likely would agree with the American scholar Kenneth Boulding (1910–1993) who said, "Anyone who believes that exponential growth can go on forever in a finite world is either a madman or an economist."[43]

This section explains how humanity—if it embraces a superabundance mindset that emphasises rational optimism over fatalistic pessimism, knowledge creation over intellectual stagnation, and industriousness over idleness—can expand its resource base for a very long time and, potentially, into infinity.

Many of the ways in which a growing population can expand its resource base will be familiar. Let us start with increased supply. When the price of a metal or mineral increases, people hoping to make a profit have an incentive to look for more deposits. We have surveyed only a fraction of the planet, and the ocean floor remains largely a mystery. As surveying and extracting technologies improve, we will dig deeper, faster, cheaper, and, most likely, cleaner to reach previously untouched metals and minerals.

Next, consider efficiencies. When it was first launched in the late 1950s, an aluminium can weighed close to 3 ounces. Today it weighs one-sixth of that. Profit maximisation motivates people to reduce the cost of an input, such as aluminium, to produce a cheaper output, such as a Coca-Cola can. Why spend more than you absolutely have to? That is how we can, as Andrew McAfee from the Massachusetts Institute of Technology showed, produce "more from less."[44]

Also, consider substitution. For thousands of years, humans cut down trees for lighting and heating. As a result, tree coverage around the world declined. But then we discovered electricity to light our homes, and gas to heat them. The global tree cover rebounded and is expanding. People worry about having enough lithium to make batteries that will power millions of electric vehicles in the future. But scientists are already working on alternatives, including a quick-charging sodium-ion battery—and there is much more sodium than lithium on Earth.

Moreover, consider dematerialisation. Just a few years ago, every hotel room in advanced countries came equipped with a thick blue copper cable that connected the guest's laptop to the internet. Nowadays people use Wi-Fi. Cables are no longer needed, and all that copper is being used somewhere else. Likewise, the smartphone has diminished, and sometimes eliminated, the need for paper maps and calendars, dictionaries and encyclopaedias, as well as calculators, sat-nav, watches, torches, radios, compasses, cameras, mail, telephones, voice recorders, stereos, alarm clocks, and so on. These technologies represent huge savings in terms of raw materials as well as energy.

Note that apart from a little bit of aerospace-grade aluminium or titanium that we sent into outer space, all of our material resources are still here on Earth. True, we have "used" huge amounts of steel to build our skyscrapers, but all that steel could be recovered and reassigned to different tasks. Something similar has happened before. During the Second World War, the US government loaned 14,000 tons of silver to the Manhattan Project to make electromagnets needed to create the atomic bomb. After the war, all that silver was returned to prop up the value of the US dollar.

But surely, our ever-increasing consumption will eventually reach a level where all useful atoms are physically incorporated into objects that delight us. At that point, our economic growth must stop. This argument invokes a hypothetical future—thousands of years from now—when humans mine the Earth's core for metals and minerals needed to sustain our highly technologically advanced civilisation. Still, let us take that argument seriously.

For millennia, people dreamed of transmuting elements. Then, in 1919, Ernest Rutherford artificially transmuted nitrogen into oxygen. Today, transmutation is everywhere. The smoke detectors in our homes, for example, contain americium—a man-made radioactive metal produced by plutonium's absorption of neutrons in nuclear reactors. Specialists transmuted lead into gold many years ago—though the process is currently uneconomical, for it requires far too much energy to replace mining.

But what if we were able to produce plentiful energy that is too cheap to meter? Today, some 30 countries operate over 400 nuclear fission reactors and plans are afoot to make future fission tractors smaller, safer, and cheaper. Moreover, we have on our doorstep a titanic nuclear fusion reactor that converts millions of tons of mass into energy every second. One day, we will be able to capture more of the Sun's energy using ever more efficient solar panels or, perhaps, a Dyson sphere.

We could also build our own fusion reactors. Aside from providing us with more energy, fusion reactors would allow for greater transmutation. The "Big Bang" created hydrogen and a little bit of helium and lithium. All the other elements were created by transmutation inside various kinds of stars. When those stars went supernova, they dispersed throughout the universe most of the elements we consider "natural" here on Earth. All we need to produce even the rarest of elements, therefore, is abundant energy and hydrogen, which is plentiful in our oceans and is the most common element in the universe.

However, it is very likely that by the time we need large-scale transmutation, humans will have developed the knowledge to acquire more atoms and energy from asteroids and other planets. Put differently, the number of atoms that we can utilise here on Earth may not be finite after all. All that is required is more knowledge that springs from the human mind. Or, as the American economist Don Boudreaux put it, "The human mind is the ultimate resource because it, and only it, creates all of the other economically valuable inputs that we call 'resources.'"[45]

Human Innovation

Human innovation is the chief means that people use to create wealth and escape poverty. As Matt Ridley noted in his 2020 book, *How Innovation Works: And Why It Flourishes in Freedom*,

> "Innovation is the most important fact about the modern world but one of the least well-understood. It is the reason most people today live lives of prosperity and wisdom compared with their ancestors, the overwhelming cause of the great enrichment of the past few centuries, the simple explanation of why the incidence of extreme poverty is in global freefall for the first time in history: from 50 percent of the world population to 9 percent in my lifetime."[46]

Committees do not have ideas. Algorithms do not have ideas. Machines do not have ideas—at least not yet. So far, ideas have always been a product of human intelligence. Those ideas lead to inventions, and, in turn, inventions tested by the market lead to innovations that drive economic growth and a rise in living standards. That is why all human beings deserve dignity, respect, and liberty: to think up, experiment with, and market their ideas.

Culture provides incentives that either encourage (or discourage) individuals to manifest their ideas in reality. Individuals who lack equal legal rights and face onerous regulatory burdens, confiscatory taxation, or insecure property rights, will be disincentivised from turning their ideas into inventions and innovations. Conversely, people who function under legal equality, sensible regulation, moderate

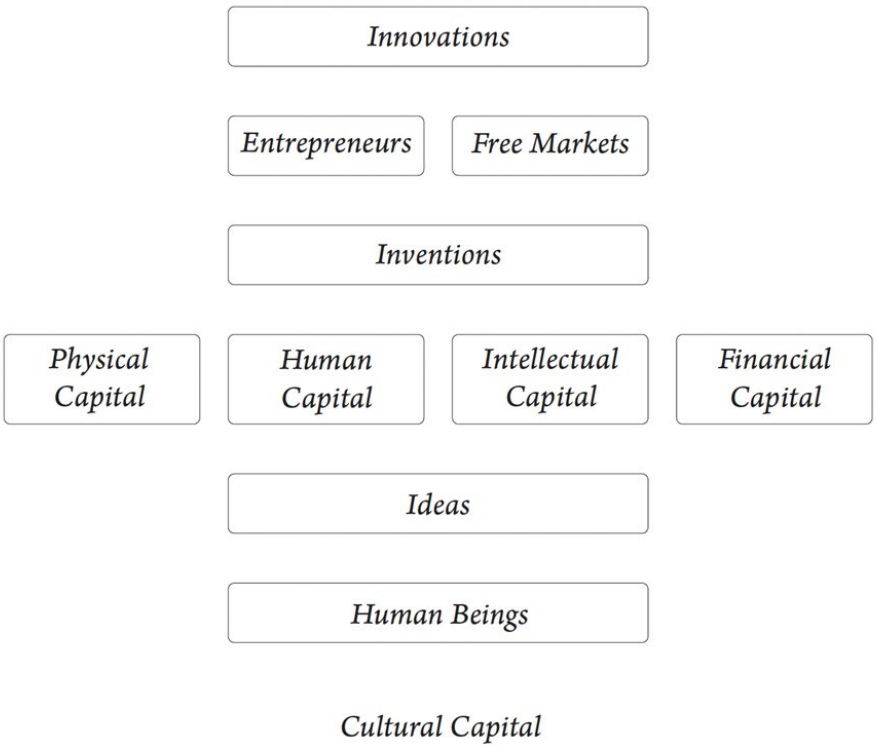
taxation, and secure property rights will apply their talents to their benefit and, ultimately, to that of society.

Although we live in a world with a theoretically fixed number of atoms (though that may change once we start extracting atoms from space), there are infinite ways to arrange those atoms. The possibilities for creating new value are thus immense. For value to be created, however, humans need a relatively free market. This is necessary because knowledge is dispersed in the minds of billions of individuals. That knowledge reveals itself in prices. The price system is a learning system because it creates public information that allows people to exchange things that they value for things they value even more.

We discover and create value by continuously using our various forms of capital—human, physical, intellectual, and financial—innovatively. Human innovation organises and reorganises existing forms of capital to make them more productive and, hence, more valuable. It also creates new capital. Wealth creation, then, is really capital innovation.

Human innovation is a complex process with many aspects. The model of human innovation (see below) that Dr. Gale L. Pooley and I developed in *Superabundance* shows how these parts work together.

Figure 6[47]



Tolerant, Cooperative, and Trusting Cultural Capital

Our innovation framework begins with cultural capital, which works to create and connect or "synergise" all the other types of capital with one another. Cultural capital includes many things. Fundamentally, however, cultural capital is concerned with people's treatment of one another. Vernon Smith, the Nobel Prize-winning economist from Chapman University in California, noted that "the human capacity for fellow feeling, in particular for mutual fellow feeling, is the primary mechanism through which we are socialised creatures."[48] This "fellow feeling," which is either underdeveloped or

lacking among nonhuman animals, changed over time, and has enabled humanity to flourish in recent centuries.

