Financial Innovation and Technology

Martin Užík
Christian Schmitz
Sebastian Block *Editors*

Financial Innovation and Value Creation

The Impact of Disruptive Technologies on the Digital World

Springer

Financial Innovation and Technology

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Research, diligence, and continuous as well as determined work of the whole team are behind this publication. The editors would like to thank all authors and supporters of this book project for their patience. A special thanks goes to Martha Solveig Münnich for her tireless and continuous revision of the individual contributions as well as their additions and changes.

Preface

Ever since the Internet was first established in 1983, people around the world have continuously adapted by applying this new digital technology to socializing, economics, and even solving overarching health questions on a global scale. In all economies, a shift of global demand to digital services has led to a clear picture of digital dominance associated with companies like Google or Facebook.

Many are seizing the various new opportunities and have acquired a rich set of individual skills and experiences in the economics of the industrial world. Global markets and businesses have evolved in a way that could be perceived as predictable, reliable, controllable, and evolutionary. The dynamics of change have been driven by the burst of economic bubbles, globalization, and tectonic shifts in global politics and societies.

Nowadays, technologies are not only door openers to the digital world, but they are also key drivers of change. Fueled by accelerated pace, these key drivers of digitalization literally force individuals to adapt. We aspire to comprehend those dynamics of the digital world to reflect on our capability to adapt. Thereby, an inquisitive mind will be an advantage when it comes to comprehending and revealing the endless opportunities that the digital world accommodates for.

It is the endeavor of the editors and authors to treat the chapters as a joyful learning experience of academic insights into the digital world. Many of the papers included in this book were presented at the Berlin Digital Conference of the Berlin Institute of Finance, Innovation and Digitalization e. V. (BIFID) in 2018 and 2019, and we are always striving to share our knowledge with our students at the Berlin School of Economics and Law.

A clear focus is set on the attractive, diverse selection of a relevant topicality highlighting the variety of digital economics. The unique blend of academia and business practice, coupled with empirical studies, will allow the reader to penetrate the complexity of digitalization from two angles:

In Part I, the key prerequisites which enable an accelerated pace of digitalization are introduced. Concretely, the digitalization of money from a fiat to a crypto currency, predominantly Bitcoin, is presented. This phenomenon has allowed for an unparalleled rise of the digital world of economics built on globally scaling markets.

Part II inhibits a well-rounded introduction of corporate financial strategy of value creation. The reader is taken on a journey through the digital world: Starting with the example of value creation of professional soccer athletes, the following chapters offer an in-depth analytical and empirical insight into how digital pioneers like Alphabet or Amazon dominate today's digital world.

Finally, I hereby cordially invite you join the digital world through this reading experience.

Berlin, Germany Martin Užík
Fall 2022

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Part I
The Key Prerequisite of Digitalization: Money

Chapter 1
Digital Gold and Gold-Backed Crypto Currencies: The Return of the Gold Standard

Torsten Dennin

Abstract Amazon.com revolutionized the way we sell books as well as pushed e-readers and e-books. Digital gold and gold-backed crypto currencies might do the same for the traditional gold market. With the end of Bretton Woods in 1971, national currencies were not backed by gold anymore. During these 50 years, global debt increased much faster than global GDP (Gross Domestic Product), and the devaluation of the U.S. dollar massively decreased the purchasing power of consumers. Gold proved to be a trusted asset for wealth preservation for about 5000 years and has been accepted as money for more than 2500 years. However, the development of Bitcoin and other crypto currencies since 2009 has shown an alternative to the traditional fiat money system and the monopoly of central banks. But the volatility of the price development of crypto currencies is eroding trust and implementation, as well as diminishing classic functions of money. Using gold as a currency again in the form of a digital gold currency combines the strengths of two concepts: innovative technology and proven trust. After almost 50 years of the global fiat money system, there are signs that the gold standard celebrates a comeback.

Introduction

"[Gold] gets dug out of the ground in Africa, or someplace. Then we melt it down, dig another hole, bury it again, and pay people to stand around guarding it. It has no utility. Anyone watching from Mars would be scratching their head" is a famous quote of superstar investor Warren Buffett twenty years ago at Harvard university. It impressively demonstrates his view on gold (marketwatch.com, 2013).

Today, as humankind progresses into the digital age, a lot of effort is put into digitalizing gold. Why are we doing that? Is it time to question the adolescence of the

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human race? Or is there a reason, other than that humans are acting like magpies or Gollum in the Lord of the Rings, why we put our trust in gold instead of the euro, U.S. dollar, or yen?

The following analysis offers an insight into the redevelopment of digital gold currencies, the development of gold-backed crypto currencies, and other forms of the digitalization of gold. For that reason, different concepts of six companies are introduced and compared to traditional forms of gold investments. Asset-backed crypto currencies, especially gold-backed crypto currencies, already conquered an attractive niche. As a consequence, the traditional gold market has opened up for new technologies and new investors.

The remainder of this chapter proceeds as follows: Section "Viva La Revolution! Bitcoin, Blockchain, and the Digital Age" is dedicated to phenomena like Bitcoin, blockchain, and the digital age. Section "Breaking the Monopoly: The Decentralization of Money" discusses the decentralization of money. Section "What Is Money Anyway? The Evolution of the Global Currency System in a Nutshell" defines the term "money" in the context of the global currency system. Section "Let's Take One Step Back: Gold, Gold Standard, Nixon Shock, and Fiat Money" focuses on the issue of the gold standard and fiat money. Section "Asset-Backed Crypto Currencies and Gold" compares asset-based crypto currencies to gold. Section "Cui Bono? What Is the Value-Added Proposition of Gold Digitalization?" highlights the phenomenon of gold digitalization. Section "Gold Digitalization and Gold-Backed Crypto Currencies: Concepts and Best Practice" focuses on concrete relevant crypto currencies. Finally, Section "Conclusion" summarizes and concludes the previous sections.

Viva La Revolution! Bitcoin, Blockchain, and the Digital Age

The Digital Revolution, also called the Third Industrial Revolution, is widely interpreted as the shift from mechanical and analog electronics to digitalized technologies and marks the beginning of the Information Age. The keys to this revolution are mass production and the widespread use of digital logic circuits as well as the derived technologies including the PC, cell phones, and the Internet.

"Digitization" describes the conversion of analog information and content into a digital form. The resulting process of digitalization has enabled, for example, the Internet of Things, Industry 4.0, big data, machine learning, blockchain, and crypto currencies. It also drives the digital transformation of our daily life. Especially the financial industry is in the foreground of these changes. Robo advisors are replacing client assistances and relationship managers, fintech is slicing a growing piece of pie from the corpses of traditional universal banks. Wall Street bows for algorithm traders, machines not only executing but also implementing trades based on the analysis of big data, evolutionary, and self-learning algorithms. The industry is changing more rapidly than ever during the last 20 years.

Blockchain emerged as the backbone of a new and existing industry. A blockchain is a public ledger of all transactions in a given system that have ever been executed. It is constantly growing as completed blocks are added to it. The blocks are added to the blockchain in a linear, chronological order through cryptography, ensuring that they remain beyond the power of manipulators. The blockchain thus stands as a tamper-proof record of all transactions on the network, accessible to all participants (The Economist, 2015).

A crypto currency is a digital asset designed to work as a medium of exchange that uses strong cryptography to secure financial transactions, controls the creation of additional units, and verifies the transfer of assets (Greenberg, 2011). Bitcoin, first released as open-source software in 2009, is generally considered the first decentralized crypto currency. Since today, over 4000 alternative coin variants to Bitcoin (altcoin) have been created.

The development of blockchain and crypto currencies is a quantum leap for the progress and integration of the digital age, as it kick-starts new applications.

Breaking the Monopoly: The Decentralization of Money

Money is the center of gravity of the economy and sometimes also of private life. As the common saying goes: "You can't buy happiness, but you can buy ice cream. And that's almost the same thing." Sanctioned by governments, central banks are the authorities of money supply and distribution.

The latest global financial and economic crisis starting 2007 was fought using unconventional money policy at a scale that had never been attempted before. As the governor of the European Central Bank (ECB), Mario Draghi, said on the peak of the European Financial Crisis, "we will do whatever it takes" to save the euro (Plickert, 2014). Central bank balance sheets around the world—no matter if Fed (Federal Reserve System), ECB, BoE (The Bank of England), SNB (Swiss National Bank), or BoJ (The Bank of Japan)—inflated like gigantic balloons, and have stayed inflated until today (see Fig. 1.1). For example, the balance sheet of the European Central Bank exceeds the entire GDP of Germany.

Institutions and individuals became worried if the taming of the current crisis, as so often, already seeded the next global crisis. Movies like "Fight Club" or the extremely popular Netflix series "Money Heist" question the soundness of our socio-economic system, including the role of the financial industry and almighty central banks.

With Bitcoin and other crypto currencies, a decentralized money scheme based on blockchain technology has emerged, having the disruptive potential to break the multinational monopoly of central banks.

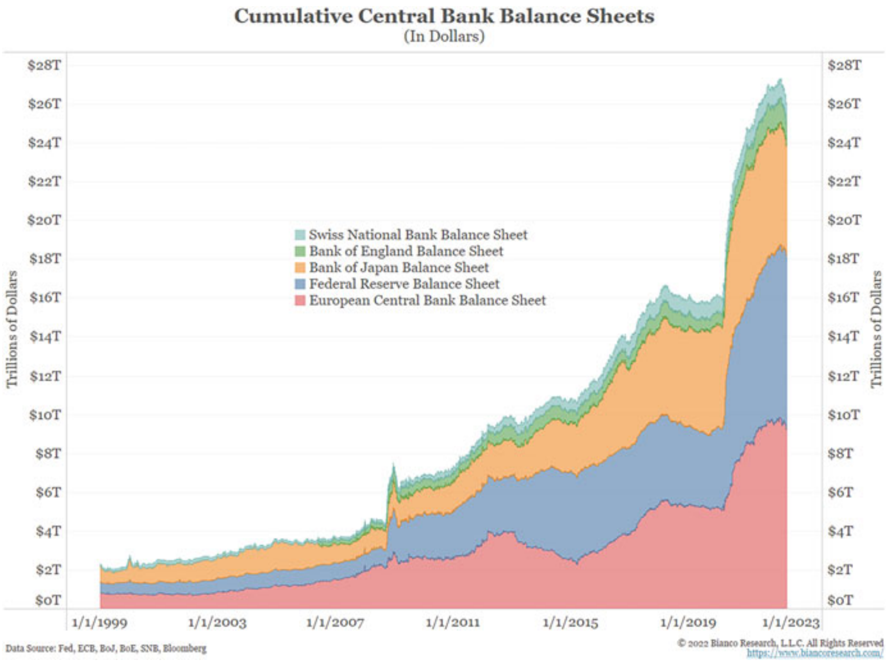

Fig. 1.1 Central banks' balance sheets from 2007 to 2020. Assets for the European Central Bank, Bank of Japan, Federal Reserve, Swiss National Bank, and Bank of England. (Ovaska, n.d.)

What Is Money Anyway? The Evolution of the Global Currency System in a Nutshell

Bitcoin is valuable because people agree to exchange it for other things of value. This holds true for every form of currency, and it does not matter if it is seashells, cigarettes, iron coins, bars of silver or gold, or your classic fiat currencies like the U.S. dollar, euro, or Swiss franc.

But who is deciding about what we accept as money? Classic economic theory implies three functions that money needs to incorporate to work properly: It has to be a medium of exchange, a unit of account, and a store of value.

That means that the same money is widely accepted for payment of goods and services. As a unit of account, money is a measure of relative worth. A store of value is the function of an asset that can be saved, retrieved, and exchanged at a later point in time. If one of these basic functions is disturbed, people start looking for an alternative currency.

On a global scale, a currency needs to reach a certain size in its use or application. In the summer of 2017, Bitcoin market capitalization just exceeded USD 40 billion, and all crypto currencies summed up to a value of USD 100 billion (see Fig. 1.2) (howmuch.net, 2017).

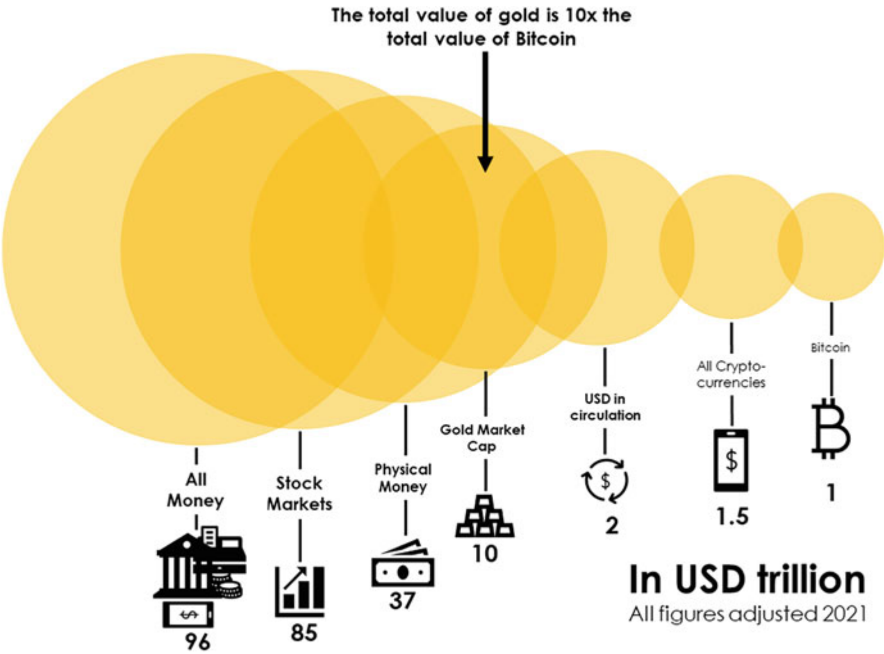

Fig. 1.2 Putting the world's money into perspective in 2021 (howmuch.net, 2017; adjusted 2021), own creation

In August of 2018, market capitalization of Bitcoin was USD 120 billion, and all crypto currencies summed up to a value of USD 400 billion. Yet, the crypto currencies' value is still exceeded by the physical gold market at USD 8.2 trillion, not to mention the value of the world's entire stock market or of all fiat currencies combined. Note that physical money means money in the form of notes and coins, whereas all money includes bank and other deposits as well as notes and coins.

One basic question about the intrinsic value of a currency arises. What is the fair value of a Bitcoin? USD 20 or 200,000? Has gold an intrinsic value? What about fiat currencies, for example a 20 euro note?

Let's Take One Step Back: Gold, Gold Standard, Nixon Shock, and Fiat Money

In a nutshell, gold as a medium of exchange and store of value has a history of about 5000 years. Around 700 BC in Lydia (today's Turkey), gold was formed as coins for the first time, enhancing its usability as a monetary unit. Before this, gold had to be weighted and checked for purity when settling trades. For centuries, precious metal coins circulated as currency in many countries before the first introduction of paper money. Once paper money was introduced, currencies still maintained an explicit link to gold. But this should not be mistaken for the often quoted "gold standard," which was at its peak between 1870 and World War I. The gold standard was a system under which countries fixed the value of their currencies in terms of a specified amount of gold or linked their currency to that of a country which did so.

After World War II, the Bretton Woods system established the monetary rules for the USA, Canada, Western Europe, Australia, and Japan. A system of fixed exchange rates was indirectly disciplined by the new global reserve currency, the U.-S. dollar, which itself was tied to gold. Bretton Woods also established the International Monetary Fund (IMF) and the predecessor of the World Bank. The USA, having controlled two thirds of the world's gold at that time, insisted that the Bretton Woods system should rely on both gold and the U.S. dollar.

The global monetary system changed dramatically in August of 1971 as the United States' president Nixon unilaterally canceled the direct international convertibility of the U.S. dollar to gold, the so-called Nixon shock. The reason for the failure of Bretton Woods was that the USA was running a huge trade deficit and printed lots of its currency in the 1960s. The system of fixed currency pegs collapsed and all the currencies in the world started to float. Once the gold standard was dropped, countries began printing more of their own currency, resulting in a surge of inflation, but for the most part, abandoning the gold standard created more economic growth.

Since this decoupling of the U.S. dollar from gold, a system of fiat currencies has been in use globally. Fiat money (from Latin "so be it") is a currency without intrinsic value that has been established as money by government regulation. This big economic experiment from the last century has worked now for almost 50 years, but more and more people become worried about rising international debt levels and the stability of the system, especially after the global financial crisis in 2007.

One consequence of printing money without a fixed base is a massive loss of purchasing power of fiat currencies. Since the end of Bretton Woods in 1971 and the beginning of one of the biggest experiments in economic history, lending without responsibility, the U.S. dollar, for example, has maintained only 17% of its purchasing power today. Simply put, USD 100 in 1971 were much more valuable in 1971 than in 2018. Or to be more precise, USD 100 in 1971 had the same purchasing power as USD 620 in 2018 (dollartimes.com, 2018; investor-verlag.de, 2018).

Another concern is the evolution of global debt. Currently, the global GDP (meaning the value of all products and services produced around the globe), which is the base of our wealth, reached USD 80 trillion (80,000,000,000,000 USD) in 2017, 22 times its 1970 level of USD 3.4 trillion (Fao.org, 2018; statista.com, 2018).[1] Global debt, summing up the debt of households, public debt, and non financial corporates (NFC), rose by over USD 8 trillion in Q1 of 2018 to over USD 247 trillion (315% of GDP) (Institute of International Finance, 2018a, 2018b; compare with Fig. 1.3). As it has easily been concluded, global debt rose much

[1] Adjusting for inflation, real GDP increased by 3.6 times, from USD 15.6 trillion to USD 56 trillion in 2005 constant USD.

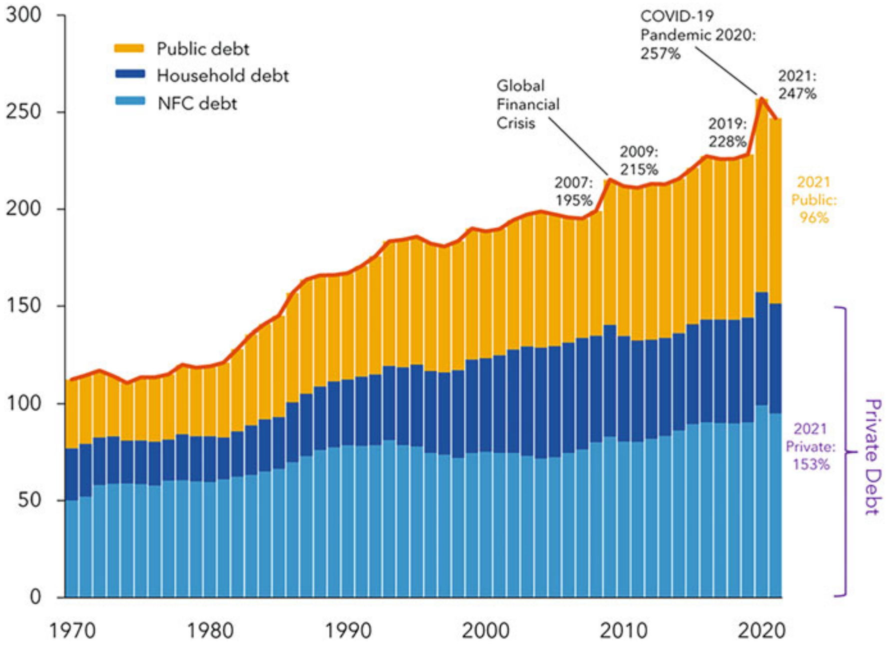

Fig. 1.3 Global public and private debt ratios. Debt as a percent of GDP. (IMF, 2022)

faster than global GDP: Compared to 1970, it is more than a staggering 50 times increase!

Besides not being the anchor of the economic system anymore, gold never lost its appeal as an asset of real value neither for the government and other institutions, nor individuals. But what is gold really worth? One way to look at this is by what you are able to buy with it.

In ancient Rome, you could buy a fine tunic for 1 oz of gold in case you were in need to make a smashing business presentation or to speak in front of the senate. The same is valid today: For the equivalent of 1 oz of gold you are able to dress yourself in a fine suit, including a shirt, tie, and shoes. This is a famous and often quoted example for that besides short-term price fluctuations, gold is able to conserve purchasing power.

But let us move on from myths to a more solid example. In 1971, a base model Ford Pinto costed USD 1850. This was equivalent to 45 oz of gold (Woodhill, 2011). Today, 45 oz of gold are worth USD 56,000. The cheapest new car to buy in 2018 was a Chevrolet Spark for USD 13,875 (almost eight times your original USD 1850), while for USD 56,000 you can afford a brand-new BMW Series 5 (see Fig. 1.4). You can argue about the style of a 1971 Ford Pinto, but you cannot argue about the difference between a Chevrolet Spark and a BMW 5.

Another way to look at this is scarcity. While there are still trees growing, we can print paper money. It is even more easy to add a few zeros in the virtual space of money. Gold, however, is not only shiny, but relatively scarce on the planet.

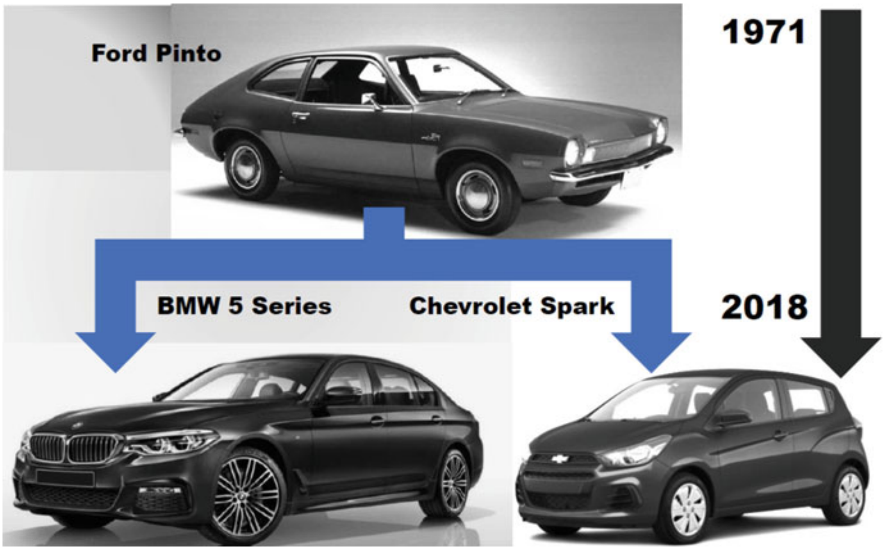

Fig. 1.4 Purchasing power of gold and the U.S. dollar from 1971 to 2018 (General Motors, 2018): A BMW 5 in 2021 is used as an equivalent to a Ford Pinto in 1971. For the amount of USD needed to buy a Ford Pinto in 1971, a consumer could buy 1/8 of a Chevrolet Spark today

Therefore, adding new gold to the global available supply in form of new mine production becomes more expensive and more difficult in terms of technology. All gold ever mined by humans in known history—the so-called above-ground gold—is estimated to sum up to almost 200,000 tons according to World Gold Council (2019). For visualization purpose, if all of this gold was taken together and melted, say for paying a global ransom to an aggressive invading alien race, a massive cube could be manufactured, with a side length of approximately 22 meters. This cube of pure gold can easily be placed under the arc of the Eiffel Tower in Paris (Erwin et al., 2004). Besides of the touristic effect, it is not that impressive, right?

Asset-Backed Crypto Currencies and Gold

Crypto currencies first emerged in 2009, when the world's first decentralized currency, Bitcoin, was created. The main idea of crypto currency is to create a secure and anonymous way to transfer currency from one person to another (Chia, 2018). Although as of today, more than 4000 alternative coins have been introduced, only a handful is important enough to be considered alternatives to Bitcoin. In August of 2018, the top ten crypto currencies by market capitalization were Bitcoin, Ethereum, Ripple, Bitcoin Cash, EOS, Litecoin, Stellar, Cardano, IOTA, Tether, and Tron (coinmarketcap.com, 2018).

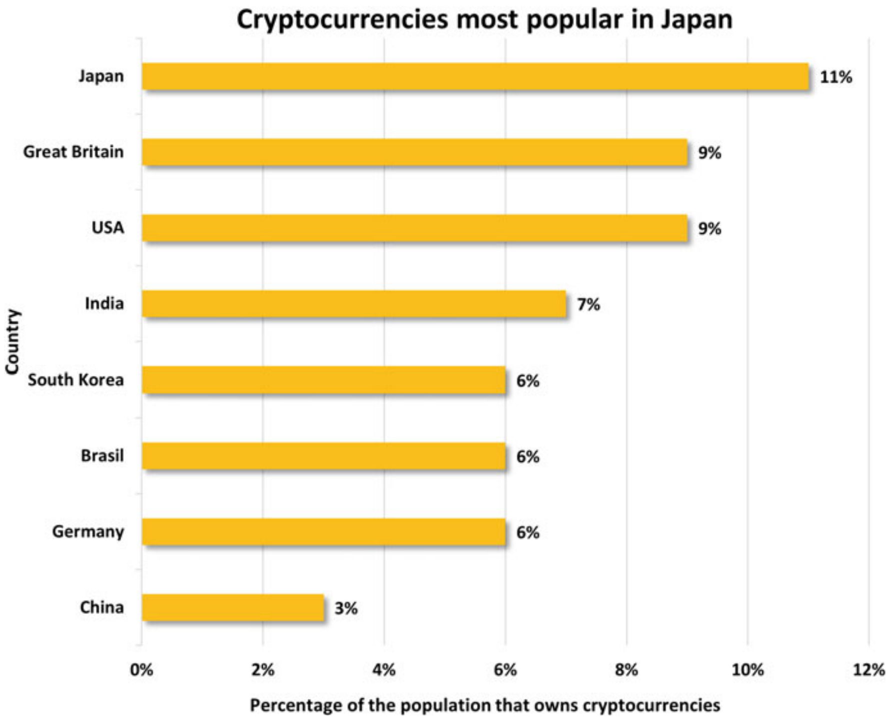

Fig. 1.5 Cryptocurrencies most popular in Japan. Own creation based on Loesche. (Loesche, 2018)

Despite banning Bitcoin trading and initial coin offerings, the People's Bank of China has executed plans to implement its own digitalized fiat currency, as China has one of the most advanced mobile and digital payment markets in the world (Ping et al., 2018). In other Asian countries, the integration of Bitcoin into the economy is more progressed. Western countries and companies have more concerns about the implementation because of the high volatility of Bitcoin and regulation risks.

The Japanese government has viewed crypto currencies favorably (see Fig. 1.5), legalizing Bitcoin as an official payment method in 2017. By the end of the same year, about 260,000 shops were accepting Bitcoin as payment. A consortium of Japanese banks, led by the Mizuho Financial Group and Japan Post Bank, was seeking to launch a new national digital currency in time for the Tokyo 2020 Olympics. The J-Coin, exchanged at a one-to-one rate with the yen, has the support of Japan's central bank and regulators, and aims to allow the Japanese people to pay for goods and services using their smartphone (Ping et al., 2018).

With Sweden's rapid move toward a cashless society, the government is seriously considering a digital complement to cash that can ensure a safer and more efficient payment system. Therefore, Sweden's central bank, the Riksbank, is seeking to introduce the E-Krona (Ping et al., 2018).

Similarly, the city of Zug in Switzerland and Dubai, the financial capital of the United Arab Emirates, are leveraging the potential of the crypto currency to also reinvent themselves as "crypto hubs." Switzerland made the move to become a "crypto nation" when it launched the "Crypto Valley" in Zug in late 2016. Zug, for example, started accepting Bitcoin as payment for government services already in 2016.

But for clarification, all these national initiatives have the digitalization in common, for example the modernization of their traditional fiat currencies. Bitcoin, on the other hand, is something completely different, as its value is not based on fiat currency.

First, the preadolescent price development of Bitcoin and other crypto currencies is not only scaring new potential users and investors. As a reminder, Bitcoin evolved from USD 1000 in 2017 to USD 20,000 in January of 2018, to fall back below USD 6000 (−80%) within weeks. But there have been multiple volatile price swings in the past years. In 2012, Bitcoin lost almost 60% of its value within three days. In 2013, Bitcoin fell from USD 259 to USD 45, as well within three days (−83%). Counting from November of 2013 to January of 2015, Bitcoin even fell from USD 1163 to USD 152 (−87%), which was its biggest crash so far. Today, in March of 2021, Bitcoin is trading at USD 55,000. Since its inception, Bitcoin saw a downward price swing of more than 30% in almost every quarter. This interferes with the fundamental function that money should provide as a store of value but opens the door for speculators (see Figs. 1.6 and 1.7).

Second, there is evidence that gold and other precious metals have proven their reliability as a store of value over the long term. As a traditional "safe haven" investment, investors are looking at gold for wealth protection and preservation.

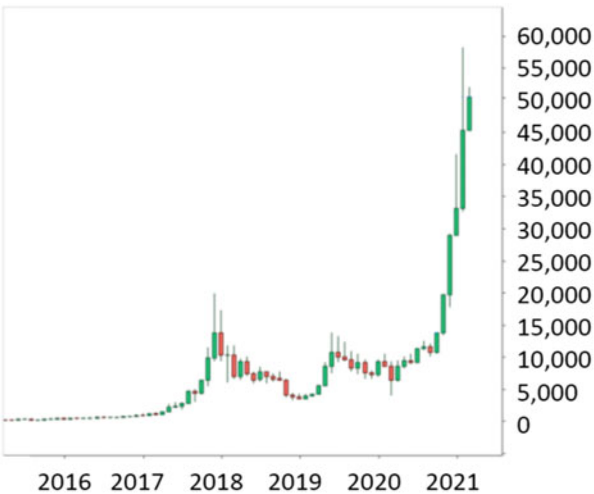

Fig. 1.6 Price of Bitcoin in USD (USD/BTC) since 2016—a classic speculative bubble or just a price correction? (Lynkeus Capital, 2018; investing.com, 2019; adjusted 2021)

Fig. 1.7 Price of gold (USD/oz): the price of one troy ounce of gold since 1980 (Lynkeus Capital, 2018; investing.com, 2019; adjusted 2021)

According to some "gold bugs," financial Armageddon looms just around the corner, but gold has historically always been a popular store of value not only for diversification of portfolios, but also as a safe haven investment in times of financial distress or crisis.

Arguments of gold investors typically fall into the categories of financial, political, and event risks.

Some examples are:

- Wealth preservation
- Hedge against inflation
- Lowering total risk of investments
- Consequences of quantitative easing
- Financial bubbles and financial crises
- Collapse of the U.S. dollar
- Bank insolvencies
- Limitations in bank deposit guarantees
- Pension fund mismanagement
- Expropriation and unlawful confiscation of assets

An important characteristic of black swans (Taleb, 2007) is that you do not see them coming. Therefore, gold might never lose its safe haven attire.

Thus, turning physical assets such as gold into tradeable digital assets in the form of an asset-backed crypto currency creates a rise in demand, allows for a greater degree of liquidity, and decreases the barrier to enter for private investors in asset classes that are traditionally dominated by institutional investors and high net worth individuals.

Cui Bono? What Is the Value-Added Proposition of Gold Digitalization?

To answer why there is a demand for digital gold, we need to look at the analog alternatives from the "old" investment world. What are eligible instruments and products to invest in gold?

As a physical store of value, you can acquire gold bars and coins in various sizes and numerations. You can store those bars and coins either at home in your own vault, in a bank vault, or tax-free in a bonded warehouse. Banks and precious metal dealers are happy to assist in that process. Another option is to open a gold account with your bank that is working the same way as your checking account but is based on ounces instead of euros or U.S. dollars.

Rooted in the traditional financial world, you might consider buying a physically backed gold fund like, for example, Julius Baer or the ZKB are offering. Or you might add a gold exchange traded note (ETN) or product (ETP) in the form of a tracking certificate to your portfolio of stocks and bonds. If you are willing to add a little more risk, an investment in shares of gold mining companies, either directly or by a specialized investment fund or exchange traded fund (ETF) is a valid option. Well-known examples are the Blackrock World Gold Fund or VanEck's Gold ETF (GDX). As a professional investor, you might also consider an investment in gold via futures and options. Fig. 1.8 gives an overview of the different kinds of options in regard to the underlying risk, lists some examples for investment products, and includes six digitalization approaches.

In a nutshell, you can buy gold bars and coins, buy a financial product that is linked to either gold or gold mining companies, or buy gold in a new digital form. So, why consider digital gold?

Physical ownership of bars and coins comes at a price. First, there are costs of research and information ("where to buy"). Second, the majority of bars and coins sell at a premium to the price of gold ("how to buy"). Third, you need to consider storage and insurance costs. Additionally, there is the argument of opportunity costs, as gold—as always quoted—pays no interest or dividend, different for example to some gold mining companies.

The financial industry has therefore created several gold and gold-related investment products such as gold accounts, gold exchange traded funds, gold certificates in the form of exchange traded notes or other exchange traded products, and gold equity funds. All these solutions offer an easy way for investors to get involved and combine different cost and risk profiles.

The common ground is that you are trapped in the financial system. If you are thinking of an investment in gold because you mistrust financial markets or even the financial industry and the government, then the crypto space is offering an alternative. To provide easier access to gold in combination with a different cost and risk profile, several fintech startups are leveraging blockchain technology to digitalize gold. This opens the gold market to a bigger crowd of investors.

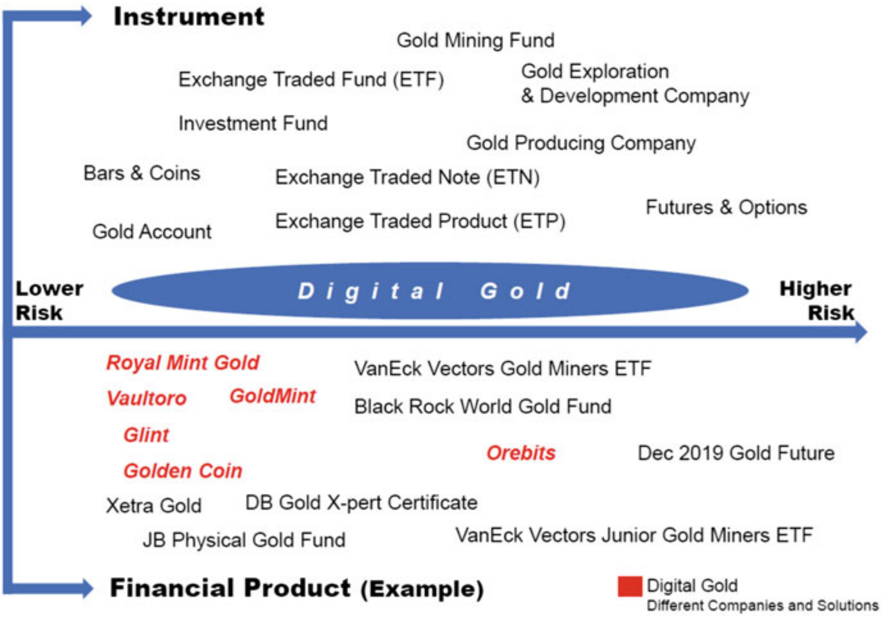

Fig. 1.8 Investing in gold: instruments and examples (Lynkeus Capital, 2018)

Gold Digitalization and Gold-Backed Crypto Currencies: Concepts and Best Practice

With blockchain technology becoming established as a secure accounting method and with Bitcoin becoming better known to the general public, requirements for a new gold rush have been established. [2] Companies and even countries are looking to issue their own gold-based crypto currencies. The basic concept is as easy as compelling. When a token is issued, it represents a certain amount of gold. The gold is stored preferably by a third-party trusted custodian and can be traded with other coin holders. Digitally, gold can easily be divided into smallest parts to be used as a base for a payment system.

