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CLOUDONOMICS

The Business Value of Cloud Computing

Joe Weinman

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Additional praise for *Clouddonomics: The Business Value of Cloud Computing*

It is a business imperative to do more with less—and do everything faster. *Clouddonomics* offers a much-appreciated framework for sorting through cloud computing options and the marketing hype.

—Lorraine Cichowski, SVP and CIO, Associated Press

Joe Weinman is one of the foremost thinkers in cloud computing. He has captured a topic of fierce complexity and expressed it with elegant prose and simple, powerful, and compelling mathematical rigor. Weinman delivers his arguments with a clarity and logic that is unassailable. *Clouddonomics* should be required reading for every enterprise CIO seeking a way through the clutter and hype of vendors' cloud solutions and looking for a set of crystal clear, mathematically grounded, and meticulously presented arguments that show the way through the morass of cloud computing.

—Simon Crosby, PhD, CTO, Bromium; founder and former CTO, XenSource; former CTO, Data Center and Virtualization, Citrix

Clouddonomics is a seminal work on cloud based on an axiomatic mathematical theory, and not on popular opinions and baseless assumptions. Based on rigorous quantitative analysis, the book is amazingly simple to read with real-world examples in a lucid language that will resonate with both the technical and business professional. This book is a must-read for every

professional interested in cloud and is an invaluable reference for any advanced course on cloud computing.

**—Ravi Rajagopal, VP, Cloud Strategy and Solutions,
CA Technologies; Adjunct Professor, New York
University**

Joe Weinman's masterful book looks past the hype to offer new insights into the impact of cloud computing. *Clouconomics* is must-reading for anyone interested in a more analytically based understanding of the cloud's transformative potential.

**—Christopher S. Yoo, John H. Chestnut Professor of
Law, Communication, and Computer & Information
Science and founding director of the Center of
Technology, Innovation and Competition, University
of Pennsylvania**

The cloud is redefining how technology is being used for businesses. *Clouconomics* is a book that will help you understand the economics and importance of this change and what it means for your industry.

**—Om Malik, founder, GigaOM & Structure: the Cloud
Computing conference**

Cloudbconomics

The Business Value of Cloud Computing

JOE WEINMAN



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To Paige, Ali, and Sierra

Preface

In the course of human history, there have been a number of bona fide revolutions in the interdependent arenas of technology, society, religion, economics, and politics: flint tools, money, writing, agriculture, democracy, printing, steam power, capitalism, mass production, telephony, and electricity, to name a few. We are 65 or 70 years into one such revolution—the *information age*—which has permeated every corner of the earth and beyond—from video games to war games to baseball games, and from first-world stock markets to third-world fish markets, to out-of-this-world interstellar probes.¹ Oh yes, and musical greeting cards, talking dolls, and intelligent thermostats too.²

Does the advanced age of this advanced age signal impending retirement? Some argue that “the opportunities for gaining IT-based advantages are already dwindling,”³; however, this sounds suspiciously similar to alleged pronouncements, such as “everything that can be invented has been invented” or “there is a world market for maybe five computers.”⁴

The revolution is accelerating, not slowing.

Technologies such as quantum computing, digital electroholographic displays, brain-computer interfaces, natural-language interaction via speech-to-text and semantic processing, homomorphic encryption, and new electronic components such as HP’s nanoscale memristor, Intel’s three-dimensional chips, and on-chip optical interconnects are still in their infancy. Innovative cognitive computers are now being designed by IBM to use “brainlike” neurosynaptic chips. Other disturbing anomalies, from quantum entanglement to apparently faster-than-light neutrinos, may form the foundation for future disruption.⁵

In this ocean of innovation, *cloud computing* is the latest of successive waves that have eroded the shoreline of prior paradigms, such as the mainframe, the minicomputer, and the personal computer.

Cloud computing is a tsunami of transformation exemplifying Schumpeterian creative destruction: amassing immense wealth for companies that didn't exist a few years ago—such as Google, Facebook, Amazon, [Salesforce.com](https://www.salesforce.com), and Zynga; disrupting long-standing business models and ecosystems including publishing, advertising, television, the recording industry, telecommunications, and retailing; and reordering relationships within the computing industry: among hardware vendors, licensed software vendors, distributors, value-added resellers, and systems integrators, to name a few.