As the economic historian Deirdre McCloskey noted, the increased spread and appreciation of human dignity, respect, and liberty were the foundations of "the Great Enrichment."[49] In numerous works, she advanced the idea that people must be free to "have a go." All humans, she argued, have the capacity to create value because they can make others happy. That freedom to "have a go" may seem obvious to those of us who live in politically and economically free societies today, but people in the past did not think in this way. Even today, there are parts of the world where people are not free to "have a go." That holds us all back. How many Mozarts and Einsteins are humanity not benefiting from because hundreds of millions of people worldwide are still not free to "have a go"?

Other aspects of cultural capital include the rule of law, property rights, and the enforcement of contracts. Stable money, non-punitive and non-arbitrary taxation, and a reasonable and predictable regulatory environment also contribute to the cultural foundations of innovation because they build trust. A culture in which people trust one another will perform better than a culture in which people do not trust one another.

One of the chief reasons for the success of the Jews in medieval Europe and that of the Chinese diaspora in more recent times was the relatively high level of trust in those closely-knit communities. Even today, as research by Harvard University political scientist Robert Putnam shows, homogeneous societies are more trustworthy than heterogeneous ones.[50] That should not be altogether surprising since, over the millennia, we have evolved in small groups of people who have shared common interests, survival strategies, and (very often) familial connections.

Thankfully, trust among more diverse people can be enhanced through the evolution of "trusted" institutions. Countries with a reputation for an impartial legal system and speedy, cost-efficient dispute resolution mechanisms, for example, tend to register a higher level of trust than societies that lack either. Consider the ease with which an ordinary person can open a bank account and obtain credit in the United States today. Using a credit card, individuals can purchase anything they want online or in a shop from complete strangers. Similarly, consider the ease with which people can buy and sell property. Land surveying, title recording, transaction services, and transparent public records make this process relatively smooth and effortless in advanced countries.

Not so in much of the developing world.[51] In developing economies, financial interactions tend to be cash-based and transactions often occur only among people who already know one another. Such limits on the range of transactions limit value creation, and less trusting societies tend to be less prosperous.

History shows that not all cultures are equally conducive to innovation and growth. Different cultures have developed different values, expectations, and norms, which then impact the scope and speed of progress. These cultural differences often depend on a differing worldview or cognitive orientation of an individual or society. The worldview of a person and a society will determine what they believe to be true, good, and beautiful.

Worldviews influence the political structure, the political structure determines the legal system, and the legal system looms large in determining the economic system. Cultures that help people cooperate and trust one another and that place a high value on human freedom and dignity tend to thrive. Cultures that protect the status quo and discourage creative destruction with heavy regulation and social stigma tend to flounder.

Let us look at one specific example. The co-founder of the Apple Corporation, Steve Jobs, created trillions of dollars in value for humanity because he enjoyed a culture that rewarded risk, creativity, and discipline.[52] Jobs was born in San Francisco, California, in 1955 and was adopted at birth by Paul and Clara Jobs. His biological father was born and raised in Syria. Jobs grew up in Mountain View and Los Altos, neighbourhoods densely populated with engineers and innovators who shared California's culture of freedom and entrepreneurship. What would the world look like today if Jobs had been born and raised in Syria instead of Silicon Valley? How many Steve Jobs's live in Syria or similar places today? It is a great tragedy for human flourishing and prosperity that billions of people live in cultures that discourage or prevent innovation. Thousands, perhaps tens of thousands, of potentially world-changing entrepreneurs remain inactive because they are forced to live in places with little cultural capital. Culture is the soil, and the entrepreneur is the seed.

Keep in mind, however, that cultures can and do change. China, during the Song Dynasty (960–1279), led the world in technological progress, generating such inventions as movable print, gunpowder, and the magnetic compass. When the Venetian merchant Marco Polo (1254–1324) visited the kingdom shortly after the Mongolian Yuan Dynasty replaced the Song Dynasty in the late 13th century, he was amazed by China's riches and power. In particular, he noted the size and density of Chinese cities (he called Hangzhou "beyond dispute the finest and the noblest in the world"),[53] the heavy traffic of its waterways, the riches of its markets, the extent of the public works, and the efficiency of its postal service.[54] By the time of the Italian Jesuit Matteo Ricci's trip to China in the late 16th century, the country was already in the midst of technological stagnation, in which it would remain for the next 400 years.

Likewise, great cultural, economic, and scientific flourishing characterised the Islamic Golden Age between the 8th and 13th centuries. Conversely, Europe fell into the "Dark Ages" after the fall of Rome, and the Renaissance was, in part, propelled forward by hand-copied Arabic translations of ancient Greek and Roman texts that Europe had already lost and had to rediscover via the Muslim world. Once again, cultures changed. For example, the German goldsmith Johannes Gutenberg (c. 1400–1468) perfected the printing press in the mid-15th century, thus accelerating the Renaissance, the Age of Discovery, the Scientific Revolution, and the Reformation. Conversely, a narrow-minded outlook in the Islamic world, which prioritised protection of the employment of scribes over the mass production of printed books, prevented the adoption of the printing press until 1727, when a Hungarian emigrant known by his adopted name of Ibrahim Mutafarraqa (1670–1745) was permitted to open a printing press in Constantinople, only to have it shut down again in 1742.

Put differently, a culture of openness (freedom, respect, and risk-taking) is, to a great extent, a choice made by actual human beings. The same is true of its opposite.

Human Beings, Population Growth, and Ideas

Population growth, the next step in the framework, is integral to innovation. Julian Simon noted that the human population had to reach a critical mass, urban density, and a certain degree of freedom before humanity could enter the Age of Sustained Innovation and escape absolute poverty. He agreed with Adam Smith that larger populations create larger markets that can absorb the high fixed costs associated with many innovations. Larger populations, Smith observed, also allow for more specialisation and production of niche products.

In *The Rational Optimist*, Ridley explains the process of innovation in terms of sex. Imagine how slow evolution would be if animals were to reproduce asexually. There would be random mutations in each generation, but those mutations would be restricted to one lineage only. Sex brings the genes of two separate individuals (including their mutations) together, thereby drastically increasing the speed of

evolution. Ideas obey the same principles. More people can generate more ideas. Even if only a small fraction of humans can generate a good idea, the number of good ideas will grow in proportion to population growth.[55]

Furthermore, freedom multiplies the production of ideas, thereby accelerating the speed of human progress. People who are free to interact with one another are more likely to combine two or more ideas into a new idea. China and India, for example, were the world's most populous countries long before they liberalised their economies in 1978 and 1991, respectively. Both were dirt-poor, giving rise to the joke that the Chinese (and the Indians) were successful everywhere except for China (and India). Since liberalisation, both countries' economies grew massively, with China becoming the second-largest economy and India the fifth-largest economy in the world in 2020 (at current US dollar exchange rates).[56]

Larger populations enable the division of labour, or specialisation, which contributes to the production of new ideas. By assigning specific tasks to the individuals who are most skilled in those tasks, humans can increase the efficiency of the economy radically. When the best hunters hunt and the best toolmakers craft tools, society saves time and resources. Moreover, under this arrangement, hunters are able to devote all their energy to hunting, and craftsmen can concentrate on crafting. Both become more skilled in performing their tasks and better aware of the shortcomings in the production processes, which they can address through further improvements. The chances of new inventions and innovations thus increase. Crucially, the benefits of the division of labour rise with population growth since bigger groups can specialise more than small groups.

Consider one example. Some 35,000 years ago, humans populated Australia, including its southeastern corner, which would eventually become Tasmania. These people lived a hunter-gatherer lifestyle but developed basic technologies like bone tools, cold-weather clothing, fishhooks, and traps. Around 10,000 years ago, melting ice filled the low-lying plains that separated Tasmania and Australia, creating an impassable strait and isolating the Tasmanians. At the time of the European arrival in the 17th century, only about 5,000 Tasmanians were on the island. They were virtually naked and had not made a bone tool in thousands of years. By contrast, Australian Aboriginals retained their existing technology and invented new things, such as the returning boomerang.

So, what went wrong in Tasmania? Ridley argues that the island's technological backslide occurred because Tasmania could not support enough people to maintain its level of technology, let alone invent new technologies. Consider the process of human learning. In general, people learn new skills by copying experts in the field. The best fishermen teach the next generation to fish, and the best toolmakers teach the new generation to make tools. Larger, more specialised populations have plenty of experts, while small populations have few. That fact means that small populations are significantly more vulnerable to technological regression. What if, for example, the most knowledgeable expert refuses to teach anyone or is killed by a venomous snake before he could employ an apprentice? What if a storm wipes out all the fishermen on a fishing trip at once? Through a pure accident, generations of accumulated knowledge could be destroyed.

The only sure way for smaller populations to thrive is to trade. On Tierra del Fuego, an island with about the same landmass and population as Tasmania, the people possessed traps, nets, hooks, harpoons, clothing, and canoes because, unlike the Tasmanians, the inhabitants had traded with mainland South America. Despite their small population, the Fuegians could access a larger continental market, allowing them to prevent technological regression and benefit from the specialisation developed on the South American mainland. If sharks ate all their fishermen, they could ask their neighbours across the channel how to cast a line. If the last man who knew how to make a hook had a heart attack, they could relearn the skill from continental toolmakers or just trade pearls for some fish hooks every few months.

So, innovation relies on population growth and the freedom to exchange goods and ideas. The larger the population, the larger the market. The larger the market, the more specialised a population can become. The more specialised a population becomes, the more prosperous it grows.