It comprises many associated risks as well. While blockchain accounts for the coins, the accounting for your physically stored gold is another matter. When evaluating the risk of such tokens—besides technology and fraud risk—you need to validate who actually owns the gold and how it is stored (Garikiparithi, 2018).

[2] Digitalization of gold is not an invention by the blockchain community, but a new form of its application in the form of tokenization. Electronic gold (e-gold) was launched as a digital currency in 1996, allowing users to open a website-based account and make instant transfers to other e-gold accounts. The system got suspended due to legal issues (such as money laundering, missing banking license, etc.) in 2009.

Fig. 1.9 Gold-backed crypto currencies, concepts, and best practice (glintpay.com, 2018; goldmint.io, 2018; orebits.io, 2018; royalmint.com, 2018; vaultoro.com, 2018), own creation

Different concepts are competing in a dynamically growing market, and every day, a new concept enters the project stage (Clark, 2018). In this subchapter, six companies with their concepts are introduced as a representative and a best practice example: Royal Mint, Vaultoro, GoldMint, Glint, Golden Coin, and Orebits.

Royal Mint and Vaultoro offer the digital investment in physical gold. While Royal Mint is a government-owned UK entity, Vaultoro is a classic crypto/fintech startup. GoldMint offers a gold-backed crypto currency called GOLD. Glint and Golden Coin offer gold-based account and payment solutions. Orebits bases its smart contract not on physical gold, but on proven gold reserves. You can compare the concept with a gold exploration and development company, which is not yet producing gold, and therefore offers a higher risk and return profile.

All six of the introduced concepts below offer a non-traditional, for example digital, solution to invest in gold. With Vaultoro, Glint, and Golden Coin, this section includes three concepts of digital gold-based payment, saving, and storage solutions (see Fig. 1.9).

Gold-backed crypto currencies in a closer sense are Royal Mint Gold (RMG), GOLD by GoldMint, and Orebits. For a more comprehensive list, see Table 1.1. It is highly recommended to check the background of the companies and crypto currencies on the list in regard to due diligence.

Table 1.1 List of gold-backed crypto currencies

Airgead	GoldMineCoin (GMC)
ANTHEM (AGLD)	GoldMint (GOLD and MNTP)
AurumCoin (AU)	HelloGold (HGT)
AurusGold (AWG)	IC3 Cubes (IC3)
BullionCoin (XAAU)	OneGram Coin (OGC)
CURRENSEE (CUR)	Orebits
Darico (DRC)	Orocrypt (OROC)
DigixGlobal (DGX and DGD)	OZcoinGold (OzGLD)
DinarDirham (DNC)	PureGold (PGT and PGG)
Flashmoni (OZT)	Reales (RLS)
Gold Bits Coin (GBeez)	Royal Mint Gold (RMG)
Gold Cryptocurrency (GOLDC)	Sudan Gold Coin (SGC)
GoldBase (ABG)	X8currency (X8C)
Goldbloc	Xaurum (XAUR)
GoldBlocks (GB)	XGold Coin (XGC)
GoldCrypto (AUX)	ZenGold (ZGC)

Note: The number of gold-backed crypto currencies is steadily increasing (Clark, 2018). Therefore, this list attempts to be a first overview, not a complete reference

Royal Mint and Royal Mint Gold (RMG), United Kingdom (www.royalmint.com)

The Royal Mint is a government-owned mint that produces coins for the United Kingdom. The Royal Mint has teamed up with the United States' derivative exchange CME Group to offer bullion on the blockchain. Royal Mint Gold (RMG) is gold stored in the Royal Mint vault and traded on a digital trading platform provided by CME Group. Each RMG represents direct ownership of physical gold bullion held in the form of fully allocated, segregated London Bullion Market Association (LBMA) good delivery bars within the highly secure storage facilities. Royal Mint Gold can be digitally traded. 1 RMG represents ownership of 1 g of real gold, which is stored in the vault of the Royal Mint. RMG has no ongoing storage or management fees.

Vaultoro, United Kingdom (www.vaultoro.com)

London based Vaultoro, founded 2015 by Philip and Joshua Scigala, allows its users to invest in physical gold using Bitcoin without the need of a bank account to conduct payments. When a user purchases gold on the online platform, the gold is deposited in an insured gold bullion vault in Switzerland. Fees: 0.5% trading fee, 0.4% storage fee.

GoldMint, Russia (www.goldmint.io)

GoldMint is led by CEO Dmitry Plutschevsky, who co-founded LOT-Zoloto, a gold trading company based in Russia with trading transactions totaling USD 100 million in 2017, and former banker Konstantin Romanov. GoldMint runs on a blockchain ledger and works through a digitalized crypto asset called GOLD whose crypto currency value is based on physical gold, which is 100% backed by delivery futures or physical gold. This means that one GOLD costs the same as one ounce of gold on the Chicago Mercantile Exchange. GoldMint stores physical gold in United States' Federal Reserve System banks and with Singapore custodians.

Glint, United Kingdom (www.glintpay.com)

The fintech company Glint, founded by Jason Cozens and Ben Davies, cooperates with Lloyds and Mastercard to create an app which can be used to buy a portion of a physical gold bar. Customers use the app at the checkout to select whether to pay in a currency or gold, before transacting with their Mastercard. Based in London, Glint is regulated and fully authorized by the FCA. Glint's debit card and app allow people to pay for goods in gold. Fees: 0.5% trading fees.

Golden Coin, Switzerland (www.goldencoin.com)

Golden Coin was founded in Zug, Switzerland, by Daniel Weitmann. The company provides its customers with an alternative to a regular bank account. It comes with an app and a payment card and uses your private stock of 1 oz United States' gold coins instead of the euro or U.S. dollar. 1 oz American gold coins are legal tender money, minted by decree of the United States Congress. Or, as the CEO is quoted on the company homepage "we simply sell, buy, and store gold coins with intelligent technology." Fees differ with varying account models.

Orebits, USA (www.orebits.io)

As a fintech start-up, Orebits provides asset-digitalization for precious metal reserves. Orebits provides a smart contract, or smart certificate investment instrument, tied to proven gold reserves. This means supplies of the metal that are known to be in the ground, but have not yet been processed. These "Orebits" can freely be traded and exchanged as tokens on a blockchain platform. Each certificate is backed by 5 oz of proven gold reserves.

Conclusion

A digital asset, in essence, is anything that exists in a binary format and comes with the right to use it. By turning physical assets like gold into tradeable digital assets, an additional physical demand is created, the degree of liquidity increases, and barriers to entry for investors are lowered. Amazon.com revolutionized the way we sell books as well as pushed e-readers and e-books. Digital gold and gold-backed crypto currencies might do the same for the traditional gold market.

After an experience of 50 years with a global system of fiat currencies, the voices articulating worries grow louder. These worries concern, for example, the massive loss of purchasing power of fiat currencies, the growing gap between economic development (GDP) and global debt, and the excessive growth of central bank balance sheets after the latest financial and sovereign crisis.

Blockchain and Bitcoin are enabling digitalization to reach the next level. In combination with the state of the financial system, they also triggered a gold rush in gold digitalization, a reemerge of digital gold currencies, and the development of gold-backed crypto currencies. The digitalization of money is an ongoing process. The decentralization of money, on the other hand, is breaking the monopoly of national central banks.

Compared to physical ownership or an investment in either a gold-based exchange listed product or in shares of gold mining companies, digital gold and gold-backed crypto currencies offer a clear value-added proposition: a different return, risk, and cost profile.

As a lot of projects and startups got realized in this field in 2017 and 2018, this analysis has introduced six different companies and concepts as a first reference. Vaultoro, Glint, and Golden Coin are offering digital gold-based payment, saving, and storage solutions. Gold-backed crypto currencies in a narrower sense are Royal Mint Gold (RMG), GOLD by GoldMint, and Orebits, which combine the advantages of the technological developments in the crypto space, digitalization, and proven trust of an investment in gold.

It seems that based on secular and private initiatives, the gold standard is trying a comeback after 50 years of absence since the end of Bretton Woods.

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Chapter 2
Crypto Currencies: Speculative Bubble or Disruptive Technology?

Eduard Meider

Abstract Blockchain is considered one of the most important technologies of the future. The origin of this invention came with the launch of the Bitcoin (BTC). The most famous and valuable crypto currency has experienced high fluctuations throughout the last years. Bitcoin has reached significant milestones in the past years, especially when it was declared as a legal method of payment in Japan in April of 2017. Mainly after this regulatory achievement, crypto currencies were more often mentioned in mass media, which increased the interest of investors but also reinforced a bubble debate. In this chapter, it is investigated whether Bitcoin and other crypto currencies are a temporary trend resulting in a bubble or whether they have the potential to become a disruptive technology. For this purpose, the fundamental value of the crypto currency is estimated to verify the market value. In the empirical part, the Bitcoin price development is compared to bubble theories. Based on the results of the analyses, the risks and opportunities of crypto currencies are investigated in order to evaluate their potential as a future technology.

Introduction

With a growth rate of approximately 750% from 2020 until Q1 2021, Bitcoin (BTC) was one of the most profitable assets. However, digital currencies certainly did not prove to be a safe investment. The development showed various bubbles and massive price drops in the last 10 years. The last massive price crash was observed after the bull run in 2017. Within 1 year, the price rose from USD 1,000 per BTC to almost USD 20,000 per BTC and fell back by approximately 65% to USD 7,000 per BTC in Q1 2018.

Due to this turbulence, critics like James Dimon, CEO of JP Morgan, has termed Bitcoin as fraud resulting in a bubble worse than the tulip mania (Son et al., 2017). Nobel laureate Robert Shiller, an expert on price bubbles, has stated that the best

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example for irrational exuberance and speculative bubbles is Bitcoin (Detrixhe, 2017).

On the other hand, famous entrepreneurs and investors see a high potential for crypto currencies that justify their price. Elon Musk's company Tesla invested a sum of USD 1.5 billion in Bitcoin in February 2021 (Kovach, 2021). Aswath Damodaran, Professor of Finance at Stern School of Business, states that "cryptocurrencies have already replaced gold for younger investors" (Kim, 2017).

Definitions

What Is Blockchain?

Blockchain is a decentralized protocol for transactions that captures every change transparently (Klotz, 2016). This means that the program is not monitored by one certain party but by many participants who voluntarily join the network and provide resources to keep its system going. A blockchain consists of a locked algorithm that automatically executes transactions when the necessary contract conditions are met. Therefore, it can cut out the intermediary, who used to be responsible for complying or monitoring a transaction.

Blockchain transactions are not limited to financial transfers but could also include any information exchanges, for example contracts, shares, licenses, etc. With this possibility, companies can provide smart contracts that ensure the compliance of an agreement in a transparent, neutral, and efficient way (Kozma & Nowiński, 2017).

In the original Proof of Work (PoW) Blockchain that works on Bitcoin, the so-called miners are responsible for the validation of transactions. They receive coins as a reward for providing computing power. Several transactions are accumulated to one block with a certain storage volume. The miners solve certain mathematical equations with their computer to validate a block. If the miners' majority accepts the block, including all transactions, it is placed on the open-sourced blockchain protocol, a distributed ledger that allows everybody to inspect the changes (Underwood, 2016). To secure the system against manipulation, it is not possible to cancel or change a particular transaction subsequently.

After detecting complications on the original PoW Blockchain, especially a scaling problem resulting in increasing energy costs, developers started inventing advanced blockchain technologies with new consensus systems. For example, in the Proof of Stake (PoS) concept, a block is not validated by the highest computing power. Instead, the mechanism attributes mining power to the proportion of coins held by a miner. The higher the stake of a miner, the higher the chance that this miner will validate the transaction and receive new coins as a reward (Frankenfield, 2021).

What Is a Crypto Currency?

According to the ECB "a virtual currency is a type of unregulated, digital money, which is issued and usually controlled by its developers, and used and accepted among the members of a specific virtual community" (ECB, 2012). Most crypto currencies are based on blockchain technologies that provide cryptographically secured, decentralized, and transparent transactions. In contrast, conventional fiat currencies are legal tenders that are issued by (central) banks and additionally provided in a physical form.

Users of crypto currencies receive a virtual wallet that is usually assigned to an identifier (ID). This pseudonymity ensures that nobody can connect the ID with the public identity of the user, but the blockchain can relate it to an account to record the transaction. Users can create as many wallets as they want but are personally responsible for them because they cannot restore the coins if they lose the access data to their wallet.

For a transaction, they need to log into their wallet, type in the ID code of the other party, enter the transaction amount and then accept the order. When the transaction is sent to the blockchain network, miners validate the transaction (e.g., check if the amount that was sent is available in the user's balance). As an incentive, the miners receive a fee from both affiliates and/or additional coins by the program itself. This is how new coins can be created. For certain crypto currencies, the number of coins is limited to avoid long-term depreciation (Ghaisas & Sontakke, 2017). For Bitcoin, only 21 million units can exist, of which about 18.69 million are already mined as of April 2021.

Besides the mining process, coins can be bought on online exchanges by trading them for fiat currencies. Most exchanges apply certain provisions concerning the identity of their users so that trading is no longer anonymous. However, if crypto currencies are transferred outside the exchanges, users do not always have to provide personal data. This pseudonymity is a major point of criticism as participants can use crypto currencies for trading on the black market or for money laundering.

Another way to purchase crypto currencies is given by Initial Coin Offerings (ICO). Blockchain start-ups use this method to finance their company by providing new crypto currencies, the so-called Tokens that are related to their business model. The new token is available for a fixed price during a limited time and additionally traded on an exchange after the funding.

In total, the top 100 crypto currencies have an estimated market capitalization of USD 2 trillion as of April 2021. Bitcoin tops the list with a market capitalization of USD 1.04 trillion, followed by Ethereum with USD 280 billion and Binance Coin with USD 88 billion (coinmarketcap.com, 2021).

The legal status of crypto currencies varies in different countries. Most developed countries have classified them as complementary currencies. This includes free trade and payment with crypto currencies. However, they are not a legal tender and are only accepted voluntarily. In China, crypto currencies are not considered as currencies but as legal virtual commodities whose trading is strictly regulated. In addition, Initial Coin Offerings are prohibited. In other developing countries like Bolivia, Ecuador, and Bangladesh, the governments have officially banned trading with crypto currencies.

What Is Bitcoin?

Bitcoin is the oldest crypto currency and was first mentioned in a paper by an author with the pseudonym Satoshi Nakamoto in October of 2008. The founder described Bitcoin as "a system for electronic transactions without relying on trust" (Nakamoto, 2008, p. 1). The crypto community interprets this invention as a possibility to escape the current financial system, which suffers from decreasing trust in banks after the financial crisis of 2008. Although more than 9,000 crypto currencies had been created by 2020, Bitcoin still represents about 50% of the total market value.

From a scientific point of view, it is controversial whether Bitcoin should be defined as a currency or commodity. According to Kiyotaki and Wright, currencies need to be able to be used for transactions, as a unit of account, and as a store of value (Kiyotaki & Wright, 1989).

Being Able to be Used for Transactions

Bitcoin can be used for transactions. However, the coin is not very efficient in this process due to a current scaling problem that results in high transaction costs and low transaction speed. This is one of the reasons why only few people use Bitcoin as a payment for goods or services. A study by Chainanalysis shows that approximately 90% of the Bitcoin transactions happen on exchanges but only 1.3% can be accounted to economic transactions coming from merchants (Bloomberg, 2019).

Being Able to be Used as a Unit of Account

Bitcoin can serve as a unit of account since it is divisible, fungible, and countable. One Bitcoin can be split into 100,000,000 Satoshi which is the smallest unit and correspond USD 0.00055 as of April 2021. "All Bitcoins are created equally and [. . .] can be interchanged" (Carrick, 2016).

Being Able to Store Value

The characteristic as a store of value for Bitcoin is controversial. The crypto currency has a high volatility which indicates rather speculative characteristics (Torres, 2017). While the definition of store of value requires a daily stable value, Bitcoin cannot fulfill this condition. On the contrary, the digital currency shows long-term price growths and has gained higher trust for investors. This implies that Bitcoin conserves value as a scarce commodity, comparable to digital gold.

Fundamental Analysis

Financial bubbles are defined as major deviations of the market from the fundamental value of an asset. The market price is calculated by the weighted average price of Bitcoin in USD that is traded on major crypto exchanges. The fundamental or intrinsic value of assets is usually calculated using the discounted cash flow method or the multiplier models.

The problem is that most crypto currencies do not achieve calculable cash flow. This is roughly equivalent to the complexity of evaluating start-up companies without profit or even revenue.

The multiplier method is also not easy to apply because the Blockchain is a new technology which is difficult to compare. Overall, mathematical valuations can only be used to a limited extent. Instead, the valuation needs to be more focused on soft key figures. In doing so, the equation is run through various scenarios applied to Bitcoin:

Programming Costs

Crypto currencies are developed computer programs. In certain cases, such as Bitcoin, the computer code is even publicly accessible (open-source). Their algorithm can be copied by anyone with the necessary knowledge to create their own crypto currency. Due to this fact, crypto currency critics argue that their fundamental value is close to zero.

However, it is easy to argue that the same criteria also apply to other assets. For example, cash is ultimately just paper, to which society ascribes an exchange value for goods and services. If we counterfeit paper money, it does not mean that the counterfeit notes hold the same value as the original. Accordingly, this also applies to crypto currencies which correspond the value a group of people believe the currencies to have.

Production Costs

Many crypto currencies are produced by a mining process. In the case of the Bitcoin (proof of work concept), an effort—substantially in the form of electricity costs, acquisition of hardware, and time—is required in order to successfully produce digital coins. Bitcoin has the additional programming of the so-called Halving, which takes place approximately every 4 years when 210,000 blocks have been verified for the blockchain protocol. This means that miners receive only half as much Bitcoin as a reward for their programming efforts.

Furthermore, the Mining Difficulty indicator ensures that the more miners are active in the network, the more difficult it is to solve the equation for producing a block. As a result, miners have higher costs when the Bitcoin price increases because more people join the mining process (Bitpanda, 2021a). If the price of Bitcoin decreases, mining becomes less profitable. Therefore, the number of miners in the network decreases accordingly, but also the mining difficulty decreases in the same way. Thus, the system balances itself out through a demand and supply model.

According to Garcia et al., mining costs represent a "lower-bound estimate of the fundamental value [which has the] advantage of being independent from any subjective assessment of future return" (Garcia et al., 2014, p. 3). Considering current mining hardware (Antminer S19 with 110 TH/s hashrate and 3500-Watt consumption) in a country with low electricity costs like China (approximately USD 0.1 per KW/h), the production costs of approximately USD 40,000 per BTC (as of April 2021) arise. At the same time, the market price was about USD 53,000 per BTC. A certain deviation of the production costs is justified, since one takes a significantly higher effort and risk by mining, possibly even paying commercial taxes for it.

In fact, this value shows an approximate trend of what a crypto currency should be worth at least. Overall, production costs are less meaningful because mining costs are dynamic and based on the market price of the currency, but not vice versa.

Gold Multiple

Another approach is based on the idea of Thomas Lee (co-founder of Fundstrat Global Advisors), who values Bitcoin as a "substitute for gold" (Cheng, 2017). Indeed, the comparison is not devious. People have invested in gold when they distrusted the financial system or a local currency. Analogously, Bitcoin was born after the financial crisis to provide an alternative monetary system. Both assets are rare, limited, and mined under high effort. Bitcoin as a store of value even has the advantages of low storage costs over any precious metals. In contrast, gold might have an intrinsic value because of its esthetic or industrial use as a noble metal, but this value is significantly below the market price.

When applying Thomas Lee's idea, it would lead to a scenario in which gold investors withdraw their money from the gold market and relocate it to Bitcoin. Considering the amount of gold (approximately 201,000 tons) and its market price in April 2021, this would result in a total market capitalization of around USD 6,872 trillion. If this sum is distributed to Bitcoin (with a current amount of 18.69 million), it would generate a value of USD 609,000 per BTC. This is about ten times higher than the market price of one Bitcoin (approximately USD 60,000) in April 2021. Although Thomas Lee does not expect Gold to be replaced by Bitcoin 1:1, it still shows the potential of the crypto currency when considering it as a store of value.

Bitcoin as a Global Currency

The ultimate scenario for some crypto enthusiasts is that a digital currency will replace all fiat currencies. Alternatively, a currency standard could be considered in which the national central bank is willing to exchange fiat money for the crypto currency at a fixed rate at any time. This calculation assumes that the global money supply is replaced or pegged to the Bitcoin. Unfortunately there is a lack of data for the world-wide M3 money supply which includes large time deposits, institutional money market funds, short-term repurchase agreements, larger liquid funds, and M2 money). In order to calculate a meaningful approximate value, the sum of m2 money supply (cash, checking deposits, and easily convertible near money) for the EU, USA, China and Japan is applied instead. This adds up to USD 83 trillion (The Global Economy, 2021). Converting this money supply into Bitcoin, its value would rise to an estimated amount of USD 4.4 million per BTC.

Conclusion of the Fundamental Analysis

Altogether, it cannot be said that crypto currencies have no fundamental value just because they are intangible. On the contrary, a scenario in which a crypto currency would become a global standard is rather unlikely because governments and central banks would not submit so much authority. More probable is a situation in which one or more crypto currencies would be accepted as a parallel currency in a country or region. Furthermore, Bitcoin as digital gold is already a present state for many investors. With a growing network, this can even result in prices beyond USD 600,000 per BTC. Still, it is highly uncertain whether these scenarios will occur.

Empirical Analysis

Crypto currencies have experienced tumultuous price movements since their invention. Since Bitcoin has the longest history, the following subchapter analyzes its price development representative for the whole crypto market. In addition, the data are compared to previous price bubbles to give evidence whether crypto currencies can be identified as one.

Preconditions of Speculative Bubbles

Financial bubbles of the past have shown certain patterns that can be adopted for the Bitcoin price development. According to Rapp (2015), bubbles usually occur when certain preconditions are fulfilled: First, the asset results from a technological or financial invention. This is given for Bitcoin and the blockchain system which enables decentralized transactions and an alternative investment opportunity. Second, investors have different expectations concerning the intrinsic value of the asset. As shown in the fundamental analysis, the complexity of Bitcoin and its future utility does not allow an absolute calculation of its value. Third, bubbles generally arise during periods of low interest rates and high money supply. Even this condition is true for Bitcoin as there is a low interest rate environment since the financial crisis in 2008 (Rapp, 2015).

Phases of a Bubble

Bubbles go through certain phases in their development. Rodrigue characterized four stages from the birth to the burst of a bubble (see Fig. 2.1). In the stealth phase, mainly smart money investors discover the technology and expect a decent return for a long-term investment. During the awareness phase, institutional investors enter the market causing a noticeable price increase (Porras, 2016). As the media attention for the asset is growing, public investors enter the market during the mania phase. When prices start to increase massively, investors develop greed and delusion. In the end of this phase, market prices do not reflect the fundamental value anymore (Rodrigue, 2008). Eventually, a trigger results in a paradigm shift which leads to the blow off phase. From this point on, investors start to sell the asset again and prices fall.

Concerning Bitcoin, similar patterns as mentioned above could be observed during the last years. Major bubble developments occurred in 2011, 2013/2014, and 2017/2018. The latter is taken as an example to compare its development with Rodrigues's model.

As can be seen in Fig. 2.2 during this period, the Bitcoin price grew by approximately 1,900% from USD 1,000 per BTC to almost USD 20,000 per BTC and

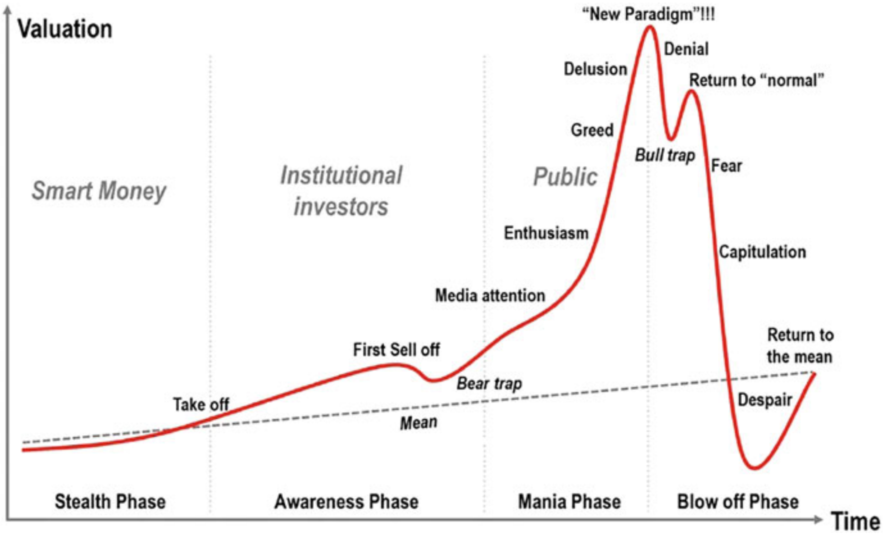

Fig. 2.1 The four stages of a bubble according to Jiménez (Rodrigue, 2008)

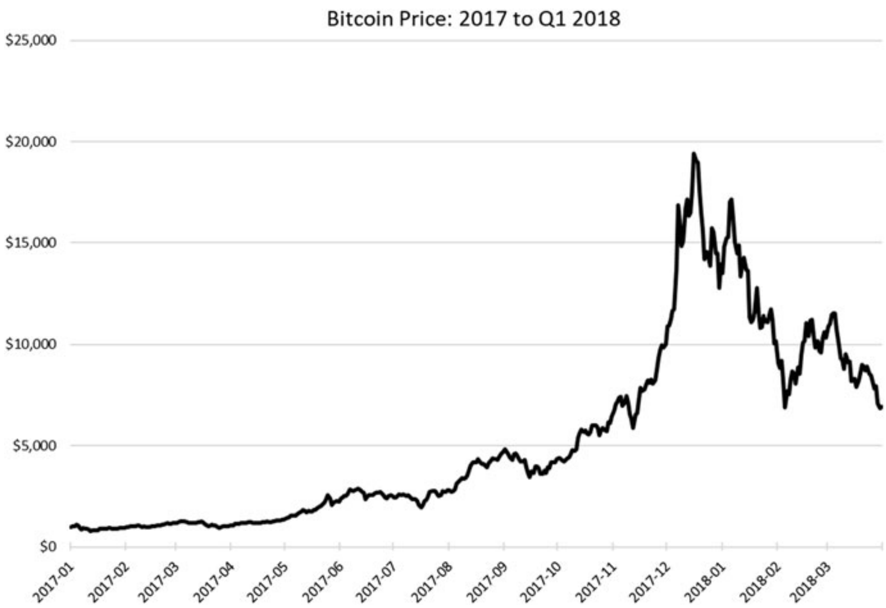

Fig. 2.2 Bitcoin Price: 2017 to Q1 2018 (finanzen.net, 2021)

thereafter fell by approximately 65% to USD 7,000 per BTC. One could say that from January to April 2017, there was the Stealth Phase, from May to September 2017 the Awareness Phase, from October to December 2017 the Mania Phase, and from January to March 2018 the Blow Off Phase. From a technical perspective, this development seems to be identical to the bubble model (see Fig. 2.1).

On the contrary, Rodrigue's model assumes that the asset experiences only one price bubble in its life cycle. For example, it cannot go through the stealth and awareness phase more than once because the asset is already known to the public. But in the case of Bitcoin, this bubble pattern has been observed at least three times. To verify the bubble argument, a longer timescale must be observed. For this case, a long-term chart with a logarithmic scale helps to better understand the exponential growth of the digital currency:

Bitcoin Price Development

As can be seen in Fig. 2.2 after the first exchanges for crypto currencies launched in 2011, a strong price growth for Bitcoin was observed. The price increased by 4.275% within 3 months (from USD 1 per BTC to USD 35 per BTC) and fell by 93% (to USD 2.29 per BTC) within the same year due to negative press regarding illegal trading and money laundering related to Bitcoin (Wallace, 2011) (Fig. 2.3).

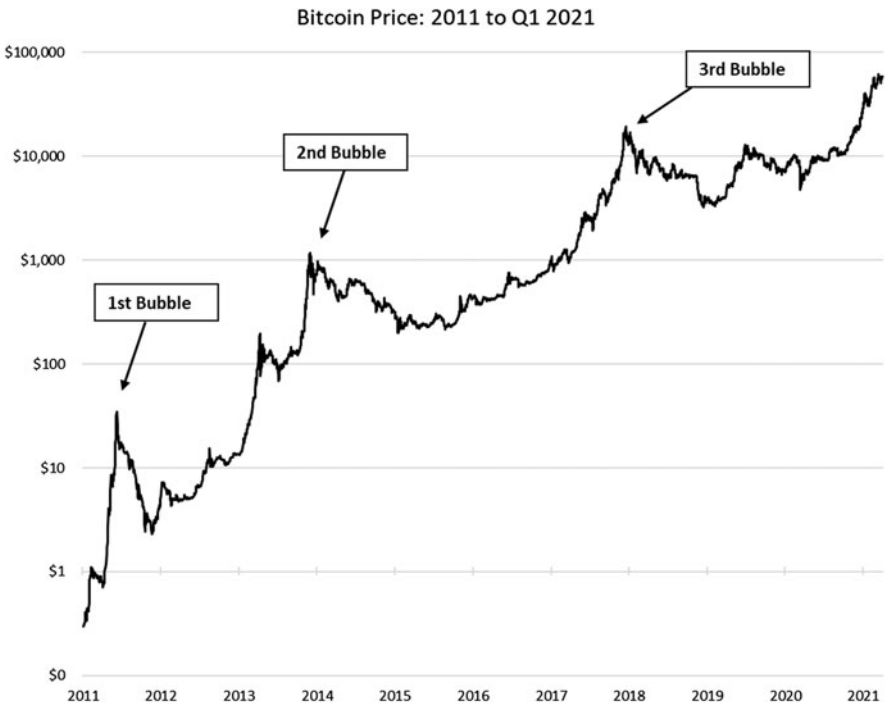

Fig. 2.3 Bitcoin price: 2011 to Q1 2021 (finanzen.net, 2021)

In 2013, the next boom was triggered after Bitcoin reached new milestones in the acceptance of several governmental agencies (Calvery, 2013). The euro crisis additionally triggered an increasing demand for alternative investment options such as crypto currencies (99Bitcoins, 2021). The price increased by around 8,750% within eleven months (from USD 13 per BTC to USD 1,150 per BTC). After the largest crypto exchange at this time, MT Gox was hacked, resulting in USD 400 million worth of Bitcoin being stolen, the bubble collapsed and fell by about 65% (to USD 400 per BTC) until April 2014 (Carrick, 2016).

The last significant bubble was observed in 2017 to 2018. The boom was triggered after Japan declared Bitcoin as a legal method of payment (Keirns, 2017). During this period, an increasing regulation of governments had a positive impact on the sentiment of crypto currency investors. At the same time, Initial Coin Offerings (ICOs) started an even more speculative rush for new crypto currencies. Overall, this boom had a positive impact on the whole crypto market, so that the Bitcoin price increased by approximately 1,900% (from USD 1,000 per BTC to USD 20,000 per BTC) in 1 year. The tipping point was reached in January 2018. Among other things, a significant trigger event was the insight that most ICOs did not satisfy the expectations so that investors gave up their support for crypto currencies. A research showed that 78% of all ICOs in 2017 and 2018 were identified as scams. Only 15% of the new crypto currencies were successful enough to be listed on a crypto exchange (satisgroup.io, 2018). The situation was comparable to the dotcom boom when many Internet companies had not been able to generate profit or revenue, but still took in millions of USD from investors. Other triggers include the announcement that South Korea and China were planning to ban crypto currency trading (Gibbs, 2018). Although this has not actually happened to date, the sentiment tilted and led to a crash of approximately 65% for Bitcoin (to USD 7,000 per BTC) in Q1 2018.

In 2020–2021, crypto currencies have finally recovered from the previous bear market and reached new highs. Until Q1 2021 Bitcoin reached a price of approximately USD 60,000 per BTC with a total market capitalization of more than USD one trillion. Several reasons explain this development:

The corona pandemic in 2020 had the side effect that people became more aware of digital software and assets in general. FinTech companies like PayPal offered new services to easily access the crypto market for private investors (Shevlin, 2020).

To finance the corona measures, most governments and central banks also printed more money and ran into debts, causing the expectation of increasing inflation. "People moved their money [. . .] in[to] deflationary assets like gold and Bitcoin" (Metzger, 2021). Several institutional investors bought crypto currencies during the pandemic, including MassMutual, MicroStrategy, and Tesla (99Bitcoins, 2021).

Conclusion of the Empirical Analysis

Altogether, the empirical development shows a high volatility in the crypto market. Three major price bubbles and their bursts were observed between 2011 and 2020.

However, these price bubbles only occurred in the short term but have always recovered in the long term. As a matter of fact, this development cannot prove that crypto currencies in general are frauds that result in a bubble. It needs to be considered that crypto currencies are still in an early stage, which results in exponential growth, but also high volatility. Tech companies were overvalued in the 1990s, too, resulting in a stock market crash. Certain companies failed but the general market, including the Internet technology, recovered in the long term and had a disruptive impact on society. Same can be true for crypto currencies that have shown long-term growth and a technology which can significantly improve the way people store value and apply transactions. However, this is a speculative scenario of the future that crypto currencies have not reached to the full extent yet.

Opportunities and Risks of Crypto Currencies

In the following subchapter, the opportunities and risks of crypto currencies are analyzed to draw conclusions about their potential as a disruptive technology of the future.

Security of Transactions and Balances

Critics question the security of the blockchain technology since several hacker attacks on crypto currencies have been reported. Although cyber-attacks are an actual problem, it must be differentiated how they occur. In most cases, the login data of a user, which represents the private key to a crypto wallet or the password for a crypto exchange, is hacked. This happens due to a lack of security measures not by the blockchain but by the user or by the exchange platform itself. Several regulations and new security standards have been established to solve these problems. Exchange platforms like Coinbase.com are regulated by the SEC (United States Securities and Exchange Commission) to provide security for the customers. Also, many exchanges have transferred the crypto currencies to a hard wallet in order to store their value offline and prevent hacker attacks.

Besides, a blockchain itself with an advanced network is considered as a safe and unassailable system. In the Bitcoin blockchain, for example, every transaction must be validated by the majority of miners. In order to hack the blockchain, one needs access to approximately 51% of the network mining power. The resulting financial gains would not be worth the effort (Bitpanda, 2021b). Few exceptions were observed for smaller crypto currencies that do not have an advanced network yet or rather low hash rates. The coin Ethereum Classic, for example, was successfully attacked by hackers who accumulated 51% of the computing power for a short time to steal coins with an equivalent value of USD 4.8 million (Thompson, 2020).

Compared to the existing financial system, the above safety features do not provide significant added value for everyone. In the current state, banks are regulated by financial authorities, such as the SEC in the US, to provide security for transactions and balances. Therefore, they maintain high trust by the general population.

The reason why crypto supporters prefer a decentralized financial system is because they worry about a negative influence of governments and central banks on the monetary system.