The cloud is both an existential threat and an irresistible opportunity. Virtually any summary of key trends or chief information officer (CIO) focus areas ranks cloud computing at or near the top of the list. A recent Gartner survey of 2,000 CIOs places cloud computing as the number-one technology priority.⁶ Most if not all of the rest of the top priorities—virtualization, mobility, collaboration, business intelligence—enable, are enabled by, or otherwise relate to the cloud.

Wharton fellow and author Jeremy Rifkin would consider this to be a natural consequence of “the Age of Access.”⁷ He has argued that the market economy—in which people own and trade goods—is being replaced by the network economy—where people pay to access them. Why bother owning something if you can access it anytime, anywhere? People don't want drills but the holes that they make; people don't want CDs or applications but the music or functionality that they provide.

Although Rifkin has positioned this trend as something new, in many respects it represents a return to a prior age.

After all, the idea of content ownership is relatively new: Before *owning* records, CDs, or MP3s, people *accessed* audio content via the concert hall or radio; before VHS, Beta, or DVDs, there was broadcast and cable television, movie theaters, and, even earlier, plays and operas. In the Age of Access 2.0, however, the logic, characteristics, and payment models are certainly changing. Rather than traveling to theaters and opera halls, the content comes to you; unlike broadcast, it is personalized, contextualized, and on demand.

So the cloud is the *new*, new thing, but what it actually *is*, is a matter of disagreement. Cloud computing, so named by Ram Chellappa of Emory University, is, at a high level, computing that is done *somewhere* out there in an undisclosed location away from your own laptop, smartphone, tablet, or data center.⁸ The cloud model applies to the discovery and acquisition of applications, services, and content, such as eBooks from ebookstores; tablet and smartphone apps from app stores; songs from Lady Gaga on Vevo or blockbuster movies on demand; and customer relationship management software executed far from your device. The cloud is at the heart of social networks such as Facebook and LinkedIn, social games such as Zynga's FarmVille, microblogs such as Twitter, and texting, messaging, and mail such as AOL Instant Messenger, RIM's BlackBerry Messenger, Microsoft Hotmail, and Google Gmail. But it also applies to the core infrastructure (computer servers and data storage), the utility software (middleware and databases), and the currency of the digital economy, "big data" (petabytes of information), that together enable those applications to run at the scale of millions or hundreds of millions of users.

Like the parable of the blind men describing an elephant—one feels the legs and says the elephant is like a pillar, the other the tail and says it is like a rope—or perhaps like real

cloud gazers—one sees a rabbit, one his Aunt Martha—everyone has a different perspective on the cloud. Some see a new technology, say, virtualization; others, a new silo-busting integrated development and operations model; others, a means of delivering software functionality; still others, an ecosystem that enables applications spanning mobile devices, networks, and cloud-based resources and services. They are all correct in their own way.

For the purposes of this book, however, we consider cloud computing primarily from the business, financial, and economic perspective: *Clouconomics*, to use the term I coined in the summer of 2008 for Clouconomics.com and a blog post for the popular technology site GigaOM.com, syndicated to *BusinessWeek*.⁹ As such, we consider core characteristics of the cloud—on-demand resources, usage-based charging, resource sharing, geographic dispersion, and the like—and how they map to and drive business—and even societal—value.

I would claim that such a perspective is one of the most important ways to evaluate and exploit the cloud, since *unless a technology drives compelling value, it will end up in the dustbin of history*. Remember the CueCat barcode reader?¹⁰

The value of the core characteristics of the cloud has been proven time and again in domain after domain: hotel chains, airlines, electric utilities, taxi services, manufacturing service providers, and others. Taxis offer transportation capacity on an on-demand, pay-per-use basis. Banks rent resources as well—principal—on a pay-per-use basis—interest. Companies can buy workers' services from what could be called the "labor cloud" either on a flat-rate basis—a salary—or a pay-per-use basis—hourly wages.

Ubiquitous access and location independence are key. When you order a *physical* book from Amazon.com or DVD from Netflix, you don't really need to know what distribution

center it was sent from as long as it arrives on time, and when you order an eBook from [Amazon.com](https://www.amazon.com) or stream a video from Netflix, you don't really need to know what data center it came from. Either way, you trust that the provider has figured out the appropriate locations to get you what you want within the time frame that you would like and to which you agree via the terms of service.

In the pay-per-use model of the cloud, we see the same charging model used by hotels and barber shops. In on-demand provisioning, we see the same resource allocation strategy used in accessing energy resources by turning on an electric switch, or financial resources by tapping into a home equity line of credit. Geographically dispersed data centers and content-delivery networks echo the approach used by coffee shops and fast food chains to distribute their wares globally. Resource sharing of computer servers in a cloud data center is not that different from sharing servers—waiters and waitresses—in a restaurant.