Human Ideas, Technological Advancement, and Social Innovation

The next element in our framework is human ideas. Innovation requires inventions, and inventions begin with ideas. That said, ideas leading to new inventions and innovations are a bit of a mystery. We don't know who will have them or when they will appear.

In fact, most people do not invent or innovate anything.[57] That is surprising because human achievement is largely measured by technological advancement. Human evolution, in contrast, is defined by social, rather than technical, innovation. Figuring out how to throw a stone is a technical problem, but using stones to ward off predators requires a social solution (i.e., the coordinated bombardment by many hominids).

Homo erectus invented tools superior to those produced by its ancestors. Still, the division of labour, which improved the manufacture of those tools and enabled our ancestors to hunt large animals, was entirely social. Finally, fire increased our capacity to extract calories from food, but without using the former for social gatherings, we would never have developed the rich and diverse cultures that made it possible to accumulate knowledge. Technology makes our lives easier, but the success of our species is contingent on our ability to cooperate and organise as a society.

Moreover, since the evolutionary fitness of individual humans is based primarily on their ability to cooperate, most people choose a social solution over a technical one when confronted with a problem. If you need sunscreen on your back, it is easier to ask your friend to rub it in than to "MacGyver" your own lotion-rubbing apparatus. The only reason not to ask for help would be that you did not have any friends around or—and this is crucial—that you had a unique personality characteristic that made asking for help unappealing.

Less social individuals appear to be more likely to invent a technical solution rather than a social one. People who would prefer to solve a problem by themselves would be more likely to invent something. Besides intuition, lots of data suggest a negative correlation between sociality and technical innovation. "Engineers and physical scientists show higher levels of autistic traits (one of which is diminished social orientation) than people in the humanities and social sciences," von Hippel and Suddendorf noted. "Unsurprisingly, engineers and physical scientists are also more likely than people in the humanities and social sciences to hold patents and are also more likely to innovate products for their own use." They continued, "As a notable example, Silicon Valley is a hotbed of technical innovation and also features an unusual concentration of people on the autism spectrum."[58]

Furthermore, autistic individuals tend to exhibit a particular combination of the Big Five Personality Traits. Namely, they tend to be "more neurotic and less extroverted, agreeable, conscientious, and open to experience."[59] In a word, they tend to be "quirky" or eccentric. Liberal societies—which is to say, free or open ones—are relatively good at accommodating eccentricities. But will that continue? In the long run, social evolution favours conformism and social innovation. Inventors and innovators, by contrast, tend to exhibit eccentric traits and favour technical innovations. If social pressure (norms, mores, speech codes) prevents eccentric people from flourishing, society will tend toward technological stagnation. Conversely, a society that tolerates eccentricity will enhance its potential for technological innovation.

The Ingredients of Innovation

What is the difference between invention and innovation? Inventions begin with ideas that emerge from the human mind. Individual human intelligence and consciousness (or alertness to new opportunities) are keys to innovation. Individuals demonstrate their ideas with inventions. People test their inventions in the marketplace. An innovation, therefore, is a market-successful (or, to use Deirdre McCloskey's term, "trade-tested") invention.

This distinction between invention and innovation is imperative. People invent many things, many of which are useless or even harmful. *Time* magazine has compiled a list of the worst inventions of all time, including New Coke, Clippy, CueCat, hydrogenated oils, Honeygar, hydrogen blimps, hair in a can, red dye no. 2, the Ford Pinto, the parachute jacket, the baby cage, the hula chair, the Pontiac Aztek, the Snuggie for dogs, and the Mizar flying car.[60]

As such, people need market forces to discover whether their inventions are valuable. The market is the metaphorical place where inventors learn the value of their inventions through a process of discovery. Once the market gives its stamp of approval to an invention, the invention becomes an innovation. An innovation, in turn, creates a positive net value for humanity.

Yet, only a small fraction of the trillions of ideas that exist become inventions, and of those inventions, only a small fraction become innovations. Consider the data. On 19 June 2018, the United States Patent and Trademark Office issued its 10-millionth utility patent using the current numbering system that started in 1836. Article 1 of the Constitution of the United States affirms that Congress has the power "to promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries."[61] While many valuable inventions are not patented, around 5% of the 2.1 million patents that are currently active (most patents expire after 20 years) are commercially profitable. That statistic suggests that only 105,000 inventions patented in the United States in the last 20 years meet the test of market success.

Innovations take a variety of forms. There are disruptive innovations (a new product or service that starts operating from the low end of the market, slowly moves up the value chain, and finally replaces the incumbent product or service), sustaining innovations (an innovation that aims to improve the quality and feature of the current product offering), and efficiency innovations (innovations that try to do more with less in the manufacture of a product).

Despite these distinctions, all innovations fall into two broad categories: consumption innovations and capital innovations. Consumption innovations create products and services that are consumed by "end users" or customers.[62] Capital innovations are products and services that contribute to developing innovations that are still new. They include "explicit organisational knowledge residing in an organisation's intellectual property, business designs, business process techniques, patents, copyrights and trade secrets which enable organisations to create a competitive advantage either through economies of scale and scope or differentiation."[63]

Physical Capital

Ideas become innovations through different forms of capital, the first being physical capital. Harvard economist Gregory Mankiw wrote that physical capital "consists of man-made goods (or input into the process of production) that assist in the production process."[64] Real estate, equipment, and inventory are examples of physical capital. All physical capital consists of a finite number of atoms, the basic building blocks of ordinary matter. Combining and recombining those atoms in new ways has long been

the "stuff" of innovation. In a 2015 article, "Economic Growth," the Nobel Prize-winning New York University economist Paul Romer observed that while there may be a fixed number of atoms, there are virtually infinite ways to arrange and rearrange those atoms.[65] Therefore, the value creation process is also virtually unlimited.

Nuclear fission is a perfect example of the new ways in which human beings can rearrange atoms—or, in the case of nuclear power, "split" them—to produce a brand-new source of energy, one that does not emit any carbon dioxide into the atmosphere. Nuclear fusion, should it ever become economically viable, will rearrange atoms oppositely by crushing them together to produce energy that will be even safer than nuclear fission. To quote George Mason University economist Donald J. Boudreaux: "It's true that nature created... materials, but nature did not transform them into resources. This all-important transformation was the product exclusively of human creativity, intellect, and effort."[66]

Human Capital

Adam Smith recognised the importance of human capital. In *The Wealth of Nations*, Smith noted that the acquisition of talents constitutes an individual's fortune as well as the fortune of his society. He explained, "The improved dexterity of a workman may be considered in the same light as a machine or instrument of trade which facilitates and abridges labour and which, though it costs a certain expense, repays that expense with a profit."[67] We value education because learning provides us with the opportunity to increase our knowledge and skills further. Skills are actionable knowledge.

Other aspects of human capital include integrity and trust. As Warren Buffett has remarked, "I look for three things in a person: intelligence, and a high energy level, and integrity. If they don't have the latter, the first two will kill you."[68] Being worthy of trust is one of the most valuable human capital traits one can possess. That is especially true in the context of a free economy, where individuals and companies tend to interact based on their respective reputations (in non-free economies, the state may dictate economic interactions between two parties irrespective of the latter's ability to fulfil their part of the contract). Equally as important as integrity and trust are the networks individuals develop. Who you know can be as valuable as what you know, if not more so.

Human capital also includes a person's life expectancy, health, leadership skills, personality, and network. Life expectancy is a proxy for the health of a country. The greater the number of years of life, the greater potential for human capital to create more value. Human capital is an active asset. No matter how much knowledge and how many skills one might have, these assets remain inactive capital without health. Leadership skills are also important. Whether innate or learned, this element of human capital can be exceptionally valuable in guiding people and companies between different courses of action and accompanying opportunity costs.

Other enhancers of human capital are personality traits that allow people to work in teams and be pleasant and inspiring. Different economic activities require different personality traits. As noted before, inventors and innovators succeed in generating new ideas precisely because they do not seek the approval of the people around them. Once new ideas are produced, the people responsible for actualising them and marketing them tend to be precisely the kinds of people who are pleasant and try to get along. Society, in other words, multiplies the positive effects of technical innovation.

To improve human capital, such as knowledge, skills, and relationships with others, people must believe that they live in a society that will reward those improvements in the future. In the past, people believed in the strict stratification of human society into slaves, peasants, nobility, and priests. That order, they thought, was preordained and made vertical mobility impossible. A son born to a blacksmith would take over his father's business and pass on that enterprise down to his son. This stasis could go on for many

generations and is attested to by the rise of "professional" last names, such as Smith, Potter, Cooper, Mason, Tyler, and so on.

Similarly, people who still live in societies that are socially immobile or antagonistic to entrepreneurship are typically disincentivised from investing in their own futures. Why, for example, should a person study (invest in his or her future) if university tenure is awarded based on nepotism rather than merit? Why should a person build a business if a well-connected army general can steal that enterprise? So, the organisation and reorganisation of human capital also depends on an idea—namely, the idea of progress or the belief that the future can be better for individuals and their descendants.