Transaction Efficiency

Transaction efficiency mainly concerns the key figures cost and speed. The characteristics differ depending on the crypto currency. In the case of Bitcoin, transaction time and costs depend on the transaction frequency of the network. On average, it takes ten minutes to transfer Bitcoin (coinmarketcap.com, 2021). As of February 2021, the average transaction costs amounted to USD 23 (Hertig, 2021).

For a potential daily means of payment, these key figures are suboptimal. This is because the Bitcoin blockchain has limited storage space available to accumulate transactions. Additionally, miners need to be compensated by transaction costs that are high enough to secure the network. As mentioned above, Bitcoin is less suitable as a means of payment at this stage, but rather as a store of value.

Technologically, an improvement could be made through the so-called Lightning Network. This creates a parallel blockchain, a second layer on which payments are exchanged more cheaply (less than USD 0.01 costs per transaction) and within seconds. Afterwards, these transactions are summarized in the original Bitcoin blockchain, the first layer (Kho, 2021).

Further possibilities are offered by altcoins, which use newer generations or other models of the blockchain. Crypto currencies like Ripple, Stellar, and EOS, for example, can process transactions instantly and almost free of charge (kraken.com, 2021).

In terms of money transfer, this is not necessarily a great added value as things stand today. P2P (peer-to-peer) payments can also be processed instantly and partly free of charge via FinTech providers such as Klarna or PayPal. Credit cards can also be used to process payments in a matter of seconds. However, those payment methods still have difficulties when transferring money in foreign currencies or into countries with a lack of financial institutions. In these cases, transaction fees increase rapidly. This is less due to technical problems but rather due to bureaucratic obstacles between countries. On the contrary, crypto currencies overcome those hurdles because users only need an Internet device to transfer money without an intermediary.

Smart Contracts

Besides financial trading, blockchains also enable contractual transactions with the so-called Smart Contracts. They work with the following scheme: If condition X is fulfilled, then Y is triggered. Such a contract is programmed into the blockchain, so in theory no delays or manipulations are possible. Smart contracts could evolve into a disruptive technology, superseding intermediaries such as notaries, trustees, and partly banks. This gives rise to several use cases that enable more efficient, secure, and transparent economic interactions:

Decentralized Finance DeFi apps (dApps) enable all users with an Internet device to access various financial services that are organized in a decentralized manner. This means that no institutional banks, insurance companies, etc., are required, as the transactions are secured via the network and smart contracts. Especially for people in developing countries, who have had little access to the financial market, dApps could offer a high added value. Those services include P2P lending, P2P payments, trading of securities, insurances, and more. For this purpose, crypto developers have also issued stable coins like Tether, which are pegged to the value of the USD (1 Tether = 1 USD). They allow easy access to a fiat currency that is represented in a virtual form and provide an alternative to volatile crypto currencies. Owners of these coins can also use them for the so-called staking to maintain the blockchain network and receive interest in return. Staking is the equivalent of mining, in which one's own crypto currencies are lent instead of computing power (Binance, 2021).

Supply Chains The blockchain documents when goods arrive at participants in the supply chain, triggering automatic actions such as price payments. This speeds up the processes and creates transparency for any authorized person. For consumers, this can create proof of the authenticity of the product or its ecological value.

Real Estate Transactions Buying or selling real estate usually includes an intermediary, for example a notary, who documents the trade and generates additional costs. With a smart contract, this process could be done without an intermediary. For example, an entry would be made automatically in the digital land register as soon as the contractual conditions (including payment of the purchase price) have been met.

Data Protection Information can be stored securely and digitally on the blockchain. Users can define ownership, for example regarding patients' records, and share them only upon consent.

Licenses and Copyright For digital artworks, movies, and music, ownership can also be transparently represented and documented on the blockchain. The so-called NFTs (non-fungible tokens) already allow to trade digital trading cards and more in which ownership is transferred via the blockchain to avoid counterfeiting.

State Governments Government actions, distribution of subsidies, tax payments, and even elections can be handled via smart contracts to create more transparency, efficiency, and security.

Developed countries already have legal systems that cover most of the mentioned issues, but none that operate automatically and truly independently. The economic participants still have to trust each other. But in everyday life, processes can be manipulated or delayed, so that months or even years can pass before certain transaction are successfully executed. In certain jobs, this inefficiency and intransparency is even desired to gain advantage over customers and competitors. Herein lies one of the reasons for why smart contracts might not prevail. They would dispense certain industries so that people lose jobs. Before that happens, there might be an outcry from a lobby to slow down or stop the disruptive technology.

Digital Store of Value

According to the idea of the Internet of Value, it is possible to store and transfer financial value digitally (Ripple, 2017). Not only does this possibly work faster and cheaper, but the dwindling trust in fiat currencies is the reason why crypto enthusiasts are looking for an independent store of value as an alternative. They fear an increasing devaluation of fiat currencies, possibly even a complete collapse of the monetary system. In those worst-case scenarios, a government could start seizing physical value, such as real estate, gold, and securities managed by banks. Similar scenarios have been witnessed by mankind several times even in the last 100 years. Crypto currencies would make such government expropriation and control much more difficult, if not impossible.

Bitcoin is preferred as such an alternative store of value. This is because Bitcoin is the oldest and most established crypto currency. The coin has a high level of trust and has shown a long-term growth of value. Technically, Bitcoin already meets the requirements of a rare asset today: New coins can only be mined through considerable labor and the total number is limited. This results in a deflationary character, which in theory leads to a steady increase in value compared to inflationary fiat currencies. Thus, similar characteristics are given as for precious metals. Gold, silver, etc., have been recognized by mankind as valuable objects of exchange for several thousand years, but crypto currencies could become more important with increasing digitalization. A survey by The Tokenist shows that the number of people who prefer Bitcoin to gold has doubled from 8% (in 2017) to 16% (in 2020). If we filter the respondents' selection to the Millennial generation, the approval even rises to 32% (The Tokenist, 2021). A major point of criticism as to why the rather older generation in particular places less trust in crypto currencies is the high fluctuations in value (see subchapter: High Volatility).

In addition, not all crypto currencies have the characteristics of a store of value. For example, the second largest crypto currency, Ethereum, has an unlimited minable amount. Also, the Ethereum blockchain is expected to switch from the proof of work to proof of stake method in 2022, so a smaller amount of work will be required to produce new Ethers (Benson, 2021). These features allow crypto currencies like Ethereum to scale better, so transactions are executed more efficiently. However, they lose the deflationary characteristics of a scarce asset like Bitcoin.

High Volatility

The most significant criticism on crypto currencies is their high volatility which has led to several price bubbles. This statement is reasonable because Bitcoin's daily price volatility to the USD is on average about five times higher compared to gold (Klein et al., 2018).

The high volatility is caused by different circumstances: Blockchain technologies are not mature or sufficiently tested yet. As shown in the fundamental analysis, different scenarios can occur for crypto currencies, but there is no confidence whether they will prevail at all. Therefore, there is a highly speculative component for the future of crypto investors. Additionally, a large proportion of crypto owners are "inexperienced and volatility-shy" investors (Denton, 2021). Accordingly, they might react more emotionally to price swings, so that prices subsequently break out even stronger compared to other asset classes. In contrast, almost 80% of Bitcoin investors are long-term oriented, so they do not only intend to make profit through short-term speculation (DeCambre, 2021).

Despite several crashes, the crypto market has always been able to recover and rise significantly in the long term. However, volatility remains the normal state in the crypto space until today.

Government Regulations

Government regulations can have positive or negative influences on the price development of crypto currencies. During the bull run in 2017, measures such as the recognition of Bitcoin as a legal tender were positively received. All events that allow institutional investors to invest in crypto currencies create more demand and lead to an increasing price. In late 2017 and early 2018, hopes rose that the SEC would approve a Bitcoin ETF (Exchange Traded Fund), allowing crypto currencies to be traded on securities exchanges. In the summer of 2018, the SEC rejected the draft, so the Bitcoin price fell by over 30% within two weeks (Bain, 2018).

Furthermore, crypto currencies were initially launched to create a more decentralized, independent monetary system. If the crypto market continues to grow, governmental and central institutions will lose control over the monetary system. It can be assumed that they will try to prevent this power shift. Additionally, tax authorities might intend to profit by the growth of crypto currencies so that they will increase taxes for trading digital coins. Several scenarios could become a serious threat to the price development of crypto currencies:

Ban on Private Ownership of Crypto Currencies In principle, a state could legally ban crypto currencies. Several justifications for this measure could be found: trade of illegal goods, speculative asset, not a state-approved means of payment, etc. Such restrictions were introduced in several countries already, for example in 1933 to 1974 in the USA for gold ownership (Campbell, 1978). Usually, massive interventions like this had arisen in currency crises in the past. A scenario of a collapse of the monetary system is exactly the scenario that many crypto investors are afraid of. However, such a prohibition for crypto currencies is unlikely as digital ownership cannot be easily proven.

Ban or Restriction of Crypto Exchanges An easier way to harm crypto currencies is to ban crypto exchanges. This would complicate the process of trading digital coins so that only illegal trading via P2P transactions would be possible. Less people would be willing to interact in this black market so that they would rather stop trading crypto currencies. However, a ban would be a massive intervention and lead to a strong resistance of crypto investors. A less radical solution would be to introduce stricter regulations for the exchanges. This involves considerable effort, which could not be afforded by every trading platform. The remaining crypto exchanges could pass those costs on the customers so that the appeal of trading is gradually lost.

Higher Taxation of Crypto Currencies Capital gains on crypto currencies are taxed differently depending on the country. In Germany, for example, private gains on crypto currencies are tax-free when the respective currency is held for at least 1 year (McClure, 2021). Compared to other assets, this is a generous and simple tax regime, but it might not last forever.

If governments intend to make the issue more complex and increase taxes, there would be less incentives to invest in crypto currencies. A possible death blow would be if governments decide to tax unrealized gains on crypto currencies so that taxes must be paid yearly although the asset was not sold yet. This would discourage people from investing in crypto currencies in the first place. On the other hand, investors would have to regularly sell their digital currencies to pay the tax, which in turn decreases the price of the coins.

High Power Consumption Bitcoin consumes around 119 TWh of electricity per year, which is roughly equivalent to the energy consumption of the Netherlands (Digiconomist, 2021). For environmentalists, this is a large amount and gives crypto currencies the reputation of being harmful for nature. However, one must weigh the costs and benefits for the technology and compare it to other assets. Bitcoin consumes less than 10% of the electricity needed for traditional banking and less than 40% of the electricity for gold mining (Arkinvest, 2020). Further studies by CoinShares estimate that about 73% of Bitcoin miners obtain at least a part of their electricity from renewable sources (CoinShares, 2019). For Bitcoin's proof of work process the energy consumption is necessary in order to ensure the safety of the system. However, newer blockchain generations mostly use the proof of stake method and therefore require significantly less power.

Scalability Scalability is an essential condition to prepare crypto currencies for an increasing number of transactions. Thus, when more active users join the blockchain, it must still be possible to complete transactions quickly and cheaply. This is where Bitcoin comes in for criticism. Its blockchain is programmed to generate about 1 MB of storage per block within about ten minutes, so that it can only process seven transactions per second (Bitpanda, 2021a). If the network is overloaded, this leads to delayed transaction times and higher fees. However, Bitcoin in its current version is used less as a means of payment and more as a store of value. Thus, the characteristics of scaling are only secondary.

Technologically, further approaches are currently being developed to solve the scalability problem. These include the provision of higher storage capacity and/or a parallel blockchain on which microtransactions are executed. Ethereum 2.0, which is planned for 2022, should already be able to process 100,000 transactions per second (Conway, 2021).

Central Bank Digital Currency One possible danger for the currently decentralized crypto currencies is that state-owned central banks and larger companies (e.g., Facebook's crypto currency Libra) copy the concept of digital currencies and implement them on their own terms. Such projects could bring benefits because they are issued by a reputable provider and are trusted from the beginning.

The Chinese central bank introduced the digital Yuan in 2020, which is a digitized form of the fiat currency. While this simplifies payment transactions and may also be more secure than carrying cash, the approach is nowhere near the decentralized principles of a crypto currency. Critics of state-owned digital currencies believe this is intended as a possible abolition of cash, which would serve to tighten the control of citizens. Crypto currencies issued by private companies are also centrally organized, but could at least create a competitive environment. This would have the advantage that only the best currencies would prevail among users.

Overall, neither option fulfills the original idea of decentralizing the financial system to avoid control by one entity. However, the latter is part of the charm of blockchain for many users. State-owned digital currencies may gain global importance in the future but cannot replace the existing crypto currencies in their current state based on an independent and decentralized blockchain.

Conclusion

Altogether, crypto currencies are still in an early stage but there is potential to disrupt the financial market and replace it with more decentralized and transparent structures, including automated processes. The various crypto currencies serve different purposes. Bitcoin is rather considered as digital gold and has experienced high growth rates in the long term. It should also provide deflationary characteristics to protect against inflation of fiat currencies or the collapse of the current financial system. However, the Bitcoin price still shows a high volatility so that it cannot be regarded as a stable and safe investment. Other crypto currencies, such as Ethereum, are rather appropriate for daily financial transactions or smart contracts to provide more efficient trading without intermediaries.

Certain obstacles can stop the assertion of crypto currencies, though. In the current state, digital coins are rather labeled as speculative assets because, in most cases, they are not utilized for the purpose they should serve, yet. This results in a highly complex valuation of the fundamental value, which is characterized by different possible scenarios in the future. Consequently, the uncertainty of the fair value has led to several bubbles with massive price crashes in the short term. In defense of Bitcoin, the price crashes of the last 10 years have always recovered and achieved new highs.

Furthermore, if crypto currencies gain more importance, they might encounter resistance mainly by governments and central banks who could be afraid to lose power over their currency. Those entities can restrict possession and trading of crypto currencies so that the crypto market would become less attractive.

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Chapter 3
Theoretical Basics of Distributed Ledger Technologies

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Abstract Distributed ledger technologies and in particular the term blockchain have been mentioned more and more frequently in recent years in connection with the digitalization and modernization of existing digital processes. Even though the basic concept has been known since the early 1990s, it was rediscovered primarily through the concept of the cryptocurrency Bitcoin presented in 2008 and is almost ubiquitous at the present time. However, the subject area of distributed ledger technologies is wide ranging and complex. This article describes the most important sub-areas and concepts and outlines their interrelationships.

Distributed Ledger Technologies

Various definitions for distributed ledger technologies can be found in the literature. Some definitions are very broad, such as that of the Deutsche Bundesbank, which defines a distributed ledger as a database that enables participants in a network to share writing, reading, and storage operations (Deutsche Bundesbank, 2017). In contrast, other definitions are interpreted very narrowly and do not distinguish between distributed ledger technologies and blockchain (Deshpande et al., 2017). Unclear terminologies as well as fuzzy distinctions have led to Distributed Ledger Technologies (DLT) becoming an umbrella term used to describe a variety of concepts, some of which are only weakly related to each other, including blockchain, among others (Rauchs et al., 2019). Since the understanding of the term distributed ledger technology, with all its contexts, is an essential part of the present paper and especially important for understanding the evaluation of the results in Chap. 4, it will be considered in detail below.

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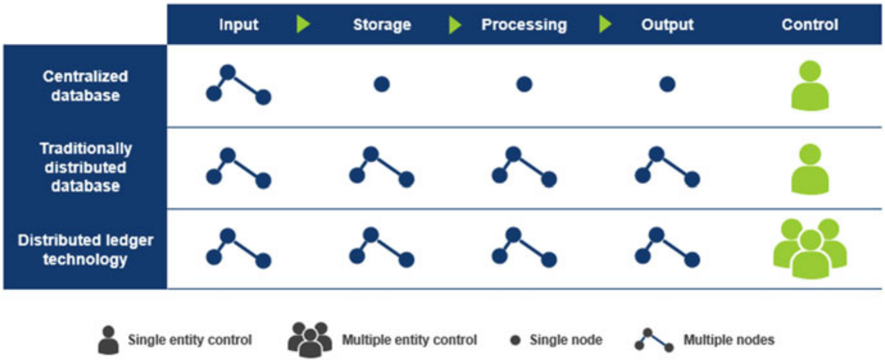

Fig. 3.1 Features of centralized and distributed databases (Rauchs et al., 2019)

By dividing the term into its individual components, its functionality can also be derived in principle. A "ledger" is an account or general ledger that is often embedded in a centralized system maintained within the information system structure of an organization (such as a bank or clearinghouse) to demonstrate that a payer or paying bank has sufficient funds and to additionally process and transfer those funds between accounts (ASTRI, 2016).

A "distributed" ledger, unlike a conventional ledger, is maintained collectively by all participants in the system rather than by a central party. All participants are referred to as nodes of the system. Essentially, nodes are the computers of each participant, each containing a complete set of transaction records. Collectively, these nodes participate in the creation and maintenance of the distributed ledger. Because a "local" copy of the same ledger is maintained and developed in each node—instead of being centrally controlled and managed by a specific party—the system is referred to as a distributed ledger system or distributed ledger (ASTRI, 2016).

DLT can thus be viewed as a type or subset of distributed systems that have a number of specific characteristics that distinguish them from more traditional distributed systems (Rauchs et al., 2019). Figure 3.1 illustrates these fundamental differences between a traditional single-entity database system, a traditional distributed database, and a distributed ledger. While each system accepts input from different sources, control over how the data is stored, processed, and executed varies from one type to another.

From the aggregation of the described characteristics and the resulting consequences for the system, a list of general characteristics can be drawn up that a distributed ledger system should guarantee (Rauchs et al., 2019):

(1) Collaborative record of information, which allows participants to jointly create, maintain, and update a common record.
(2) Community consensus, which allows all participants to agree on a common set of data sets.
(3) Independent validation, which allows each participant to independently verify the status of their transactions and the integrity of the system.

(4) Tamper evidence that allows any participant to trivially detect non-consensual changes to records.
(5) Tamper resistance, which makes it difficult or impossible for individual participants to change past records, such as transaction history.

The goal of a DLT system, therefore, is to create a cryptographically linked set of records that are validated and executed via a consensus process by multiple participants, all in the absence of a central authority. Participants in the network create and send unvalidated transactions—proposals for a new entry in the ledger—which are bundled into entries and subsequently added to the ledger. The instructions contained in the validated transactions can then be executed automatically, as the data validated by this process is robust against adversarial interference, double spending, censorship, forgery, tampering, or other types of malicious acts (Rauchs et al., 2019).

Since a fundamental part of DLT is represented by blockchains, the description that is technically necessary for understanding this paper will be explained in a more differentiated manner in the following section using a "permissionless" blockchain. Permissioned blockchains and other distributed ledger technologies will be discussed in the following section.

Permissionless Blockchain

The basic techniques for blockchains were already described in the early 1990s by Haber and Stornetta (1991), however, the term blockchain only became popular in 2008 with the crypto currency Bitcoin (Nakamoto, 2008), which was conceived as a parallel digital currency or as a medium of exchange to ensure independence from intermediaries (Brito & Castillo, 2013), although other tools and systems, such as Git as early as the early 2000s, were also based on this clearly traceable technology (Brown, 2018).

The blockchain, as the best-known subset of distributed ledger technologies, can basically be interpreted as a distributed ledger of accounts, as described in the previous section. Information, e.g., about transactions in the field of application as cryptocurrency, can be recorded, tracked, and verified without an intermediary. This information is stored in blocks in an organized, constantly growing, and chained list and converted into a standardized format by a hash function (Deutsche Bundesbank, 2017).

Since there is no uniform standard for blockchains and therefore each blockchain approach would have to be described separately, the following description is kept general, but is based on the concept of Bitcoin. Special features of other blockchain approaches, such as different consensus procedures, are taken into account at the appropriate point.

The core element of a blockchain is the so-called block, which contains the jointly recorded information. This is divided into a block body, which in the case of a

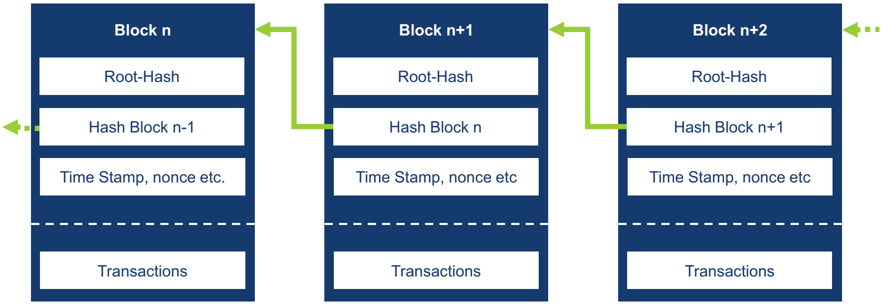

Fig. 3.2 Simplified structure of a blockchain (Schuster et al., 2020)

cryptocurrency contains the corresponding information for the transfer of units in the virtual currency, and a block header.

First, all the individual pieces of information in the block body are cryptographically encoded in hash values and then hierarchically compressed. This hierarchical compression of the individual pieces of information is known as a hash tree or Merkle tree (Merkle, 1987), which can be used to uniquely represent the set of information (Fill et al., 2020). The root hash of this hash tree is stored in the block header. Furthermore, at least a timestamp, a nonce value, and a hash reference to the previous block are stored in the block header. Depending on the blockchain approach, the information in the block header differs (Fill et al., 2020).

If a new block is added, the hash value of the existing encoded block is included in the hash calculation of the new block. The blocks are thus linked to the existing history of existing blocks, creating a chain of blocks (blockchain). Figure 3.2 further illustrates this process. This encoding of the information means that it is no longer possible to subsequently change existing blocks, as this would change the hash value and the hash tree would therefore no longer be consistent (Fill et al., 2020).

Basically, the system is decentralized, so it has to cope without a trusted central authority. However, if any node within the system can add new information, there is a risk that this could be maliciously exploited by certain nodes in some way; in the most common case, to enrich themselves without authorization. This is where the central and innovative component of blockchain technology comes into play, the so-called consensus mechanism. Achieving distributed consensus depends on two processes, validating each transaction and broadcasting the validated result to all other nodes within the network. The nodes jointly decide whether the new transactions in a block are valid and the block can be included. Once a validating node has validated one or more transactions, it initiates a process to add the new block to the network. In doing so, the validating node first sends information about the new block to other validating nodes. Other validating nodes may have validated the same set or different sets of transactions. The consensus process allows them to communicate with each other and agree on a common set of validated transactions. After consensus is reached, other nodes evaluate the validity of all transactions in that block. Thus, trusted, identical copies of the entire transaction history usually exist on all participating nodes (ASTRI, 2016). The latency between submission and confirmation of a transaction depends on the particular DLT and consensus mechanism. For Ethereum, this takes approximately three minutes, through a block production rate (block time) of 14 seconds and a block confirmation of twelve blocks. If reference is then made to the chain with the already validated block, this is considered to be finally accepted (Xu et al., 2017).

However, depending on the type of design, the consensus mechanism described is very complex and computationally intensive, which results in high energy costs for the validating nodes, among other things. The question arises as to why a node operator would accept these costs. This is done through various incentive schemes, where nodes involved in validating new blocks are rewarded by a share of the cryptocurrency. In the case of Bitcoin, this would be the Proof of Work consensus mechanism, which grants a share of Bitcoins to the first node to confirm a block. This process is also known as mining (Schuster et al., 2020).

Permissioned Blockchain

In addition to the concept of a completely decentralized data structure without any access restrictions described in the previous section, there are also concepts that restrict these freedoms. A distinction cannot be made easily because the transitions between permissioned and permissionless blockchains are often fluid. In principle, a permissioned blockchain can be owned, controlled, or managed by a central, trusted party, or a group of participants in the form of a consortium. In this way, it is possible to regulate who has access to the information stored in the blockchain. Writing permissions can also be regulated in the same way. Thus, only trusted or verified participants can participate in the control and maintenance of permissioned blockchains. To ensure encapsulation and privacy, it is also possible to grant participants reading and writing access to separate blockchains that are operated in parallel but interconnected (Wüst & Gervais, 2018).

Another advantage results from the validation process, which does not involve a computationally intensive mining process that consumes large amounts of electrical energy and computer resources. The validating nodes usually check the validity of a transaction with a Byzantine Fault Tolerance (BFT) mechanism. This means that this blockchain or ledger can be updated faster and in a more energy-efficient manner. It should be noted that a permissioned blockchain can also be public if, for example, public verifiability of the content is desired. In this case, it is referred to as a Public Permissioned Blockchain. (Wüst & Gervais, 2018).

Directed Acyclic Graphs and Other DLT Technologies

As already indicated, the term blockchain is often used colloquially as well as partly also in the scientific literature as a synonym for DLT (Atlam & Wills, 2019). This is due to the fact that a large part of the known distributed ledger technologies from the field of cryptocurrencies are based on blockchains (OECD, 2018). Regardless of this, other technologies also exist, such as Directed Acyclic Graph (DAG) or also Radix DLT, which fulfill the described characteristics of distributed ledger technologies (Atlam & Wills, 2019). The following description of DAG in the context of DLT is based on the so-called tangle of IOTA (Popov, 2018), the best-known cryptocurrency based on DAG (Atlam & Wills, 2019) and the only one with relevance for the study in Chap. 4, although other technologies based on directed countercyclical graphs also exist (Kondru & Rajiakodi, 2020).

Unlike systems based on blockchains, which use sequentially linked blocks with multiple transactions within a block, in a DAG, each transaction has its own block. As can be seen in Fig. 3.3, a topological order is used (Raschendorfer et al., 2019).

If a participant in the network adds a new transaction, they must confirm or approve at least two previously attached and still unconfirmed transactions. The more transactions attached to a new transaction, the higher the level of trust in the validity of that transaction. Transactions that receive additional approvals thus achieve a higher level of trust. Since the network users themselves validate the transactions, cryptographic hash calculations (mining), as in the permissionless blockchain described earlier, are not necessary. All participants in the network have the same role, so all participants issue and validate transactions. Therefore, the cost of a transaction only includes the computational cost of validating two other transactions (Raschendorfer et al., 2019).

The described features of a DAG bring some advantages compared to the blockchain. Among other things, transactions are possible without mining fees. In addition, a DAG scales significantly better than a blockchain. Furthermore, a DAG can be partition tolerant, meaning that a portion of the network can split off from the

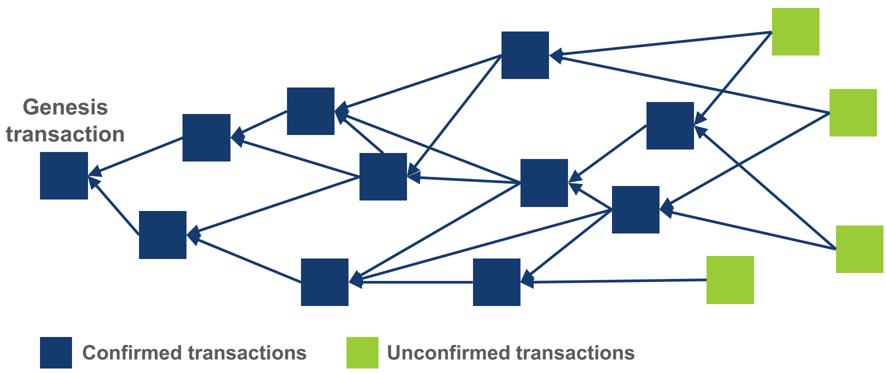

Fig. 3.3 Simplified structure of a DAG (Popov et al., 2019)

main network for a period of time and function without an Internet connection. These split-off parts can later be connected to the main network when Internet connectivity is restored. However, DLT based on directed graphs are still at a development stage, while blockchains have already proven their industrial suitability (Atlam & Wills, 2019).

Consensus Mechanisms

Consensus, in the context of a distributed computer network, is a mechanism by which multiple physically separated participants can agree on something, such as the validity of a transaction. As early as 2016, a study by Lashkari and Musilek (2016) had identified over 130 consensus mechanisms. However, some of these were only variations of the best-known mechanisms, such as the proof of work consensus mechanism mentioned earlier. Since consensus mechanisms have an essential part in the evaluation of qualitative features in tokenization, the mechanisms relevant to the research in Chap. 4 are presented below.

Proof of Work

The Proof of Work (PoW) consensus mechanism was the first consensus mechanism used in crypto currencies (Nakamoto, 2008) and is still the most widely used in this field (Nijsse & Litchfield, 2020). As described in section on the topic of Permissionless Blockchain, the PoW mechanism validates transactions based on computationally intensive cryptographic puzzles. The PoW mechanism has emerged as a proven and robust consensus mechanism to securely operate a decentralized network. Participants in the network are rewarded with a share of crypto currency when they provide computing power to validate transactions. If the value of a crypto currency increases, more participants are incentivized to join the network, which increases its performance and security (Zheng et al., 2017).

However, this high level of security comes at a price, as validation by the PoW mechanism is very resource-intensive due to the computing power required. For example, the Bitcoin network consumes more electrical energy resources than many smaller countries (CBECI, 2021). Another difficulty is the low scalability of the PoW mechanism. For example, Ethereum can currently only sustain a throughput of about 15 transactions per second, while a centralized system like Visa can handle workload peaks of more than 50,000 transactions (Schäffer et al., 2019). If the network is additionally stressed by smart contract transactions, transaction fees increase further because the demand for transaction confirmations is higher than the supply of computing power (Wüst & Gervais, 2018). There is a trade-off between decentralization and throughput that must be considered when selecting a DLT for tokenization.

Proof of Stake

The Proof of Stake (PoS) consensus mechanism is also based on solving cryptographic puzzles, but they are easier to solve than with PoW. Participants in the network (nodes) that want to confirm transactions must have a certain amount of the corresponding crypto currency in PoS. It is believed that participants who hold a higher amount of the corresponding crypto currency for a longer period of time are less likely to attempt to attack the network (Zheng et al., 2017). In PoS, the selection of validating participants or nodes is random, with the chance of being selected depending on the amount of crypto currency held (Vasin, 2014).

Participants in the network who take over the validation of blocks provide their resources in the form of computing power and are rewarded for this. While in PoW the reward is that a miner is allowed to generate new shares for the blockchain of the corresponding crypto currency after successfully generating a new block, in PoS the so-called forger is rewarded with a predefined transaction fee when a new block has been validated (Vasin, 2014).

Participants of the network who try to introduce manipulated transactions into the blockchain, on the other hand, will be penalized. They lose a portion of the crypto currency held and are no longer eligible to perform validations. This additional security compared to PoW is further supported by a broader distribution of validating nodes, because the network is no longer dependent on the few network participants that can provide a particularly large amount of computing power, as was the case with PoW. Energy consumption is also much lower than in PoW. However, in PoS, random selection, depending on the amount of crypto currency held, favors financially strong participants in the selection process (Nguyen et al., 2019).

In addition to this basic form of PoS, there are other variants. Delegated Proof of Stake (DPoS) attempts to counteract the preferential treatment of financially strong network participants by means of a democratic election process. In DPoS, the validating participants are not selected directly from all network participants, but by electing representatives, the so-called witnesses or delegates, who are responsible for various network tasks. The participants of the network are thereby entitled to vote depending on the amount of crypto currency held (Yang et al., 2019).

Delegates are responsible for the administration and security of the network and adjust parameters of the network such as block size and block intervals or check whether the participants of the network comply with the applicable rules. The core of the system is formed by the witnesses, who are responsible for generating and validating blocks. These are chosen depending on their reputation, which is formed, for example, by long-term trustworthy behavior. Since the witness system requires significantly fewer nodes to validate blocks, DPoS has a higher confirmation rate for transactions (Zheng et al., 2017). Since witnesses are not deselected unless there are specific reasons such as dishonest behavior, this leads to higher centralization (Yang et al., 2019).

Leased Proof of Stake (LPoS) is another variation or further development of PoS and was introduced by the crypto currency Waves. LPoS allows participants in the network with a small number of coins (the so-called lite nodes) to rent or lease them to nodes with a higher number of coins (the so-called full nodes) and thus receives a share of the validation reward. This additionally increases security, as coins that are not owned by a full-node can also be included in the validation process (Waves, 2021).

Practical Byzantine Fault Tolerance

The Practical Byzantine Fault Tolerance (PBFT) mechanism (Chondros et al., 2011) is primarily used in permissioned blockchains, where all nodes or participants of the network are known. However, it is also frequently used in conjunction with other consensus mechanisms, for example together with DPoS in the crypto currency EOS (EOSIO, 2018). PBFT is based on Byzantine fault tolerance, but has the property of low complexity as well as higher practicality in distributed systems (Castro & Liskov, 1999).

Byzantine fault tolerance assumes that messages within a closed system may have errors. These can be missing messages or parts of messages lost during transmission, but also intentionally manipulated messages spread by a dishonest network participant (Lamport et al., 1982).

In PBFT, these faulty messages are identified using redundant queries. The network participants decide on the validation of a block in several rounds using a voting procedure (Zhang & Lee, 2020). A trustworthy consensus is reached even in the presence of erroneous messages, provided that a certain proportion of these erroneous messages is not exceeded. PBFT generates a large part of its security from the fact that all participants in the network who want to validate transactions or messages are usually registered with their real identity at a central location (Castro & Liskov, 1999). The simple consensus building described above thus makes PBFT efficient, but the actual basic idea of a cryptographic decentralized database is only partially fulfilled because the mechanism requires a certain degree of centralization.

There are also various other variants of PBFT, like the Stellar platform, which uses an improved form of PBFT with its crypto currency Lumens. Stellar uses a modified form, the Federated Byzantine Agreement (FBA) mechanism, where the validating participants of the network can decide which node they trust to carry out the consensus process. All validating nodes maintain their own list of trusted network participants, which is merged into an overall list. Thus, FBA does not require the identities of the validating participants of the network to be known centrally (Mazières, 2016). This leads to a high level of security, but worsens latency because more complex algorithms have to be used.

Another modified form of PBFT is used by the Neo platform with the delegated Byzantine Fault Tolerance (dBFT) mechanism. Similar to the already described DPoS mechanism, the network participants elect representatives, the so-called witnesses or delegates, who are responsible for various tasks of the network. However, unlike DPoS, the election is independent of the amount of the corresponding cryptocurrency held. Anyone can become a delegate as long as certain requirements are met (Neo, 2021). One of the advantages of using the dBFT mechanism is that it is highly effective due to real-time voting and absolute finality, but like PBFT, this is achieved by the network not being fully decentralized (Zhang & Lee, 2020).

DAG Consensus Mechanism

Blockchains face the challenge of having to be decentralized, secure, and scalable at the same time—known as the Scalability Trilemma (Hafid et al., 2020). The Scalability Trilemma states that only two of the three characteristics of decentralization, scalability, and security can be guaranteed at any given time, so only one side of the triangle at a time (see Fig. 3.4). The previous remarks on the subject of consensus mechanisms have shown that this inevitably leads to compromises. The DAG architecture and its consensus mechanisms were developed to overcome these challenges of traditional consensus mechanisms. Since DAG is not a blockchain, the consensus mechanism also works differently in this case (Cao et al., 2019).

In many of the described consensus methods (PoW and PoS) from the blockchain area, branching or forking can occur due to probabilistic finality. Attackers could try to pass off a compromised branch as the main branch to maliciously manipulate the network. However, they would need to have majority control over the network, which arises, for example, in networks based on the PoW consensus mechanism from an absolute majority. This attack on network integrity is known as the 51% Attack for this reason (Sayeed & Marco-Gisbert, 2019). One form of this compromise would be the so-called double spending. In this case, the same digital coin or token is spent more than once, which is easy to do with digital objects due to their duplicability (Chohan, 2021).

