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Using Hidden Dimensions to Solve Unseen Problems

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Introduction

"Man's mind, stretched by a new idea, never goes back to its original dimensions."

Oliver Wendell Holmes, Jr.

Times were tough. Too many omelets to make. Not enough eggs. So, the woodcutter and his wife hatched a plan. We will abandon the kids deep in the woods, far from home; they schemed aloud, within earshot of the youngsters in the next room. With them, we starve. Without them, we eat. Once they're gone, we will be fine, the parents told themselves.

There was a way around that, the kids figured. They decided we'd get some white pebbles and drop them behind us as we walked into the woods. Then, after we are alone, we will follow them back in the moonlight. In this way, Hansel and Gretel made it back to their home.[1]

So, what are *you* to do when you are in uncharted territory? An economic territory, that is.

Do what Hansel and Gretel did.

Plot the dots.

If there were only one sentence to explain this book, that would be it.

Everything else follows from that.

Why Hansel and Gretel wanted to return to a place where they were unwelcome is anyone's guess. But notice what they did in the process. They laid out a trail of high-contrast dots (the bleached pebbles) that traced the way home. Going in another direction might lead them deeper into the woods or, worse yet, into the paths of mythical animals involved in other incredible fairytales (say, a talking Big Bad Wolf[2] since they are Grimm Brothers' characters). Instead, they constructed a plan.

Without the rocks, they had no point of reference. With them, they had a way home.

So, why would you plot the dots or, more precisely, the market dots? In part, you will do it for the same purpose as Hansel and Gretel—so you will not become lost. Beyond that, you will find many more reasons to plot the dots within the framework this book describes for the first time. H & G found their way home, sure. Did they find their *optimized* way home? They will never know.

You can.

In our observations about market dots, we are not talking about pebbles, rocks, or pieces of the Earth, though we will see many analogies to the Earth's geography. So precisely what kinds of dots are we addressing?

We will look at dots representing *value, demand,* and *cost*.

As used in this book, these dots typically relate to goods and services in markets. We'll find that when it comes to economic activity, buyers in markets collectively self-organize in ways we can discover, portray, analyze, and exploit using dots. Understanding this self-organization is crucial for buyers, sellers, and new market entrants. We'll also examine other realms in which approaches used here may prove helpful.

Importantly, we will find that doing this shows us the limits markets face, how buyers change their behaviors when prices and features change, and where the competition lies—and where it does not.

Because we need to know where the dots (read that as competitors) are and where they are not, in so doing, we'll be throwing away the hypothetical constructs of what we now call modern or Neoclassical economics in favor of the empirical approaches that Hypernomics employs uniformly.

We will prove that consumers ultimately determine both value and demand. In these systems, we always have left-hand or green dots for value and opposing right-hand or red dots for demand, each of equal height, representing different aspects of the same product in linked adjoining realms. We will want to hold them, remove them from the flat of a page, and turn them into spheres. The ones on the right match the ones on the left, and both have the same distance from the base. We have a pair for every product we buy, representing a dual state—with left and right spheres.

Dr. John Snow was one of the first researchers to plot the dots with significant effect. A cholera outbreak besieged the Soho district of London, United Kingdom, where he lived in 1854. Determined to find the source, Dr. Snow plotted the Soho deaths from cholera using dots, one dot to a person. He discovered their locus at the Broad (now Broadwick) Street water pump, which he urged authorities to turn off. They did. The epidemic subsided.

Some have used dots or lines to represent troop movements on the battlefield. Interestingly, battles and markets have many things in common. We will use combat analogies in our study of markets and their changes over time.

However, people have not yet felt much need to plot the dots for their markets.

That changes now, as this book introduces Hypernomics (or Multidimensional Economics [ME]), a discovery about how customers make buying decisions and how those actions work with the producers' costs to provide goods and services.

These market dots representing individual products have deep meaning, both by themselves and taken together. Once analyzed, they reveal the inner workings of every market.

Green or left-hand dots stand for values, the prices buyers are willing to pay for products based on their features. What you are ready to shell out for a given good or service may differ from what your neighbor will gladly pay or what I will. Given enough dots for values, market patterns emerge as lines, inclined planes, or curved surfaces. Those patterns will reveal how people, in general, value a product, what features they like, and which attributes they want more than others. Overpriced or underpriced new products cause lost profits. Worst cases lead to product failures or bankruptcies.

At the same time and on the other hand, we have customer demand. With our right-hand dots plotted, we can find demand limits as fuzzy lines that we must identify and the market reactions to them that we will discover we are obliged to know. Producers expecting to sell goods and services far beyond customer-determined demand limits will find sales lagging below goals.

When we compare the consumers' left-hand dots for value and the right-hand dots for demand to producers' costs, as blue dots, we can determine profitability for past projects and predict it for future ones. We can map future outcomes like we plan a camping trip and find the best spots with the fewest neighbors.

We will have lots of dots. We need to have a wide-open space to hold them all. For that, we will go to the South Pole. We will need Elvis, too. Not the King himself, mind you. Elvis left the building some time ago. Instead, we will retrieve his home, that two-room place where he was born in Tupelo, a white clapboard shotgun shack, its central wall intersection with one of its outer walls squarely planted over the South Pole. The house will keep us warm and help us plot our dots. We will find that the House of Elvis is analogous to a pair of essential constructs, collectively known as coordinate systems, which allow us to plot items of interest.