Intellectual capital

Generating new ideas involves combining or recombining other (often previously generated) ideas. Intellectual capital includes all of humanity's stores of knowledge. Paul Romer distinguished between physical capital (i.e., atoms) and intellectual capital (i.e., bits), writing that "even [Adam] Smith recognized that... objects are of no inherent value as inputs without knowledge of how to combine them in ways that generate valuable output."[69]

Yet, not all countries possess the same amount of intellectual capital. Advanced economies are increasingly being referred to as "knowledge" or "bit" economies, while some other countries, including the tragically poor Burundi and Central African Republic, are yet to undergo industrialisation at all. Mercifully, countries that lack intellectual capital to spur innovation and growth can access,

> "ideas that are available in the rest of the world... partly through unimpeded flows of the capital goods that are produced in the industrialised nations of the world. These goods embody many new ideas."[70]

Economic development, Romer noted, "requires a mechanism for ensuring adequate flows of the large quantity of disembodied ideas that are used in production." He continued,

> "[T]he government of a poor country can therefore help its residents by creating an economic environment that offers an adequate reward to multinational corporations when they bring ideas from the rest of the world and put them to use with domestic resources."[71]

Dissemination of intellectual capital, then, also depends on ideas. Specifically, it depends on abandoning the discredited idea of economic self-reliance, characterised by protectionism, and embracing free trade. Innovation and economic development depend on an intellectual shift from a mindset that sees foreign investment and the operation of multinational corporations ("MNCs") as tools of capitalist exploitation to a mindset that sees foreign investment and MNCs as sources of valuable and growth-enhancing knowledge.

Romer also notes that ideas are non-rivalrous and non-excludable goods. A non-rivalrous good, such as a telecast or streaming television documentary, can be watched or "consumed" by everyone at the same time. A Snickers bar, in contrast, is a rival good, for it can be consumed by only one person (or a very limited number of people). A non-excludable good such as national defence covers everyone. Once it is provided, people cannot be excluded from enjoying it, even if they want to do so. Private parking, in contrast, is an excludable good; people who do not pay for a parking spot do not get to enjoy it.

Romer worries that the generation or production of new ideas may be retarded by their non-rivalrous and nonexcludable characteristics. The solution to that problem, he believes, includes the expansion of public funding for research and development ("R&D").

Since government revenue is finite, someone will have to decide who gets to receive taxpayer support and who does not. Should politicians and bureaucrats make those kinds of decisions? And what is the likelihood that public R&D investments will be more effective and efficient than private ones?

The answers to those questions are beyond the scope of this paper. But British scientist Terence Kealey and British economist Martin Ricketts contend that researchers tend to thrive on sharing their knowledge with one another as part of reciprocal social relationship networks. Thus, they argue that a lack of government funding for R&D may be less of a problem in hindering future innovation than is often assumed.

Financial capital

The fourth form of capital is financial capital, which includes institutions and innovations that measure and manage money and risk. It is vital to innovation because the process does not function unless inventors and entrepreneurs can rely on a relatively stable currency and are able to incorporate businesses, borrow money, buy or sell shares, purchase insurance, and have a common language to understand financial performance.

A stable currency is a vital component of a stable society. Consider Great Britain between 1700 and 1914. At the start of this period, the English polymath Sir Isaac Newton (1643–1727) served as the master of the mint. During Newton's tenure, Great Britain moved to the gold standard, which ensured the stability of the pound sterling and provided the monetary structure of the British Empire during one of the greatest periods of economic growth ever experienced by the human race.

The limited liability company ("LLC"), a legal business entity with state authorisation to operate, is another salutary component of financial capital. The Dutch East India Company (Vereenigde Oostindische Compagnie, or "VOC"), established in 1602, is commonly considered the first modern corporation, which limited the liability of its stockholders to the amount they invested in the company, in the event of business failure. Before the invention of the LLC, stockholders could lose everything, including their private possessions and even their freedom. Today, corporations raise millions of dollars from thousands of investors who enjoy limited risk. This arrangement allows societies to take on large and complex projects that non-LLCs could never attempt.

Banks serve as financial intermediaries, providing people with the ability to create value for one another by lending and borrowing. Bank deposits are lent to borrowers while earning interest for lenders. Before the rise of modern banking, lending and borrowing tended to occur mostly among people who knew each other (and, therefore, were aware of the contracting parties' respective reputations). Modern banks still verify the reputations of borrowers through credit scores, but the sheer volume of transactions and the size of each bank's lending network lower the risk to individual lenders, thus allowing for more and riskier lending.[72] Greater liquidity, in turn, stimulates faster growth.

Another key aspect of financial capital is the stock exchange, which creates markets for buying and selling financial instruments such as government bonds, promissory notes, securities, commodities, corporate shares, and other investments.[73] Stock markets emerged in Amsterdam, London, New York, and Paris. Most countries have since developed their own stock markets, including new exchanges in Vietnam and Saudi Arabia. The ability to easily buy and sell financial instruments on exchanges increases

financial liquidity and spreads risk across large numbers of individual investors with different valuations and risk tolerances.

Insurance is a vital part of financial capital that allows contracting parties to diversify and share risks. By knowing the maximum financial downside of their investment (i.e., losing the insurance premium and specified deductibles), insured entities (individuals or corporations) can take greater risks with the potential for higher returns. Although the Chinese and the Babylonians practised different approaches to managing these kinds of risks in the 3rd and 2nd millennia BC, respectively, the first known insurance contract dates to Genoa in 1347.[74] Today, insurance is a major component of the American economy, amounting to $1.22 trillion in 2018.[75]

Double-entry accounting or bookkeeping is another aspect of financial capital, which has been practised since the time of ancient Rome. In 70 CE, for example, Pliny the Elder described the structure of double-entry accounting as "on one page all the disbursements are entered, on the other page all the receipts; both pages constitute a whole for each operation of every man."[76] As the Australian author Jane Gleeson-White noted in her book, *Double Entry: How the Merchants of Venice Created Modern Finance*, "You could itemize the profits in each account, so you knew which products you were doing well in and which you weren't. Then you could start to think about how you would change your business activities. It was just a whole revolution in the way of thinking about business and trade."[77] The longevity of double-entry bookkeeping attests to its usefulness to commerce and economic development.

These attributes of financial capital create an environment conducive to innovation, trade, and commerce.

Free Markets and Entrepreneurs

The market is the place and the process for discovering what is valuable. It is where inventions are tested for their value-creating power. To maximise learning in markets, buyers and sellers must be free to come and go, and prices must be free to rise and fall. An invention is much more worthy of attention, praise, and reward if designed and constructed to succeed in the market. The question that markets answer is this: "Is it [the product] made well enough, cheaply enough, with the right set of features, and with key complementary goods in place, so that it could be sold for a profit?"[78]

Free markets serve another beneficial role in human society: they build trust and cooperation. Competition, as everyone knows, is an essential part of a capitalist economy. It drives businesses to innovate and to provide consumers with less costly and better products. If businesses fail to innovate, they go bankrupt. The marketplace can be a brutal place—"Capitalism without failure is like religion without sin. It doesn't work"—but it is also one of the most cooperative of human endeavours.[79] Goods and services are traded among strangers and across vast distances, guided greatly by price mechanisms and the reputation of the trading parties. Repeated transactions among trading parties encourage trustworthiness, a moral side-product of capitalism, which creates the conditions for prosperity and increases cultural capital.

In the short run, competition produces winners and losers (although over the long run, it is very difficult to find anyone in a market society who does not daily enjoy substantial gains or "wins" from market competition). As Amazon expanded, for example, neighbourhood bookstores shuttered across the United States. Some people thought that was a great tragedy, for bookstores provided a pleasant way to browse through publications and, sometimes, to meet interesting people. Ultimately, however, the convenience of the internet, superior choices, and lower prices proved to be more valuable to the average customer. Amazon and its clientele won, while your local bookseller lost. The losers who emerge

from capitalist competition appear to confirm a zero-sum bias in the human brain. It is for that reason that many people tend to focus on the closure of their local bookstores rather than revel in the falling prices and increased choices made possible by Amazon. Where did that bias come from?
For hundreds of thousands of years that we spent wandering the planet as hunter-gatherers, the success of one group of people, often related by family bonds, came at the expense of another group. When the resources in an area occupied by Group A ran out, Group A moved on to a territory occupied by Group B, provoking conflict. Conflict continues to define the interaction among animals. Humans, by contrast, evolved additional ways of interacting with one another. Permanent settlements were a key part of that process. Strangers who settled next to one another had to learn how to cooperate. In that process, they either acquired a reputation for trustworthiness or became social outcasts excluded from a larger economy.

Extreme Environmentalism: A Critique of Modern Life

Despite the widespread benefits of human innovation and a superabundance mindset, scarcity narratives maintain their hold on the public imagination, thus contributing to a sense of despair and decline. The chief among them is extreme environmentalism. Like its precursors, including fascism and communism, extreme environmentalism is also rooted in Romanticism.

Whereas the scholars of the Enlightenment thought that humans could coexist in harmony with nature, Romantics thought that our domination of nature would bring about humanity's downfall. The machine embodied the division between the two schools of thought. To many Enlightenment thinkers, the machine was a harbinger of progress. To the Romantics, it meant the coming of an apocalypse.

English Attitudes

These attitudes found expression in poetry and literature. The English poet William Blake (1757–1827) lamented how the pastoral landscapes of Britain were now pockmarked with "dark, Satanic mills." He described London, the peak of modern development, as full of "marks of weariness" and "marks of woe."[80] Worse, from Blake's perspective, the hard-working bourgeoisie that pushed society forward was becoming spiritless, empty, and philistine in its pursuit of profit and easy wealth and luxury meant materialism became inescapable. H. G. Wells (1866–1946) captured concerns over machines and spiritual degradation in his novels, where he wrote stories with the premise that technology was not only at war with nature: it was, above all, a war that technology could not win.