This forking is allowed in DAG-based consensus mechanisms or included implicitly in the mechanism. Transactions can be inserted into the graph at any time as long as previous transactions are validated in the process. These branches or

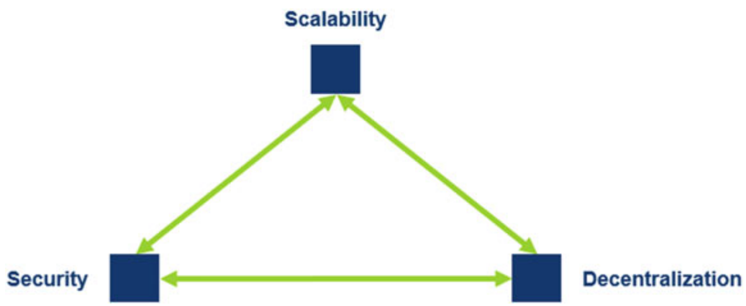

Fig. 3.4 Scalability trilemma (Hafid et al., 2020)

forks lead to confirmation rates and transaction speeds (TPS) that are theoretically no longer limited.

Due to the technical complexity of these consensus mechanisms, we also refer to Cao (2019) and Popov (2018).

Smart Contracts

The term smart contracts and the underlying idea were defined by Szabo (1996) many years before the emergence of distributed ledger technologies. Smart contracts refer to software-based contracts that are linked to certain conditions and are executed automatically if these conditions occur. They extend distributed ledger technologies to include the ability to perform computations, which also enables the automation of processes and the representation of regularities and organizational principles. The term smart contract was first mentioned in connection with this technology in the context of the Ethereum project by Buterin (2013), but it is often misunderstood because smart contracts are basically just persistent, executable program code or small programs (Schütte et al., 2017).

Due to the described feature of tamper-proof DLT, the program code can no longer be changed after it has been stored in the blockchain or the DAG, but an update by storing a new version of the smart contract is possible and can be seen and tracked by everyone. For all parties involved, there is thus certainty that the agreed event will actually be triggered if the deposited conditions occur (Schuster et al., 2020). If the event is the transfer of an asset, for example in the form of a crypto currency, this payment can usually be processed directly via the blockchain or the DAG. There is no need for a central intermediary, which can sometimes cause a long execution time and additional costs (Zheng et al., 2020). In the area of traditional financial instruments, automatic triggering of payments, such as interest or dividends, could be stored. The associated notifications to all parties involved, such as shareholders and supervisory authorities, or the exercise of voting rights could also be represented via smart contracts.

In the area of tokenization of financial or real assets, smart contracts are necessary depending on their design, which means that their underlying requirements also affect the quality characteristics in tokenization. While simple smart contracts can be created via limited toolkits, more complex schemes require corresponding purpose-built programming languages, such as Solidity for Ethereum and other platforms (Solidity, 2021). Solidity enables the programming of the so-called distributed apps. It is turing complete and offers the possibility to standardize contracts as well as to issue own tokens (Schuster et al., 2020).

Smart contracts can offer a high level of security, as it is no longer possible to subsequently change the terms of the contract and they are usually cryptographically encoded (Schuster et al., 2020). However, challenges arise from this power. Once smart contracts have been initiated, they may no longer be able to be stopped. It must therefore be ensured that the smart contract runs both logically and programmatically correctly (Schütte et al., 2017).

Furthermore, one of the central challenges of smart contracts is the integration of external information. In the case of financial assets, this could be securities prices, for example. The so-called oracles that collect, verify, and provide this information are not secured by the cryptographic mechanisms within the blockchain or the DAG and thus offer the possibility of manipulation, which represents a certain security risk. (Schuster et al., 2020). A detailed technical description about the individual phases of smart contracts can be found in Zheng et al. (2020).

Tokenization

A token represents an abstract value or serves the abstract storage of information. In material form, the use of tokens as a representation of economic objects has a long tradition. There is evidence that the Sumerians used tokens as early as about 5,000 years ago in the form of small, geometric, and hand-shaped clay objects that represented different types and quantities of goods such as grain, livestock, or other commodities (Provasi & Farag, 2013).

In the context of distributed ledger technologies, a token—sometimes also referred to as a "colored coin" or "custom token" (Garcia-Teruel & Simón-Moreno, 2021)—represents an abstract value. How a token is defined more precisely in this context is not entirely clear. The opinion held by a majority of the literature is that a coin symbolizes a cryptocurrency that has its own native blockchain or native DAG, while a token is generated on and dependent on an existing distributed ledger (Oliveira et al., 2018).

Tokenization in the DLT space, according to this definition, is thus the issuance of a digital representation of an existing asset on a blockchain or DAG. In many ways, this is similar to the process of traditional asset securitization, but with a modern twist (Laurent et al., 2018). Asset tokenization involves the representation of pre-existing assets onto the distributed ledger by creating, linking, or embedding the economic value and rights that can be derived from those assets with digital tokens on the blockchain or DAG (BaFin, 2019). They act as stores of value. The real assets on which the tokens are issued continue to exist outside the distributed ledger. They typically need to be held in custody to ensure that the tokens are constantly backed by these assets (see Fig. 3.5). Tokenized assets can thus be seen as a form of dematerialized assets that are operated and recorded on decentralized distributed ledgers and are no longer managed in electronic book entries or central securities registers (OECD, 2020).

In the case of tokenized assets in the real world, a fundamental distinction must be made between two different types of tokens, the so-called fungible tokens and non-fungible tokens. The possibility of creating fungible tokens was first introduced in 2015 with the ERC-20 token standard on the Ethereum platform (Vogelsteller & Buterin, 2015). Fungible tokens are arbitrarily interchangeable. For example, if

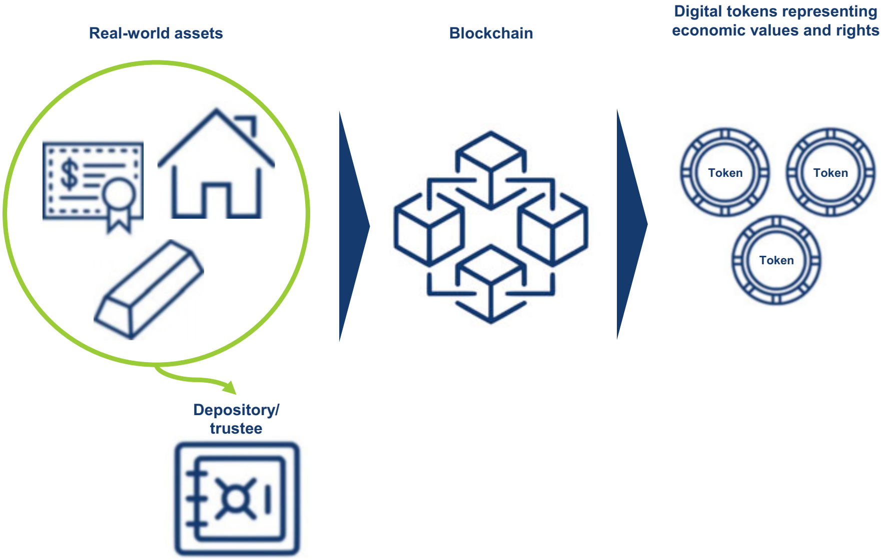

Fig. 3.5 Tokenization of real-world assets (OECD, 2020)

metals are tokenized, it is meaningless which bar or which part of a bar the token represents. The metal is arbitrarily interchangeable or fungible. Fungible tokens currently represent a large part of the assets tokenized via DLT.

This contrasts with Non-Fungible Tokens (NFT), which were introduced to the Ethereum platform earlier in 2018 with the ERC-721 token standard (Entriken et al., 2018). Each NFT is unique and cannot be shared or merged. NFTs can thus be used to represent ownership of unique items that are not arbitrarily exchangeable. These can be representations of digital objects, such as unique virtual items in a computer game or digital art, but also tokenized physical objects in the real world, such as art, collectibles, or real estate. Items tokenized with NFT can thus have only one official owner or holder at a time. By using DLT, no one can change this record of ownership or title to these items (Regner et al., 2019). NFTs are thus also an interesting quality feature for tokenizing real-world assets in particular.

Conclusion

Distributed ledger technologies can be viewed as a type or subset of distributed systems that have a number of specific characteristics that distinguish them from more traditional distributed systems. The application of DLT proves particularly useful when data is to be recorded jointly in a tamper-proof manner between parties that do not trust each other without an intermediary. The term blockchain, in turn, only represents a subset of DLT. Since 2008 and especially in the last few years, this area has developed considerably and offers various possibilities for the development of application examples, such as the representation of real or financial goods in digital form. In addition, other developments continue to advance that can better and more efficiently address the complex challenges of blockchains to be simultaneously decentralized, secure, and scalable. DLT have already brought about significant structural changes to existing processes and will enable more efficient processes in many other areas.

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Chapter 4
Qualitative Comparison of Selected Token Standards for Asset Tokenization

Christian Schmitz and Martin Užík

Abstract Pioneers of distributed ledger technologies (DLT), such as Bitcoin or Ethereum, are reaching their technological limits with the steady development of new application areas, such as tokenization. This limits their usability. At the same time, new platforms are constantly entering the market on which these new application areas can be implemented. The question arises as to which features exist in the corresponding platforms and to what extent these are relevant for tokenization. The qualitative characteristics of the respective platforms through which tokenization of assets is possible are identified, compared, and analyzed in this chapter for their suitability for the area of financial and real assets. The identification of these characteristics was done through a review of recognized literature and through the respective websites, white papers, and documentation of the platforms. This showed that various qualitative features exist within the framework of distributed ledger technologies that are relevant for tokenization of assets. However, a general answer to the question of the suitability of distributed ledger platforms for the tokenization of financial and real assets did not emerge. All platforms have their individual strengths and weaknesses, and many of these platforms are fundamentally suitable for tokenization in the two categories of assets studied. The decision for or against a platform thus depends on the respective project and the individual requirements for quality features.

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Introduction

Distributed ledger technologies (DLT) such as blockchains, and in particular tokenization based on these technologies, have the potential to transform markets and enable a new kind of financial system (OECD, 2020). In recent years, tokenization has become increasingly important in the field of DLT, meaning the digital representation of rights to financial or real assets in the form of digital asset tokens (PwC, 2018). In the first years after the appearance of Bitcoin, a separate distributed ledger technology had to be created at great expense and with a great deal of expertise in order to represent a digital asset (Elrom, 2019). However, in late 2015, the ERC-20 standard interface for tokens on the Ethereum blockchain introduced an "easier" way to implement digital assets (Vogelsteller & Buterin, 2015). Since the ERC-20 standard was the pioneer in this field, a majority of tokens issued today are based on the Ethereum platform (Fahlenbrach & Frattaroli, 2021). However, with the continuous increase in usage, the limitations and challenges of this protocol also became apparent, with particular mention of the limited scalability (Schäffer et al., 2019) and the high costs (Coinmetrics, 2021) for confirming transactions. This limits the usability for certain application areas, such as microtransactions or arbitrage transactions. At the same time, other platforms have been and are being developed that have already addressed these challenges during development or focus on a specific area in tokenization (Knirsch et al., 2019). However, an overview or comparison of the qualitative characteristics of the different platforms with regard to asset tokenization cannot be found. Therefore, the question arises which of these qualitative features exist in the respective platforms and to what extent they are relevant for tokenization in one of the respective classes of assets.

In this chapter, the qualitative characteristics of the respective platforms through which tokenization of assets is possible will be identified, compared, and analyzed for their suitability for the area of financial assets (for example, shares or bonds) and the area of real assets (such as commodities or real estate) in order to clarify the central question of the suitability of certain platforms for the asset groups described. In addition, the qualitative characteristics (like the degree of decentralization, transactions per second (TPS), or level of fees) that are decisive for the tokenization of the corresponding asset groups will be presented.

Methodology

The objective of this chapter is to identify and contrast the qualitative characteristics of platforms through which tokenization of assets is possible, and to analyze them for their suitability in the financial and real assets domain. In order to fulfill this objective, the analytical framework was developed using an inductive-deductive approach, as this is an investigation of the current situation. Due to the varying evidence of the quality characteristics, a division was made into primary (technical) and secondary quality characteristics, whereby the primary characteristics can be substantiated with technical facts and the secondary quality characteristics are partly defined in a "softer" way. Since the majority of these qualitative characteristics are technical in nature and subject to the respective technical requirements as well as limitations of the corresponding platform, a metacharacteristic was chosen for the further categorization of these characteristics. The choice and combination of qualitative characteristics are centrally responsible for the success or failure of asset tokenization. The metacharacteristic serves as a basis for the identification and categorization of further characteristics.

The starting point for the categorization into metacharacteristics was the search for literature dealing with the general technical characteristics of DLT, since these characteristics are subject to the technical requirements of the respective DLT, independent of tokenization. A search using the terms "blockchain" or "distributed ledger" in conjunction with "taxonomy" and "classification" identified metaliterature that was dedicated to the topic and derived categorizations, classifications, or frameworks of technical features or DLT as a whole based on this. In particular, these include Huang et al. (2021), Garriga et al. (2020), Casino et al. (2019), Xu et al. (2017), and Yli-Huumo et al. (2016). These classifications were used as the basis for the structure of primary (technical) metaattributes described below. In addition, a listing of secondary quality attributes that cannot be clearly quantified was developed. Categorization of the secondary quality attributes was not done due to the smaller number. Also, these characteristics cannot always be clearly compared and substantiated, for example in the scope and quality of documentation.

The identification and study of distributed ledger platforms enabling tokenization was limited to the largest public platforms by market capitalization in the first half of 2021. This approach was chosen because market capitalization is the most popular way to measure the success of distributed ledger platforms and the popularity of the underlying platform could have an impact on the future development and success of technological development including tokenization. In addition, other characteristics to measure popularity, such as transaction volume, usually come to a listing with similar results (Hileman & Rauchs, 2017). All platforms through which tokenization of assets is possible and that were in the top 50 by market capitalization on coinmarketcap.com as of May 16, 2021, the largest data service provider in the field of distributed ledger technologies, have been included in this research. The identification was done by reviewing the respective websites, white papers, and documentation of the platforms. This identified 15 platforms through which tokenization is possible. Two platforms, Ripple and Bitcoin Cash, were excluded due to their severe restrictions on the issuance of tokens. In this case, the creation of tokens is only feasible via a web form without any further customization options. Theta and Tron were also not considered, as Theta focuses exclusively on decentralized video streaming and Tron aims to build a global entertainment system for digital content. Permissioned blockchain frameworks without an underlying crypto currency, such as Hyperledger fabric, R3 Corda, or Quorum are not part of this study, as they represent a toolkit rather than a finished product (Polge et al., 2021). For the analysis of the actual quality attributes, block explorers were used in addition to the sources already used for identification, which provide up-to-date data on the state of the networks.

All primary quality characteristics were initially normalized to a value between 0 and 1, with 1 always representing the optimum value of the platforms examined. No weighting was applied to individual quality features, but it should be noted that weighting these features in more extensive analyses could lead to a different ranking. To determine the ranking, 1 was first divided by the value of the quality feature determined for the respective platform, as shown in the following formula. Then the minimum value of all platforms for the corresponding quality feature was divided by the result obtained.

$$\frac{\min(VQ_1, \ldots, VQ_n)}{\left(\frac{1}{VQ}\right)}$$

VQ = Value of the quality feature

For numeric values, this was done directly. Non-numerical values were first converted into numerical values. For this purpose, the value 1 was always used as the ideal starting value and was graded down to 0 according to the number of values of the quality characteristics. If a quality characteristic had the three values "yes"/"possible," "no"/"not possible," and "restricted," the value 1 was used for "yes"/"possible," the value 0.5 for "restricted," and the value 0 for "no"/"not possible."

If the corresponding value for a quality attribute of a particular platform was 0, the value's eighth decimal place was set to 1 and the result of the normalization was then rounded to six decimal places, as it is not possible to divide by 0. In cases where the metaattributes resulted from several quality characteristics, an arithmetic mean was calculated. An arithmetic mean was also calculated for values of quality attributes for which an interval was specified.

For the further evaluation of the suitability of the platforms for tokenization, an evaluation of the relevance for the respective categories of assets was carried out on the basis of assumptions, which were derived on the basis of the theoretical foundation section and the existing specialist literature and served as a weighting factor. The conversion into numerical values was carried out using the procedure already described.

In a final step, the values of the quality features of the respective platform were multiplied by the weighting factor of the various categories of assets and summed to produce an overall result. The ranking of the platforms examined determined in this way was then critically examined, taking into account the secondary quality features.

Analysis

The analysis section is divided into three sections. First, the qualitative characteristics relevant to this study are identified and categorized before they are analyzed for the identified platforms in the following section. The final section then evaluates the analyzed platforms for suitability for tokenization of the respective asset categories.

Qualitative Characteristics

In the following, both the primary (technical) quality characteristics, such as scalability or functionality, and the secondary, non-technical quality characteristics, which cannot be directly proven with a technical fact but are nevertheless relevant when selecting a distributed ledger platform for tokenization in the area of financial or real assets, such as establishment or the reputation of the platform, are defined. Regulatory and legal features are not considered in this research. An overview can be found in Garcia-Teruel and Simón-Moreno (2021).

Primary Qualitative Characteristics

To provide a better overview, the primary (technical) quality characteristics are categorized on the basis of the metaattributes performance and scalability, costs (despite the fact that they tend to be of a business nature), security, functionality and extensibility, and decentralization and data protection. A clear assignment is not always possible since different technical quality characteristics are tangential to different metaattributes. It is therefore possible that the corresponding characteristics occur several times in the following section, but are always assigned to only one primary metaattribute.

Performance and Scalability Decoupling performance (latency and throughput) and scalability is not completely possible. Both characteristics are limited by the design decisions made when creating the distributed ledger and are especially dependent on the consensus mechanism. For performance, the characteristics of transactions per second (TPS), confirmation time, and block production rate are relevant. However, since the block production rate is implicitly included in the confirmation time, it was not considered in the evaluation in order to avoid a higher weighting of the two characteristics compared to the TPS.

Costs Although the use of distributed ledger technologies could theoretically be free, several aspects exist that are related to costs. A direct link exists for the execution of transactions, which in most cases require a transaction fee that includes, among other things, the incentives of the validating nodes. Depending on the consensus mechanism, these fees also depend on the utilization of the network, thus there is an additional connection between the confirmation time and the block production rate, since at high utilization rates not enough blocks can be confirmed for technical reasons to cover the high number of requests. Furthermore, there are also minimal fixed costs for the use of applications, such as for the creation of smart contracts. Since these costs cannot be clearly documented and are highly dependent on individual project decisions, they are not included in the analysis. The confirmation time and block production rate have already been assigned to performance and scalability due to the closer linkage. Thus, only the transaction fees are assigned to the metaattribute cost. The calculation was made as of May 16, 2021. Since the exact fees for many platforms depend on various factors and differences in the range of fractions of a eurocent are irrelevant for the asset classes examined, a classification was made into the categories "very low" (no transaction fee or fractions of a eurocent), "low" (single-digit eurocent range), "medium" (up to one euro), and "high" (over one euro).

Security One of the main features of DLT is the immutability of confirmed transactions. This provides data integrity through tamper resistance. This security depends on the ledger technology used, for example blockchain, DAG, or others, and the consensus protocol used. Depending on the implementation, this results in a fault tolerance above which it is possible for attackers to gain control of the network, known in Bitcoin as the so-called 51% attack. The confirmation time could also be assigned to the metaattribute security, since in blockchains it is only certain after a certain number of blocks that these also belong to the main branch and thus finality is given. The confirmation time has already been classified under performance and scalability. Thus, only fault tolerance is assigned to the metaattribute security and divided into three categories: 1/3 attack, 51% attack, and asymptotic security, where 1/3 attack offers the lowest security and asymptotic security the highest security.

Functionality and Extendability Interoperability and compatibility are essential for broader use and further growth of distributed ledger technologies, as no standard for DLT technologies will exist in the medium term. These features allow different blockchains or even different DLT to work together while maintaining their individual security properties (Belchior et al., 2021). Smart contracts extend the functionality of DLT with the ability to create distributed applications. This possibility is closely related to the programming language used. Also, the possibility of using NFTs, which represent ownership of unique items such as a particular property, is of interest for this purpose. Thus, for functionality and extensibility, the characteristics of interoperability, smart contracts, non-fungible tokens, and programming language are relevant. For all characteristics, except the programming language, an assignment of the values "Yes," "No," and "Limited" was made. Indices with rankings for programming languages, such as TIOBE (2021), could be interesting for an assessment of the programming language. Since the programming language has a direct influence on the possibilities of the smart contract feature and is indirectly included in it, this feature was not considered separately in the evaluation.

Decentralization and Data Protection In principle, all distributed ledger technologies are based on non-centralized networks, in which a common consensus must be reached among all network participants in order to collect, store, and manage data. Depending on the design of the implementation, permissioned versus permissionless as well as public versus private, different degrees of decentralization can result. Data protection also depends on the type of implementation. While most DLTs are designed to protect the integrity of transactions, they do not take privacy into account. They often do not have anonymity, but pseudonymity, where transactions can still be traced back to their sender or recipient. Both decentralization levels and privacy depend on the consensus protocol, ledger implementation, and permission scheme. Since no clear rating can be given for the consensus protocol and the ledger implementation, the permission scheme and the degree of centralization of the network nodes were taken into account in the evaluation, with a higher degree of decentralization being rated as positive.

Secondary Qualitative Characteristics

In addition to the technical quality characteristics described above, there are also secondary or non-technical characteristics which are partly dependent on the characteristics and metaattributes already described, but cannot be directly assigned to them. For example, environmental friendliness depends on energy efficiency, which in turn depends heavily on the consensus mechanism. These characteristics are presented below. Due to the small number of these characteristics, they were not categorized into metaattributes.

Environmental Friendliness Environmental friendliness or energy efficiency has also become an increasingly significant factor in the field of DLT in the past (Sedlmeir et al., 2020). While Bitcoin as the pioneer of blockchains has been increasingly criticized in the recent past due to its high energy consumption, subsequent developments in the field of DLT have already taken this factor into account in the design concept. While environmental friendliness or energy efficiency is mainly dependent on the consensus mechanism of the corresponding DLT, it is also influenced in this context by factors such as confirmation time and block production rate. For environmental friendliness, the energy consumption per transaction is used as a key figure where available.

Establishment The establishment of a platform is a point that should not be neglected when selecting it. Projects in the area of tokenization can become very extensive, as they sometimes have to be integrated into complex existing IT ecosystems. Small and new platforms are more likely to be abandoned than projects that are established in the market. Also, platforms that have been on the market for a long time and can boast a high quota of tokens usually have a certain degree of maturity (Cukier & Kon, 2018). Thus, the year of release in combination with the position of the market capitalization at coinmarketcap.com at the time of the investigation is used for the establishment (coinmarketcap.com, 2021). A combination with the distribution, in the form of Initial Coin Offerings (ICO) carried out on the platform, would be very interesting in this context, but cannot be implemented in a meaningful way due to the poor data availability on the smaller platforms.

Documentation and Community Especially in complex software projects, detailed and good documentation is important. This applies both to the actual developers, which enables software quality to be maintained at a high level, and to the users, who have to build on a complex existing software ecosystem (Kipyegen & Korir, 2013). In addition to documentation, other aids are also relevant for the implementation of a software project. Appropriate tools or existing frameworks can make the tokenization process much easier and also more secure since there is a kind of standard for implementation. The size of the developer community is also significant here, since it drives the development of the platform with its own ideas and tools and it can be helpful with individual implementation problems (Abdulwahhab et al., 2016). To assess the community, the size of the community is used. For this, the number of users of the corresponding interest group on Reddit is used. For the assessment of the documentation, the terms of the identified quality characteristics were searched for in the help documents of the respective platform and, if these were available, the comprehensibility was also critically examined.

DLT for Tokenization

The following information was largely determined on the basis of the various white papers of the websites and the technical documentation of the respective platform. However, block explorers and scientific literature were also used if the values of quality characteristics were not clear from the sources used for the respective platform. A simplified summary of the results can be found in Fig. 4.1. As of June 2021, tokenization of IOTA is only possible using DevNet.

Results for the Asset Categories Under Review

In order to address the question of which of the described platforms is best suited for tokenization for the financial or real asset sector, an evaluation of the identified and described qualitative characteristics in relation with the respective classes of assets is required. However, it must first be clarified what differences exist between these two classes of assets.

			Ethereum	Cardano	Stellar	Solana	EOSIO	Neo
Primary Quality Characteristics	Performance and Scalability	Block Production Rate	14 Seconds	20 Seconds	Almost Immediately	0.4 Seconds	0.5 Seconds	17 Seconds
		Transactions per Second (TPS)	ca. 15	50 (1,000+ in Future)	10 (1,000 OPS)	900 (50,000 in Future)	4,000+	ca. 1,000
		Confirmation Time	3 Minutes (12 Blocks)	1 Minute (3 Blocks)	ca. 5 Seconds	ca. 2 Seconds	ca. 165 Seconds (330 Blocks)	17 Seconds (1 Block)
	Costs	Transaction Fees	Configurable	Small	Very Small	Very Small	Very Small	Configurable + per Operation
	Security	Fault Tolerance	51 % Attack	51 % Attack	Asymptotic Security	1/3 Attack	1/3 Attack	1/3 Attack
	Functionality and Extendability	Interoperability	Yes	Limited	No	Limited	Limited	Limited
		Smart Contracts	Yes	Yes	Limited	Yes	Yes	Yes
		NFT	Yes	Yes	Yes	Yes	Yes	Yes
		Programming Language	Solidity + Vyper + Yul	Haskell	Java, Python, Go, C#, Ruby etc.	Rust, C, C++	C++	C#, Go, Python, Java, TypeScript
	Decentralization and Data Protection	Consens Mechanism	PoW	PoS (Modified)	SCP (Modified FBA)	PoH	DPoS-BFT	dBFT
		Ledger Implementation	Blockchain	Blockchain	Blockchain	Blockchain	Blockchain	Blockchain
		Permission Scheme	Permissionless	Permissionless	Permissioned	Permissionless	Permissioned	Permissioned
Secondary Quality Charac-teristics	*KWh per Transaction	Environmental Friendliness*	97	0.5479	0.00003	n/a	n/a	n/a
	**Year; Place	Establishment**	2015; 2	2017; 4	2014; 16	2020; 16	2018; 28	2016; 21
		Documentation	Extensive	Extensive	Extensive	Extensive	Extensive	Rudimentary
		Community	999 k	523 k	194 k	23 k	88 k	111 k

			Klaytn	IOTA	Tezos	Algorand	Waves
Primary Quality Characteristics	Performance and Scalability	Block Production Rate	1 Second	n/a	1 Minute	ca. 4.5 Seconds	1 Minute
		Transactions per Second (TPS)	ca. 2,500	More than 1,500 (Scalable)	ca. 30 to 40	ca. 1,000 (46,000 in Future)	100 (1,000 Possible)
		Confirmation Time	1 Second	ca. 10 Seconds (Scalable)	6 Minutes (6 Blocks)	ca. 4.5 Seconds	10 Minutes (10 Blocks)
	Costs	Transaction Fees	Very Small (per Operation)	None	Very Small	Very Small	Configurable
	Security	Fault Tolerance	1/3 Attack	1/3 Attack	51 % Attack	1/3 Attack	51 % Attack
	Functionality and Extendability	Interoperability	Limited	Limited	Limited	No	Limited
		Smart Contracts	Yes	No	Yes	Yes	Limited
		NFT	Yes	No	Yes	Yes	Yes
		Programming Language	Solidity	Rust	Michelson	TEAL, Python	Ride
	Decentralization and Data Protection	Consens Mechanism	IBFT	MCMC + FPC	DPoS (Modified)	PPoS	LPoS
		Ledger Implementation	Blockchain	DAG	Blockchain	Blockchain	Blockchain
		Permission Scheme	Permissioned	Permissionless	Permissionless	Permissionless	Permissionless
Secondary Quality Charac-teristics	*KWh per Transaction	Environmental Friendliness*	n/a	ca. 0.000001	0.00003	0.000008	n/a
	**Year; Place	Establishment**	2019; 32	2016; 33	2018; 37	2019; 44	2019; 50
		Documentation	Extensive	Extensive	Extensive	Very Extensive	Satisfactory
		Community	Less than 1 k	136 k	49 k	26 k	59 k

Fig. 4.1 Comparison of the quality characteristics of different DLT platforms (own representation)

Characteristics of Financial and Real Assets

Real assets are tangible assets with an identifiable physical presence. They have their own intrinsic value resulting from their substance and characteristics. The value of real assets usually depends on factors such as location, function, or condition, as well as operating and replacement costs. They are often acquired as a hedge against inflation (Froot, 1995). Real assets can be, among others, land, real estate, infrastructure, precious metals, vehicles, technical equipment, art, collectibles, luxury goods, or any other form of tangible economic resource (Gunzberg & Alsati-Morad, 2016; Froot, 1995).

Financial assets, in contrast to real assets, are intangible. They neither have intrinsic value, which is given by reference to the underlying asset, nor do they have a physical presence other than a possible document representing the ownership interest in the asset. Financial assets are fungible and can usually be quickly exchanged for other assets, such as cash. Such financial assets can be, for example, stocks, bonds, or securities (Cartas & Harutyunyan, 2017).

It should be noted that many of the quality characteristics described will be relevant for both classes of assets, but with different weightings. For this reason, the categorization is done with the attributes "essential," "important," "less important," and "irrelevant" (see Fig. 4.2). In addition, it must be taken into account that the assets within the category of real assets and their requirements in terms of qualitative characteristics can be very different and it will be difficult to consider all variations of real assets. With that in mind, use cases of particularly relevant real assets are given as examples.

	Financial Assets	Real Assets
Performance and Scalability	Important (Essential)	Less Important
Costs	Important	Less Important
Security	Important	Important
Functionality and Extendability		
Interoperability	Important	Important
Smart Contracts	Important	Important
NFT	Irrelevant	Essential
Decentralization and Data Protection	Important	Important

Fig. 4.2 Relevance of quality characteristics in tokenized assets (own representation)

Relevance of the Quality Characteristics

Performance and scalability are particularly important for financial assets. Price fluctuations can occur quickly in underlying assets, such as stocks, and stock traders must be able to respond quickly to these fluctuations (Karpoff, 1987). It is assumed that traders will also react to these fluctuations in tokenized assets as in traditional stock markets. In particular, this requires fast confirmation times, but also good scalability for heavy trading volumes. Real assets are generally not subject to these price fluctuations (for example, real estate), or not as much (for example, precious metals). Even though the market of tokenized real assets is more fungible due to the small units given by tokenization and might gain similar dynamics as in traditional stock markets (Wandmacher & Wegmann, 2020), this characteristic is assumed to be less important for real assets.

The situation is similar with regard to costs. Assuming that financial assets are traded more frequently and in smaller quantities, a low transaction fee is important for them. Real assets, in contrast, can usually only be acquired as a whole (for example, real estate or luxury goods) or in minimum sizes that make economic sense (for example, precious metals) without traditional securitization or tokenization. Even if small denominations are possible through the tokenization of these assets, the assumption is made that transaction fees play a less important role than with financial assets.

The security attribute is equally important for both financial and real assets.

In the case of functionality and extensibility, a more granular view must be taken due to the heterogeneity of the assigned quality characteristics. It is assumed that interoperability is of equal relevance for both asset classes, but depends on the respective project and its requirements. In principle, interoperability has to be classified as important in order not to stand isolated in the growing ecosystem of DLT in the future. The possibility of creating smart contracts is also equally relevant for the tokenization of financial and real assets, but depends on the individual project requirements. For example, dividend payments from tokenized shares could be paid out automatically to the respective shareholders. Similar processes could exist in the future for proportional payouts of rental income from tokenized residential or office buildings. Smart contracts thus represent an important feature depending on the complexity. Since financial assets are by definition fungible, non-fungible tokens are irrelevant to them. In the context of real assets, on the other hand, the possibility of creating Non-Fungible Tokens is essential in many cases. Luxury goods and art objects, in particular, are unique and cannot be exchanged at will. The programming language is not listed separately because, as already described, it can limit the possibilities of smart contracts and was implicitly taken into account in the smart contracts feature.

Decentralization and data protection are implicitly assumed in the basic idea of distributed ledger technologies, yet gradations exist in this area, since, for example, the degree of decentralization is dependent on other characteristics (scalability trilemma). It is assumed that decentralization and data protection as a whole are an important, if not essential, characteristic for all tokenized assets. However, there is also a strong dependency on individual project preferences for this quality characteristic.

The secondary quality features turn out to be equally important or less important for both categories of assets. Once again, these are highly dependent on individual project preferences, but are taken into account overall when recommending specific platforms in the following section.

Platform Selection and Recommendation

The combination of the analyzed quality characteristics or metaattributes and the weighting with the respective relevance of the two categories of assets results in the ranking in Fig. 4.3. However, the ranking should not be understood as a final order of suitability for the tokenization of financial or real assets, but rather represents an indicator, since the metaattributes were taken into account with equal weighting and project-specific requirements, such as the scope or power of smart contracts, can also be important. It should also be noted that quality characteristics that were essential but not fulfilled by a platform did not lead to the exclusion of this platform.

It can be seen that Stellar ranks first in both categories of assets studied, as this platform is the only one that offers asymptotic security, which minimally sets it apart from other platforms that are similarly positioned in the other quality attributes. In addition, all platforms that occupy the top ranks in financial assets are very well positioned in terms of performance and scalability and have low transaction fees, which is an important point for this category of assets.

Stellar's good suitability for both categories of assets is also confirmed when the secondary quality characteristics are taken into account. Stellar is an established

	Financial Assets
1 Stellar	2.189475
2 EOSIO	2.126205
3 Solana	2.125095
4 Klaytn	2.092350
5 Algorand	2.021033
6 IOTA	1.948605
7 Cardano	1.864520
8 Tezos	1.752269
9 Neo	1.736591
10 Ethereum	1.684009
11 Waves	1.679981

	Real Assets
1 Stellar	1.983071
2 Cardano	1.934923
3 Solana	1.922021
4 Ethereum	1.900168
5 EOSIO	1.839326
6 Klaytn	1.822398
7 Algorand	1.814490
8 Tezos	1.795548
9 Waves	1.787154
10 Neo	1.644519
11 IOTA	1.389443

Fig. 4.3 Ranking of platforms for suitability in asset class (own representation)

platform and can also convince with the characteristic of environmental friendliness or energy consumption, which is becoming increasingly important in this day and age. In addition, the platform is extensively documented and also offers a high number of members in the interest group. Stellar is one of the few platforms that only offers a limited scope in smart contracts and is also not compatible with other platforms. The platform also ranks more in the midfield in terms of decentralization. However, unless these features are crucial for a project, Stellar can be recommended for both categories of assets.

EOSIO and Solana are very close to each other in the ranking of financial assets and differ mainly in the framework of performance and scalability. While EOSIO offers the highest value of transaction speeds among the platforms considered, this platform only places itself in the rear midfield in terms of finality of confirmations, which should be taken into account when making individual project decisions. When considering the secondary quality characteristics, both platforms differ only marginally. In terms of environmental friendliness, both platforms position themselves in the midfield, although no precise comparative figures on energy consumption are available. However, it must be taken into account that both platforms, especially Solana, are still relatively new on the market, which has an impact on the size of the community and could possibly result in gaps in the protocol that have not yet been discovered.