Note to self. And to you, too. Let's leave our negativity at home. There are no negative regions here. Hypernomics will not abide by them.

That said, be aware that flexibility is essential for you and the dots within this new type of market analysis. Dots move, and we will need to accommodate and anticipate that.

We'll find that market dots are as fundamental to economic analysis as subatomic particles are to physics or cells are to biology. Just as we can make molecules from disparate elements and build bodies with dividing cells, we can consider the entire global economy in one view—if we plot and analyze enough dots.

The notion of how to account for the position of dots began nearly 400 years ago with the French philosopher and mathematician René Descartes.

Various stories abound about how Descartes came about his Cartesian coordinate systems in the early 1600s. Perhaps the one told most often describes him lying in bed, looking up, watching a fly (a moveable dot!) creep across the ceiling, and wondering how to define its position. Another relates how he went into an abandoned oven and thought about the nature of a location. He came to a pair of new ways to describe a place with mathematical precision relative to a point on a plane or in space. Centered on an origin, with two or three lines at right angles to one another for his two-dimensional and three-dimensional systems, we cannot overstate the importance of these arrangements to modern mathematics.

By design, these systems necessarily entertained negative numbers. The notion of negative spaces is crucial in many instances. A bird flying with an airspeed of 20 miles per hour head-on into a 30-mile-per-hour wind moves negatively at 10 miles per hour relative to a fixed point on the ground. When loaded at sea, boats routinely find a portion of their hulls below the waterline, which Cartesian coordinate systems can describe as negative positions in space (often using the "waterline" as an axis).

By the time Descartes came up with his systems, scientists had long had the notion of front, back, left, right, up, and down to describe physical space. Therefore, his use of orthogonal axes made sense. Physicists, engineers, and mathematicians the world over loved it. No one seriously questions the utility of the Cartesian coordinate systems.

This book certainly does not.

But consider this: Are we, in all instances, bound to them? Are those schemes designed for the physical universe the end-all for economics?

Do we *require* negative dimensions?

Must we have right-angled axes?

It turns out that the answer to all of these questions is "no," as we will see throughout the following chapters.

Thus, this is a book about economic phenomena across multiple market dimensions. It bridges the fields of microeconomics and macroeconomics, and places them in a single collapsible and expandable worldview. It provides for the exhaustive study of any market or multiple or all markets simultaneously. We begin with four axes to describe any market and add three dimensions for each added market. This construct has no upper limit to the number of axes within it.

These observations about markets necessarily require novel ways to consider them. The most important of these new techniques in *Hypernomics: Using Hidden Dimensions to Solve Hidden Problems* (hereafter, *Hypernomics*) involves 1) the Law of Value and Demand, 2) Four-Dimensional

Coordinate System, 3) Five-Dimensional Coordinate System, and 4) N-Dimensional Coordinate System. This book addresses all of these concepts.

This book is the first of its kind at the time of its writing. That makes it dissimilar from others you have read about economics and may make this book appear very different from what you think you know. However, the phenomena described herein with these new constructs can trace their existence to the very first markets, which defines this book primarily as discovery rather than invention. It offers new views of transactions that date back to initial exchanges of goods and services between people, and trace through to modern times.

You, the reader, take part in them virtually every day.

Indeed, these trades of money for goods or services define markets. To many, market workings lie deeply embedded in mystery and are hard to discern. Myths abound. Solid facts are hard to find. This book's usefulness lies in its ability to separate economic facts from financial fiction and offer mathematically supportable ways to analyze markets empirically and determine the product features needed to enter given markets in an optimized fashion. Alternatively, given a product in a market, Hypernomics offers ways to enhance its profitability through price changes or feature modifications possibly.

So. . .what is Hypernomics? It is a new field of study, the name for which comes from:

> *Hyper-*
> *pref.*
> *3. Existing in more than three dimensions: hyperspace.*
> *[Greek* huper–*, from* huper*, over, beyond;]*[3]

and

> *-nomy*
> *suff.*
> *A system of laws governing or a body of knowledge about a specified field: aeronomy.*[4]

So, combining the suffix and the prefix, we get the singular noun that we call *Hypernomics:* "the study of forces in four or more dimensions."

Hypernomics unavoidably varies from standard representations that mimic the material world to do this. If you were to ask them, physicists would tell you that we live in a three-dimensional physical world. A line or axis describes movement forward and backward, one for right and left and another for up and down, with all axes at right angles or orthogonal.

If they consider it, time adds another dimension for physicists, a fourth. This three-dimensional framework works well for us in many respects. We can build buildings, boats, and aircraft or just about anything else with it and work out trajectories to distant objects. It allows us to solve a variety of mathematical problems.

While three-dimensional systems well describe physical properties, such arrangements do not do nearly as well with market economics. Physical dimensions bear little resemblance to economic dimensions. Concerning the empirical analysis of financial systems, as we will see through this book, a reasonably detailed analysis of any given market begins with four dimensions. Adding time gives us the fifth dimension. A deeper analysis reveals that other factors still influence demand, value, cost, and critical constraints on these dimensions. While not exhaustive, this book shows many such elements and their effects.