German Romanticism

Around the same time, German biologist, Ernst Haeckel (1834–1919) coined the word "ecology", and advanced his philosophy of monism, which dictated that the universe was one united, dynamic, and purposeless process. He hoped that it would replace Christianity in Germany.[81] While Haeckel never accomplished his goal, monism was very popular in *fin de siècle* Germany, which became obsessed with the Romantic view of nature and deeply ambivalent about commerce, urbanisation, and industrialisation.[82]

The German Youth Movement, for example, started in 1896 and became popular with some 8 million German children affiliated with it by 1938, who were committed to its devotion to outdoor activities. It was for this Movement that German philosopher Ludwig Klages (1872–1956) wrote his 1913 essay

"Man and Earth," which extolled the beauties of the undisturbed German countryside and landscapes before they became polluted with the signs of industrial and technological progress.[83]
German Romanticism influenced the National Socialists, including Martin Heidegger (1889–1976), who distilled Romanticism's ideas into a comprehensive critique of Western life, identifying technology and capitalism as two nature-destroying forces. For Heidegger, technology gave humanity the ability to dominate nature, and capitalism destroyed any connection between nature and the product of work (or economic output). Some advocates of the National Socialist worldview regarded the Aryan, with his connection to blood and soil, as the perfect man to reunite humanity with nature. The Nazi state machinery encouraged organic farming because it harmonised the relationship between humans and the land.[84]

American Environmentalism

In the United States, environmentalism materialised in 1962 and coincided with the publication of Rachel Carson's *Silent Spring*, which attacked the "indiscriminate" use of pesticides. Carson caused a revolution in public opinion. Within a year, Congress passed the 1963 Clean Air Act, giving the American federal government more power to regulate the environment. Five years later, Paul Ehrlich's book *The Population Bomb* caused a sensation of similar proportions.

The speed and extent of environmentalist triumphs in the United States are noteworthy. The year 1970 kicked off with the celebration of the first Earth Day on 22nd April, featuring "Lectures and rallies… at more than 2,000 college campuses, 10,000 elementary and high schools, and thousands of other places across the country."[85] Writing for *Reason* magazine, Ronald Bailey recounted that "Forty-two states adopted resolutions endorsing Earth Day, and Congress recessed so that legislators could participate in the activities in their districts" as part of "the largest public demonstration in history."[86] By the end of that same year, President Richard M. Nixon helped create the Environmental Protection Agency, and private environmental organisations, including the more militant Greenpeace, also flourished.[87]

As the 1970s rolled on, American environmentalism became increasingly anti-capitalist. Arthur Herman from the Hudson Institute avers that it was the American writer Charles A. Reich (1928–2019) who brought German ideas to America with his book *The Greening of America* (1970), and he notes that "modern ecology [in the United States]... replayed the same enthusiasms that had animated every modern cultural regeneration movement since the German Romantics."[88] According to Reich:

> "Work and living have become more and more pointless and empty. There is no lack of meaningful projects that cry out to be done, but our working days are used up in work that lacks meaning: making useless or harmful products, or servicing the bureaucratic structures. For most Americans, work is mindless, exhausting, boring, servile and hateful, something to be endured while "life" is confined to "time off." At the same time our culture has been reduced to the grossly commercial; all cultural values are for sale, and those that fail to make a profit are not preserved. Our life activities have become artificial, vicarious and false to our genuine needs, activities fabricated by others and forced upon us."[89]

Rather than acknowledge that his critique mirrored the Marxist critique of capitalism as "alienation" of labour, Reich veered straight into environmentalism and predicted revolutionary turmoil where a new creation would emerge and renew man's relationship with himself, others, and the land. Reich's book was a bestseller in 1970 and 1971, topping the *New York Times*' bestseller list on 27 December 1970.[90]

Other voices critical of capitalism's effect on the environment soon emerged. They included American biologist Barry Commoner (1917–2012), who argued that modern society was unsustainable and focused on capitalist production techniques (pollution-causing detergents and synthetic textiles, for instance), advocating for "eco-socialism."[91] Commoner found support in British economist Barbara Ward (1914–1981) and French American microbiologist René Dubos (1901–1982) who warned that the exponential economic growth of industrial society threatened the entire planet's survival. For these environmentalists, wealth generation was no longer capitalism's saving grace. It was a problem that needed to be tackled.

By the 1980s, environmental demands had become more radical. Norwegian philosopher Arne Naess (1912–2009), for example, thought that reforming industrial society was not enough. Instead, he called for a change of culture that allowed any amount of ecological destruction to exist at all. Like Haeckel's monism, Naess's philosophy of "deep ecology" concluded that modernity placed humans above other lifeforms, creating an inflated ego that enabled our species to destroy nature.

In 1986, American social theorist Murray Bookchin (1921–2007) published *The Modern Crisis*, calling for replacing environmentally destructive capitalism. Embracing deep ecology, Bookchin's utopia was radically egalitarian, with men, women, plants, and animals living on equal terms and promoting each other's well-being. As he saw it, such a utopia had existed for thousands of years in the form of primitive societies. Bookchin's ideas amounted to a total inversion of human progress. Civilisation, he averred, was just domination over nature, wrenching away the last remnants of a paradise that still existed among the aborigines of Africa and South America.

Likewise, in his 1991 book *In the Absence of the Sacred*, American activist and author Jerry Mander claimed that primitive societies are based on a rejection of modernity, not ignorance of it. Mander believed the subsistence lifestyle is a conscious cultural choice to avoid civilisation. To this day, deep ecologists view primitive societies as not only ecologically harmonious but free of the cultural desire to exploit nature.

In 1992, then-American Vice President Al Gore published his book *Earth in the Balance*, which critiqued modern society for being ecologically destructive, materialist, and shallow, thus repelling authentic experiences. Gore's culprit, however, was new. This time, the fault was with human nature itself. In Gore's vision, culture at its most basic level represents control over nature. Stone tools and cave paintings are just rudimentary attempts to impose artificial order on the organic world. Likewise, the Western world, capitalism, technology, sexism, and racism are extensions of the innate human desire to dominate.

At even more extreme levels, some ecologists began to fantasise about the end of the world, with dreams of dams bursting and cities crumbling, forcing the last remnants of humanity to return to a primitive lifestyle. The French explorer Jacques-Yves Cousteau (1910–1997) called the idea of getting rid of suffering and disease "not altogether a beneficial one" and urged that "we must eliminate 350,000 people per day."[92] Likewise, American environmentalist Christopher Manes called HIV/AIDS "the necessary solution" to environmental degradation.[93] Finally, in his 1994 bestseller, *The Hot Zone: A Terrifying True Story*, Richard Preston from the *New York Times* wondered whether extremely deadly viruses such as Ebola and Marburg may be the biosphere's reaction against "the human parasite" and the "cancerous rot-outs" of advanced industrial societies.[94]

It is evident that a scarcity mindset persists despite the fantastic potential of human innovation and trends pointing to the superabundance of resources.

Anti-Humanism and Anti-Natalism

Environmentalism has grown more extreme over time. Legitimate concerns over environmental degradation caused by industrialisation gave way to a total rejection of the modern world and, even, the salience of our very own species. It is to the anti-humanism of the extreme environmentalists to which this paper now turns.

Anti-Humanism

In May 2019, a CNN report on the newly released study of the United Nations' Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services asserted that "we must act now; consuming less; polluting less; having fewer children" to prevent an environmental catastrophe.[95] To emphasise the supposed link between population growth and a coming planetary disaster, CNN interviewed none other than Paul Ehrlich, who noted that:

> "for a species that names itself *Homo sapiens*, the wise man, we are being incredibly stupid. The other organisms on our planet are our life support systems. You don't have to worry about them if you don't care about eating, if you don't care about breathing, if you don't care about having freshwater, and so on, then you can just forget about it and die. I am very, very optimistic about what we could do in theory. I am very pessimistic about what we will do [in practice]."[96]

In a February 2019 question-and-answer session that was live-streamed on Instagram, Congresswoman Alexandria Ocasio-Cortez, a rising star of the US Democratic Party, told her viewers that unless humanity takes urgent action on carbon dioxide (CO_2) emissions, there is no hope for the future. She explained that it leads young people to question: "Is it OK to still have children?"[97]

Likewise, Bill Maher from HBO opined in April 2019 that the population problem is "not about space; it's about resources. Humans are already using 1.7 times the resources the planet can support. We don't need smaller carbon footprints [sic]; we need less [sic] feet." He also downplayed concerns about falling birth rates: "Whatever problems are caused by falling birth rates aren't nearly as dire as those brought on by overpopulation. In 1900, there were less than two billion people on Earth; now it's approaching eight. We can't just keep on like this. The world is just too crowded." In his view, "The best thing you can do for the earth is to not have kids, die, and stay dead."[98]

Anti-Natalism

As Maher's remarks foreshadow, the logical continuation of the Malthusian concern with population growth is the Voluntary Human Extinction Movement ("Vhemt"). According to its American founder Les Knight, Vhemt (pronounced "vehement") is gaining traction among the young. "In the last year," Knight told the British newspaper *The Daily Mail* in January 2019, "I've seen more and more articles about people choosing to remain child-free or to not add more to their existing family than ever. I've been collecting these stories, and last year was just a groundswell of articles, and, in addition, there have been articles about human extinction."[99]

He is right. Recent articles embracing the benefits of human extinction include the *New Yorker*'s "The Case for Not Being Born," *NBC News*' "Science Proves Kids Are Bad for Earth. Morality Suggests We Stop Having Them," and the *New York Times*' polemic "Would Human Extinction Be a Tragedy?". The last piece muses that "our species possesses inherent value, but we are devastating the earth and causing

unimaginable animal suffering. It may well be, then, that the extinction of humanity would make the world better off."[100] Similarly, the American business magazine *FastCompany* released a disturbing video titled "Why Having Kids Is the Worst Thing You Can Do for the Planet" in April 2019.[101]

In November 2019, the British daily newspaper *The Guardian* ran Rebecca Tuhus-Dubrow's article titled "I Wish I'd Never Been Born: The Rise of the Anti-Natalists," which shared the story of an Indian man who, as a symbolic gesture, sued his parents because they should not have begotten him without his consent.[102] The lawsuit intended to set an ethical precedent, according to which the net effect of bringing life into the world is, by definition, negative, thus rendering all procreation objectively immoral.