These statements also apply to Klaytn and Algorand, in the following places. Both platforms offer high speeds and low costs, but are rather young compared to the other platforms, have small communities, and are thus not yet particularly established in the market. While Klaytn is strongly oriented toward Ethereum and also offers interoperability with this platform, Algorand is currently not yet compatible with other platforms. Algorand, on the other hand, can be described as less centralized than Klaytn.

The following platforms are not recommended for tokenization of financial assets due to high transaction fees and low speeds, but should still be considered in an individual project decision. IOTA in particular could take on a pioneering role here due to the possible solving of the scalability dilemma, provided that the missing functionalities compared to other platforms are subsequently delivered.

Besides the already described platforms Stellar and Solana, Cardano and Ethereum also occupy a place in the top ranks for real assets. This is due to the fact that performance and scalability as well as costs were not rated as being as important for real assets as for financial assets. Both platforms tend to be among the poorer performers in the comparison field for these quality characteristics, but are well positioned in terms of the degree of decentralization and functionality. Even though both platforms are very well established, offer the largest communities, and are extensively documented, both are by far among the worst representatives of the platforms examined in terms of environmental friendliness.

The other platforms follow at some distance and are generally suitable to fulfill the tokenization of real assets from the requirement side. An exception from this is IOTA, which is currently unable to provide NFT. The decision for or against a platform can only be generalized to a certain extent. Whether one of these platforms should be preferred to Stellar, Cardano, Solana, or Ethereum must therefore once again be decided on a project-specific basis.

Conclusion

It has been shown that various qualitative features exist in the context of distributed ledger technologies that are relevant for the tokenization of assets. In principle, a distinction can be made between two categories of identified qualitative features. On the one hand, there are primary qualitative characteristics that are subject to the technical properties of DLT and can be assigned to the metaattributes of performance and scalability, costs, security, functionality, and extensibility, as well as decentralization and data protection. In addition, there are secondary or non-technical characteristics such as environmental friendliness, establishment, as well as documentation and scope of the community, which are partially dependent on the technical characteristics but cannot be directly assigned to them and should be taken into account when selecting a DLT platform for the tokenization of assets.

While qualitative characteristics in the area of performance and scalability as well as costs are more relevant for the tokenization of financial assets due to the high fungibility of the underlying assets, the area of functionality and expandability is of particular importance for real assets, which in most cases are not interchangeable at will. Thus, a basic requirement for the tokenization of real assets is the possibility of creating non-fungible tokens. The remaining metaattributes of the areas of security as well as decentralization and data protection are basically of equal relevance for a tokenization of assets. The same applies to the secondary quality attributes, although these are more dependent on individual project decisions or premises, in contrast to security and the degree of decentralization in the context of the primary quality attributes, which should in principle tend to have a high value.

A general answer to the question of the suitability of distributed ledger platforms for the tokenization of financial and real assets does not exist for the platforms examined. All platforms have their individual strengths and weaknesses and many of these platforms are suitable for tokenization in the two categories of assets examined. The decision for or against a platform thus depends on the respective project and the individual requirements for the quality features.

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Chapter 5
Legal Requirements in the Field of Virtual Currencies

Sebastian Block

Abstract The digital world brings new challenges, especially in the legal field. For example, it may be technically unproblematic to create and circulate a crypto currency based on blockchain technology, but this process has far-reaching legal consequences for the issuer. In Germany, issuers of crypto currencies are sometimes unaware that they fall under possible permit requirements of the German Federal Financial Supervisory Authority (Bundesanstalt für Finanzdienstleistungsaufsicht, BaFin). In particular, engaging in transactions requiring a permit without the appropriate permission is punishable by law, which could result in the initiation of administrative offense proceedings as well as the risk of liability under private law toward investors due to a public offering without a prospectus. The objective of the paper is to present the specific legal classification in the field of crypto currencies, taking into account the fundamental view of German law. When issuing or conducting transactions in connection with crypto currencies, the question arises in Germany whether these are subject to licensing.

Introduction

It has been more than a decade since the world's most famous crypto currency was created. In 2008, Satoshi Nakamoto laid the foundation for this very crypto currency, Bitcoin, in his white paper "Bitcoin: A Peer-to-Peer Electronic Cash System" (Nakamoto, 2008). The idea behind Bitcoin was to use software made up of cryptographic algorithms to create a digital currency whose code everyone could contribute to and which could be transferred worldwide without central banks or financial institutions (Deloitte).

At the time, it was not yet possible to foresee the potential hidden in the increase in value of a Bitcoin, and so it was not surprising that about 1.5 years after the

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Bitcoin was created and issued, software developer Laszlo Hanyecz offered 10,000 Bitcoins to anyone who would order him two large pizzas (Bitcoin Forum, 2010). The value of the deal at the time was approximately USD 41. Over the years, the ever-increasing acceptance and accompanying hype surrounding crypto currencies, especially bitcoin, caused their value to rise year after year, and crypto currencies became one of the most spectacular investment assets of the last few decades. Twelve years after the original pizza order, the equivalent value for 10,000 Bitcoins was an astronomical USD 395 billion (as of March 14, 2022).

In the beginning, politicians smiled at the emerging hype around crypto currencies, and even in finance-savvy Switzerland, a Federal Council report (2014) came to the conclusion that virtual currencies (VC) were a marginal phenomenon and that therefore, there was no need for action in the area of legislation. However, acceptance among the general public for crypto currencies continued to grow, resulting in a wide range of new crypto currencies offered by various providers. In addition, new online trading venues emerged, such as Bitpanda or Binance. Thus, the legislature was forced to develop and implement new legal regulations. Especially in the area of money laundering and financial market law, new directives have therefore been increasingly created at the European Union (EU) level in recent years, which have been incorporated into national law and are regulated by the BaFin in Germany. In this regard, Steinbrecher (2017) says that the lack of legal requirements and transparency regulations for ICOs means an enormous risk for investors. Investors should be aware of the risks of loss—even an irreversible total loss of their investment is possible. This is aimed at preventing abuse by actors who want to enrich themselves unlawfully through the sale and distribution of crypto currencies.

Definitions

Crypto Currencies

What exactly is meant by the term crypto currency is defined by EU law in the 5th Anti-Money Laundering Directive (RL EU 2018/843), which has been incorporated unchanged into the German Banking Act (Kreditwesengesetz, KWG) Section 1 (11) Sentence 4. It should be noted in advance that in practice the terms crypto currencies, crypto values, crypto tokens, and crypto assets are mostly in use, but in the true sense they are virtual currencies. Accordingly, a virtual currency is the digital representation of a value that has not been issued or guaranteed by any central bank or public institution and is not necessarily linked to a legally established currency and does not have the legal status of a currency or money, but is accepted by natural or legal persons as a medium of exchange and can be transferred, stored, and traded electronically (Deutscher Bundestag, 2021). To be distinguished from crypto currencies is the so-called e-money. According to the Payment Services Supervision Act (Zahlungsdiensteaufsichtsgesetz, ZAG) Section 1 (2) Sentence 3, e-money is any electronically, including magnetically, stored monetary value in the form of a claim on the issuer, which is issued against payment of an amount of money in order to carry out payment transactions with it within the meaning of Section 675f (4) Sentence 1 of the German Civil Code (Bürgerliches Gesetzbuch, BGB), and which is also accepted by natural or legal persons other than the issuer. As an example, electronic cash (EC) as well as credit cards can be listed here.

In the literature as well as in regulatory practice, three main groups have emerged in the field of crypto currencies that can represent a crypto asset (BaFin, 2019, p. 5): currency tokens, utility tokens, and security tokens.

Currency Token

Bitcoin is the best-known example of a currency token and is once again distinguished among experts as a coin. This is linked to fiat money, for example to the U.S. dollar or the euro. It can be purchased against fiat money on crypto exchanges and used as a means of payment across countries with partners who accept Bitcoin as a means of payment. These can then exchange the Bitcoin for fiat money again in reverse order via crypto exchanges. The advantage of this method is that when paying with crypto currencies, the cross-country fees that are mostly charged by financial intermediaries such as VISA or PayPal are eliminated. Only the shipping and transaction costs incurred in the respective network have to be paid (Zimmerling, 2017, p. 6).

Meanwhile, at the time of writing this paper, the market capitalization of the ten largest crypto currencies is approximately USD 1.5 trillion (about EUR 1.35 trillion). The largest crypto currencies in terms of market capitalization include: Bitcoin, Ethereum, Tether, BNB, USD Coin, XRP, Terra, Solana, Cardano, and Avalanche (see Table 5.1). These crypto currencies are technically different from each other (Müller & Ong, 2020). In this context, Bitcoin has established itself as the strongest crypto currency among the ten largest crypto currencies with over 50% market capitalization.

Table 5.1 Overview of crypto currencies by market capitalization (coinmarketcap.com, 2022)

Rank	Name	Market capitalization
1	Bitcoin	USD 775,152,695,740
2	Ethereum	USD 336,333,245,620
3	Tether	USD 80,153,826,791
4	Binance	USD 64,041,279,910
5	USD Coin	USD 52,490,726,137
6	Ripple	USD 38,137,126,590
7	Terra	USD 32,370,824,193
8	Solana	USD 28,649,903,309
9	Cardano	USD 28,407,587,860
10	Avalanche	USD 21,328,512,552
Total market capitalization		USD 1,457,065,728,702

Utility Token

Utility tokens allow access to certain services and products. These can be thought of as vouchers or admission tickets that entitle the holder to redeem them for a predetermined service. BaFin clarifies that, in principle, a utility token does not constitute securities within the meaning of the German Securities Prospectus Act (Wertpapierprospektgesetz, WpPG) or asset investments within the meaning of the Capital Investment Act (Vermögensanlagengesetz, VermAnlG) (BaFin, 2019).

Security Token

Security tokens, also known as equity tokens, relate their value to external, tradable assets (Hönig, 2020) and therefore have similarities to securities. Therefore, holders of such tokens are entitled to membership rights or claims under the law of obligations with asset-like content. These are comparable to those of a stockholder or holder of a debt security, such as interest, co-determination, or claims to dividend-like payments. Due to their similarity to securities, these tokens fall within the scope of the Prospectus Regulation (Prospektverordnung, ProspektVO), the German Securities Prospectus Act (Wertpapierprospektgesetz, WpPG), and the Securities Trading Act (Wertpapierhandelsgesetz, WpHG) and also constitute financial instruments within the meaning of the German Banking Act (Kreditwesengesetz, KWG) (Bafin, 2019, p. 6).

Blockchain

The creation of a crypto currency is carried out by complex mathematical procedures and is based on one of the most well-known distributed ledger technologies (DLT), the so-called blockchain. The concept was already described in the early 1990s by Haber and Stornetta (1991), but was only brought back to life by the idea of Bitcoin. BaFin understands distributed ledger technology as a distributed ledger (literally "distributed account book") that is a public, decentralized account book. It is the technological basis of virtual currencies and is used to record user-to-user transactions in digital payments and business transactions without the need for a central authority to legitimize each individual transaction. Blockchain is the distributed ledger underlying the virtual currency Bitcoin (Geiling & BaFin, 2016).

Bitcoin and all other crypto currencies are based on the so-called blockchain (Groh, 2021). Using the Bitcoin blockchain as an example (see Fig. 5.1), all transactions are recorded in a pool and wait to be confirmed by the network. Once confirmed, the transactions are executed. The idea behind this is that the decentralized system means that the database in which the transaction is stored

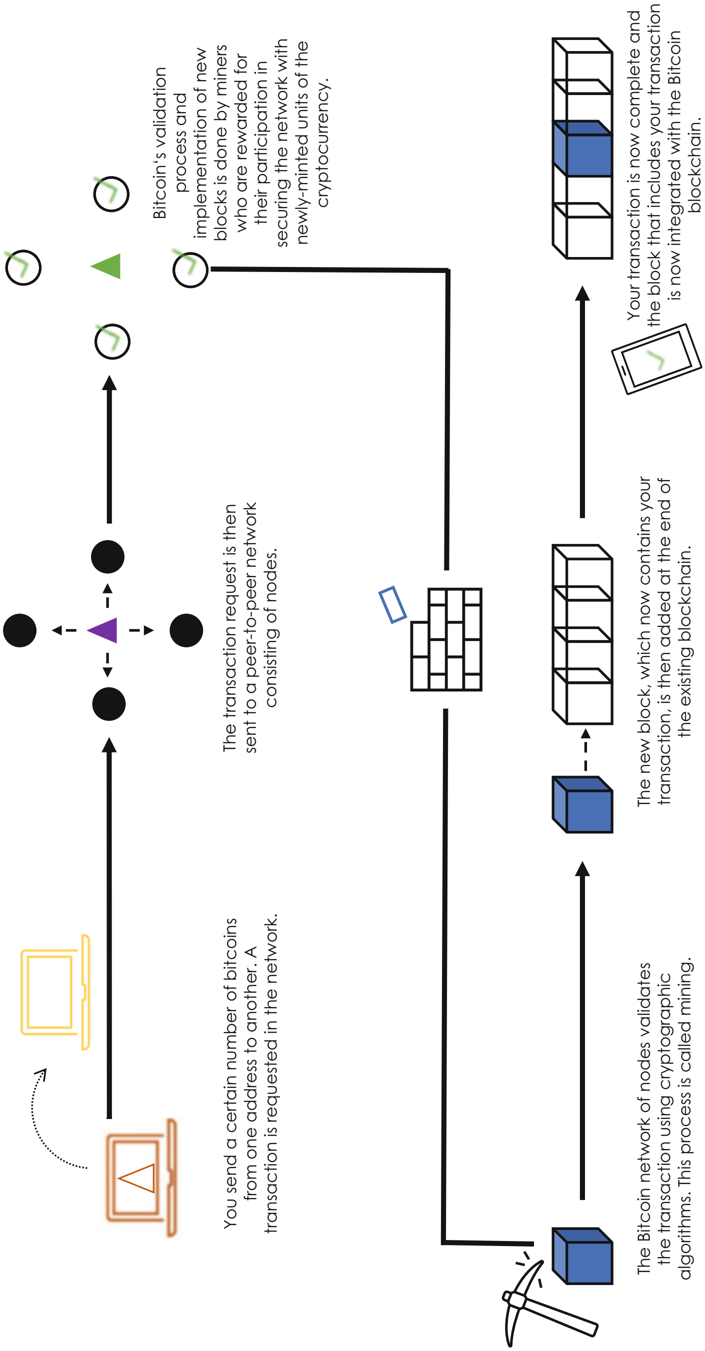

Fig. 5.1 What is a blockchain and how does it work? (Bitpanda), own creation

and executed cannot be manipulated, making a financial institution that acts as an intermediary between payers and payees obsolete. In order for every transaction to be stored in a blockchain, a high level of computing power is required. This can theoretically be provided by anyone who wants to participate in the network. In return, the participant receives currency units in the form of coins or tokens, which can then be exchanged for fiat currencies on crypto exchanges.

Initial Coin Offering

Once the programming has been implemented on the blockchain to create crypto currencies, these can be issued with the help of an Initial Coin Offering (ICO). In principle, an ICO (also known as a token sale or token generating event) is used by a company to raise funds for the realization of a business idea. The term is based on the term Initial Public Offering (IPO), in which shares are issued to potential investors through an IPO. In contrast to an IPO, the so-called tokens are issued in an ICO instead of shares. The difference with tokens is that they have a different form and structure than shares. Even if the impression is given that they are in fact one and the same form of share issue, Steinbrecher (2017) states that this is neither legally nor technically the case.

For startup companies in particular, an ICO offers a new form of financing for the companies themselves as well as specific projects. The first company to use an ICO to fund a project was Mastercoin. In total, 500 investors invested nearly USD 500,000 (Hahn & Wons, 2018).

Legal Requirements of the Licensing Obligation for Issuers of Crypto Currencies and Crypto Service Providers According to the German Banking Act (Kreditwesengesetz, KWG)

Due to the attractiveness of crypto currencies, legislators are forced to adapt to the new developments and to take regulatory measures. In this context, directives and regulations have been issued at EU level in recent years, some of which have found their way into German law. The background to this is that currency tokens in particular are associated with criminal acts on the Internet. Such crimes are carried out, for example, in the areas of online fraud and cyber extortion (ransomware) as well as for trading on the darknet. In addition, currency tokens are associated with money laundering. The most important laws in Germany in the field of cryptocurrencies include the German Banking Act (Kreditwesengesetz, KWG), the Money Laundering Act (Geldwäschegesetz, GWG), the Payment Services Supervision Act (Zahlungsdiensteaufsichtsgesetz, ZAG), the German Investment Code

(Kapitalanlagegesetzbuch, KAGB), the German Electronic Securities Act (Gesetz über elektronische Wertpapiere, eWpG), and the Crypto Asset Transfer Regulation (Kryptowertetransferverordnung, KryptoWTransferV). For a better understanding of the extent to which the issuance of crypto currencies is subject to licensing, the following will focus in particular on the KWG as well as on the BaFin's information letters.

If a required permit is not available when issuing or conducting transactions related to crypto currencies, this generally constitutes a criminal offense pursuant to Section 54 KWG and BaFin may order the immediate cessation of business operations and the immediate winding-up of such transactions vis-à-vis the company and the members of its executive institutions pursuant to Section 32 KWG. Exceptions apply to companies with their registered office in another state of the European Economic Area (Section 53b KWG). An example of this is the cross-border payment service provider Bitpanda, which has a PSD2 (Payment Services Directive 2) license.

Whether or not the issuance of crypto currency tokens and the provision of such services on a commercial basis is subject to licensing can best be clarified by regularly referring to the information issued by BaFin in the so-called leaflets/advice letters. This makes it clear that, in principle, the mere use of currency tokens as a substitute for cash or book money to participate in the economic cycle in exchange transactions does not constitute an activity requiring a license (BaFin, 2020). Service providers or suppliers can therefore have their services paid for with currency tokens without falling within the scope of the KWG and requiring a permit from BaFin. It only becomes problematic if financial services are provided within the scope of crypto currency tokens on a commercial basis or on a larger scale. The requirement for permission under Section 32 (1) Sentence 1 KWG is that the company issuing the tokens conducts banking business in Germany on a commercial basis or on a commercial scale, which would qualify it as a credit institution, and/or provides financial services, which would lead to classification as a financial services institution. What needs to be clarified is whether crypto currency falls within the scope of financial services and should be counted as a financial instrument. Crypto currencies are counted as financial instruments and are explicitly mentioned in Section 1 (11) No. 10 KWG. It must therefore be examined whether issuers of crypto currency as well as crypto service providers provide services within the meaning of the KWG.

Permit Requirements for Financial Commission Transactions (Section 1 (1) Sentence 2 No. 4 KWG)

The offense of a financial commission business includes the commercial acquisition and sale of tokens in one's own name for third-party accounts. Pursuant to Section 32 (1) KWG, this constitutes a banking transaction that requires a license from BaFin. A circumvention of the permission by a company not acting in its own name but in the name of a third party can be directly excluded, since again the offense of brokering pursuant to Section 1 (1a) Sentence 2 No. 2 KWG would be fulfilled and this also requires a license by BaFin (Hahn & Wons, 2018).

Permit Requirements for Investment Brokerage (Section 1 (1a) Sentence 2 No. 1 KWG)

Under certain circumstances, platform-based token models could constitute investment brokering and require a permit from BaFin. According to Section 1 (1a) Sentence 2 No. 1 KWG, investment brokerage exists if the brokerage of transactions relating to the acquisition and sale of financial instruments is carried out. In addition to units of account pursuant to Section 1 (11) No. 2 KWG, financial instruments also include, among other things, investments. Pursuant to Section 1 (2) VermAnlG, investments can, for example, be shares that grant a participation in the earnings of a company, as well as other investments that grant or hold out the prospect of interest and repayment in exchange for the temporary provision of money. In order for the act of brokering within the meaning of Section 1 (1a) Sentence 2 No. 1 KWG to be truly fulfilled, the targeted promotion of an investor's willingness to enter into a transaction is required so that the investor concludes a transaction on the acquisition and sale of financial instruments with a third party. In addition, the forwarding of an investor's declaration of intent to acquire or dispose of financial instruments to the person with whom the investor intends to enter into such a transaction can also be regarded as an intermediary activity. Furthermore, crypto service providers should pay attention to the fact that they fall within the facts of intermediation if they merely act as a messenger. BaFin does not distinguish between whether the transmission of the investor's declaration of intent is oral, written, or electronic (Hahn & Wons, 2018).

Licensing Requirements for a Multilateral Trading System (Section 1 (1a) No. 1b KWG)

Commercial trading in currency tokens is mostly carried out via platforms, which are often also referred to as exchanges. Many different business models are summarized under this term. However, when it comes to the question of whether permission is required, a distinction must be made according to the technical implementation and the respective structure of the transactions (BaFin, 2020).

A person who commercially buys and sells currency tokens in their own name for the account of a third party, such as the Bitpanda trading platform, is conducting a financial commission business that requires a license. The acquisition or sale of currency tokens is carried out for the account of a third party if the economic advantages and disadvantages from this transaction affect the principal. Furthermore, the activity must be sufficiently similar to the commission business according to the German Commercial Code (HGB), whereby individual rights and obligations may deviate from the typical commission business. In the case of currency token platforms, the financial commission business requiring a license is therefore fulfilled if

- the individual participants are authorized to give instructions to the platforms until the order is executed by specifying the number and price of the trades
- the respective participants are not aware of their trading partners and the platform does not act as a representative of the participants but on its own behalf
- the economic advantages and disadvantages of the transactions affect the participants who transfer money to platform accounts or transfer VC to their addresses and
- the platform is obliged to account to participants for the execution of trades and to transfer acquired VC (BaFin, 2020).

If there is no financial commission business in the case of platforms, it may be the operation of a multilateral trading system. This brings together the interests of a large number of persons in the buying and selling of financial instruments within the system in accordance with specified rules in a way that results in a contract for those financial instruments. This means that there is a set of rules governing membership, currency token trading between members, and reports of completed trades. A trading platform in the technical sense is not required. Multilateral means that the operator only brings together the parties of a potential transaction on currency tokens. Expressions of interest, orders, and quotes also count as interest in buying and selling. Multilateral also means, above all, that it does not require an order to mediate in an individual case. Interests must be brought together under the rules and regulations through software or protocols to conclude a contract without the parties being able to decide on a case-by-case basis whether to enter into a VC transaction with a particular counterparty. Whether the contract is subsequently settled within the system is irrelevant (BaFin, 2020).

Multilateral trading systems are therefore particularly reasonable for platforms where providers post currency tokens and set a price threshold above which a trade is to be settled, or where providers secure transactions through escrow by transferring currency tokens to the platform and these are only released when the provider confirms payment (BaFin, 2020).

Platforms offering regionally structured paid directories of persons or companies offering currency tokens for sale or purchase regularly constitute investment and acquisition brokerage (BaFin, 2020).

Permit Requirements for Crypto Custody Transactions (Section 1 (1a) No. 6 KWG)

Even the mere storing of crypto currency now requires a permit from BaFin. While it was still possible for companies to carry out crypto custody transactions without a permit from BaFin prior to 2020, this has changed as of January 1st, 2020, as a result of the Act Implementing the Amending Directive to the Fourth EU Anti-Money Laundering Directive (Bundesgesetzblatt (BGBl) I of December 19th, 2019, p. 2602). The so-called crypto custody business was included in the KWG as a new financial service. Service providers offering the exchange of virtual currencies into legal tender and vice versa, as well as into other crypto currencies, are regularly already financial services institutions and thus obligated parties under anti-money laundering law, because crypto currencies, depending on their design, can be financial instruments within the meaning of Section 1 (11) Sentence 1 KWG. The exchange of crypto currencies that are classified as financial instruments within the meaning of the KWG falls within the catalog of banking or financial services transactions pursuant to Section 1 (1) Sentence 2 and (1a) Sentence 2 KWG. In this context, anyone who holds, manages, and secures crypto currencies or private cryptographic keys used to hold, store, or transfer crypto currencies for others fulfills the statutory requirements.

Storage means the custody of crypto currency as a service for third parties. This includes, in particular, service providers who store their customers' crypto currency in a collective portfolio without the customers themselves having knowledge of the cryptographic keys used. In the broadest sense, management is the ongoing administration of the rights arising from the crypto currency. Safeguarding is understood to mean both the digital storage of the private cryptographic keys of third parties provided as a service and the storage of physical data carriers (e.g., USB stick, paper) on which such keys are stored (Deutsche Bundesbank, 2020).

Outlook

Markets in Crypto-Assets (MiCA)

In particular, crypto currency issuers and crypto service providers are currently struggling to take full advantage of the EU internal market due to a lack of both legal certainty regarding the regulatory treatment of crypto currencies and a specific coherent regulatory and supervisory regime at the EU level (European Commission, 2020, p. 5). An improvement in the situation could come from the implementation of the Markets in Crypto-Assets (MiCA) proposals.

MiCA is a package of EU measures aimed at further unlocking and promoting the innovation and competitiveness potential of digital finance while mitigating potential risks. It aims to establish a new strategy for digital finance so that the EU can seize the digital revolution as an opportunity. Innovative European companies are to be driven forward as pioneers so that consumers and businesses in Europe can benefit from the advantages of digital finance. In addition, the package includes a proposal for a pilot scheme for distributed ledger technology (DLT)-based market infrastructures, a proposal on the operational stability of digital systems, and a proposal to clarify or amend certain relevant EU rules in the financial services area. In particular, this proposal seeks to address four general and interrelated objectives for crypto assets that fall outside the scope of existing EU financial services legislation (Markets in Crypto-Assets, 2020, p. 3):

- The first objective is legal certainty. In order for crypto currency markets to develop within the EU, a solid legal framework must be established that clearly defines the regulatory treatment of all those crypto currencies that are not covered by existing financial services legislation.
- The second goal is to encourage innovation. To encourage the development of crypto currencies and wider use of DLT, a secure and appropriate framework to support innovation and fair competition must be established.
- The third objective aims to achieve an appropriate level of consumer and investor protection, as well as market integrity, as crypto currencies, which are not covered by existing financial services legislation, often present the same risks as traditional financial instruments.
- The fourth objective is to ensure financial stability.

If the present proposals were to be implemented in a regulation, then an environment would emerge in which a larger cross-border market for both crypto currencies and crypto service providers would develop. Thus, the full benefits of the European internal market could be realized. This would significantly reduce complexity as well as financial and administrative burdens for all stakeholders involved, such as issuers, consumers, and investors.

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Part II
Value Creation in the Digital World

Chapter 6
The Social Network Value of Professional Soccer Players

Martin Užík, Gunter Nowy, Christian Schmitz, and Roman Warias

Abstract Digitalization and its influences do not stop at the sports industry. The popularity of individual athletes is emerging as an important driver for the success of an influencer's activity. Thus, the market width and depth are related to the influencing activity of individuals. In the sports sector, this fact can also have an impact on the value of an athlete. In this paper, we analyze the social media followers for selected soccer players of the German Bundesliga and develop a model to quantify the social network value of the soccer players. We then examine the relationship between the social network value and the market value of each player. Followers on social media are a significant variable for the market value of a soccer player.

Introduction

Digitalization is influencing all areas of structures at a rapid pace, both in people's private and professional environments. Therefore, it is not surprising that we can receive, share, comment on, and pass on information anytime and anywhere. Professional sport is not exempt from this development. Rather, it can be assumed that this is influenced even more by social networks and the communication of information through the potential to define athletes as influencers. Social networks such as

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Twitter, Facebook, and Instagram have even geared their own business models to this type of activity and process. The CPM (Cost per Mile) is the most important driver besides the number of followers. Based on these two attributes, this article develops an evaluation model that makes it possible to determine the individual "social network value" of a professional soccer player.

The remainder of this chapter proceeds as follows: Section "Social Media and Social Networks" focuses on the social media and social networks. Section "Influencers and Personal Brands" clarifies the role of influencers and personal brands in the economy. Section "Literature Review" presents a brief literature review. Section "Methodology and Model Baselines" explains the methodology and the model used in the empirical analysis following thereafter. Section "Data and Results" discusses data and results. Eventually, section "Conclusion" summarizes the previous subchapters and draws a conclusion.

Social Media and Social Networks

Social networks are increasingly being considered in both business (Akerlof, 1970) and socio-economic research (Fligstein, 2002; Granovetter, 1985). This applies particularly to marketing. The way in which media is published and information is organized creates new opportunities for marketing communication. Nowadays, it is easy to combine photos, videos, sounds, and text and to structure websites accordingly.

By the means of social media services such as Twitter, Facebook, or Instagram, content in the form of information can be transmitted to target groups (followers) by means of short teasers (microblog). As social media services become more widespread and interactions with these services (post, reactions) increase, networking effects in action arenas and markets become increasingly visible and can be used strategically. This leads to a fundamentally new orientation of the marketing processes of products by the means of advertising and thus leads to the necessity of being able to evaluate the activities within the action arenas.

Influencers and Personal Brands

As part of their marketing activities, companies are increasingly using cultural spheres such as sports to place advertising messages of their products. These spheres thus become arenas of action (or markets) in which the athletes assume a central function. Not only does it become a carrier of advertising messages, it also increasingly creates its own brand. This process leads to the marketing of products with the help of the personal brand of an athlete. The relatively new term influencer has entered corporate marketing and the advertising industry. People who are active as influencers develop business models in which value is only generated within the reach of their social network or position within the social network. The ability to use social networks strategically thus represents a value by itself and should therefore be reflected in a business ratio within value creation.

For this reason, more and more companies are deciding to use social networks to draw customers' attention to their own products. One of the most popular influencers today are sports professionals like Neymar Júnior, Cristiano Ronaldo, and Lionel Messi. The value of an athlete, however, obviously exceeds his operational value or his transfer fee. This is demonstrated by the advertising contract concluded between Nike and Cristiano Ronaldo, which is estimated at EUR one billion. In addition to Cristiano Ronaldo, basketball star Lebron James also has a lifetime contract with Nike (Banks, 2016) valued at approximately USD one billion. More than half a billion people (number of followers, including double counting) follows only these two athletes on social networks. This paper starts at this point by determining the popularity of an athlete quantitatively with exogenously determined parameters.

Literature Review

With regard to valuation models for professional athletes, some approaches have been published, although it should be noted that so far no approach has dealt with the valuation of the social network value of professional athletes, even though the factors of marketability and popularity have been cited by the literature as relevant valuation factors (Baetge et al., 2013).

Kulikova and Goshunova (2014) have examined the accounting perspective of young players. They note that, while the accounting of acquired young players at acquisition cost is already established, the activation of young players from a club's own offspring faces major problems.

In contrast, Baetge et al. (2013) follow a completely different path. The authors outline the possibilities and limits of an objective player evaluation in professional soccer and analyze the suitability of evaluation methods. They come to the conclusion that only scoring and analogy pricing methods can be used for the evaluation of players.

Eschweiler and Vieth (2004) have empirically examined the value-relevant factors. This includes playing strength, player position, the number of Bundesliga and international stakes, and the age of the player.

Fischer et al. (2006) apply the same factors in a scoring model.

Abraham et al. (2013) have focused on the performance perspective. They assume that the income of a sports club is largely determined by the performance of the athletes.

Kedar-Levy and Bar-Eli (2008) are developing a model to optimize sports results based on the assumption of yield optimization. This model, which is based on portfolio theory, enables the owners of sports clubs to manage their risks accordingly.

In addition to the work that derives corresponding evaluation approaches from players, the literature also contains numerous articles that focus on economic performance and its influencing factors. For example, Galariotis et al. (2018), analyze sporting success in combination with economic results.

The debate about the social network value of soccer players has not been new to academic research. Clearly, the most frequently cited studies of Rosen (1981) and Adler (1985) mark the point of departure to investigate the extra market value attributable to stardom and popularity.

Nevertheless, Chmait et al. (2020) refer to a research gap of the connection to empirically analyze the superstar phenomenon of popularity in sports economics and its monetary value. In particular, the positive network externalities associated with a global social media reach give rise to the question of today's professional athletes endorsement contracts with global players like Nike and Adidas.

In parallel, academic literature has widely acknowledged the social network value of popular sports athletes in the domain of digital marketing. Carlson et al. (2019) elaborate on the digital trend to lever social media strategies in order to enhance their brand value by influencing its targeted consumers. From this perspective, they invest in popular sports athletes in order to market their bundled products (Hogg, 2010) customized to the relevant target groups. Yadav and Rahman (2017) demonstrated that these social media marketing activities have a positive impact on purchase intentions as well as brand equity as they utilized the scaling opportunities of the social media networks. Furthermore, Wakefield and Bennet (2018) and Babutsidze (2018) show the impact and speed to initiate a positive electronic word-of-mouth (eWOM) of the followers within their social media communities.

Finally, the study of Koronios et al. (2020) emphasizes the power of sport sponsorship to increase sales in digital marketing. Overall, those studies provide an additional hint toward an assumption regarding the potential of soccer superstars to influence their respective followers and drive sales of companies such as Nike and Adidas on a global scale. Clearly, the social network value of today's soccer players builds on and equally dominates the top athlete's sports performance and is therefore worthwhile further academic research.

Methodology and Model Baselines

The evaluation model focuses on the evaluation of the social network potential of professional athletes. Their presence and activity on the Facebook, Instagram, and Twitter platforms is defined as a decisive evaluation parameter. The number of followers, interaction rates, and defined prices for media reach are taken into account in the evaluation model. Empirically, the model is tested using the data of 100 selected players from the first Bundesliga for two deadlines (September 2017 and September 2018).

The aim of the new methodology is to describe the value of networks from an economic perspective. Conceptually, we speak of the personal social network value that every person can potentially achieve in the social networks. The unit (e.g., money or consent) as well as the value depends on the arena (e.g., markets or digital communities), the number of network nodes (persons or organizations) that can be activated or reached, as well as the ability to establish connections between these nodes. The model-relevant input parameters are discussed below.

Input Parameter

CPM

One of the classic indicators for evaluating advertising measures is CPM (Cost Per Mile), the thousand contact price. This indicates the amount of money that must be invested to reach 1000 people.

In social media, this figure also plays an increasingly important role and indicates the amount that must be used to reach 1000 people. Instagram, Facebook, and Twitter in particular, play a decisive role in determining the value of soccer players. The CPM prices (see Table 6.1) used were determined via blog entries by marketing agencies for the platforms Facebook, Twitter, and Instagram. As much as possible, these values were assigned to the data collected in September 2017 (falcon.io) and September 2018. As the sources listed basic USD values, the last trading day of each September was used to determine the exchange rate between EUR and USD.

Term

For our study, we assume that a player is active on average up to the age of 33. Consequently, the valuation of the annual social network values is executed up to the year in which the player has reached the age of 33.

Interaction Rate

The interaction rate γ is represented by the proxy value of the number of match days in a season. It is assumed that in addition to club matches and cup matches, international matches are also considered. The number of match days depends on the club membership and the frequency of use, which is often determined by injuries.

Table 6.1 CPM prices (advertisemint.com, 2017; Prater, 2017; Pratschevich, 2018)

Platform	CPM Price (in USD)		
	2017	2018	+/-
Facebook	9.06	12.45	0.37
Twitter	5.76	5.93	0.03
Instagram	6.70	5.24	−0.22

This article assumes that a total of 52 match days per season have taken place for each considered player.

Market Value of the Player

The market value of the player is needed to the extent that, in addition to individual player quality, it should also reflect the player's value contribution to the club's success. The club's success, in turn, leads to an increased level of the player's popularity and vice versa. This results in a mutual relationship that can significantly influence the social network value of a player by the number of followers. In this chapter, the market value of a player will be determined on the basis of the values on the transfermarkt.de platform. On transfermarkt.de, the market values of players are collected by the community. Sources are usually statements by market participants or study results that are published in the press.