To date, most books on economics have used two dimensions to describe economic behavior. Changes over time have often been added as a third dimension in such analyses, though these studies typically have remained confined to straight and curved lines on a single plane. While usually contained in theoretical constructs, these approaches provide knowledge about various critical economic issues.

On the other hand, there are many questions in economics for which two and three-dimensional systems do not offer nearly enough flexibility or insight into the elements forcing or constraining their solutions, optimized or otherwise determined. This book directs itself to practical solutions to these real-world conditions. As these issues are diverse, cross the entire breadth of the world economy, and change over time, the study herein cannot possibly incorporate all the conditions that arise from such analysis. It amounts to a primer on the subject, a first cut. That stated, it offers new and valuable empirical ways to analyze markets to place products with justifiable reasons for success.

We will begin our study in two dimensions, as do many other texts. Then, we will expand our analysis to include three, four, five, and eventually n dimensions. While the limits of this text necessarily force us into two-dimensional representations of multiple dimensions, we will find that we can easily create a seven-dimensional model with a three-dimensional printer, creating physical market models that we can hold in our hands. We will do this not for show or academic exercise, but because this type of study reveals several important classes of analysis not attainable with other frameworks.

You may not have entertained such notions previously. That said, no matter what your background in business, economics, or mathematics is, you have everything at your disposal needed to become fluent with the most salient elements of Hypernomics. There are two significant reasons for this.

First, while this book offers different perspectives, it uses everyday objects you are familiar with to depict them. The most complicated visual frameworks you will encounter look like an extendable mirror, oddly shaped pie, or vertical Rolodex. These structures are the basis of the new coordinate system at the core of *Hypernomics*. You have undoubtedly seen bed sheets. Imagining sheets suspended over floors is also handy, as they represent the responses from buyers and suppliers alike. Finally, when it comes to visualization, the last distinct element you will need is the ability to imagine lines, which can take on many shapes. We must examine several types of them to represent economic forces adequately.

Second, and more familiarly, this book describes something you already intuitively know—your economic behavior and that of your friends, family, and everyone else. Hypernomics does not address some arcane concepts, such as String Theory, that you do not see yourself affecting in any discernible fashion. Among other elements, it addresses buyers' influence on the prices of goods and services provided to them in markets. As the book repeatedly emphasizes in various ways, markets are not hypothetical institutions you read about in books, magazines, or newspapers. In their most basic sense, markets consist of two groups: sellers and buyers. Have you ever purchased some vegetables? Bought electronics? Subscribed to a wireless service? You likely have made all these purchases at some time in your life. In every case, you helped form the market for the products in question. . .as a buyer. We will see how you valued the products you purchased and how others in the same markets made their value estimations. Subsequent purchases support sustainable prices in a process known as Value Estimating.

Understanding the worth of products, as revealed empirically through analysis of the markets themselves, is the key to understanding the Law of Value and Demand. The Law of Supply and Demand, about which you may have passing or even detailed knowledge, is, in fact, no "law" at all, as the Law of Value and Demand reveals. This is not to say that more than ample or limited supplies do not affect prices, which they empirically do. Instead, the Law of Value and Demand points out that outside of single-feature commodities (as, say, pure gold or silver or crude oil of a given grade), the would-be upward-sloping supply curves, as shown in many economics books in support of the Law of Supply and Demand, simply do not exist. Many markets have wide ranges of products with varying prices and quantities sold. Because of this, there are no sustainable market equilibriums in which supply curves and demand curves intersect at a single point to derive the quantities sold and price of goods for these markets, as Neo-Classical Economists would have you believe.

Instead, markets, like your body, manage to keep working through sustainable disequilibria. You can walk if your muscle power can overcome

Earth's gravity. Ships move forward if they have more thrust than drag. Helicopters rise skyward when they produce more lift than their weight. In much the same fashion, markets continue to function when producers sell goods or services for more than their costs and if, at the same time, they satisfy their consumers' value propositions consistent with their demand limits.

While long-standing point solutions for equilibriums for entire markets do not exist, there are special classes of vertical lines for individual products known as Profit Lines. Such lines describe per-unit profits of given goods or services and two or more of their features, costs, prices, and, in another dimension, their quantities sold.

The determination of Profit Lines turns out to be helpful.

Not having this information leaves market analysis, product formulation, and revenue projections to guesswork, which can be financially dangerous. We will entertain a few instances where such investigations went wanting and show how the producers of the products in question suffered gravely because of it. Sometimes, simple errors cost hundreds of millions to billions of dollars. Indeed, those producers would have instead kept those dollars in their pockets. Hypernomics shows how this is possible.

Even with the best applications of Hypernomics, it is quite possible to miss the most favorable positions in market spaces. You can follow a map and still get off course. However, using it allows you to visualize your destination. With a map in hand and eyes open to see what changes along the way, you have a better chance of getting there.