As the author explained, "[the] basic tenet of anti-natalism is... that life, even under the best of circumstances... [is] a harm and an imposition."[103] Anti-natalism hinges on the idea that every human life involves some amount of suffering, that suffering cannot be offset by happiness, and that reducing suffering regardless of happiness is the key moral imperative of society. It logically follows that the goal of eliminating suffering altogether requires the complete extinction of human beings.

Tuhus-Dubrow credits South African philosopher David Benatar with introducing the term "anti-natalism" and taking leadership of the modern anti-natalist movement. Benatar has attracted followers such as Dallas-based YouTuber Dana Wells, who also goes by the title "The Friendly Anti-natalist" online. Wells felt "annoyed" when questioned about why she did not have children and discovered anti-natalism while seeking like-minded people who could empathise with her. Wells now uses her platform to spread the anti-natalist message, encourage the philosophy's adherents, and "address tensions among true anti-natalists."[104]

As with any philosophy, the definition of "true" anti-natalism is a contentious subject. One group of anti-natalists are "the childfree." These people do not want children themselves, but they do not consider all procreation to be unethical. Another group consists of "denatalists." These people disapprove of procreation only under certain conditions. Wells does not consider these two groups to be "true" anti-natalists. "Real anti-natalism," Wells avers, "means opposing all births, under all circumstances."

True anti-natalists, though united by the common overarching goal of human extinction, are split into two camps: those who prioritise human extinction and those who advocate the extinction of all sentient life. Wells and Benatar fall into the latter category, which, understandably, is largely composed of vegans.

Anti-Natalists and Climate Activists

Anti-natalists and climate activists often share similar concerns, practical lifestyles, and perspectives on the state of the world. These similarities are most intriguing when they coincide with the often-radical differences between each group's ultimate goals.

Climate activists may fear having children for two main reasons. First, some activists are pessimistic enough to believe that the ecological state of the world today—and especially of tomorrow—is so bad that "inflicting" it on a child would be unjust. Second, many climate activists believe that each new life brought into the world will consume an unjust amount of scarce resources, generate emissions, and ultimately endanger the planet and fellow humans.

While climate activists and true anti-natalists may consider procreation immoral, they often have remarkably different reasons for thinking so. "Ultimately," as Tuhus-Dubrow explains, "the goals of the two camps diverge sharply."[105] No matter how strongly climate activists oppose procreation, most do so

because they fear human extinction and believe suffering is a mere obstacle to happiness. By contrast, for "true" anti-natalists, "extinction is the dream."[106]

While Tuhus-Dubrow acknowledges increasing opposition to procreation globally, she notes that this opposition is "mostly in the context of the climate crisis."[107] It is interesting to note that anti-natalism owes part of its recent growth to its proximity to this supposed crisis, but in David Benatar's own words, "It's not clear ... that the world is getting worse."[108] True anti-natalists are more likely to acknowledge the improving state of the world because their core belief is that the world can never improve enough to morally justify procreation anyway.

Birth Rate Reduction Policies and Pandemics

Most anti-natalists are content with voluntary reduction of birth rates. Others hope to achieve that goal through government enforcement. Prominent environmentalists, including Johns Hopkins University bioethicist Travis Rieder and science populariser Bill Nye, have advocated for special taxes or other state-imposed penalties on those with "too many children."[109]

Bowdoin College philosopher Sarah Conly's 2015 book *One Child: Do We Have a Right to More?* noted that, "we live in a world where a burgeoning global population has started to have a major and destructive environmental impact. The results, including climate change and the struggle for limited resources, appear to be inevitable aspects of a difficult future."[110] She acknowledged that "many view procreation as an essential component of the right to personal happiness and autonomy" and captured "the dominant view... that the government does not have the right to impose these restrictions on its own citizens, for the sake of future people who have yet to exist."[111]

Conly ultimately decided that "not only is it wrong to have more than one child in the face of such [environmental] concerns, we do not even retain the right to do so." Personal "autonomy and personal rights are not unlimited, especially if one's body may cause harm to anyone, and that the government has a moral obligation to protect both current and future citizens," she concluded.[112]

Chelsea Follett from the Cato Institute found that many "anti-natalists believe that a world without humans, or with significantly fewer of them, would eventually revert to a pollution-free paradise with abundant natural resources. As one human extinction proponent put it in January 2020 in a letter to his local paper, "In approximately 20,000 years after human extinction, this magnificent resistant biosphere will return to its perfection."[113]

As COVID-19 spread around the world in early 2020, some environmental extremists rejoiced at the growing death toll. Stanford University environmental science graduate student Sierra Garcia has compiled some horrifying instances of such rejoicing. One archetypal example is a tweet with about 300,000 likes proclaiming, "Wow. ... Earth is recovering. Coronavirus is Earth's vaccine. We're the virus."[114] The *New York Times* has noted that an upside of social distancing efforts is that they may help fight climate change.[115] CNN ran the headline, "There's an Unlikely Beneficiary of Coronavirus: The Planet."[116] Other correspondents lauded the fall in carbon emissions as the virus spread and worried that once things improved, post-recession economies will see a surge in harmful emissions.

Eco-Extremism

The most extreme adherents of anti-humanism are people who do not rely on persuasion or government action but instead take matters into their own hands and start to cull the members of the

human race, at least in part for the sake of the planet's environment. Just minutes before shooting 22 people in an El Paso Walmart on 3 August 2019, the shooter, Patrick Crusius, released a manifesto titled "The Inconvenient Truth," referencing the former US vice president Al Gore's 2006 climate change documentary.

"Our lifestyle is destroying the environment of our country," he wrote. "But … most of y'all are just too stubborn to change your lifestyle. So the next logical step is to decrease the number of people in America using resources. If we can get rid of enough people, then our way of life can become more sustainable."[117] The people in the United States that Crusius wanted to kill were Hispanics, a group that Crusius believed would give the US Democratic Party a permanent electoral advantage. In return for the Hispanic support, Crusius reasoned, the Democrats will keep the borders open, thus leading to further immigration. Crusius was clearly a white supremacist, but he partly justified his murderousness with Malthusian ideas.

He was not the first shooter to do so. In the opening statement of his manifesto, Crusius declared that he was inspired by Brenton Tarrant, an Australian man who killed 51 people at two mosques in New Zealand on 15 March 2019. Tarrant's manifesto, titled "The Great Replacement," is similar to Crusius', although the former targeted Muslims in New Zealand rather than Hispanics in the United States. In one section of his manifesto, Tarrant blamed climate change on higher birth rates in predominantly non-white countries, stating that "the invaders are the ones overpopulating the world. Kill the invaders, kill the overpopulation, and by doing so save the environment." Later, he wrote that "there is no Green future with never ending population growth, the ideal green world cannot exist in a world of 100 billion, 50 billion, or even 10 billion people. Continued immigration into Europe is environmental warfare and ultimately destructive to nature itself."[118]

Tarrant seems to have been inspired by Anders Behring Breivik, a right-wing extremist who killed 77 people in a bombing and shooting spree on the Norwegian island of Utøya on 22 July 2011. Breivik too had a manifesto, a rambling 1,500-page compendium that at one point called for a global population cap of 2.5 billion people to avoid environmental destruction.[119]

Crusius, Tarrant, and Breivik represent a global mass killer phenomenon inspired by a new ideology dubbed eco-fascism. Broadly speaking, eco-fascists combine white nationalism with environmentalist extremism, thus giving a new meaning to the concept of "blood and soil".

Malthusian killers, though, are not limited to the far right. Beginning in the late 1970s, militant Luddite Ted Kaczynski, popularly known as the "Unabomber," sent bombs to prominent figures in academia and industry, intending to topple industrial society itself and return humanity to a foraging existence. His manifesto focused on the effects of modern life on human culture and psychology rather than the environment. Still, when he did mention the environment, he lamented the loss of Malthusian checks on population growth. "One of the effects of the intrusion of industrial society has been that... controls on population have been thrown out of balance. Hence the population explosion, with all that that implies," he wrote. "No one knows what will happen as a result of ozone depletion, the greenhouse effect and other environmental problems that cannot yet be foreseen."[120]

Eco-Confidence

These are worrying trends, but it would be wrong to conclude this section by implying that all environmentally conscious individuals are comfortable with the anti-humanist and anti-natalist extremists who dominate the headlines. Many "eco-modernists" and "eco-pragmatists," such as Danish writer Bjorn Lomborg, American environmentalist Michael Schellenberger, and Rockefeller University

scientist Jesse Ausubel, believe in the possibility of a compromise between the well-being of the human race and good stewardship of the environment.

One such compromise might involve the expansion of CO_2-free nuclear power. Following Russia's invasion of Ukraine in 2022, energy prices spiked, leading some environmentalists to drop their long-standing opposition to the building of more fission reactors. Whether this welcome development continues and whether the above scholars gain the traction that they deserve is, alas, an open question.