Model Development

The combination of all input parameters in the model leads to a value-based determination of the social network value of a soccer player. The first step is the adjustment of the CPM prices. We regard this as necessary, as a standard rate for a CPM does not reflect market conditions. Hence, we assume that a professional soccer player with a high number of followers has a high reach and he can demand a higher CPM from the advertising partner. Here, we establish a relationship between the transfer market price and the number of followers. The regression coefficients for the two years 2017 and 2018 are shown in the following in Fig. 6.1.

The CPM is determined based on the relationship between the soccer player's transfer market value and the total number of followers in all three networks. Thus, the CPM Soccer used in the model forms an adaptation of the CPM values mentioned in the social networks. This adjustment is intended to take account of the high value of soccer players as influencers. Mathematically, CPM Soccer follows the following calculation methodology:

$$\mathrm{CPM}^{\mathrm{soccer}}_{\mathrm{Social\ Network},t} = \left(\frac{\mathrm{MV}_{\mathrm{TM},i,t}}{a} + b\right) \times \mathrm{CPM}_{\mathrm{Social\ Network},t}$$

Variables a and b are derived from the linear regression in which the market value MV of a player is regressed to its number of followers in all social networks. When considering the values for September 2017, a corresponds to EUR 16,792,341.22 and b to EUR 0.73. CPM Soccer of 2018 is determined on the base of the 2018 data.

The functional connection for the social network value of an athlete is determined by the consideration of the individual CPM prices of the respective social networks. Whereby F stands for Follower and the respective index designations TW, FB, and

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.556[a]	0.309	0.300	11301052.907

a. Predictors: (Constant), Follower2017

b. Dependent Variable: MarketValue2017

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4234241536730990.000	1	4234241536730990.000	33.154	.000[b]
	Residual	9450820963269010.000	74	127713796800933.000		
	Total	13685062500000000.000	75			

a. Dependent Variable: MarketValue2017

b. Predictors: (Constant), Follower2017

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	16792341.222	1386529.622		12.111	0.000
	Follower2017	0.732	0.127	0.556	5.758	0.000

a. Dependent Variable: MarketValue2017

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.499[a]	0.249	0.238	17514022.147

a. Predictors: (Constant), Follower2018

b. Dependent Variable: MarketValue2018

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7509977958190650.000	1	7509977958190650.000	24.483	.000[b]
	Residual	22698831910230400.000	74	306740971759870.000		
	Total	30208809868421100.000	75			

a. Dependent Variable: MarketValue2018

b. Predictors: (Constant), Follower2018

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	21178142.796	2141762.590		9.888	0.000
	Follower2018	0.919	0.186	0.499	4.948	0.000

a. Dependent Variable: MarketValue2018

Fig. 6.1 Regression: parameter for individual calculation of CPM (own representation)

INS designate the social networks Twitter, Facebook, and Instagram. The factor q symbolizes an adaptation to real situations. For example, followers have accounts in all three networks. In order to distinguish the number of actual followers and the number of purchased followers, the parameter q describes the efficiency of the athlete–follower relationship. In this contribution it is assumed to be set to 1. With larger data sets and over a longer time period, it is possible to measure this factor more accurately. At the same time, it is defined as values between 0 and 1 (see Fig. 6.2).

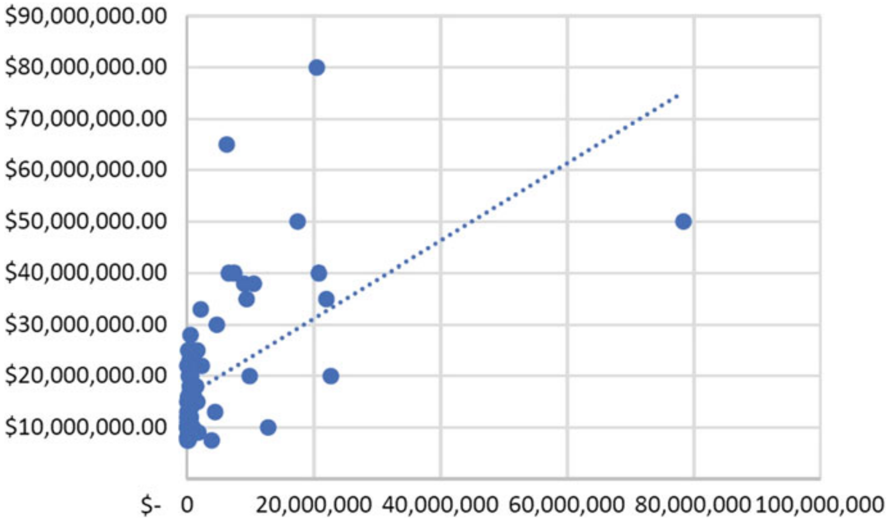

Fig. 6.2 Regression, market value to number of followers (own representation)

$$\text{Social Network Value}_{i,t} = \sum_{t=1}^{n} q_t \times \left[\frac{\left(F_{\text{TW},i,t} \times \text{CPM}_{\text{TW},t}^{\text{soccer}} + F_{\text{FB},i,t} \times \text{CPM}_{\text{FB},t}^{\text{soccer}} + F_{\text{INS},i,t} \times \text{CPM}_{\text{INS},t}^{\text{soccer}}\right) \times \gamma}{1000 \times \left(1 + r^{\text{CAPM}}\right)^t} \right]$$

Data and Results

Data

The social network values for the TOP 100 Bundesliga players (according to transfer market values) are calculated on the base of the season 2016/2017. The social network values are determined for two key dates, September 2017 and September 2018. The CPM of the third quarter of 2017 will be used for Facebook, Twitter, and Instagram in the valuation. The conversion of the CPM Soccer assigns an individual CPM value to each player, according to the second formula listed above.

The assumption of constant follower numbers is also taken into account. The calculation assumes the theoretical end of the active career and thus also the end of the calculation of the social network value. The determined social network values in the future periods up to the theoretical end of the term of 33 years are recognized as present values at the respective dates of September 2017 and September 2018. For this purpose, the return is determined on the base of the CAPM approach. For

Germany, the source of the input values is the website marktrisikoprämie.de. The risk-free interest rate is 0.46% in September 2017 and 0.33% in September 2018. The market yield is 6.89% in September 2017 and 7.78% in September 2018. The beta value is used on the base of the only listed association in Germany, Borussia Dortmund GmbH & Co. KGaA from the infrontanalytics.com site. Its beta value is 0.89.

Results

After adjusting the data under the assumption that the number of followers in the social networks must be available at both times examined, a stable social network value could be determined for 76 players out of a total of 100. On the one hand, this is due to the fact that the players have no social media accounts and therefore no followers. On the other hand, the required input values for the social valuation were not available for both dates at the same time.

In the analysis of the dependence of the individual variables, the positive significant correlation between transfer market values and the follower figures can be determined. Furthermore, a correlation also exists between transfer market values and social network values. Age is also positively correlated with the transfer market values, though it was only slightly significant in 2017 (sees Fig. 6.3). This may be an indication that the transfer market value could decline with increasing age. However, the experience parameter plays a decisive role. As we have not measured the experience, we will not elaborate the parameter in this further detail.

Next, we analyzed the relationship between transfer market values and social network values as dependent variables as well as the age of the players and their followers.

We found a strong significant relationship between transfer market values and the number of followers. Age has no significant influence on the transfer market value (see Fig. 6.4).

However, followers in 2017 and in 2018 are highly significant for the transfer market value (see Fig. 6.5).

If the age is adjusted from the regression, the regression model also becomes significant overall (see Figs. 6.6 and 6.7). The followers as explanatory variables are highly significant. The explanatory quality (r square) is 30% for the year 2017 and 23.8% for the year 2018.

Conclusion

This article presented a new model for assessing the social network value of a professional soccer player. Input variables such as followers in social networks and CPM prices played a decisive role. The CPM price was also adjusted to market

Correlations

		Age2017	Age2018	MarketValue2017	MarketValue2018	Follower2017	Follower2018	SocialNetwork Value2017	SocialNetwork Value2018
Age2017	Pearson Correlation	1	1.000**	.248*	-0.068	.251*	.240*	0.153	0.101
	Sig. (2-tailed)		0.000	0.031	0.559	0.029	0.037	0.188	0.383
	N	76	76	76	76	76	76	76	76
Age2018	Pearson Correlation	1.000**	1	.248*	-0.068	.251*	.240*	0.153	0.101
	Sig. (2-tailed)	0.000		0.031	0.559	0.029	0.037	0.188	0.383
	N	76	76	76	76	76	76	76	76
MarketValue2017	Pearson Correlation	.248*	.248*	1	.787**	.556**	.565**	.521**	.441**
	Sig. (2-tailed)	0.031	0.031		0.000	0.000	0.000	0.000	0.000
	N	76	76	76	76	76	76	76	76
MarketValue2018	Pearson Correlation	-0.068	-0.068	.787**	1	.466**	.499**	.473**	.458**
	Sig. (2-tailed)	0.559	0.559	0.000		0.000	0.000	0.000	0.000
	N	76	76	76	76	76	76	76	76
Follower2017	Pearson Correlation	.251*	.251*	.556**	.466**	1	.993**	.969**	.938**
	Sig. (2-tailed)	0.029	0.029	0.000	0.000		0.000	0.000	0.000
	N	76	76	76	76	76	76	76	76
Follower2018	Pearson Correlation	.240*	.240*	.565**	.499**	.993**	1	.974**	.953**
	Sig. (2-tailed)	0.037	0.037	0.000	0.000	0.000		0.000	0.000
	N	76	76	76	76	76	76	76	76
SocialNetwork Value2017	Pearson Correlation	0.153	0.153	.521**	.473**	.969**	.974**	1	.989**
	Sig. (2-tailed)	0.188	0.188	0.000	0.000	0.000	0.000		0.000
	N	76	76	76	76	76	76	76	76
SocialNetwork Value2018	Pearson Correlation	0.101	0.101	.441**	.458**	.938**	.953**	.989**	1
	Sig. (2-tailed)	0.383	0.383	0.000	0.000	0.000	0.000	0.000	
	N	76	76	76	76	76	76	76	76

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Fig. 6.3 Correlations (own representation)

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.567[a]	0.322	0.303	11273568.396

a. Predictors: (Constant), Follower2017, Age2017

b. Dependent Variable: MarketValue2017

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4407248361086190.000	2	2203624180543090.000	17.339	.000[b]
	Residual	9277814138913810.000	73	127093344368682.000		
	Total	13685062500000000.000	75			

a. Dependent Variable: MarketValue2017

b. Predictors: (Constant), Follower2017, Age2017

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	5096684.392	10119282.406		0.504	0.616
	Age2017	476765.095	408633.756	0.116	1.167	0.247
	Follower2017	0.693	0.131	0.527	5.296	0.000

a. Dependent Variable: MarketValue2017

Fig. 6.4 Regression 1 (own representation)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.535[a]	0.286	0.266	17189940.955

a. Predictors: (Constant), Age2018, Follower2018

b. Dependent Variable: MarketValue2018

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8637742756887530.000	2	4318871378443770.000	14.616	.000[b]
	Residual	21571067111533500.000	73	295494070021007.000		
	Total	30208809868421100.000	75			

a. Dependent Variable: MarketValue2018

b. Predictors: (Constant), Age2018, Follower2018

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	52194373.877	16015039.202		3.259	0.002
	Follower2018	1.007	0.188	0.546	5.363	0.000
	Age2018	-1213821.568	621326.630	-0.199	-1.954	0.055

a. Dependent Variable: MarketValue2018

Fig. 6.5 Regression 2 (own representation)

conditions on the base of the transfer market price and determined individually for each athlete. We determined the social network value for 100 players of the German Bundesliga, whereby only 76 players were included in the statistical analyses due to a lack of data. The analyses show that the follower figures are a significant factor influencing the transfer market value. In addition, a significantly strong relationship

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.556[a]	0.309	0.300	11301052.907

a. Predictors: (Constant), Follower2017

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4234241536730990.000	1	4234241536730990.000	33.154	.000[b]
	Residual	9450820963269010.000	74	127713796800933.000		
	Total	13685062500000000.000	75			

a. Dependent Variable: MarketValue2017

b. Predictors: (Constant), Follower2017

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	16792341.222	1386529.622		12.111	0.000
	Follower2017	0.732	0.127	0.556	5.758	0.000

a. Dependent Variable: MarketValue2017

Fig. 6.6 Regression 3 (own representation)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.499[a]	0.249	0.238	17514022.147

a. Predictors: (Constant), Follower2018

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7509977958190650.000	1	7509977958190650.000	24.483	.000[b]
	Residual	22698831910230400.000	74	306740971759870.000		
	Total	30208809868421100.000	75			

a. Dependent Variable: MarketValue2018

b. Predictors: (Constant), Follower2018

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	21178142.796	2141762.590		9.888	0.000
	Follower2018	0.919	0.186	0.499	4.948	0.000

a. Dependent Variable: MarketValue2018

Fig. 6.7 Regression 4 (own representation)

between the social network value as an independent variable and the transfer market value as a dependent variable could be shown. Finally, it should be noted that the model presented can be applied to all legal and natural persons who have an account with a social network.

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Chapter 7
Creating Value in the Digital World

Raphaela Balzer and Anna Vojtková

Abstract Observing skyrocketing valuations of digital pioneers in the capital markets with Amazon hitting the USD one trillion market valuation in 2018, many industrial conglomerates have experienced plummeting stock prices and value destruction even though they have continuously and rigorously optimized their portfolios and business operations. The fundamental change of dynamics in the digital era implies an immense challenge for most global players searching for explanations and a new recipe on how to create and sustain value in the digital era. Consequently, the demystification of digital value creation and its determination is of utmost importance for decision-makers across industries who are required to succeed in a digital, networked economy of adoption, coopetition, and self-reinforcing dynamics. This chapter is an adapted extraction of the source: Balzer, R. (2020a) *Value Creation in the Digital Era*. Dissertation thesis, Technical University of Košice, Košice.

Introduction

> You are real, they are virtual.
>
> You build, they collaborate.
>
> You are product-driven, they are customer-driven.—(DiMaggio, 2001, p. 212)

Parida et al. (2019) define digitalization as "use of digital technologies to innovate a business model [1] and provide new revenue streams and value-producing opportunities in industrial ecosystems" (Parida et al., 2019, p. 6). The authors state that

[1] A business model can be defined as "structured management tools, which are considered especially relevant for success" (Wirtz et al., 2016, p. 36) or "a reflection of the firm's realized strategy"

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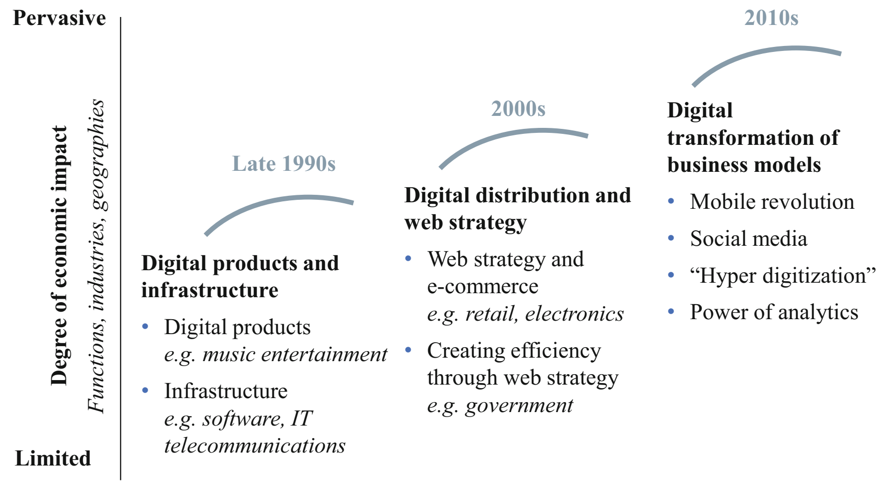

Fig. 7.1 Evolution of digital transformation (Berman and Bell, 2011, p. 4)

digitalization is a "general phenomenon, enabled by digital technologies that is changing the society at all levels" (Anttonen, 2018, p. 7). [2]

Luz Martín-Peña et al. (2018) agree and point out that digitalization has fundamentally changed the mechanisms of economics. Social networks, smart devices, and various interactive tools are now used to engage other economic agents, to determine who to trust, where and how to go, and what and how to buy. Consequently, under the virtue of sustained value creation, companies face new rules on how to succeed in digitalized markets. The global dynamics of Volatility, Uncertainty, Complexity, and Ambiguity (VUCA) become their new reality while responding to the shareholders' maxim of creating and sustaining value for their companies (Bennett & Lemoine, 2014). Therefore, they are forced to undertake their own digital transformations, rethink what customers value most, and create operating models that take advantage of digital technologies in scaling networks on platform business models. Their structure is evolving, and their boundaries are becoming more porous and less defined (Martins et al., 2015).

Figures 7.1 and 7.2 confirm these dynamic developments and show that digital transformations of business models impact both public and private sector organizations. In the 1990s, few organizations in selected industries were exploring digital products and services or building digital infrastructure. Currently, the situation

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(Casadesus-Masanell & Ricart, 2010, p. 195). Another definition is "the designed system of activities through which a firm creates and captures value" (Yu et al., 2019, p. 239). Business models have become more important in recent years as a result of digitalization as they are associated with securing and expanding competitive advantages (Wirtz et al., 2010, 2016) and contribute to corporate growth (Chesbrough & Rosenbloom, 2002; Tikkanen et al., 2005; Zott & Amit, 2008, 2010; Teece, 2010; Zott et al., 2011; Teece & Linden, 2017; Zott & Amit, 2017).

[2] The terms digitalization and digitization are considered as synonyms in this chapter.

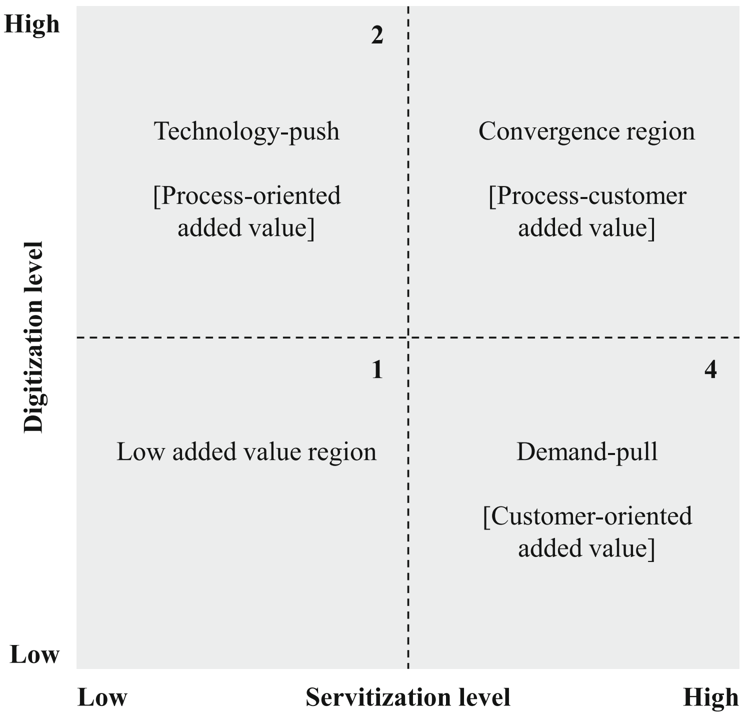

Fig. 7.2 Innovation trajectories for Industry 4.0 and servitization (Frank et al., 2019, p. 344)

requires new business models that enable decision-makers to understand and use the opportunities and challenges of digitalization (see Loebbecke & Picot, 2015).

Within the framework of searching for the ideal business model for the digital age, for example Fjeldstad and Haanæs (2018) [3] formulate three key features of a digital company: (1) human and digital agents working together, (2) technologies that can potentially enhance everything (e.g., products and/or services, internal operations, relationships with customers and/or suppliers), and (3) members' ability to self-organize, thus saving many the costs of hierarchy and enabling collaborative activities. In other words, according to the authors, a digital company should be "collaborative, agile, and minimally hierarchical" (Fjeldstad & Haanæs, 2018, p. 93).

In practice, many startup companies use digital technology to build new products and business models that disrupt and take customers away from firms that cannot

[3] According to Fjeldstad and Haanæs (2018), an example of a digital organization is Google. Google organizes itself into flexible, diverse, and modular units of employees that can be reconfigured quickly. To enable cross-functional collaboration, Google fosters a "marketplace of ideas," in which briefs about new ideas and projects are published internally. Employees can vote for the most promising projects and choose which ones to support with their time.

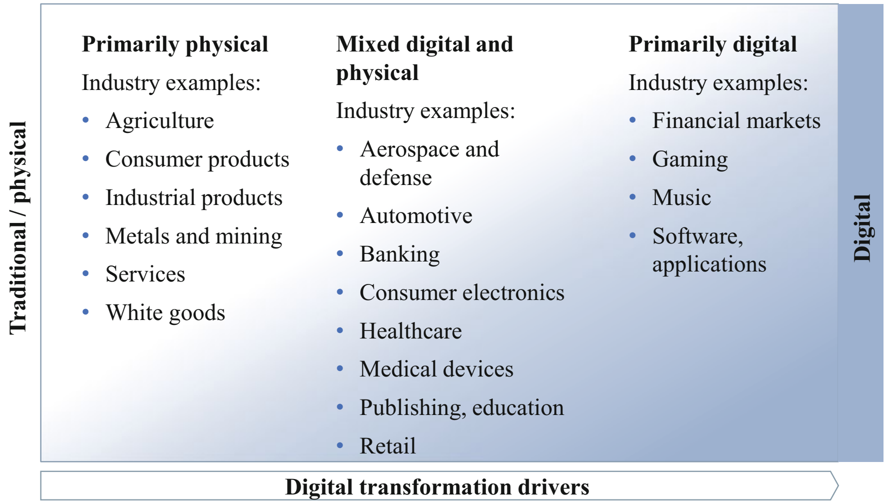

Fig. 7.3 Degree of product and service digitalization (Berman & Bell, 2011, p. 6)

change or adapt, and therefore are not flexible enough. Established companies also understand that digital technology can help their businesses with greater speed to a lower cost, and in some cases, they invite their customers to co-design and co-produce their products and/or services. This disruption is pushing all industries toward the digital end of the physical-digital continuum (see Fig. 7.3).

However, the fast-emerging digital economy is primarily changing definitions of value while redefining the means of its creation. Digitalization affects and determines all aspects of how customers behave and how companies create and capture value.

While digital pioneers attract investors to follow the digital hype, global traditional established incumbents face challenges to creating sustained value for shareholders based on their deeply rooted competitive advantage (Bughin et al., 2017). For that reason, with the DNA of strong capabilities and competences in their industry, these incumbents have to reinvent themselves at a fast pace to win the digital race by setting technological and innovational standards. As a result, the "digital winner takes it all and fast" mentality forces companies to disrupt their core along the wide range of resources, competences, and capabilities without losing focus on the paradigm of value creation resulting in long-term stable profitability levels. The need to gain a better understanding of the underlying digital mechanisms of value creation is unquestionable and of urgency to be responded to by most companies.

In order to shed a light of insight on digital value creation from a financial and strategic perspective, the remainder of this chapter is organized as follows: The digital dynamics of disruption and split economics, resulting in a dominance of the digital pioneers, are presented. From a theoretic approach, the financial core concepts of PVGO (present value of growth opportunities) and real options are outlined. Moreover, these academic concepts are introduced to explain the virtue of value creation in the digital era. Next, three strategic recommendations on how to maximize option value are elaborated upon. Finally, a summarizing conclusion offers a future outlook on the subject.

Value in the Era of Digital Disruption

From an analytical point of view, the valuation of a company is an important tool to identify the value drivers (Rohlfs, 1974; Katz & Shapiro, 1994; Corelli, 2017).

According to Manyika et al. (2018) and their analysis on the company "superstars" [4] conducted from 2010 to 2014 based on the largest nearly 2400 corporations, with the rise of digital companies, profitability expressed in economic profit becomes more concentrated. [5] Manyika et al. (2018) find that the top 10% of the companies comprise 80% of the economic profit in the group of companies with revenues of more than USD one billion, which, in the Silicon Valley, are the startup companies called "unicorns." They refer to their study as the power curve. The pattern is similar at both ends of the curve, namely, nearly 10% of the low performing companies at the bottom account for a similar amount of value destruction. They state that over time, the concentration has become more intense.

As Manyika et al. (2018) show, all companies generate USD 920 million of annual operating profits, based on USD 9.3 billion invested capital earning a return of 9.9%. After investors and debt holders claim 8% for their cost of capital, the remaining 1.9% points translate into USD 180 million of total average economic profit. The resulting curve clearly shows a dramatic exponential fall and rise at both ends which exemplify "fat tails." Most of the companies in the middle are barely generating economic profit as they only generate the required cost of capital.

In addition to the graph illustrated in Fig. 7.4, the analysis reveals that 20% of the analyzed companies generate 90% of the created total value. Very few companies strongly outperform others, fueling back into the idea of the cross-industry digital phenomenon of "the winner taking it all." The other side of the "fat tail" indicates that only a relatively small number of companies are responsible for a significantly big share of value destruction, while the clear majority seems to be "stuck in the middle" with only an 8% chance of moving to the top quintile. As the capital markets favor those share investments that have the highest economic profit and future perspective, a cycle of capital availability in a concentrated way shows that there will be clear winners and losers in the future across industries.

[4] "Superstars" are companies that have a significantly greater share of income and generate high economic profits.

[5] The authors define economic profit as the total profit after cost of capital.

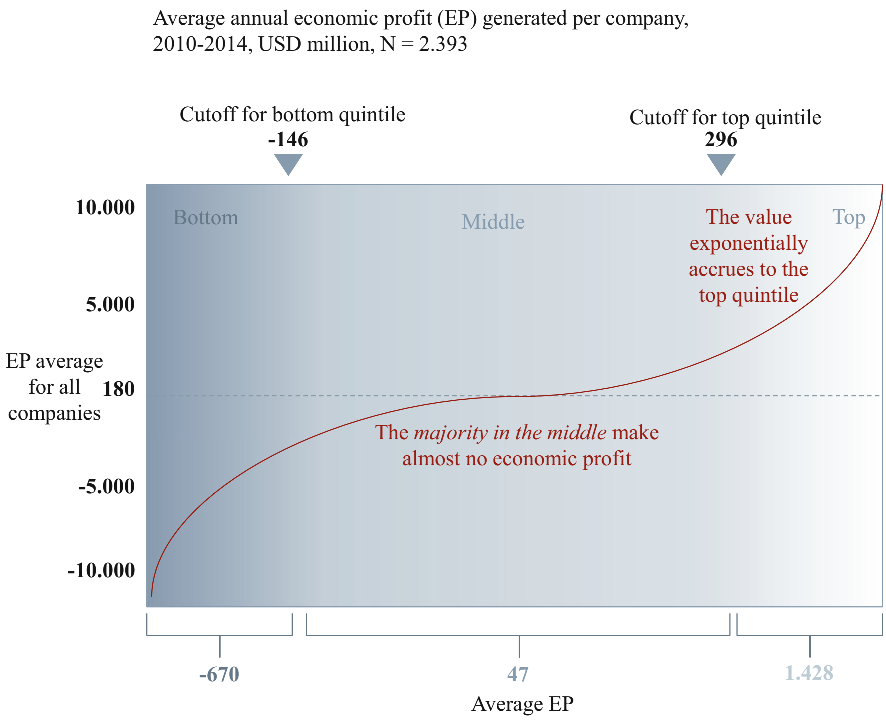

Fig. 7.4 The power curve of economic profit (Manyika et al., 2018; Ramaswamy et al., 2019)

According to the authors, another main reason for the differences in value creation is the issue of unattractive industries. In a nutshell, the key insight into the digital era can be summarized as follows: It is better to play with an average performance in an attractive market than to outperform in a less attractive market; where you play matters more than how you play. Logically, the implication for management is to manage product and market portfolios in a constant, proactive way. Multinational conglomerates like General Electric and Siemens acting in multiple businesses around the globe are forced to proactively manage their portfolios: to invest in the most attractive markets aggressively while divesting the less attractive.

In fact, value creation through digitalization can be alternatively described as two sides of the same coin: While investors require companies to sustain extraordinary levels of returns to sustain their values, corporate management therefore seeks to identify, select, and execute projects and investments generating positive NPV (Net Present Value) or economic profit. The technology leap of digitalization serves as the key enabler for companies to invest in digital technology and software expertise.

Also, Heuser (2018) notes the high levels of profitability and the question is raised which companies and dynamics are characteristic for the top performers. Even though the authors do not list the names of the companies, they allude to the fact that there are not only digital pure players but also companies across industries which meet the criteria of "superstars." The key differences to the digitally mature players, as the authors point out, are investments in intangibles that are two to three times higher than industry average, high shares of foreign revenues, and inorganic growth strategies. Finally, the study reveals that the key skill of those firms is their ability to select and execute their investment opportunities in an excellent manner. The labeling of high growth startup companies as "unicorns" was initiated in 2013, when venture capitalist Aileen Lee named a company which has been valued more than USD one billion by its investors in private or public markets a "unicorn" (Lee, 2013). She refers to those startups with this terminology to a unicorn symbolizing an extremely rare, "magical" phenomenon from the mythical world. According to her findings, three to four super-unicorns are "born" every decade, such as Google, Amazon, and Facebook.

The matter of being a digitally mature company plays such a critical role because the awareness of digitalization and its new investment opportunities has increased over the last decades. According to Andreessen (2011), technology is finally available to globally scale digital ideas. The prerequisites have been established since the mid-twentieth century: six decades after the computer revolution, four decades of the existence of the microprocessor, two decades of the Internet, most of the world population has access to the mobile Internet.

Evans and Schmalensee (2016a, 2016b) share a similar point of view regarding why digitalization is fully unfolding now. They count six technology breakthroughs responsible for the success of matchmaking companies driving their value based on multisided platform business models: [6] the performance of computer chips, the Internet, the world wide web, broadband communication, programming languages, and the cloud technology. All these technologies have been hardware- and software-related and form a variety of digital opportunities allowing matchmaking companies to transform industries over the course of many years. Evans and Schmalensee (2016a, 2016b) see digitalization rather as a transformation process to happen over decades.

The Phenomenon of Split Economics

To encompass the magnitude of the digitalization related to the economic success of a few "superstar" companies, economists have also developed a new set of categorizations to capture the contrast of industrial firms versus digital companies. In the following, some examples of frameworks are depicted to clarify the differences.

[6] In platform business models, the peer is responsible for large parts of the value creation, acting as a micro-entrepreneur in suppling goods and services to the platform's customers (Eckhardt & Bardhi, 2016).

Govindarajan (2018) categorizes digital and industrial markets into three different types. Type 1 are purely digital markets, with information goods as main products. Through Internet connectivity, digital players like Google and Facebook orchestrate the variety of positive network effects to extract abnormal profits. Type 2 of the markets has converted from analog to digital products. Books, music, and media are sold as services on digital platforms instead of physical assets. The most prominent digital players to be named are Amazon and Netflix as well as the Internet giant Google again. Type 3 is still subject to experience a subtle level of digitalization. The industrial Internet, also referred to the Internet of Things, interlinks physical products using software. The Internet connectivity enables to integrate the tangibles and intangibles and thereby generates new sources of value in existing industries. The most interesting aspect in this category revolves around the potential of success of native digital versus native industrial players.

While Govindarajan (2018) lists barriers to overcome for both groups of players, he is unclear about the success of the "hybrid" company Amazon, combining the e-commerce industry with almost unparalleled success. Nevertheless, his categorization eases a structured understanding of the industrial versus the digital markets though admitting to being vastly imperfect.

Along the lines of the idea of split economics, Arthur (1996) draws a clear picture of two bifurcated worlds of business. The industrialized world, which he labels "Marshall" world, is based on materials and processing, maintaining profitability based on optimization in an overall paradigm of diminishing returns.

In contrast, the information- and knowledge-based economy enjoys increased returns based on networks and embraces psychology, cognition, and adaptation. Arthur (1996) alludes to organizational differences between both worlds by describing the effects of unpredictability, positive feedback loops with a "casino gambling, where part of the job is to choose which game to play" (Arthur, 1996). Thereby, he clearly positions software as the dominating transmitter of information. Key success factors are the right timing, financial capacity, and strategic pricing to resign profits.

In yet another similar idea of split worlds, Silicon Valley's famous venture capital investor Andreessen (2011) states in a Wall Street Journal article that "software is eating the world." In his foray about software innovation disrupting and reshaping complete industries, Andreessen argues that software substitutes large parts of the value chain of many industries which are allocated to the physical world. From the automotive industry, oil and gas players, healthcare, and education, digitalization continues to transform the economic landscape. In 2011, Andreessen provoked with the statement that stock markets "hate technology" (Andreessen, 2011). He refers to the P/E (price-to-equity) ratio range between 10 and 15 of Apple as being "undervalued" in the notion of financial multiples. In 2018, the P/E ratio ranged at a higher rate between 16 and 19 (see Fig. 7.5). Yet, it remains questionable whether venture capitalists would consider those rates as an "emotional" swing due to the appreciation of technology companies.

Alluding to the concentration of profits as a phenomenon of digitalization (Manyika et al., 2018), the world of academia and business describes new times of economics, which are contrasted as a bifurcated world by Arthur (1989): The

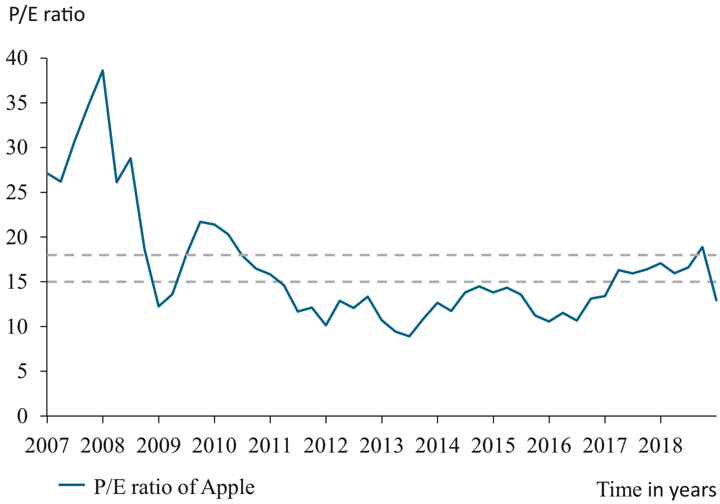

Fig. 7.5 Apple P/E ratio 2007 to 2018 (macrotrends.net, 2018)

industrialization with its long-term constant or even diminishing returns has dominated the global economy. Now, the dynamics of the digital era unfold immense growth opportunities of value creation to digital companies with increasing returns. According to Arthur (2014), the times of neoclassic economics are superseded by complexity economics, which are commonly also referred to as economic times of volatility, uncertainty, complexity, and ambiguity (VUCA).

Another study of the strategy consultancy BCG has presented value creators and value exploiters in an annual ranking on maximal total shareholder return (TSR). Thereby, they define value creators as companies creating a higher PVGO as a percentage of market capitalization than the median of the S&P 500 industry peer group and exploiters as companies below the median.