This dramatic break from conventional thinking often forces a particular organization on this book. In many chapters, a short section addresses the Neoclassical (or modern) Economics view of a specific topic to state the mainstream thinking on the subject to date very briefly. Immediately following this section is the Hypernomics viewpoint on the same subject. While the latter area will necessarily have to entertain some analytic geometry to get specific points across, separate endnotes address these topics more thoroughly, with more detailed mathematics supporting such analyses. Readers pressed for time who want to understand Hypernomics can forgo the details in those endnotes as the text within each chapter introduces the subject. Those who want to dive deeper into the workings of the economy and these new structures to describe them will likely find those endnotes helpful. They allow readers to recreate the results or extrapolate the topic at greater length. Vignettes sprinkled throughout the book show Hypernomics in action.

But enough talking about what we are going to see. Let's look at it.

Let's put some dots under the microscope.

CHAPTER 1

A Brief History of Position and Direction

"The day science begins to study non-physical phenomena, it will make more progress in one decade than in all the previous centuries of existence."

Nikola Tesla

ANCIENT MAPS

"Here are Dragons" (*HC SVNT DRACONES* in the original Latin). These are the words of warning on the Lenox Globe (c. 1510) near the eastern coast of Asia. Such admonitions were common during the early Renaissance, as cartographers laced uncharted regions with hippos, lions, and sea monsters on their maps to scare away explorers. The unknown was terrifying. It still is.

Not knowing a safe way to get to the clean water on the Serengeti can get you killed. Every cave dweller knew that. What they needed to know was where the bad routes lay. Survival, then as now, depended on learning how to get from here to there in one piece.

You do not want to die of thirst. Yet, you do not want to have to guess about how to get to a river in the safest fashion, either. If you are on an isolated hike, something as simple as a badly sprained ankle can be fatal. You may need to deal with the good paths, the obstacles, the predators, the people along the way against whom you compete, and those with whom you conduct commerce—all of them to stay alive. What to do? Where to go? How to do it?

Humans have many capabilities brought on by millions of years of evolution. Our ancestors demonstrated our faculty for abstraction in the Serengeti, where researchers found some of the first stone tools, and animal

remains together, suggestive of early hominin mutual support dating back roughly 2 million years ago. As members from that prehistoric campsite walked together across the often-uneven Olduvai Gorge, they must have seen the dangers of the terrain and the predators. Marches like those going on over the millennia may have forced the hikers to speak for the first time. The first cliff avoided, the lion attack thwarted, or an enemy fought off due to the first vocalized warning must have been quite a heady moment. Language was here to stay. The more information early humans could convey to one another, the better. Clearly, in our digital age, this trend continues.

Proto-languages appeared between 600,000 and 2.3 million years ago, with formal language developing only about 100,000 years ago. Written language, by contrast, only goes back about 5,500 years. In between, people discovered something often equally important. They found the art of map making.

Anthropologists have discovered that maps existed at least 6,000 years ago and may reach back 25,000 years, with the earliest recorded map-like representation of the terrain around Pavlov in the Czech Republic.

Imagine that your tribe has a rudimentary sense of this mapping technology (and none of your modern conveniences) as you live back in the Stone-Age Serengeti. Suppose your slightly older brother had drawn a diagram in the dirt showing the best way to get to the water. Maybe you would not have comprehended the sketch just a few years earlier, but now, with your growing cranial capacity and enhanced imagination, you do. You can understand its meaning. You see what to avoid and where to go. Now instead of having to dodge black mambas as they lunge at you out of their hole in the outcropping beside a ledge, you have a drawing that shows where they live. Where are the lions' dens? What parts of the river should you avoid because the black rhinos and crocodiles like to frequent them? To which location did the warring tribe move? A well-drawn map could show you all of that and more.

Of course, not everyone is out to get you. Maps can show you directions from one place to another and help you determine what you might find when you get there. Once again, suppose you were back in Olduvai Gorge with your brother and the rest of your tribe. You know you are good at making stone hand axes, but you cannot easily access figs. Meeting people at what might have been the first version of a marketplace would allow you to exchange one for another. You have to know where to find the market. It has a position. How do you get there? What are the directions to it?

The earliest maps were local by nature, describing as they did the surroundings near the cartographers who created them, and virtually all of the mapmakers drew their representations of the nearby geography as if from a bird's-eye view, as in Figure 1.1.

FIGURE 1.1 Perhaps the earliest authenticated map in the world is this one depicting a town in west-central Turkey, hard against an erupting volcano. It dates to about 6,000 BCE.[1]

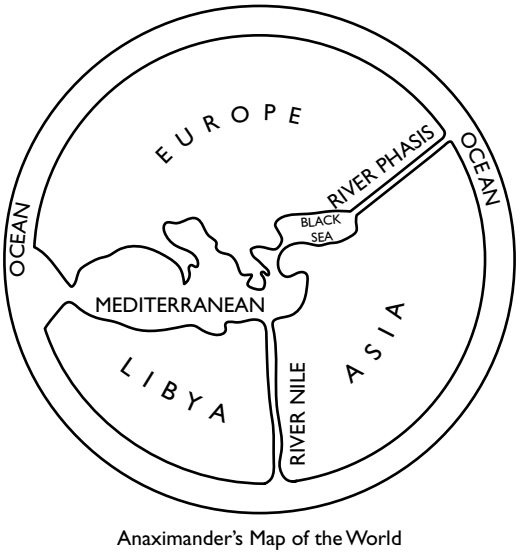

FIGURE 1.2 Anaximander's world map, c. 570 BCE.[2]

While mapmaking graduated to regional and worldwide scales, the tradition of representing the countryside as if we are looking down on them from the sky continues. As we will discover in Hypernomics, however, thoroughly entertained economic landscapes require different types of imagery.