Threats to Human Flourishing

This paper argues that human flourishing depends on two main components: people and freedom. People must be free to think, speak, read, publish, interact with others, and generate ideas. It is market-tested ideas that lead to progress. The more people the planet has and the more freedom they enjoy, the greater the likelihood that they will generate new, good ideas to tackle the problems of today and those that will arise in the future.

Consider just one such problem. Fossil fuels have freed humanity from reliance on human and animal muscle and ushered in the modern era dominated first by the steam engine and later by the combustion engine. But they have also contributed to the planet's warming that we are currently experiencing. Nuclear fission is a very safe and reliable source of energy that does not emit CO_2 into the atmosphere. Still, most countries refuse to build new nuclear reactors partly because of highly publicised accidents like Chernobyl and Fukushima.[121] Nuclear fusion could still be safer, and it can release huge amounts of energy. Alas, nuclear fusion is difficult, and to make it viable, humanity must continue innovating.[122]

By analogy, during the innovation process, elements of capital are fused into new creations, generating potentially enormous amounts of value. Since ideas are not made of matter, the laws of thermodynamics do not apply. Innovations can thus create exponential new value. But will we continue to innovate? Consider three potential threats on the horizon. The first is an environmental panic-induced decline in the global population. The second is a potentially serious decline in freedom of expression. The third is the omnipresent danger of further restrictions on free enterprise and market freedom. Let us look at them in turn.

Environmental Panic-Induced Decline in Global Population

The human population should reflect the free choices of individual men and women. That being said, parental choices are not made in an intellectual vacuum. *Ceteris paribus*, the nostrums of extreme environmentalism, can reduce population growth when they are thoughtlessly repeated by policymakers, academics, social media influencers, religious leaders, celebrities, and, above all, the news media. The impact of persistent fear mongering is readily discernible. Recent surveys show that parents who feel that having more children harms the planet or, worse, puts the future of the entire species at risk are less inclined to have more children or to have any children at all.

The population replacement level is 2.1 children per woman. Out of the world's 200 countries and territories, 89 had a fertility rate of 2 children or less in 2018. The list of countries and territories with lower-than-replacement total fertility rates is disproportionately populated (forgive the pun) by advanced jurisdictions that are most concerned with environmental issues, including France (1.9); Sweden (1.8); Denmark, the United Kingdom, and the United States (1.7); Germany, the Netherlands,

and Norway (1.6); Austria, Canada, and Switzerland (1.5); Finland, Japan, and Portugal (1.4); Italy and Spain (1.3); and South Korea (1).[123]

The list of countries and territories with below-replacement total fertility rates and the list of countries and territories most concerned about the environment do not map onto one another perfectly. Furthermore, the total fertility rate declines with income, education, and opportunities for women to earn a living outside the home. This paper takes no issue with those developments and processes. Parents should have the autonomy to have as many children as they please. But, pervasive anti-natalist sentiment clearly influences parents in many advanced jurisdictions with low total fertility rates. What the present author calls for, therefore, is a more balanced and factual debate about population growth that includes a discussion of the benefits of population growth and the dangers inherent in population decline. This leads to the second threat to prosperity: restrictions on freedom of expression.

Restrictions on Freedom of Expression

Governments have generally curtailed freedom of expression much more often than not, and speech continues to be restricted in many countries today. Certain subjects, such as the existence of a particular deity or the movement of the heavenly bodies, have been taboo, and in some places, they remain so today. People proclaiming these taboos, such as the priests and the shamans, spoke from "authority," but without logic or evidence. They enforced these taboos with ostracism, exile, imprisonment, torture, and even death.

The great contribution of the Enlightenment to human progress was to recognise that the right to free speech was important; no subject should be off limits to the discussion; free expression should not be punished; and that logic and evidence were required before a claim could be accepted as truthful. This set of enlightened values helped Western Europe gradually break free from deep ignorance and widespread superstition and embark on a journey toward global scientific and technological pre-eminence and a historically unprecedented degree of prosperity.

Unfortunately, the light of the Enlightenment had not been lit in all parts of the globe. Just consider Afghanistan under the Taliban or North Korea under the Kim dynasty. Worryingly, it is burning less brightly in some advanced countries as well. Speakers deemed "controversial" and "problematic" are being banned from speaking on university campuses—the very places that are supposed to be devoted to the pursuit of free inquiry—by a minority of vocal and sometimes violent protesters. Inconvenient questions about "sensitive" issues, such as the extent of climate change and the long-term threats posed by global warming, are being silenced in the media, and their proponents are being condemned as "denialists." Instead of relying on evidence, such as that contained in "big data" and long-term trends, we are asked to prioritise and generalise from individual people's "lived experience."[124] Instead of seeing logic and mathematics as quintessentially objective, we are being asked to see the two as, at best, subjective and, at worst, racist. Instead of searching for the objective truth, we are asked to believe "his truth" and "her truth."[125]

In other words, many of the values of the Enlightenment are in retreat. Orwellian "doublethink," by which individual men and women say one thing publicly while reserving their real feelings for the privacy of their homes, is emerging even in countries where people used to feel free to publicly say exactly what they thought privately.[126]

Some argue that limits on the free expression of some people are tolerable if they prevent hurting other people's feelings. Politeness and consideration are welcome traits, but self-censorship in matters of civic importance can have far-reaching consequences. Lest we forget, many facts commonly accepted today,

such as heliocentrism and natural selection, started as intellectual heresies that offended, discomfited, and hurt the feelings of many people when they were first proposed.

In the realm of human innovation, self-censorship is particularly difficult for people we disproportionately rely on to advance technological and scientific progress. Steve Jobs, for example, was a famously difficult boss.[127] Similarly, James Watson, the co-discoverer of the structure of DNA, is a provocateur with a penchant for shocking and offending people.[128] As noted, some of the most brilliant minds belong to eccentric individuals. A question: Should humanity forgo additional discoveries simply because future inventors and innovators fail the test of "niceness" or decide to censor themselves? This author argues that the answer should be a resounding "no."

Further Restrictions on Market Freedom

Let us now turn to the freedom of the market. This paper argues that further restrictions on the free functioning of the market are the third main threat to the continuation of human flourishing. As already noted, inventors must test their ideas in the marketplace. It is in the marketplace that inventors discover if their ideas can create additional value or not. To reveal the value of an idea, markets must be free. Buyers and sellers, in other words, must come and go as they please, and prices must be allowed to increase and decrease freely.

Market-generated profits and losses tell us much about value creation because rising and falling prices capture the personal preferences of billions of buyers and sellers. Conversely, restrictions on the functioning of the market, such as limits on profits and the socialisation of losses, prevent the emergence of valuable knowledge. American economist George Gilder argues that wealth is knowledge and growth is learning. Communist and socialist economies have failed to generate wealth because they have not had markets to help them distinguish between what is valuable (or relatively valuable, such as different uses for the same commodity, which is a key question when it comes to the efficient allocation of capital) and what is not valuable. In other words, they have failed to learn.

The free market, or to use a more loaded term, capitalism, produces more wealth and higher standards of living than any other economic system that humanity has conceived and implemented. The differences in economic performance between North and South Korea, East and West Germany, Chile and Venezuela, Botswana and Zimbabwe, not to mention the United States and the Soviet Union, speak for themselves.

Despite that generally recognised fact, capitalism has never enjoyed anything close to universal long-term support. Quite the opposite is true. That is because capitalism rubs against some very deeply ingrained parts of human nature. The psychology that evolved when our ancestors lived in small hunter-gatherer groups prepared us to cope with a world of personal cooperation and exchange in small communities. It did not prepare us to cope with a world of impersonal cooperation and exchange among millions of people (a typical advanced economy) or billions of people (the global economy). In a way, the complexity of the modern economy outran the ability of our stone-age minds to understand it.

We evolved in small bands composed of between 25 and 200 individuals. We all knew each other and were often related to one another. Everyone knew who contributed to the band's survival and who shirked his or her responsibilities. Cheaters and free riders were targets of anger and, sometimes, punishment. Just as consequentially, cheaters and free riders lost valuable cooperative partners. The latter would work with more reliable or generous individuals instead. Sharing food was common. Storing food for future consumption was not practical for semi-nomadic people. So, when hunter-gatherers acquired more food than their families could consume, they shared it with other band members,

expecting the favour to be returned in the future. Moreover, property accumulation and wealth inequality were not major concerns as our ancestors could only possess what they could carry on their backs as they moved from one location to another. Finally, sharing and cooperation among hunter-gatherers ended at the band's edge, so to speak. In a world without specialisation and trade, disproportionate gains by one band often came at the expense of another band.

To summarise, the psychology that evolved when our ancestors lived in small hunter-gatherer groups prepared us to cope with a world of personal cooperation and exchange in small communities. It did not prepare us to cope with a world of impersonal cooperation and exchange among millions of people (a typical advanced economy) or billions of people (the global economy). Yet that transition from personal simplicity to impersonal complexity makes capitalism superior at producing great wealth. To complicate matters further, the extended marketplace of millions or billions of people enables enterprising individuals with value-creating ideas to amass greater wealth than they would be able to amass while catering to small communities. That wealth inequality rubs against our egalitarian predispositions and zero-sum thinking. Finally, our tribalism helps explain why we continue to resent other nations and suspect them of thriving at our expense even when we consent to trade with them.