Based on a legacy of success, the core business of those value stock companies is "overexploited" whereas the disruptive market dynamics would suggest disrupting and innovating to obtain scaling growth opportunities. With PVGO taken as a proxy for the degree of exploration, Reeves et al. (2015) show the level of PVGO dropping by 10 percentage points between 2004 and 2014 (see Fig. 7.6). Even though they attribute a portion of growth in 2009 to large share buybacks and high dividends, the authors find especially large and established companies to literally ignore growth opportunities.

In their analysis, Reeves et al. (2015) find large corporates to face inertia as a negative effect on size scale and therefore not pursuing enough future growth opportunities rather than focusing on cost reductions to maintain profitability levels.

As top value creators in 2015, the study names the decacorns Amazon and Google being able to execute "dual discipline" even at scale. They "explore" and "exploit" value in parallel. In the ranking from 2018, the technology sector takes six

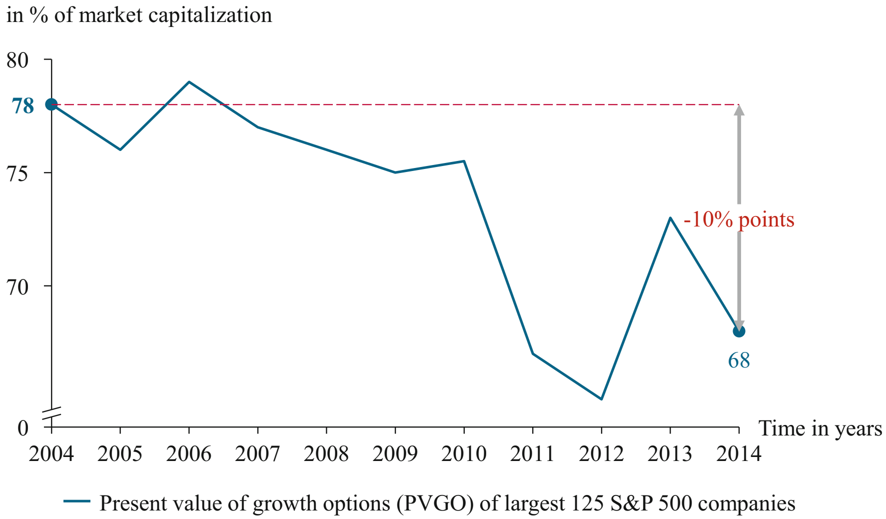

Fig. 7.6 Large companies neglect exploration (Reeves et al., 2015)

and the media sector takes three out of the first ten spots. Both industries have also been identified as digitally advanced in other studies (Hansell et al., 2018). The power of digitalization, especially in those industries with digital native companies like Netflix, Facebook, and Amazon outperforming on value creation, is remarkable. Therefore, it is essential to comprehend the source of value creation based on the core financial concepts of PVGO and real options, before integrating those with the more strategic concept of maximizing option value according to Kester (1984).

PVGO: The Financial Core Concept

Brealey et al. (2010) define that the value of growth opportunities is based on the required rate of return earned on future investments to exceed the firm's cost of capital. Furthermore, they describe tangible assets as units of productive capacity, while intangible assets are considered options to expand additional units. The sum of the option values is defined as PVGO, the present value of growth.

Investments in future opportunities, which Myers (1977) refers to as PVGO, contribute significantly to the company's equity value range. Even decades later, Brealey et al. (2010) define PVGO as the value of a firm's options created to invest and expand.

They explain the price of a stock, thus its valuation, in a two-folded approach when referring to growth: The first component is defined as the capitalized value of average earnings under a no-growth policy, consequently expressed as a perpetuity formula with EPS (earnings per share) discounted at the market capitalization rate

r. The second element PVGO is defined as the present value of growth opportunities. Those growth opportunities are a value summarized as the value of all future expected cash flows stemming from internal projects with a positive NPV, earning more than the market capitalization rate r.

$$P_0 = \frac{\text{EPS}_1}{r} + \text{PVGO}$$

If investors are paying a significant fraction of their share price for those growth opportunities, the share is commonly categorized as a growth stock. Assuming market efficiency, the PVGO can serve as an approximation to provide one piece of the valuation puzzle. However, the complexity in the application of native digital companies is apparent: While startup companies are known for negative cash flows and earnings, the formula might not always apply in its original sense (Brealey et al., 2010).

Originally, Myers (1977) illustrated the concept of investment opportunities as growth options with an empiric elaboration on five companies and their respective PVGO ratio of 66% in relation to the market value of equity ranging between 36.5% and 87.1% (Brealey et al., 2010). Two decades later, Brealey et al. (2010) refer to the decacorn Google as a "growth stock" as roughly 50% of the stock price stem from value based on investors' expectations about Google's future investment opportunities.

In the time of increased attention on digital pioneers in the Silicon Valley, Brealey et al. (2010) contrast the separation of growth and value stocks based on the PVGO concept: they depict that investors distinguish between growth and income stocks, also known as value stocks. It is the investors' motivation to buy growth stocks for the expectation of future capital gains compared to the motivation for investors of value stocks to buy those for cash dividends.

In terms of PVGO, the authors describe growth stock attributed to a high PVGO compared to the capitalized value of EPS, hence they have low ratios of book value to market value. Even though growth stocks are quickly expanding, their PVGO is assigned to the profitability of new investments.

The set of value stocks with high ratios of book-to-market value, according to Brealey et al. (2010), inhibits a higher long-run return than growth stocks. He refers to a rate of 5.2% annual difference between both types of stocks since 1926.

Myers and Turnbull (1977) extend the idea of PVGO as they refer to the payoff for shareholders depending on the endogenous availability of projects, the "assets depend on future discretionary investment by the firm" (Myers, 1977, p. 155). They distinguish between assets-in-place as tangible, non-discretionary, sunk costs whereas future investments are intangible, discretionary investments. Furthermore, they define discretionary investments as all variable costs, such as marketing expenses, research and development costs, maintenance costs on plants and equipment, and expenses on raw materials. They explicitly connect the distinction between both asset types: Real assets have a market value that is independent from the firm's strategy and real options are the opportunity to purchase real assets on possibly favorable terms, meaning positive NPV.

Pindyck (1988) introduces the call option analogy in a similar way: The capacity is defined as the firm's real assets and real options as the option to add more units. The investor's option is compared to the real option to add more capacity. Pindyck (1988) claims the value of capital in place to be less than 50% of the market value depending on demand volatility even though he does not provide any empiric proof. While most authors build on the analogy of real assets and real options, it has been rejected by Danbolt et al. (2002).

Kester (1984) builds on the concept of PVGO with a strong focus on the strategic and competitive perspective for business practice, transferring the concept from the financial to the strategic angle, stating that "value comes initially in the form of growth options rather than cash flows" (Kester, 1984, p. 14). He considers the attractiveness of tomorrow's available investments to be based on the assets put in place today.

In addition, Kester claims that real options are split in non-firm-specific, such as cost reductions, and firm-specific, defined as having no value to another firm. Examples of firm-specific real options are economies of scale, learning curves, and patents. Describing those firm-specific real options, Kester (1984) builds on his idea, calling options either proprietary or shared. Apart from timing flexibility and the characteristic of compound options, he formulates those as the three main ingredients to create value in dynamic markets—an idea which will be elaborated upon in the following.

Referring to his empiric analysis, Kester quantifies the PVGO by industry: He investigated PVGO in his empiric study in 1984 and amounted the minimum of 5% of PVGO in food processing and up to 85% of PVGO in electronics. In his paper in 1986, he calculated PVGO portions of nine companies in three industries: a PVGO of 56% in electronics, 43% in chemicals, and 43% in the paper industry.

The Split Concept of Real Options

Following the maxim of value creation, the time and scope of exercising the option can be steered: Investments as real options can be deferred, abandoned, expanded, shortened, switched, and compounded. This structuring of option characteristics (Trigeorgis, 2002) suggests that corporate finance literature agrees on the basic principles of the real options approach which serve as the fundament for more sophisticated quantitative empiric models.

Along the findings of other literature, Koller et al. (2010) describe the main variables correlated to flexibility value. While high investment costs and cash flows lost to competition are negatively correlated, other factors are positively linked: the longer the time to expiration, the higher the uncertainty about present value and the higher the risk-free interest rate, the higher the present value of cash flows and its flexibility value (see Fig. 7.7).

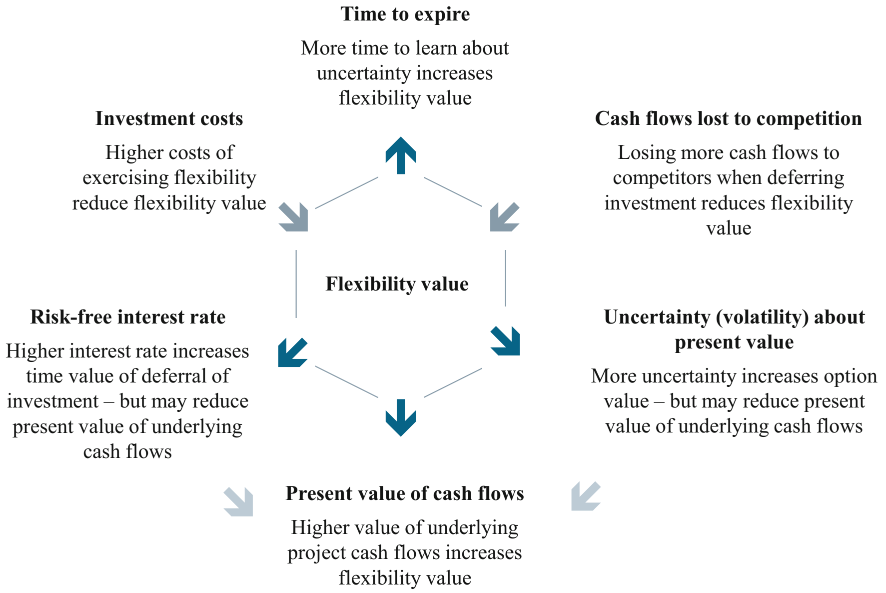

Fig. 7.7 Drivers of flexibility value (Koller et al., 2010, p. 685)

In line with others, Trigeorgis (2002) regards uncertainty and flexibility as key determinants, hence the value of options benefits with greater variability of outcomes. He extends the concept of NPV by decomposing the value into a sum of a passive NPV, flexibility value, and strategic value. In this aspect, Trigeorgis solves for the limitations of the NPV concept under uncertainty: He defines the portion which Myers (1977) refers to as “intangible” as a flexible and strategic.

In Myers’ view, the flexibility value is the real option value which increases with high uncertainty, long investment horizons, high interest rates, and compound options. Flexibility is regarded as the option to defer, reverse, stop, restart, and switch investment projects (Guo & Zmeškal, 2016).

Besides, Trigeorgis (2002) considers the strategic value as a multistage value, also called compound value. Trigeorgis (2002) notes that “empirically, companies in industries with higher uncertainty that involve multi-stage (compound) options tend to have a higher proportion of their stock price deriving from growth opportunities (PVGO/P), providing an indirect confirmation of the validity of real option predictions” (Trigeorgis, 2002, p. 13). Trigeorgis, like Kester, bridges the gap between the corporate financial and corporate strategy perspective as he explains how strategic value depends on whether the investment is proprietary or shared and whether it damages or benefits rivals. He points out the competitive pressure as a WTA (winners take all) race. When firms are induced to invest, the prisoner’s dilemma occurs: Companies who share investment opportunities lose if both pursue those individually. Consequently, they are better off coordinating with joint research and shared investment cost to maximize the strategic portion of value of equity. In another study of Trigeorgis (1991), he applies a scenario analysis in a duopoly to define the optimal timing to invest (also see Balasubramanian et al., 2000)

This aspect of introducing game theory to consider competitive reactions has been followed by many authors in their theoretic models, especially as duopolies in networked markets (Tsai & Ghoshal, 1998; Angelou & Economides, 2008, 2009a, 2009b).

Real Options and PVGO: A Fit for VUCA Times

To reflect the digital dynamics under uncertainty in the intrinsic value of a company, most corporate finance academics agree that the real option model applied to future cash flows (Götze et al., 2015) is the most accurate reflection. As a critical element of the optimal portfolio selection, investors obtain the character of an option: By paying the share price, they receive the value of the company without growth and the option to grow, referred to by Brealey et al. (2010) as the PVGO model. The investment in the PVGO is naturally hedged to its PVGO value, with an enormous upside potential based on volatility and high growth rates (Balzer, 2020a, 2020b).

Literature based on PVGO and the real options approaches the factor of risk in positive correlation to the value of growth opportunities. As the negative result is limited to the sunk cost of the acquired growth option, the upside potential of the growth option is positively related to its risk. In other words, risky projects create value. Again, Kester (1984) demonstrates straightforward arguments regarding why risk should be treated as a positive investment opportunity, analog to a call option on securities (see Fig. 7.8).

This insight might appear rather trivial from an academic perspective. Yet, it is counterintuitive to all corporates and their credo to reduce and mitigate risk wherever possible. Therefore, it could be argued that the notion of risk of the corporate management requires fundamental change. In times of digitalization, the perception of risk is still a key characteristic differentiator between large global corporates, represented as value stocks, and digital pioneers maintaining a startup style to embrace risk—appreciated by the capital markets in terms of high PVGO values.

Furthermore, while the DCF valuation assumes investors to be passive while ignoring volatility, the attractiveness of the PVGO model is dedicated to valuing the option of growth. At this point, active investors can decide whether and when to exercise the option of growth. Apparently, the following rule applies: the higher the market volatility, the higher the value of its flexibility (see Table 7.1).

As Brealey et al. (2010) concluded, the volatility increases the value of the option, the PVGO, and can therefore justify a higher pricing: Consequently, the value of native digital companies is dominantly attributed to the positive effect of volatility and its upside potential based on the real options approach (see Table 7.2).

In their empiric models, the authors Brealey et al. (2010) apply an equity risk-premium at a nominal rate of 8.4% (US 1926 to 1994) while Kester (1984) discounts at a nominal rate of 15%, 20%, and 25%, respectively. Danbolt et al. (2002) criticize

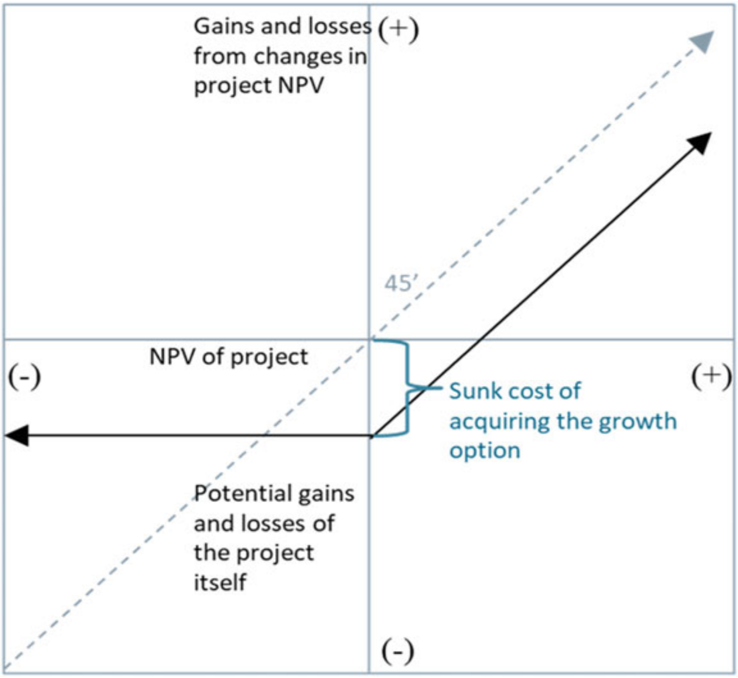

Fig. 7.8 The asymmetry between upside gains and downside losses (Kester, 1984)

Table 7.1 Volatility of establishment industries versus digital organics (Brealey et al., 2010, p. 518)

	Establishment industries	Digital organics
Number of options	100,000.00	100,000.00
Exercise price	USD 25	USD 25
Maturity	5 years	5 years
Current stock price	USD 22	USD 22
Stock volatility (standard deviation of return)	24%	36%

the variety of applied discount rates while using an 8.6% real interest rate for UK companies in their empiric study. Danbolt et al. (2002) demonstrate the limitations of the PVGO model. Overall, it can be concluded that the quantitative perception in academia of the discount factor varies.

Maximizing Value in VUCA Times

The excitement of digital technologies stems from the idea to catch new, hopefully positive, NPV opportunities. Whereas the attractiveness of the market beats all other

Table 7.2 Value of options: establishment industries versus digital organics (Brealey et al., 2010, p. 539)

	Establishment industries	Digital organics
Stock price (P)	USD 22	USD 22
Exercise price (EX)	USD 25	USD 25
Interest rate (rf)	0.04	0.04
Maturity in years (t)	5	5
Standard deviation (σ)	0.24	0.36
$d_1 = \frac{\log\left[\frac{P}{PV(EX)}\right]}{\sigma\sqrt{t}} + \sigma\sqrt{t}/2$	0.3955	0.4873
$d_2 = d_1 - \sigma\sqrt{t}$	−0.1411	−0.2177
Call value = $[N(d_1)xP] - [N(d_2)xPV(EX)]$	USD 5.26	USD 7.40

criteria in terms of value creation potential according to recent studies, corporate management can proactively create value by analyzing digital technologies in the light of potential value creation. This can be achieved by maximizing Kester's (1984) three main ingredients of exclusivity, timing flexibility, and compound options. Additionally, a more positive perception of risk as a positive attribute in investment decision-making requires a fundamental change in today's corporate thinking—with the options' nature to have limited losses while enjoying huge upside potential.

In the following, the three major ingredients stemming from the Kester framework for value creation on realizing positive NPV projects, also referred to as exercising options, are elaborated upon.

The first principle of value creation is related to the characteristic whether the option is exclusive to a company or shared within the market. Starting from the angle of corporate finance, the exclusive right to own the option increases its value: While some companies enjoy the exclusive rights of exercising real options, those are proprietary. Exclusive options are highly valuable as the value created falls to the company owning the right to exercise the option.

On the other hand, if the option has to be shared with other players in the market, it is less valuable as the probability of competitors to take away value is given and likely in most markets. While academics apply game theoretic approaches, they incorporate the aspect of competition in their models and thereby overcome the original limitations of the DCF and NPV concepts.

Clearly, the characteristics whether an option is firm-exclusive or proprietary can be interpreted as the result of capability of the management to exercise its strategy successfully by dominating markets. Hereby, in general, they steer the market dynamics as they can initiate changes regarding advanced technology or pricing adjustment (Kester, 1984). This strong position allows the market leader to control the timing and anticipate the outcome. The strategic positioning of a first mover pioneering in technologies or the second mover, also referred to as fast follower, matters critically to the optimal timing of exercising a real option by investing. Now, the variety of opportunities becomes apparent: With several new digital technologies introduced to global markets reaching a certain degree of maturity, the digitalization enables companies to move fast into new markets or build up new barriers to enter as incumbents. Depending on the potential of digitalization, new opportunities will emerge and will be taken by the first company to be able to monetize them. For academics, the modeling of game theory in combination with behavioral finance coincides with the latest technology trends. In business, the minimum skill set for future managers to create shareholder value is an in-depth analysis of the vertical IT technologies to identify tomorrow's growth opportunities.

The second element of value creation to be elaborated upon is reflected by its flexibility on a timeline. The option to choose the ideal timing to initiate or alter an investment project contains flexibility value. The longer the time horizon to maturity, for example to defer a project, the greater the flexibility for the management to identify the optimal time to exercise the option, meaning to realize the project.

According to Dixit and Pindyck (1994), the optimal timing of exercising the option is when it is "deep in the money," meaning when the option prices rise significantly above the value of the underlying asset. The option of leaving becomes valuable, for example due to demand shocks as most competitive companies wait before leaving to see if the market recovers or if rivals leave. The authors' view on investment projects as tangible assets in, for example, manufacturing industries contains a trade-off between economies of scale to produce large amounts despite uncertain demand and revenues. Those have to be balanced with incremental investments to incorporate the flexibility of options. Here, digital companies have an advantage due to their business relying on rather intangible assets.

The academic field of corporate finance inspired by Trigeorgis (1991) has developed numerous studies applying the rules of game theory and thus incorporating the competitive view into markets, as the ideal time depends on the maturity of the market as well as competitor moves, as noted before.

Corporate management, however, should refrain from investing earlier than required, as the option to defer the investment has its value and would be destroyed—this would be more critical if the investment is irreversible versus reversible. In addition, management is inclined to rather invest too early if NPV is high and risk levels and industry rivalry are low. One can conclude that the rationally optimal time to invest can only be found by a constantly self-challenging analysis based on real options and other strategic tools such as game theory.

The third element of value creation focuses on the characteristic of compound projects. Amongst other leading academics, Kester classifies projects or options according to the kind of value they create: Simple options create value as cash flow streams, according to the DCF scheme. A practical example could be restructuring programs or initiatives to increase efficiency based on cost reductions.

In the digital era, those projects will and have been vastly available to many players, increasing the level of automation in an industry. As those project opportunities are shared within the industry, the value created is shared among the players. Furthermore, it can be regarded as a hygiene factor for the industry as all players will be forced to enable those optimizations in order to sustain their profit levels. Those projects create value through cash flow originating from the assets-in-place. Another typical example in times of digitalization is the booking of flights online in the airline industry: With the digitalization of B2C markets, airlines are pressured to offer their flights with online booking and quickly establish the main sales channel in the industry in digitalization to secure future operational cash flows.

In contrast, compound projects include also further options for future projects and contain the option to generate additional cash flows in future. Typical examples include R&D projects, product, or market expansions. Yet, compound options bear a higher level of complexity, thus the management has to assess them according to their overall fit of the company's strategy (Kester, 1984). In short, simple options are a necessity while compound options can be interpreted as the "icing on the cake" to monetize on positive NPV and a necessity for all companies with the ambition to generate future growth.

Without a doubt, literature has identified far more parameters impacting the value of options in a negative or positive correlation. This insight can be inferred from the empiric studies published since the burst of the dot-com bubble in the early 2000s. As Amram and Kulatilaka (2000) note, growth options are not visible to external financial investors, but PVGO provides a level of transparency to shareholders. The authors clearly see that framing Internet growth options is a "judgement call," as growth in new markets is unknown contrary to matured markets.

The paper of Schwartz and Moon (2000) has received major attention in the academics of corporate finance due to its focus on a rational model to explain the excessive pricing of Internet company's stocks. Schwartz and Moon (2000) argue for the key determinants to impact high company valuation being changes in revenues and changes in revenue growth rates. Hereby they build their model based on the split of a core revenue stream and additional revenues from growth as exercised options. This distinction of labeled PVGO or real options and assets-in-place is at the core of valuation model. The main contribution of the insight can be attributed to the explanatory character of high valuations for an Internet company. With a high sensitivity to both key determinants, the authors imply further aspects of corporate finance literature in their discretionary model: They consider the changes in revenues and growth rates to be extremely high in the short term but to converge to the mean of reasonable industry in the long term.

Alluding to this aspect, they refer to the empirical study of Fama and French (2000) which was able to show a conversion to the mean of profitability across industries even experiencing abnormal rates of return before. Following the ambition to analyze the rational pricing, they apply the conversion to the mean to their respective revenues and growth rates to adjust for a still realistic future scenario. The example of decacorn Amazon allows the authors to empirically conclude the possibility of rational pricing for digital pioneers based on the groundwork of Miller and Modigliani (1961), Myers (1977), Kester (1984), and Trigeorgis (1991, 2002).

Conclusion

Clearly, the demystification of digital value creation and its quantification is of utmost importance for decision-makers in all industries who are required to succeed in a digital, networked economy of adoption, coopetition, and self-reinforcing dynamics.

Digitalization has rewritten the rules of value creation which are truly mastered only by a small number of companies, leading to a high concentration of capital, fueled by immense future growth. In an attempt to explain the value drivers, the core financial concepts of PVGO and real options have been introduced.

In the financial and strategic perspective taken by the capital markets, Kester (1984) refers to the value creation based on PVGO in a framework of three key characteristics. He claims that the value of the growth option is positively correlated to three main characteristics: (1) the exclusiveness, the proprietary of the option, (2) its flexibility regarding the time, scope, and reversibility of exercise, and (3) the compound effect of access to further future options.

In parallel, Arthur (1989) points out the three major strategic decision parameters to succeed in networked industries: (1) the ability to balance the level of competition and cooperation with other market players, summarized as the management of shared versus proprietary markets, (2) the importance of the optimal timing to enter, for example as a first mover, and (3) constant adoption which he states the growth of networks is based on, as markets are "self-reinforcing," building on their own dynamics.

Those similarities of findings across academic domains indicate that the virtue of digital value creation follows certain patterns which have been demystified in several fields of academic research already. As a conclusion, the innovation that fills the research gap can rather be interpreted in combining those theoretic approaches and substantiating those with a comprehensive empiric study as a next step in academic research valuable for business practice.

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Chapter 8
The Digital Magic of Value Creation: Digital Platforms in Networked Economics

Raphaela Balzer and Anna Vojtková

Abstract The nature of companies being celebrated as the value creators in the financial world has changed drastically over the last decade. Digital pioneers such as Amazon and Google—tomorrow's giants with abnormal profits—dominate global markets and set new digital standards. It is the aim of this chapter to reveal the motivation of the capital markets to pay premiums for those "unicorns" by alluding to their main success drivers: digital platforms and networks. Providing an overview of both fundamental drivers, a snapshot of strategies to leverage both is given rise to. Next, Arthur's (1989) bifurcated, digital world of platforms and networks to dominate global network markets is discussed. A critical view with regard to academic white spots as well as the limitations of growth rounds completes the chapter before offering a summarizing conclusion. This chapter is an adapted extraction of the source: Balzer, R. (2020a) *Value Creation in the Digital Era*. Dissertation thesis, Technical University of Košice, Košice.

Introduction

> Insight, imagination, and innovation are now the critical resources. This signals a time of exciting possibilities. The arrival of an exciting new game for those willing to invent the future.—(Chattel, 1998, p. 1)

The current hype and debate about the bubble of unicorns as the most valuable technology shares seems to have left solid value shares behind. Skyrocketing valuations signal from and to investors about having understood and now benefitting from the digital value propositions of famous "decacorns" such as Uber and Airbnb, valued at more than USD 10 billion, or "super-unicorn" Facebook, valued at USD 100 billion before its IPO (Initial Public Offering) (Carey, 2016).

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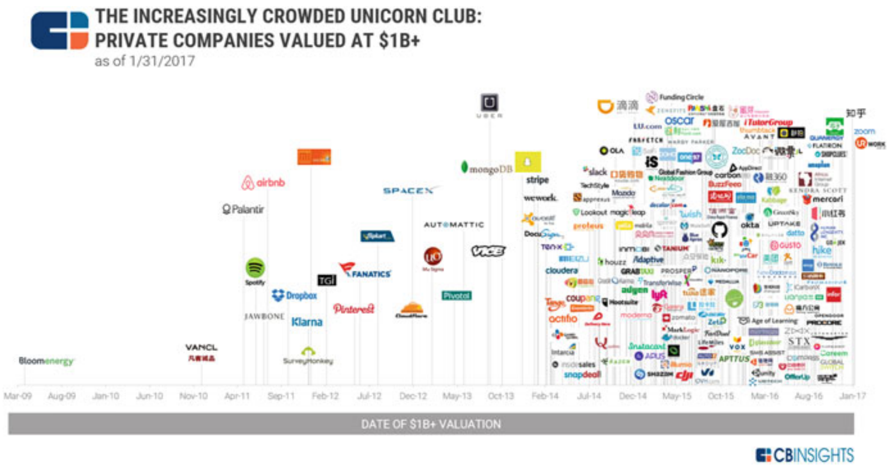

Fig. 8.1 The increasingly crowded unicorn club (CB Insights, 2017)

Even though the cradle of most unicorns is the Silicon Valley, Chinese investors push their most prestigious startups over the USD one billion valuation hurdle. In the last months shown in Fig. 8.1, the club of unicorns has become “crowded”.

These days, technology companies demand a valuation premium, however the global technology market moves basically in line with the general markets (Cogman & Lau, 2016). Notably, during the time of “cheap money” with excessive cash levels, hedge funds seek for high return opportunities. Nevertheless, late-stage investors like BlackRock and Fidelity have cut their pre-IPO valuations of unicorns (Greiff, 2016).

Historically, IPOs of unicorns have happened after more than seven years on average. Due to the extremely high valuations in the private investor markets, unicorns like Uber currently have little motivation to initiate the IPO process as the capital required is available and the probability of value destruction with plummeting share prices is a simple risk to be avoided (Erdogan et al., 2016). Investors such as Morgan Stanley have “corrected” their presumptions about the growth of unicorns, and investors have continued to interpret those valuations as a current bubble (Patterson, 2016).

In addition, private investors are said to show irrational behaviour as they fear missing out on investing opportunities. The fact of a large availability of global capital at low interest rates is another factor which drives the build-up of a financial bubble. Hence, the hypothesis of market efficiency can be challenged as market pricing seems to differ from fair valuations to a large extent. This leads back to the questions of how pricing and value are related and what the true sources of value for digital companies inhibit.

Clearly, private investors who are always interested in increasing valuations tend to enjoy special protection instruments to hedge their losses to dilution in case of

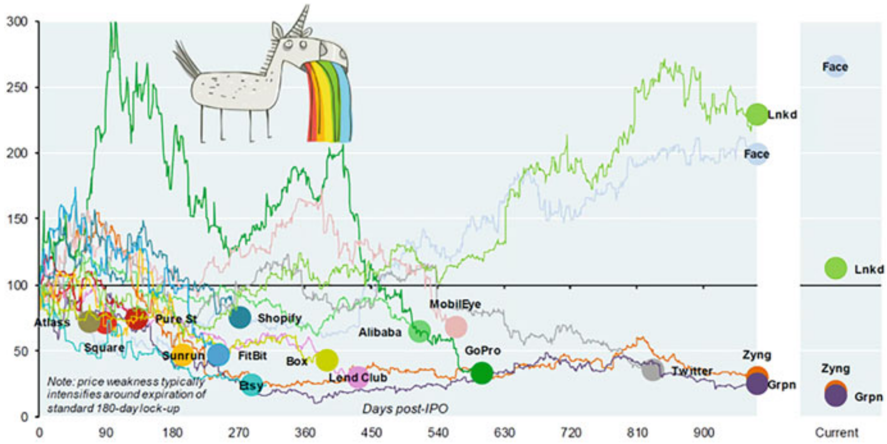

Fig. 8.2 Many unicorns find it hard to survive in the wilderness (Levine, 2016). See Miller (2020). Note: Index, closing price on IPO date = 100. "Current" shows most recent price index for company-suffering public for more than 980 days

bankruptcy (Cogman & Lau, 2016). Therefore, pre-IPO valuations of private financial investors cannot be transferred into the public IPO markets on simple one-to-one base (Milano et al., 2016).

Yet, public investors face the challenge to objectively value share prices when unicorns pursue their IPO. The reason for this issue is to be found in a high level of information asymmetry in the markets: Financial data is not published and only available to private investors. Thus, future cash flow projections, which are required to determine a mere intrinsic or fair value following the classic DCF (Discounted Cash Flow) valuation principles, become a real challenge. For public investors to participate in the unicorn hype, financial products such as the Prime Unicorn Index structured by Lagniappe Labs consist primarily of those unicorns that are privately held companies that have a determined valuation of USD one billion or greater. The fund also includes "Approaching Unicorns" with a valuation determined by Lagniappe between USD 500 million and USD 1 billion. Obviously, Lagniappe does not reveal how valuations of their portfolio unicorns are conducted in order not to reveal their own value proposition.

After going public, most unicorns have struggled to recover from ambitious IPO share prices and thus created less value than investors expected due to not delivering growth at highest profit levels in short time frames accordingly. Prominent examples are companies like Zynga and Groupon, as noted in Fig. 8.2 below, with plummeting share prices since their respective IPOs.

Besides all those facts, investors still find digital pioneers exceptionally attractive—from business angels to corporate venture capitalists. They consider the risk manageable. If they fail and turn out not to be "magical" unicorns, the investments can be hedged as they are usually minor portfolio elements in addition to value shares. Accordingly, they can gain high returns and failure is incorporated to a certain extent. This is what the corporate financial world refers to as a "call option" (Köhn, 2018).

All these facts indicate that the technology markets tend to be more efficient with a joint understanding of pre- and post-IPO valuations. With certainty, investors should continue to strive for a fundamental analysis of the source of their growth in order to avoid potential threats such as risky portfolio elements.

Unicorns can be primarily distinguished from value companies as they apply the digital dynamics of VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) to their advantage: Based on their organizational and operational flexibility, they consistently innovate new products and services, enter new markets, and embrace change with their agility. It is essential to comprehend how those characteristics translate into growth, value, and profitability.

The nature of successful digital business models relies on network effects [1] with players dominating market share to establish a standard platform (Chou & Shy, 1990, 1996; Buxmann, 2001; Von Engelhardt et al., 2017), such as those of digital pioneers like Facebook or Airbnb. While on the one hand, the cash flows generated from tangible assets for the digital pioneers are less relevant, on the other hand, the digital business models of fast pace and global scaling effects build the attractive value proposition for exponential top line growth rates. Thus, with valuations of digital pioneers at all-time high levels, the question may be raised of why share investors are willing to pay extensive premiums which can hardly be justified by traditional DCF valuations. A prominent example is the IPO of Facebook, valued at USD 104 billion (Gajic & Budinski-Petkovic, 2013), provoking the question: How can network dynamics be reflected into the classical valuation models? (Perren & Kozinets, 2018).

As the nature of companies being celebrated as the value creators in the financial world has changed drastically over the last decade, valuation in digitalized markets has to incorporate a variety of changing parameters such as digital networks, digital market dominance, digital disruption, and value co-creation (De Oliveira & Cortimiglia, 2017). However, independent of the era of digital disruption, corporate valuations have generally always been subject to the analyst. Especially valuations in "bubble" markets have to be challenged for their quality and credibility as investors are advised to question presented facts and figures, implicit assumptions, and hypotheses about future developments, for example growth rates.

In order to demystify the unparalleled success of the digital pioneers, the remainder of this chapter is organized as follows: First, the fundamental concepts of platforms and networks are reviewed and strategies and tactics to manage both successfully are presented. Second, Arthur's bifurcated digital world of platforms and networks to drive digital value creation based on the successful management of platforms and networks is discussed. By outlining the contrasts between industrial

[1] Network effects occur in industries such as banking, electricity, telecommunication, transportation, and health care (David, 1985; Katz & Shapiro 1985; David & Greenstein 1990; Arthur 1996).

and digital players in terms of value creation, the paradigm of growth is given rise to. In addition, the academic white spot of empiric evidence as well as the limitations of growth is illustrated in a critical way. Finally, a conclusion summarizes the findings.

The Digital Fundamentals: Networks and Platforms

The power and impact of networks has stimulated research across academic domains for the last decades. In economics, Heuser (2018), amongst many other researchers, points back to digitalization [2] and its effects back in the early 90s. Microsoft promoted its computer software Microsoft Office based on positive network externalities: The more the software Microsoft Office has been used, the more its value for users and developers increases, hence Microsoft Office has become a standard software. These days, the most prominent example of the digital decacorn Facebook benefits from network externalities like Microsoft a generation before: The decacorn obtains a monopolistic position in the global markets as its company value increases with its user base, which is at the core of social media. Malik (2015) identified the key success factors of algorithms, infrastructure, data, and network effects as the main reason for digital companies to thrive. All of those can be attributed rather to the age of digitalization than traditional industrialization. Apparently, the dynamics of networks effects plays a significant role for the business models of digital companies, hence a solid comprehension of those is obligatory.