There was a long transition from local to global maps. Credit for inventing the first map of the known world goes to Anaximander of Miletus,

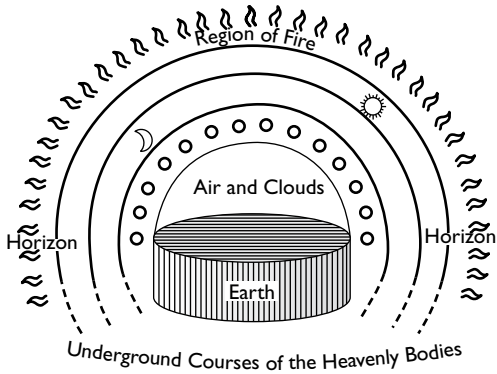

FIGURE 1.3 Side view of Anaximander's worldview, c. 570 BCE.[3]

around 570 BCE. Anaximander imagined the world as cylindrical and drum-shaped, and, when viewed from above, it consisted of Europe, Libya, and Asia surrounded by a circular ocean.

The idea that a ring of ocean circled the known dry land dates back to Homer, though he never recorded it.[4] This map, shown in Figures 1.2 and 1.3, may seem crude by modern standards. However, it offered its users some information they never had before in a single document: its worldview offered physical relationships between landmasses and seas and oceans, thus highlighting physical borders for all to see. It spelled out the relative positions of Europe, the Black Sea, Asia, and the Nile River and indicated the perceived sizes of all its landmasses and oceans. It, of course, lacks many of the features we have come to expect in modern maps. It has poorly defined coastlines; its proportions are inaccurate; the map shows rivers running from one sea to another. Moreover, the Earth's shape is more like a sphere than a drum.

Importantly, though, it offers a view of the world. Just because it is not nearly as accurate in its view of what we now call modern maps does not mean it was not extremely important in its time. As the biologist Richard Dawkins points out, "Vision that is 5 percent as good as yours or mine is very much worth having in comparison with no vision at all. So is 1 percent vision better than total blindness. And 6 percent is better than 5, 7 percent better than 6, and so on up the gradual continuous series."[5] With Anaximander's map, people knew the relative positions of Greece to Italy and Greece to Egypt and Turkey, the main rivals of that era along the Mediterranean. Knowing competitors' positions is always vital.

GEOGRAPHY BEGINS

Centuries later, Eratosthenes (275–195 BCE), in addition to being the first person to use the word *geography* as he invented the field, devised meridians, or north to south lines, and "parallels," imaginary east to west lines, which divided the Earth into sectors. We see his map in Figure 1.4. Eratosthenes spent a significant effort figuring out the distance between his home in Alexandria, Egypt, and the ancient Egyptian city of Swenet (now known as Aswan), which he believed to lie on the Tropic of Cancer. Using the distance between the two towns and a gnomon that he placed in Alexandria at noon at the summer solstice, he worked out the circumference of the Earth. He may have been accurate to within 1% of the actual figure. His earth grid system allowed people to calculate their position globally for the first time. Every point on the planet would forever have its place designated by its latitude and longitude.

MATH AND POSITION PROBLEMS

Mathematics took quite a bit longer to work out an analogous coordinate system. In 1637, working independently, René Descartes and Pierre de Fermat came up with the ideas that formed the bases for the Cartesian coordinate systems.

From Descartes' standpoint, the story (or myth) of its discovery was that he was lying in bed and observed a fly enter his room. Wondering how he could portray its position as it crawled across a wall, he envisioned the two-dimensional system. He came up with the three-dimensional design as it flew about the room. When other mathematicians enhanced these fledgling systems, they became the two-dimensional and three-dimensional Cartesian coordinate systems displayed in Figures 1.5 and 1.6, respectively. These systems allowed the development of calculus by Sir Isaac Newton and Gottlieb Leibnitz, who each separately derived this new branch of mathematics. Newton started his work in about 1666, but published nothing about it until 1693 and only gave his complete account of it in 1704. Meanwhile, Leibnitz offered his full description of the subject in 1684. The legendary dispute over who should have credit for the discovery of calculus has ended as both men have had their contributions recognized.