Understanding capitalism—let alone appreciating its benefits—requires us to distinguish between the personal and the impersonal, between the simple and the complex, and between the limited and the extended. The Nobel Prize-winning economist F. A. Hayek put it this way:

> "Part of our present difficulty is that we must constantly adjust our lives, our thoughts, and our emotions, in order to live simultaneously within different kinds of orders according to different rules. If we were to apply the unmodified, uncurbed, rules of the micro-cosmos (i.e., of the small band or troop, or of, say, our families) to the macro-cosmos (our wider civilization), as our instincts and sentimental yearnings often make us wish to do, we would destroy it. Yet if we were always to apply the rules of the extended order to our more intimate groupings, we would crush them. So we must learn to live in two sorts of worlds at once."[129]

Striking a balance between the implementation of two sets of rules—our families and our wider civilisation—is a difficult task, and we often fail to do so. When we fail—as we did most recently in Venezuela—the results can be catastrophic. The collapse of Venezuela's "21st-century socialism" should warn future generations, but the same was expected (largely to no avail) from dozens of socialist failures in the 20th century. As such, the defence of free markets will remain a never-ending struggle.

Conclusion

This paper focused on one source of despair that resonates with people today: the fear of overpopulation and the concomitant exhaustion of natural resources. That fear was, of course, real for thousands of years, and Thomas Malthus, its most prominent proponent, deserves credit for being a decent historian. Paradoxically, Malthus penned his influential thesis—the human population grows geometrically, while food production can only grow arithmetically—just as the world began undergoing fundamental change. In the late 18th century, some Western European nations and their colonial offshoots started to break out of the Malthusian trap. Their mortality rates started to fall, incomes rose, and nutrition improved.

By many measures, life became better. With time, much of the rest of the world followed in Western Europe's footsteps by adopting, however partially and imperfectly, liberal (in the European, rather than

American sense) institutions, liberal ethics, and liberal commitments to open inquiry, science, and technology. In this post-Malthusian world, our species flourished and multiplied. In 1800, there were one billion of us. Today, there are over eight billion people on the planet. Yet, as Dr. Gale L. Pooley and I showed in *Superabundance: The Story of Population Growth, Innovation, and Human Flourishing on an Infinitely Bountiful Planet*, resources became more abundant over this period of time.

In spite of that fact, much of the world is gripped by panic over the state of the environment in general and the future availability of resources in particular. The numbers and logic show that we are unlikely ever to run out of resources. But, what about the state of the planet?

This paper argues that the same superabundance mindset that allowed us to escape from the Malthusian trap will enable us to protect the environment. In fact, many of the problems identified by environmentalists are being addressed or are on the cusp of being addressed. Forest coverage is growing in rich countries, species are being protected at record levels throughout the world, freshwater reserves are being replenished through desalination in the Middle East, soil erosion is being reduced through precision agriculture in Israel, and CO_2 emissions have fallen in nuclear energy-friendly France and Sweden. In the future, genetically modified crops could lead to a decline in the use of nitrogen and phosphorus, and wild fish stocks could bounce back through greater use of aquaculture, a practice that is rapidly expanding in China.

What is needed to address current and future problems, then, is freedom and brainpower. Limiting population growth through unwarranted hysteria or government action limits brain power and, in the case of the latter, it leads to social engineering and violence such as the one-child policy in China between 1980 and 2015. Instead, population growth should be looked at through the prism of thousands of years of human history and rational optimism. People have addressed pressing environmental problems in the past—think of artificial fertiliser and the Green Revolution—and can do so again in the future.

Humanity has come far, especially in the last 200 years or so. Struggling against conflict, hunger, and disease, we have gradually gained the upper hand. In a world trending toward entropy, we have created a complex and prosperous civilisation. We have done so because humans are a unique kind of animal that have developed a cooperative culture which allows for the accumulation and sharing of knowledge. That knowledge, in turn, helps to make our society gentler and more prosperous. Population growth and freedom are crucial parts of that positive feedback loop. It is free people who generate new ideas and it is free people who test those new ideas against other people's ideas in the marketplace. The process of knowledge and value creation is at the heart of humanity's progress. It is what enables our civilisation to bend toward goodness and prosperity. Let us try to keep it that way.

[1] "Biological Extinction | Paul R. Ehrlich," YouTube video, uploaded by Casina Pio IV, 2 March 2017,
R. Ehrlich, "Biological Extinction" (lecture, PAS-PASS Workshop, Casina Pio IV, Vatican City, February 27–March 1 2017).
[2] Julian L. Simon, *The State of Humanity* (Cambridge, MA: Blackwell, 1995), p. 654.
[3] 1800-1859, quoted in 1830
[4] Thomas Babington Macaulay, *Essays, Critical and Miscellaneous* (Boston: Philips, Sampson and Company, 1859), p. 115.
[5] The median U.S. hourly wage was over $17 in 2021. https://www.statista.com/statistics/185335/median-hourly-earnings-of-wage-and-salary-workers
[6] Julian L. Simon, *The State of Humanity*, 27.
[7] United Nations, The Determinants and Consequences of Population Trends: New Summary of Findings of Interaction of Demographic, Economic and Social Factors (New York: United Nations, 1973–1978), p. 33.
[8] United Nations, Determinants and Consequences, p. 34.
[9] United Nations, Determinants and Consequences, p. 34.
[10] United Nations, Determinants and Consequences, p. 34.
[11] United Nations, Determinants and Consequences, p. 34.
[12] United Nations, Determinants and Consequences, p. 34.
[13] United Nations, Determinants and Consequences, pp. 34–35.
[14] United Nations, Determinants and Consequences, p. 35.
[15] United Nations, Determinants and Consequences, pp. 35–36.
[16] United Nations, Determinants and Consequences, pp. 36–37.
[17] Pierre Desrochers and Joanna Szurmak, "The Terrors of Dr. Suzuki," C2C Journal, February 6, 2019.
[18] United Nations, Determinants and Consequences, p. 37.
[19] David Hume, Essays Moral, Political, and Literary, 3rd edition (London: Longmans, Green, and Co., 1882), p. 384.
[20] Joseph de Maistre, *Against Rousseau: On the State of Nature and On the Sovereignty of the People*, (trans. and ed. Richard A. Lebrun, Montreal: McGill-Queen's Press, MQUP, 1996), p. 157.
[21] Malthus, *"An Essay on the Principle of Population as It Affects the Future Improvement of Society, with Remarks on the Speculations of Mr. Godwin, M. Condorcet, and Other Writers"* (1798). A geometrically growing value increases proportionately to its current value, such as always doubling (for instance, 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024). An arithmetic growth rate, in contrast, increases at a constant rate (1, 2, 3, 4 or 1, 3, 5, 7).
[22] Malthus*, Principle of Population*, Chapter 7.
[23] Note that Malthus revised his 1798 essay on five more occasions. In addition to the six editions of his essay, he also published A Summary View on the Principle of Population in 1830. It is from that last work that the "preventive checks" quote comes from. See Thomas Malthus, *An Essay on the Principle of Population and a Summary View of the Principle of Population* (London: Penguin Books, 1985),
p. 250.
[24] Stephen Broadberry et al., *"The Population of England,"* Our World in Data, January 21, 2020.
[25] Ryland Thomas and Samuel H. Williamson, *"What Was the U.K. GDP Then?" Measuring Worth,* accessed August 6, 2020, https://www.measuringworth.com/datasets/ukgdp/
[26] Ronald Sheppard and Edward Newton, *The Story of Bread* (London: Routledge & Kegan Paul Ltd., 1957), Appendix A.
[27] In the late 1960s, Paul Ralph Ehrlich, a professor of biology, wrote *The Population Bomb*, which brought Malthusian concerns into the mainstream and opened with the oft-quoted prediction: "The battle to feed all of humanity is over. In the 1970s, hundreds of millions of people will starve to death in spite of any crash programs embarked upon now."
Paul Ralph Ehrlich, *The Population Bomb,* (Ballantine Books: New York, 1968), xi.
[28] John Tierney, "Betting on the Planet", The New York Times Magazine, December 2, 1990,
https://www.nytimes.com/1990/12/02/magazine/betting-on-the-planet.html.
[29] John Tierney, "Betting on the Planet", New York Times Magazine, Dec. 2, 1990,
https://www.nytimes.com/1990/12/02/magazine/betting-on-the-planet.html
[30] To calculate the time price, Dr. Pooley and I divide the nominal price of a good or service by the nominal hourly wage at the start and repeat that process at the end of the analysis. Time prices thus avoid subjective and disputed adjustments such as the Consumer Price Index.
[31] Marian L. Tupy and Gale L. Pooley, *Superabundance: The Story of Population Growth, Innovation, and Human Flourishing on an Infinitely Bountiful Planet*, The Cato Institute, August 2022.
[32] (-65.5% [fall in Basic 50 commodities time prices] ÷ 79.4% [growth in world's population] =-0.825% [average drop in time prices per 1% growth in world's population]).
[33] ([1 + percentage change in personal resource abundance] x [1 + percentage change in population]).
[34] 2.9 units bought in 2022 for the same price as 1 unit in 1980.
[35] Marian L. Tupy and Gale L. Pooley, *Superabundance: The Story of Population Growth, Innovation, and Human Flourishing on an Infinitely Bountiful Planet*, The Cato Institute, August 2022.

[36] (190 [personal resource abundance] ÷ 79.4 [population growth])
[37] (420 [population resource abundance] ÷ 79.4 [population growth])
[38] Marian L. Tupy and Gale L. Pooley, *Superabundance: The Story of Population Growth, Innovation, and Human Flourishing on an Infinitely Bountiful Planet*, The Cato Institute, August 2022.
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