These are more than casual analogies; the point is that the same immutable principles—say, resource utilization improvements from demand aggregation or diminishing returns from investments in geographic dispersion for latency reduction—apply *regardless* of domain. I call these the *Laws of Cludonomics*. The Laws of Cludonomics are not restricted to cloud computing any more than the Law of Gravity is restricted to apples.

From these parallels—and an analysis of underlying, abstract models—we can determine that there are quite a few characteristics and behaviors that contravene simplistic thinking, a sort of freakonomics of the cloud. For example, branch expansion is doomed to fail eventually. Rational customers often should be *delighted* to pay *more* for cloud services—really—even when there are *no differences* in characteristics such as performance or security. It can cost nothing to accelerate performance. Even after both heavy

and light users switch rate plans from flat rate to pay-per-use or vice versa to save money, a firm or industry can maintain revenues. As the cost of IT plummets, IT spend will stay the same—or increase.

This book doesn't focus on industry market projections or vendor offerings but rather on strategy, business models, customer value, and their relationships. The intent of this book is to be multidisciplinary, seminal, evergreen, rigorous, forward-looking, and irreverent and to appeal to a broad range of customers, prospects, strategists, venture capitalists, investors, technologists, executives, service providers, and academics, both within the field of cloud computing and beyond.

This book is first and foremost *multidisciplinary*, drawing on illustrative industry examples but also a broad range of fields: strategy, economics, psychology, system dynamics, calculus, statistics, computing technology, and theoretical computer science, with forays into botany, biology, and physics. Most readers should find most of the book quite readable, and experts in a variety of fields should find the breadth of *Clouconomics* of interest.

Second, I hope that much of this book is *seminal*. I believe I've been first to explore a number of areas as they relate to the cloud, such as the architectural implications of cost optimization, analysis of latency for interactive applications using packing of spherical caps, and computational intractability of networked resource allocation.

Third, rather than conducting a *Consumer Reports*-style analysis of ratings of the different vendors and service providers that would be out-of-date before the book is even published, the intent is for the book to be *evergreen* (i.e., usable for a long time to come) in assessing architectural and business alternatives, developing new business models, and incorporating cloud into your own business strategy.

The suffix “-nomics” has been used for important insights into business trends and strategy—Eric Qualman’s *Socialnomics* on social media, Ken Doctor’s *Newsonomics* regarding the digitalization of news, and Don Tapscott and Anthony Williams’ *Wikinomics* covering IT-based collaboration—to the more quantitative *Freakonomics*, presidential economic policies such as Reaganomics, Clintonomics, and Obamanomics, and humorous insurance advertising—Geckonomics. However, *Cloudonomics* is quantitatively rigorous. I’ve skimmed the surface of much of the math for this volume. However, it is worth noting that most claims are supported by detailed proofs. My research has taken me far afield of “the cloud” and uncovered unusual connections. For example, cell site or content delivery network node placement is related to cannonball stacking, the Tammes problem—solved by evolution—of designing pollen spores, and the Thomson problem of minimum energy electron configurations, which in turn relates to baryon density isosurfaces of Skyrmions, whatever they are.¹¹

References are provided to more detailed papers and to my simulation Web site: ComplexModels.com, which provides easy-to-use Monte Carlo simulations illustrating the Laws of Cloudonomics.

Of course, being overly quantitative can lead to precise yet *incorrect* conclusions due to quirks, biases, and anomalies in human behavior, which I will touch on. These experiments have led to more than one Nobel Prize in economics¹² and provide fascinating insights into what Duke University professor Dan Ariely calls “predictable irrationality.”¹³

Cloudonomics posits forward-looking scenarios for cloud computing and industry ecosystem evolution and revolution. For example, braking at high speed through a turn on a wet road used to be the domain of professional stunt drivers;

now any driver can perform at the same level using standard antilock braking systems (ABS), electronic stability control, and traction control. Similarly, proprietary virtual server provisioning tools, for example, are not likely to offer sustainable competitive advantage to a cloud service provider. This technology is diffusing just like ABS.

Finally, the book is *irreverent*, challenging conventional wisdom. The truth in cloud is often counterintuitive and nuanced; better mental models mean better business and technology strategies and investments.