John von Neumann said, "The calculus was the first achievement of modern mathematics, and it is difficult to overestimate its importance. I think it defines more unequivocally than anything else the inception of

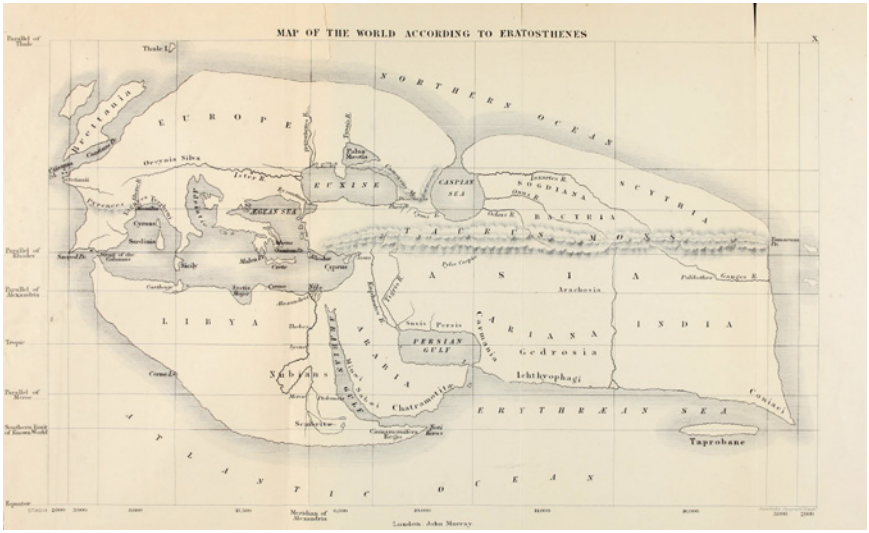

FIGURE 1.4 Here is a world map by Eratosthenes, c. 194 BCE. Note the use of parallels and meridians, an invention by Eratosthenes and a first in mapmaking.[6]

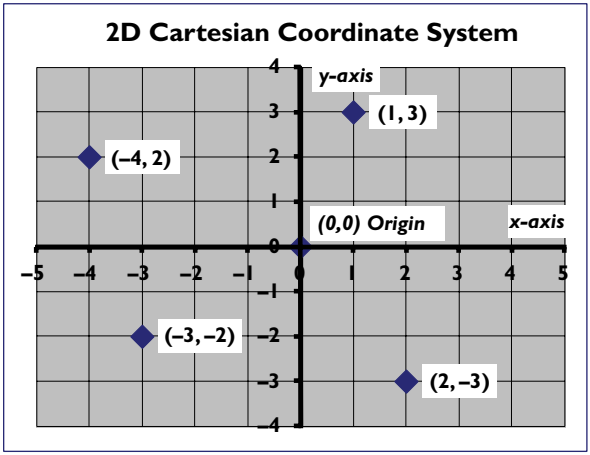

FIGURE 1.5 The 2D Cartesian coordinate system.[7]

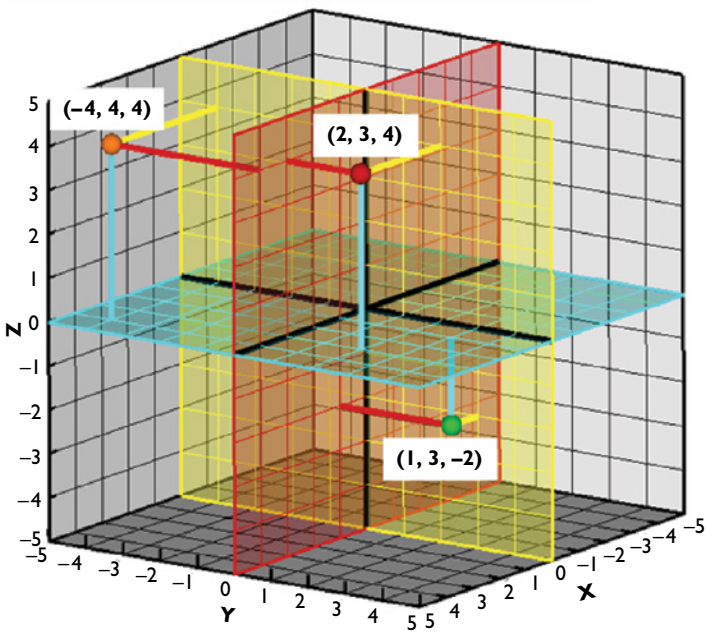

FIGURE 1.6 The 3D Cartesian coordinate system.[8]

modern mathematics, and the system of mathematical analysis, which is its logical development, still constitutes the greatest technical advance in exact thinking."[9]

While "exact thinking" is not always possible in using the principles from Hypernomics, given that it studies the statistics and analytic geometries of consumer and producer behaviors, the drive to be *more exact* is always a goal. As we will discover later, exactness is a function of our accuracy (how far away from our target are we?) and precision (how broad are our errors?). We shall strive to improve both. Goods and services face competing products with a wide variety of features. It is not enough to design and build a product and see "what the market will bear." Many companies do that. Many products fail. But what if we could *map competitors' positions* and *determine customers' directions* about product features in advance? If we could do that, we could minimize competition while offering clients what they want, do not have, and can afford. This may seem impossible, but it is really at the heart of this book—and it turns out that we can do just that. However, we first need to know positions and directions in an economic space to enable that.

As sailors have long known, having a position is not the same as knowing your place. Understanding one's location and heading on the ocean is incredibly crucial. While determining latitude was relatively easy on the sea centuries ago, finding longitude was not. Oceans do not offer the stable, immovable surfaces that dry land affords, and calculations of east-west locations were often fraught with significant errors. Given that the Earth rotates 360° per day or 15° per hour (in mean solar time), time and longitude have a direct relationship. With the prime meridian (0° west longitude) in Greenwich, United Kingdom, and Denver, Colorado, at 105° west longitude, we know that if it is noon in Greenwich, it is 5:00 a.m. in Denver. We know this not only concerning the time within each city's time zone but also, more significantly, in the sense that the sun will be at its highest point in the sky on any given day in Denver seven hours after that happens in Greenwich. Because of this phenomenon, knowing one's longitude with the requisite exactitude to navigate effectively and avoid known obstacles is possible *if* one has a chronometer with sufficiently high precision. In the early 1700s, however, sea-faring timepieces could not regularly offer the accuracy needed to avoid disaster.

After leaving Gibraltar on September 29, 1707, less than a month later, on October 22 (November 2 on the new calendar), some of the 21 ships returning to Portsmouth, England, led by Commander-in-Chief of the British Fleets Sir Cloudesley Shovell, found themselves badly off course. Believing they were nearly 100 nautical miles south-southeast of where they were, four ships crashed into the low rocks off the Isles of Scilly and sank.

At least 1,400 and perhaps over 2,000 marines, sailors, and officers died in the disaster.

In the aftermath of this catastrophe, finding that errors in navigation were the root cause of the event, the British government passed the Longitude Act in 1714, which established the Board of Longitude and offered large cash prizes to anyone who could accurately determine longitude at sea. John Harris, an English carpenter turned clockmaker, largely solved this problem with his series of timepieces developed over four-plus decades. King George III tested one of the later versions in 1772 and found it accurate to within one-third of a second per day. At sea level, one minute of angle along the equator or a meridian is approximately equal to one nautical mile, which is exactly 1,852 meters or about 6,076 feet by international agreement. With 60 seconds per minute, each second is about 101 feet. With John Harris's chronometer to King George III, a third of a second error translates to about 34 feet per day. Had that instrument been available to Sir Cloudesley Shovell's navigators and properly used, the east-west course error over the 23 days since they began their voyage and crashed into the rocks would have been about 780 feet, not the error measured in dozens of miles that they had.

Note that the position problem for the Scilly misadventure was not only one of mistaken longitude but one of errant latitude as well. The badly miscalculated estimate of their north-south position may have been due to human error that added to the miscalculation in predicted longitude and prevented ships from finding safe passage through the English Channel. History shows that that combination on the high seas was deadly.

By contrast, when the latest product goes bust in the market, people seldom die over it. Fortunes dedicated to its development may be forever lost, and companies funding such products are placed under deep financial stress. They wonder what went wrong. Mariners discovered they had to know their positions and headings and compare them to their charts to make it safely to their destinations. Mathematicians found they could describe instantaneous points in space, direction, speed, and acceleration for various objects. At the same time, companies have long speculated: What must we do to become more profitable? What position and direction should we take?

At the same time King George III wandered about London with John Harris's chronograph, a Scottish philosopher wondered about economics. In 1776, after 10 years of working on it, Adam Smith published *An Inquiry into the Nature and Causes of the Wealth of Nations* (usually shortened to *The Wealth of Nations*). This was the first deep look into the subject, and because of that, many modern scholars hail Adam Smith as the "father of modern economics."

As the field was wide open as he invented it, he focused his study on what most now call *macroeconomic* behaviors. This field addresses the structure and behavior of a national, regional, or world economy. This contrasts with *microeconomics,* which studies the component elements of national economies, including firms, households, and consumers.

While Smith addressed many topics, we shall concentrate on one of his most enduring points. This is his notion of "an invisible hand," or, more broadly and less figuratively, the enlightened self-interest of producers to give the public what it needs.

Smith described that idea in this way:

> *As every individual, therefore, endeavours as much as he can, both to employ his capital in the support of domestic industry, and so to direct that industry that its produce maybe of the greatest value; every individual necessarily labours to render the annual revenue of the society as great as he can. He generally, indeed, neither intends to promote the public interest, nor knows how much he is promoting it. By preferring the support of domestic to that of foreign industry, he intends only his own security; and by directing that industry in such a manner as its produce may be of the greatest value, he intends only his own gain; and he is in this, as in many other cases, led by* an invisible hand *to promote an end which was no part of his intention. Nor is it always the worse for the society that it was no part of it. By pursuing his own interest, he frequently promotes that of the society more effectually than when he really intends to promote it.*[10]*. . . . It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner but from their regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages.*[11]

That there are forces afoot that allow producers to maximize their gain and promote positive outcomes for their customers is a firmly held tenet in this book. In this regard, Hypernomics aligns itself with *The Wealth of Nations*. As we march further into the work at hand, however, we will discover those producers *must* promote their customers' interest in particular ways. Those ways will vary from market to market but always involve specific, *visible* product points relative to Value Space and Demand. Businesses can succeed to the fullest extent possible through the deliberate satisfaction of their clients. With this tenet, this book is diametrically opposed to *The Wealth of Nations*.