I hope to provide a lens to view the world of cloud computing economics, so that you can consider my questions and evaluate my arguments but draw your own conclusions. I do not necessarily provide all the answers but present models with which you can perceive, comprehend, and thereby exploit the cloud for your own uses, whether as a customer, service provider, equipment manufacturer, software vendor, venture capitalist, or investor. This is not the end of the dialogue, but the beginning.

¹Michael Lewis, *Moneyball: The Art of Winning an Unfair Game* (Norton, 2003). Robert Jensen, "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector," *Quarterly Journal of Economics* 122, No. (2007): 879–924.

²www.nest.com/living-with-nest/.

³Nicholas Carr, "IT Doesn't Matter," *Harvard Business Review* (May 2003). 81(5) 41–49.

⁴These quotes are of questionable authenticity. See Kevin Maney, "Tech Titans Wish We Wouldn't Quote Them on This Baloney," *USA Today*, July 5, 2005.

www.usatoday.com/tech/columnist/kevinmaney/2005-07-05-famous-quotes_x.htm.

⁵Adrian Cho, "From Geneva to Italy Faster than a Speeding Photon?" *Science*, September 30, 2011, Vol. 333, No. 6051, p. 1809.

⁶Gartner, "Gartner Executive Programs Worldwide Survey of More than 2,000 CIOs Identifies Cloud Computing as Top Technology Priority for CIOs in 2011," *Gartner Newsroom*, January 21, 2011. <http://www.gartner.com/it/page.jsp?id=1526414>.

⁷Jeremy Rifkin, *The Age of Access: The New Culture of Hypercapitalism, Where All of Life Is a Paid-For Experience* (Tarcher, 2001).

⁸www.bus.emory.edu/ram/.

⁹Joe Weinman, "The 10 Laws of Clouconomics," *GigaOM.com*, September 7, 2008, <http://gigaom.com/2008/09/07/the-10-laws-of-clouconomics/>. Joe Weinman, "The 10 Laws of Clouconomics," *BusinessWeek*, September 6, 2008, www.businessweek.com/technology/content/sep2008/tc2008095_942690.htm.

¹⁰Dan Tynan, "The 25 Worst Tech Products of All Time," *PCWorld*, May 26, 2006. www.pcworld.com/article/125772-8/the_25_worst_tech_products_of_all_time.html.

¹¹Gerald Edward Brown and Mannque Rho, *The Multifaceted Skyrmion* (World Scientific Publishing, 2010).

¹²Technically, the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel, nobelprize.org.

¹³Dan Ariely, *Predictably Irrational: The Hidden Forces that Shape Our Decisions* (HarperCollins, 2008).

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The usual disclaimers apply; I take full responsibility for any errors, which, sadly, have a nonzero probability of existing in a book of this scope.

Any delineation of the main causal path of events leading to my involvement in the cloud would have to include Eric Shepcaro, Allan Leinwand, Om Malik, and Alistair Croll. I worked for Eric beginning at the turn of the millennium when he was AT&T's senior vice president of application networking. We were pioneers in introducing new hosting

services—called utility computing at the time—and, thanks to Eric, I was an active participant in Don Tapscott’s IT & Competitive Advantage program—the syndicated research effort that led to *Wikinomics* and included in-depth collaboration with a host of thought leaders: Don himself, David Ticoll, Joe Pine, Anthony Williams, Rena Granofsky, Paul Strassmann, Erik Brynjolfsson, Charlie Fine, Mike Dover, and others.

Eric also introduced me to Chris Albinson and Allan Leinwand of Panorama Capital, who invited me to join their Technology Advisory Board. Allan also introduced me to Om Malik. My first official cloud event was Om’s Structure, in June 2008, where I was on a panel moderated by Alistair, who asked a number of thought-provoking questions, which in turn led to my first blog posts for GigaOM.com, including “The 10 Laws of Cludonomics.” This book is a 100,000-word-plus expansion of the “Laws” post and a number of others I’ve done for GigaOM.com.

Om is the epicenter of the cloud, between his own social and professional network, the focus GigaOM.com and GigaOM Pro put on it, and the Structure event, which I’ve had the pleasure of participating in as MC, moderator, and panelist since its inception. At Giga Omni Media, I’ve had the good fortune to work with Paul Walborsky, Stacey Higginbotham, Surj Patel, Derrick Harris, Carolyn Pritchard, Celeste LeCompte, Mike Sly, a host of cloud innovators and executives, and the magnificent Magnify Communications team: Stacey Tomlinson, Erin McMahon Lyman, and Jill Short Milne.

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