It was hard to understand until Hypernomics's observation that "visible hands" work throughout the economy. Consumers place values and limits on goods, which are readily discernible. The economic forces at work were not fully apparent to Smith, given his era's lack of data and mathematical modeling techniques. In modern times, however, we can make manifest "visible hands" within and across markets with enough research and mathematics. Correctly displayed, they allow us to see what had been previously unseen.

A previously invisible atmospheric occurrence became apparent after the 1883 eruption of the Krakatoa volcano. Observers noted that ejected ash went high into the atmosphere and flew in a fast, thin meandering river of air running west to east.[12] Initially called the "Krakatoa easterlies,"[13] we now call these phenomena the jet streams, as depicted in Figure 1.7. These air currents range in altitude from 23,000 to 52,000 feet, are one to three miles thick, up to hundreds of miles wide, and may run in length for thousands of miles. Once discovered, pilots from World War II flying from the United States to the United Kingdom could use these air columns to their advantage. They are powerful enough to add 100 miles per hour or more of ground speed from high-flying aircraft flying west to east or remove an equivalent amount for vehicles moving east to west. Predicting jet stream movements and strength is vital in modern aviation and weather forecasting. Knowing that jet streams are forceful, movable, and real are reasons to study them if your livelihood depends on them, even if you cannot always see them.

Adam Smith understood that fundamental forces are at work in the economy and created a landmark book to describe them. We now call his brand of study classical economics. While he addressed the idea of economic position little, if at all, he understood the notion of economic direction from the beginning. He noted, "[W]hen cultivation is extended over the greater part of the country...[then t]here is then more bread than butcher's meat. The competition changes its direction, and the price of butcher's meat becomes greater than the price of bread."[14] Mathematical explanations of the economy's position and direction were not yet apparent in Smith's era. Had they been, Smith likely would have employed those devices.

The ability to describe position and direction mathematically took a significant leap forward with the advent of regression analysis. Invented by Adrien-Marie Legendre in 1805[15] and refined by Carl Friedrich Gauss in 1809[16] and 1821,[17] regression analysis allows forecasters to find trends in data. Legendre and Gauss were tracking celestial bodies and needed a way to predict where those objects would be, based on where they had been. To do that, they had to invent and refine a process known as least squares regression.

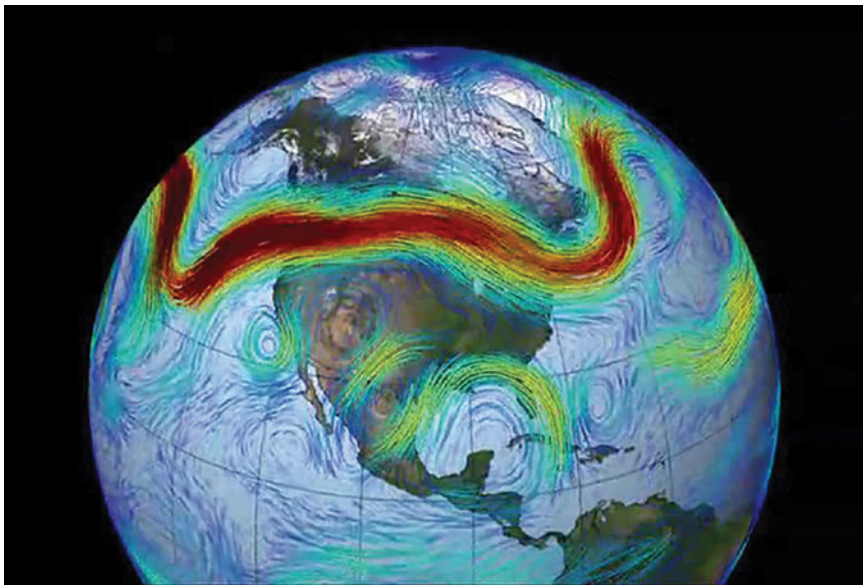

FIGURE 1.7 Usually invisible but always real: there are prevailing wind currents across the globe; the fastest of these are the jet streams capable of speeds of 200 miles per hour, which were unknown until 1883.
Note: NASA/Goddard Space Flight Center, 24 January 2012
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Source: https://en.wikipedia.org/wiki/File:Aerial_Superhighway.ogv

Regression analysis considers the position of the points in a data set and finds the mathematical direction through them.

As shown in Figure 1.8, given a series of independent variables (in this case, engine size in cubic centimeters) and dependent variables (All-Terrain Vehicle or ATV prices) depicted as a series of ordered pairs (every dot on the figure represents the engine displacement as the horizontal component and price as the vertical element of a single ATV model), regression analysis finds the line of best fit through the data.[19] If that line satisfies specific established criteria, as does the one in Figure 1.8, we say it is statistically significant, meaning we can use it for predictions.[20]

Decades later, Alfred Marshall, with his 1890 book *Principles of Economics,* founded the field we now call neoclassical economics. Because of that, many recognize him as the father of modern economics (thus taking it from Smith). Along with Keynesian economics (which addresses macroeconomics), neoclassical economics (primarily concerned with microeconomics) dominates the mainstream study of the field today. As a practical matter,