German economists like Belleflamme et al. (2016) define a network as a group of users making the same usage decision. The network effects arise from the number and intensity of usage of the network. Brass et al. (2004) understand a network as a set of nodes representing a kind of relationship. The density of networks is based on the level of collaboration versus opportunistic intentions.

Other widely recognized scientists like Katz & Shapiro (1985) described the source of positive externalities as the "utility that a user derives from consumption of the good [which] increases with the number of other agents consuming the [same] good" (Katz & Shapiro, 1985, p. 424). In 1994, they referred to network effects as "the value of [a] membership to one user [which] is positively affected when another user joins and enlarges the network" (Katz & Shapiro, 1985, p. 94). Liebowitz and Margolis (1994) define network externalities as the value an agent extracts from a good when the number of agents consuming a similar good does change. The authors allude to the difference to the term of network externalities only if the participants fail to internalize those network effects.

Furthermore, major authors on the economics of network effects such as Arthur (1996), Katz and Shapiro (1985), and Farrell and Saloner (1986) agree that industries with network effects may experience the dominance of technological minor goods

[2] The terms digitalization and digitization are considered as synonyms in this chapter.

due to those networks effects. The initial study published by David (1985) refers to the example of the established standard of the QWERTY keyboard as opposed to the technological advanced solution of the Dvorak Simplified Board. He substantiates “strong technical interrelatedness, scale economies, and quasi-irreversibilities due to learning and habituation” (David, 1985, p. 336). The provoking thought of markets not following superior quality, but rather stochastic, random events, is of high interest and relevance to networked industries.

Literature draws a connection between the high benefits of applying stochastics to reflect uncertainty about the outcome. In the case of standardization based on network effects, the application of the Polya’s urn scheme (Artur et al., 1983) demonstrates how market dominance by standardization may evolve based on random historic events. Those network effects majorly contribute (David, 1985) to the conclusion of imperfect economic market mechanisms in networking industries, as the markets experience a lock-in due to the factors mentioned above.

In principle, strategists agree that the nature of digitalized industries changes the “rules of the game” as value is created in ecosystems and related networks. Digital platforms require new strategies to be taken whether they should be closed or shared. The distinction between competition and cooperation vanishes under the paradigm of shared value creation. And last, the prominent first mover advantage is subject to yet another debate under the light of game theory.

Numerous empiric models have attributed to that fact by emphasizing the importance of game theory when fighting, accommodating, and deterring entry of new players in a network market.

The probably most striking model to underline the contrary characteristics of the industrial world compared to the digital economic world is Arthur’s study discussed in the following chapter. Even though it has been published in 1989, it provides a “sneak preview” of the digital dynamics in a macro- and micro-economic fashion of increasing returns.

In parallel to the rise of networks, digital business models evolving around platforms are the prerequisite to utilizing the frequently cited network externalities.

When the first Silicon Valley Internet companies entered the market with digital platforms more than 20 years ago, it was not even possible to foresee the immense triumph of software platforms worldwide. US and, increasingly, Chinese technology companies have since then established Internet-based platforms for e-commerce, social media, online search, or the procurement of driving services and accommodation, thus winning millions of users.

Today, digital platforms play a crucial role in the digitalization of entire value chains. Classic supply-driven business models are transforming into platform-based business models (see Fig. 8.3). While the development in business-to-consumer (B2C) markets was faster due to low entry barriers for consumers (free registration and use), the first platforms in the business-to-business (B2B) sector have been established in recent years. After the transformation in the media and entertainment industry (Apple iTunes, YouTube, Spotify) and the retail trade (Amazon, eBay, Alibaba, Zalando), business processes are now also changing in other industries such as manufacturing (Industry 4.0), mobility (Mobility-as-a-Service), healthcare (Smart

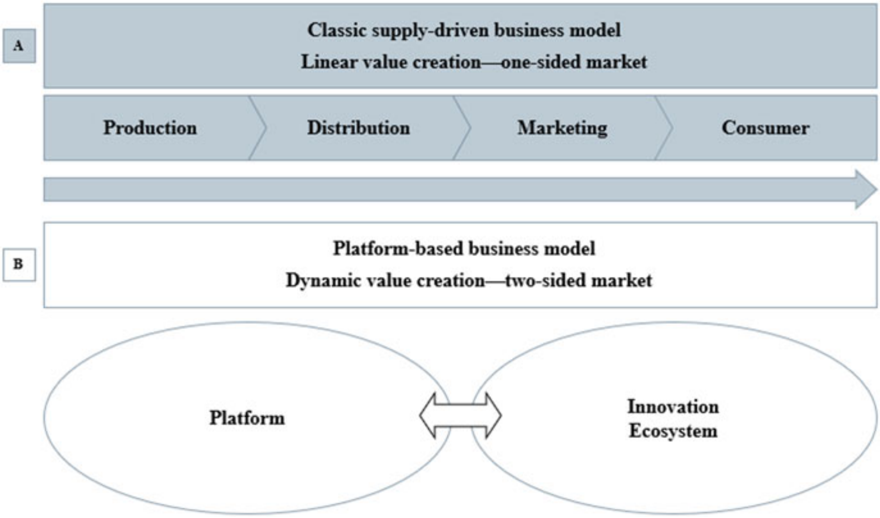

Fig. 8.3 From traditional supply-driven to platform-driven business models (Tiwana, 2014; Winter, 2017, p. 76)

Health), and construction (building automation, smart home). This has considerable effects on existing business models of established market participants, on value-added shares, and on the interface to the customer. Finally, examples such as Amazon, Booking, or Uber show that digital, cloud-based platforms shift between traditional providers of products and services (e.g., booksellers, hotels, taxi companies) and their customers. Supply and demand are bundled, commissions are generated, and access to immense customer data including individual preferences is gained, which in turn is used to individualize products and services. Platforms have a highly disruptive character, changing the balance of power in industries and markets and shifting value-added shares dramatically (Christensen et al., 2015).

One example of a quasi-monopoly in the digital platform market can be attributed to Alphabet with Google as its dominant search engine. Due to aggregated valuable databases, intelligent algorithms, and their global reach, digital platforms enable users to interact on a global scale. Sharing platforms also contribute to efficiency and sustainability by improving the utilization capacity of cars, apartments, and machines.

Generally, however, a network platform is defined as a subset of components (Katz & Shapiro, 1994) used in common across a suite of products (De Reuver et al., 2018). According to Van Alstyne et al. (2016), platform models are comprised of four players creating value as they transact with each other. The platform itself, for example the application software Android, is provided by the mobile devices. In the example of Galaxy smartphones, the company Samsung provides access to the Android platform base. The platform owner, in this example Google, controls the valuable IP (intellectual property) of the platform and executes the platform

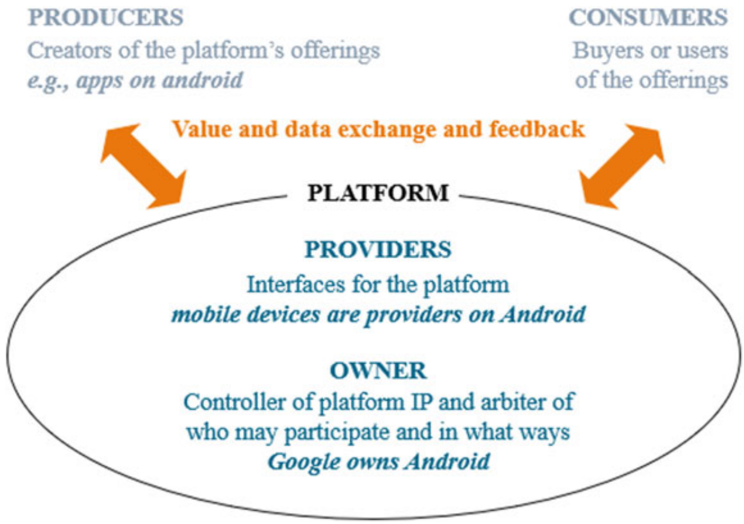

Fig. 8.4 Platforms in ecosystems (Van Alstyne et al., 2016)

governance by defining the rules about who and how the players have access to the platform. The producers, in the example the developers of application software (apps) on the Android platform, represent the supply side of the platform. On the other side, the consumers who buy the developed application software represent the demand side (see Fig. 8.4).

In addition, positive same-side network effects exist within each group: The more software applications are offered on the Android platform, the more convenient it is for developers to utilize and sell their own development application due to the popularity and standards set by the other developers. Consumers, while providing reviews and ratings, govern the quality of the applications and guide other consumers with their feedback to make the right buying decision. This is referred to as the positive feedback loop (Van Alstyne et al., 2016).

Strategic Decisions on Platforms with Network Effects

> The value of connecting to a network depends on the number of other people already connected to it.—(Shapiro & Varian, 1998, p. 174)

In contrast to the sequential value chain models in traditional industries, the platform model offers multi-dimensional sources of value creation: Producers and consumers, both sides, exchange value on a transaction base. The higher the amount of developed software applications, the more consumers are attracted to use the Android platform. The more consumers are attracted, the higher the incentive for the producers, for example the incentive for developers to market their developed software on the Android platform. The value for both increases with the size of the counter group on the platform which is defined as cross-side network effects (Eisenmann et al., 2007).

Already in 2007, Eisenmann et al. pointed out that value created in value chains moves from the left, the costs of the company, to the right, the revenue of the company. In two-sided networks, however, costs and revenues of the company flow from and to suppliers and customers (Eisenmann et al., 2007).

Instead of firms contributing to the schemes of sequential value-adding activities in digital industries, multiple stakeholders contribute and integrate services and products and thereby co-create value in a digital ecosystem (Koch & Windsperger, 2017). According to the definition of the authors, a digital ecosystem is comprised of an interlinked network with companies intending to create and sustain value by reinforcing network effects (Katz & Shapiro, 1994).

Furthermore, Koch & Windsperger (2017) interconnect digital dynamics to digital platform business models generating value. They use the term digitization, and they define this term as a process beyond the pure conversion of analogue information into digital, but additionally as the application of digital technology shaping infrastructures to create, store, and distribute content, applications, and services. As firms integrate software and hardware to a network, value creation is enabled through a digital platform. As they conclude, companies compete or coordinate their value creation activities based on their share of the platform.

Also, Belleflamme et al. (2016) refer to digital companies such as Airbnb. The company is acting as the intermediary of a two-sided platform, actively manages the quality of the network by increasing the matchmaking between both groups and therefore increases their value. As the function of a platform is "bringing together many users interacting with each other" (Belleflamme et al., 2016, p. 3), the effect of the increase of value for the users with its increased number of users is defined as a direct network effect, functioning within this group. Second, the indirect effects, also called cross-group network effects, can be observed if one user group only indirectly values the number of other users within their group. For example, the users of the platform Airbnb value a large offering based on the large number of suppliers, which are themselves attracted by the large number of consumers searching for rental apartments. As the platforms manages both groups, suppliers and users, it is a two-sided platform.

Platform owners manage to increase the number of interactions and associated network effects to accelerate value creation. Hagiu and Eisenmann (2007) explain the catch-22 issue of platform companies in a multistep strategy: At first, platforms like Amazon or Google were solely one-sided, focusing on value creation for one side. While Amazon attracted consumers, Google has initially focused on superior search algorithms. Only when positive feedback within both consumer groups had allowed for a large installed base, the other side was added in a second step. In the case of Amazon, those were third-party suppliers, while Google could leverage its attractive value proposition to the advertising industry only after reporting a significant market share of search engines.

The platform owner actively manages the groups to provide access to the groups by incentivizing some groups, such as successful application developers, and excluding others. The unit of measure is the value the producer provides to the platform: Applications perceived as valuable to the consumers need to be incentivized to remain on the platform instead of creating their own platform. For the producers with fewer transactions, the platform owner evaluates the positive niche value or negative noise which the player contributes to the platform (Van Alstyne et al., 2016).

Moreover, the owner governs the scope of activities provided on a platform. Activities which hinder or create negative feedback on transactions are managed to be diminished while activities enticing positive feedback and network effects are incentivized. A successful governance is at the core of all platform strategies, as its successful matchmaking translates into the value that the platform is able to create for all participants.

Evans and Schmalensee (2016a, 2016b) introduce the complexity of managing different user groups of the platform. While Google is categorized as a search engine and Facebook belongs to social media, both are direct rivals in terms of their sources of revenue: the online marketing and advertisement industry. From a different perspective, shifting ecosystems from PC to mobile-app service has introduced even another layer of complexity that digital companies need to compete with.

Still, the complexity of pricing of producer and consumer groups is puzzling: While the consumers of the social media network Facebook or the users of the software Adobe are not charged, the cross-group subsidizes the business model: In the case of Facebook, the advertisement industry subsidizes the social media users. In the example of the Adobe software, the publishers who pay to utilize the PDF format, subsidize all other PDF users. Those observations indicate the high level of interconnectivity in the value-creating ecosystem which are evolving from a more complex value creation network.

Compatibility and Adoption

> A good is often more valuable to any user, the more others use compatible goods. (Farrell & Saloner, 1986, p. 940)

In the scenario of incompatibility, the respective benefits are product-specific. In the scenario of compatibility, benefits are generated across networks, hence both networks coexist. Consequently, compatibility is a benefit to the consumer if he adopts by doing what others do. Eisenmann et al. (2011) have analysed by applying game theoretic models how duopolies in those markets evolve: On a micro-economic level, each player makes the key strategic decision whether to share their network and make it compatible or not.

Also, Farrell and Saloner (1986) incorporate the characteristics of user adoption as their point of departure: In their model, they incorporate those effects as they describe the scenarios of "excess inertia" and "excess momentum". In the first one, early adopters are reluctant to switch to a superior network as they are locked in the other network already and would run the risk of "betting on the wrong horse" and be stranded with the new technology. Consequently, they do not adopt, or adopt too late. Another inefficiency causing new equilibria is the penguin effect: A user prefers the other user to adopt the new network first—like penguins who wait until their fellows enter the water due to the fear of predators. In the "excess momentum" scenario, early adopters inefficiently adopt a technology too eagerly before the new network is established. In their analysis, the authors demonstrate how incumbents of the old network can effectively deter entry from new competitors by using product pre-announcements and aggressive price cuts. Building on this hypothesis, Belleflamme et al. (2016) conclude that the users of digital platforms behave non-rationally and thus are highly influenceable.

In the scenario of incompatibility, users must decide on only one network and they will do so based on their expectations about the survival of the superior network. One famously cited example alludes to the standard war of VHS and Betamax: Users expected one technology to "win" the standards war and VHS established as the new standard, a phenomenon commonly referred to as the "self-fulfilling prophecy". If only one platform survives as all users converge, the company dominates the market as "the winner takes it all".

Co-Opetition

Literature has widely applied the dynamics of two companies battling for a market to the concept of game theory: Analogue to the famous prisoners' dilemma, the payoffs of both competitors combined in platform markets are greater than the payoff of a monopolist. As Liebowitz and Margolis (1994) allude, overall market size with the coexistence of a duopoly is bigger than in the monopolistic situation. Thus, the level of coordination of competitors, also referred to as co-opetition (Nalebuff & Brandenburger, 1997), is crucial to the individual and the overall market value creation potential.

Farrel and Besen (1994) couple the technology market dynamics targeting standardization to game theory tactics in a very illustrative way. They identify a set of strategies to win standardization wars set in three different categories, depending on their individual payoffs: (1) Inter-technology competition: Both companies battle to win the industry standard for the market. (2) Intra-technology competition: Both companies agree to have only one standard in the industry, but they prefer their own standard succeeding in the market. (3) One company imitates the other company's standard.

If companies behave in similar ways, they choose the compatibility strategy: By offering compatible products, industry standards evolve rather quickly. If both companies want to establish their own industry standard, they will fight for consumers (1) to join their network—which Farrell and Besen (1994) refer to as inter-technology competition. If companies set propriety standards, they will battle for a standard (2), the intra-technology competition. In case of asymmetric companies (3), fighting tactics are more likely to emerge as the entering company follows the existing standard while the incumbent company deters from entry.

The authors distinguish the difference between network effects and “tipping” in networked industries as the network effects are determined by the consumer expectations on the prevailing dominating standard while the tipping relates to the consequence of high growth sales of the dominant company: A major part of value created in the market can be extracted by the “winner” (Farrell & Besen, 1994).

Also, platform providers have to define their strategy to extract value from the platform. They are confronted with the identical strategic choice to decide whether to join the platform owner or to fight the player by establishing a rival platform (Eisenmann et al., 2011) and thereby becoming a platform owner themselves. One famous example is the company Apple which initiated the battle by establishing the iOS platform.

Time to Move First

With the increased prominence of platform business models, literature has continuously exchanged pro- and counterarguments regarding whether there is a first mover advantage. While authors like Hagiu and Rothmann (2016) argue for the unicorns to have built their networked success on not being the first mover, Heuser (2018) and Economides (1996) have a different point of view: Only the first ones are able to enjoy the network effects with abnormal profits.

From the angle of strategic pricing, Katz and Shapiro (1994) emphasize the fact that companies which strive for market leadership do not (yet) enjoy supernormal profits as they seek to invest in winning the markets first. In 1994, the authors explained the success of today’s digital pioneers by a two-step system, consisting of getting consumers locked in a technology first, and then building on the excess inertia by pricing as a quasi-monopolist. Also, Arthur (1996) confirms that at first, profits are not in the focus to build networks as the user platform has to be built to convince with an immense value—at least three times compared to alternative—for its users. Later, profitability kicks in with the network effect based on generating value for all players of the ecosystem.

Eisenmann et al. (2007) differentiate the short-term margin potential of platforms from their long-term potential: By sacrificing short-term potential and making high investments in R&D (research and development) and marketing, a solid long-term user base can be built. Proprietary platform providers bear all related costs and risks while sharing a platform allows for a split of investments and risks. Yet in the long term, Eisenmann et al. (2007) argue that margins of proprietary platforms and winning WTA battles reap higher returns. They categorize the digital platform as the digital business model: In their example, creating a competitive advantage through a proprietary platform is the key enabler for a company to monetize its investment options.

Whether the concept of competitive advantage (Porter, 1985) still holds is argued in different ways in literature: While economists have analysed the perishability of competitive advantage in the digital era (Fama & French, 2000), the time horizons of competitive advantage have changed drastically (Koch & Windsperger, 2017). As Van Alstyne et al. (2016) exemplify in their article, with the introduction of the iPhone, Apple took over 90% of the market share for smartphones in 2007 after only one year.

Moving first in terms of rapidly growing too much is not necessarily an advantage: If companies focus on growth instead of creating value for suppliers and sellers, they are at risk. For example, Groupon proceeded with their IPO market capitalization of USD 18 billion in 2011 while manoeuvring around USD 2 billion in 2018. Rumours are that Groupon is looking to be acquired. The value Groupon can provide to the local advertising industry is much smaller than the value provided by Google and Amazon, so there is little added value in the digital platform based on coupons and discounts.

Winning in the Digital World of Networked Economics

In 1989, Arthur contrasted the "Marshall" world of economics of industrialized markets with constant or diminishing returns to the digital one with increasing returns. While he claimed the mantra of industrialized markets to evolve around optimization to maintain profitability, the paradigm of fast adoption and networks represents the digital world of increasing returns.

In concrete terms, Arthur (1989) claims that modern, complex technologies inhibit increasing returns which arise naturally as consumers choose between technologies competing for adoption. By contrasting his analysis of increasing returns to the regimes of diminishing and constant returns, Arthur explains to what extent those regimes differ in the so-called properties of predictability, flexibility, ergodicity, and efficiency (see Table 8.1).

According to his model, predictability is in fact lost as consumers may be able to predict that a technology will dominate the market. However, irrespective of neoclassic supply and demand analysis they might have available, they are not able to predict ex ante which technology will dominate. Arthur points to the model of probabilities as famously applied in the real-option models: With a 50/50 market

Table 8.1 Properties of the three regimes (According to Arthur, 1989, p. 121)

	Predictable	Flexible	Ergodic	Necessarily path-efficient
Constant returns	Yes	No	Yes	Yes
Diminishing returns	Yes	Yes	Yes	Yes
Increasing returns	No	No	No	No

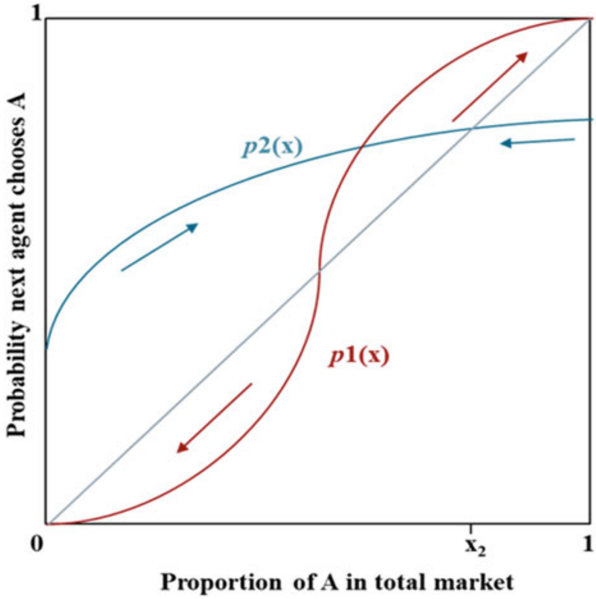

Fig. 8.5 Two illustrative adoption functions (Arthur, 1989, p. 124)

split, probabilities lead to a calculated average value. In practice, the dominance of one technology, however, will lead to an "all or nothing" approach. The calculated average value will have a significant error.

The root cause for the dominance of one technology is based on the principle of randomness: Historic, small events determine the outcome of the winning technology, which is not necessarily the superior or more innovative technology. Arthur refers to this matter as "path-inefficient" or "nonergodic".

In addition, Arthur elaborates on the inflexibility of markets with increasing returns. Due to "tipping", demand-sided network externalities drive the market participants into being "locked-in" with a technology, even if it is not superior. Hence, as the innovation of the technology is not as critical as it is in markets with diminishing or constant returns, the quality of the technology in modern, complex markets may be treated as a trade-off to the first mover advantage (Arthur, 1996; Shapiro & Varian, 1998) to be able to dominate the market as the pioneer.

Due to those elucidated properties, Arthur's framework refers to the evolvement of market shares in technology industries based on the number of adopters in the market and the historic random events, which he illustrates in two adoption functions (see Fig. 8.5).

In both examples of adoption, Arthur combines the relative market share of technology A to the probability of the sequentially following consumer to choose the technology A. In p1(x), the probability of adopting to either technology A or B converges to 1: It is certain that one technology will win. Either A will take over the market with 100% market share or loose with 0% market share. The company of the winning technology "corners" its competitor while locking in its consumers. In function p2(x), the process of adoption in the long run converges to a fixed point with a specific market share of x_2 at a probability of p_2. Arthur explains the convergence to this point as the phenomenon of technology advantage being required in order to be "self-reinforcing".

Overall, Arthur reinforces his conceptual idea by outlining the implications of industries with competing technologies: The observation of increasing returns in those markets can be attributed to an industry being locked by a technology which does not have to be superior in terms of innovation or quality. Once locked-in, the industry is rather inflexible and challenging to predict; due to historic random events, markets become unpredictable. David (1985) formulates the lock-in phenomenon as the "quasi-irreversibility of investments" which clearly is valid for asset-intense markets such as infrastructure. Yet, in digital market environments, the extent of irreversibility is debated in literature by recognized economists such as Evans and Schmalensee (2016a, 2016b).

In the light of the new level of complexity stemming from digitalization, the nature of multiple equilibria and market imperfections with a clear concentration of oligopolies and monopolies allows to challenge the theorem of market efficiencies in networked industries. Dynamics such as high levels of R&D investments driving innovation and a high probability of tipping redefine the game rules in today's digital global market as alluded to by Katz and Shapiro already in 1994.

Transaction-based platforms for buyers and sellers are a highly profitable business model (Hagiu & Rothmann, 2016): Due to the discussed network effects, scaling on demand and supply side, low operating costs, and limited assets, digital companies like Airbnb, eBay, Uber, or Amazon succeed in platform models (Hagiu & Wright, 2015). Those companies master the "art" of managing digital platforms with profit levels of 60% and more.

The Shortfall of Empiric Evidence

Evans and Schmalensee (2016a, 2016b) criticize the "winner takes it all" and network approach in the digital age as more reversible than in earlier waves of industrialization. While, for example, network effects based on assets such as rail infrastructure require immense upfront investments, digital network advantages rely on immaterial values which are vulnerable to be destroyed. Again, the example of Facebook losing the trust of its users due to flaws in data protection threatens the business model and therefore its shareholder value in a drastic way. Today, dominating players like Facebook and Airbnb face challenges in governmental, regulatory issues: Both impact market valuations significantly, as share prices plummet in terms of Facebook selling data of its users without approval in 2018 and Airbnb being banned from the European metropolis Amsterdam due to harming residential real estate markets, tied to social welfare.

Further criticism is raised by Liebowitz and Margolis (1994) who represent a different point of view in literature by drastically challenging the theory of network externalities presented by Arthur (1989, 1996), Katz and Shapiro (1985, 1994), and Farrell and Saloner (1986). The authors demonstrate the limitations of network externalities into business practice by questioning the most famous examples such as the QWERTY keyboard case introduced by David (1985). Liebowitz and Margolis (1994) consider the network effects as solely pecuniary, thereby lacking empiric evidence. They conclude: “After we economists have had our fun, thinking about network effects and considering how social interactions have a similarity to networks, we need to acknowledge that the a priori case for network externalities is treacherous and the empirical case is yet to be presented” (Liebowitz & Margolis, 1994, p. 150).

Including Katz and Shapiro (1994), who have shaped today’s literature view on networked economics, the major listed scientists refer to the required next step in the field of research: The substantiating value of the empiric studies based on the developed models. In the light of digitalized economies, the question of empiric proof is a pressing subject looking for answers beyond the pure fields of theoretic academics.

In the last decades, further mathematical refinements to quantitative modelling in platform economics have been proceeded in academics while the basic concepts of platform concepts have gained a higher level of attention with the rise of the digital companies. Interestingly, the same authors elaborating the platform models stemming from Stanford, MIT, and other top tier technological academic institutions have published in the popular economics literature like Harvard Business Review which is appreciated by senior managers. It is noted that the concepts explained in the 1990s are less contributing to new findings but rather reformulating prevailing academic literature into strategy advise. In other words: The literature of networks and platform economics has benefitted from the digital economy by a possibly vastly exponential increase in interest of management practitioners. Instead of developing those concepts further, academics reinforce their concepts from the past decades and seem to tiptoe around digitalization to finally find empiric evidence for the respective phenomenon.

The Limitations of Growth

Due to the striving impact of network effects on the value creation potential of digital platform business models, it is essential to investigate the growth patterns of those network effects. Scientists like Tongia and Wilson III (2011) from various domains such as biology, physics, sociology, and economics have studied the characteristics and unfolding of networks in the last decade. Due to the limited scope of this chapter, only a selection of growth patterns is presented here.

First, the common pattern of linear growth originates based on Sarnoff. As Sarnoff’s Law postulates that the value of a network grows linearly in its size, there is no net gain in value from combining two networks. As an example, Sarnoff named the broadcasting networks. The linear growth function n can be interpreted as the starting point of network valuation whereas scientists of other growth theorems contradict the validity of Sarnoff's Law for the digital economy (Odlyzko & Tilly, 2005).

A second growth pattern is attributed to exponential growth. The often-cited simplified function n2 of Metcalfe's Law states that the value of a network for the user is almost exponential to every user added. Hence, growth is asymptotic and even close to be exponential. Robert Metcalfe's theorem served for the all-time high financial valuations of the telecom industry, such as for AT&T to explain extraordinary company valuations during the dotcom bubble in the 2000s. Even though Metcalfe refers to the critical mass to be achieved rather than the network externalities, his law is still the most prominent to elaborate the growth of networks. The theory of exact exponential growth is associated with Reed's Law (Odlyzko & Tilly, 2005).

Third, the pattern in form of a S-shape is relevant to describe economic growth. Naturally, literature across social and natural science domains has vastly criticized Metcalfe's Law, as the value growth for networks can be better described as the logistic S-shaped function n*log (n) (Odlyzko & Tilly, 2005; Briscoe et al., 2006). According to the authors of network economics, the rate of growth of the consumer and producer groups' willingness-to-pay related to the network size decreases at later stages due to several reasons: First, there might be budget constraints. Second, the group of late adopters execute fewer transactions and add less value to the platform system. In addition, the potential of value added that a new consumer or producer contributes to the network is reduced. Consequently, growth allocated to network effects is limited (Balzer, 2020a, 2020b).

Briscoe et al. (2006) build their thesis around the differing value of "nods" or "users" to other users. While Metcalfe assumed the value to be equal for all, Barabási and Albert (1999) analyse the variation of individual value in networks as follows: Complex networks, such as business networks, expand based on the addition of new vertices, with the new ones preferring to attach to those already well connected. Network models should incorporate growth and preferential attachment following the logic of this so-called Power Law.

Hence, there are limitations of growth even in the digital e-commerce world of excessive scaling. As Buckup (2018) from the World Economic Forum claims that companies may develop "superpowers", they are more vulnerable to fail as they experience the "Godzilla" problem: The availability of resources becomes the limiting factor of growth, and in the case of the superstar companies, they require high investments in human talents. In his analogy to the science of biology, Buckup (2018) illustrates how organisms split their energy between growth and maintenance in order to sustain.

Adding to the limitations of growth, Arthur in Tetzeli (2016) calibrates the impact of network effects attributed to the digital pioneers in an interview: "The power of increasing returns is not infinite, however. The experience of Airbnb and Uber illustrates some of the limits. Both companies have exploited markets with increasing returns. The more apartments go up on Airbnb, the more customers the service attracts. The more customers it attracts, the more owners want to list their homes. The more drivers who sign up with Uber, the faster Uber can get to a customer. The faster Uber gets to a customer, the more customers want to sign up. The more customers sign up, the more attractive Uber becomes to drivers. But that cycle doesn't go on forever. It kind of plateaus out. Once you get a certain density of drivers, if you double the density it's not going to make that much difference when I call for an Uber. The same could be said of Airbnb, which says it has over 2 million listings; 4 million wouldn't make the service twice as good" (Tetzeli, 2016)

Conclusion

In summary, the foregoing chapter has achieved the objective to establish a terminology of networks and platforms, including a presentation of its strategic principles to successfully manage both in order to create value. Cornerstones of strategic decisions have been outlined with regard to adoption, co-opetition, and first-moving tactics. From the aspect of academic literature, an overview has been provided, followed by a focus on the networked industries by Arthur (1989). In addition, arguments of critique have been demonstrated, thereby focusing on the shortfall of empiric evidence as well as the limitations of digital growth patterns. Nevertheless, the chapter illustrates the key strategic ingredients of value creation and growth in a digital world from a multifaceted perspective.

In general, there is a set of far-reaching implications which can be concluded from the presented analysis.

Arthur's complexity economics of standardized markets, adaptation, and increasing returns can be associated with the unparalleled growth patterns of the digital players like Alphabet and Amazon. Those companies represent a club of digitally dominating "decacorns" while the majority of digital companies has experienced a challenge to sustain growth and value in the capital markets.

Furthermore, this aspect alludes to the concentration of companies in served markets. Whenever standardization leading to a quasi-monopolistic market setting, as established by Microsoft in the 1990s, occurs, market dominance of only a few competitors unfolds. In the future, market structures will continue to change drastically from a perfect competitional setting to a quasi-monopolistic one, because of globally scaling platform models in network industries.

The topicality continues to be of great interest for academia and practitioners alike as the demystification of digital dominance has merely started. Without a doubt, the value contribution of digital technologies will persistently reshape markets and force a technology and data-driven mindset, especially in the most traditional industries. For global conglomerates, the era of digitalization comprises a new level of complexity of digital and tangible assets, as well as a new paradigm of value creation expressed in a substitution of value streams rather than an additional increase.

In the past decade, classic industrial companies have extended their value chain offering from a product- to a service-oriented portfolio and levered their existing IT acquired knowledge to digitalize existing business models. Today, technology companies have the means to build a business model that is based on digital platforms from scratch and to increase their vertical industry knowledge by acquiring domain-specific knowledge or hardware. While traditional corporates frame their digital ventures as a level of innovation, they consider companies like Alphabet as co-opetition: On the one hand, they offer value-driving platforms, on the other hand, their dominance of digital competence imposes a clear threat. Easily, the digital pioneers could apply their core IT competences to acquire domain expertise from industrial corporates and combine all ingredients to create sustained value on a new level.

A key insight for investors is the urgency of diversification, as the VUCA environment, coupled with the digital pace in complexity economics, does hardly allow to predict economic success based on pure KPI analysis. Even though the notion of digital value creation rather enriches than substitutes the industrialized economic paradigm, a thorough understanding of the emerging phenomenon of digitalization is of utmost importance for all those who focus on value creation and its growth.

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Chapter 9
The Value of Digital Dominance: Why the Silicon Valley Outperforms Industrial Giants

Raphaela Balzer and Anna Vojtková

Abstract Digital pioneers dominate today's race for unlimited access to global capital. They set the stage of global markets in the digital world. In this chapter, the study aims to validate the hypothesis that digital native companies of the S&P 500 have created substantially more value of equity than their industrial peers in the past decade. The analysis is based on the simplistic Present Value of Growth Opportunities (PVGO) concept of splitting value into the present value of existing assets and future growth opportunities. First, digital tech giants like Alphabet, Amazon, Facebook, Apple, and Microsoft are compared to classic industrial companies, all equipped with a top-ranked Market Value of Equity (MVE). Second, a cluster analysis of the top 20 MVE companies of the S&P 500 offers further insights while provoking further academic research. Based on the PVGO concept, the empiric study transfers the academic insights of the real options concept into the age of digitalization. A blend of expected as well as surprising results strives to demystify the paradigm of value creation of equity in the global arena of digitalized economics. This chapter is an adapted and extended extraction of the source: Balzer, R. (2020a) *Value Creation in the Digital Era*. Dissertation thesis, Technical University of Košice, Košice.

Introduction

In his rudimentary concept, Myers (1977) differentiates the value of assets-in-place (Present Value of Existing Assets, PVEA) as tangible, while the Present Value of Growth Opportunities (PVGO) is intangible. This differentiation can be extended to a wider perspective. On the one hand, industrialized companies have a variety of tangible assets in their balance sheets while, on the other hand, digital companies are

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built on intangibles such as human capital and software patents (Vogelsang, 2010; Schneider, 2014; Jona-Lasinio & Meliciani, 2018; Schneider, 2018), yet the split of existing and future cash assets still applies (Vogelsang, 2010).

The concept of the split is also explained by Pindyck (1988) as he compares growth options to adding additional capacity in a manufacturing environment, years before the impact of digitalization [1]. Yet, Kester's (1984) snapshot of empiric analysis alludes to the split without an adequate empiric data set of hypothesis validation.

The most significant contrast of the split in fundamental economics results in a bifurcated world of fundamental economics (Arthur, 1996). In his studies, Arthur (1996) has laid the foundation for a new dimension called "complexity economics" to outline the source of value creation in an illustrative way. He describes industrial, production-related companies based on tangible assets of production as linear and fragmented in global markets. By contrast, digitalized markets bear the characteristics of an intangible, fast-paced market with players who dominate based on globally scalable platform models (Schneider, 2014, 2018; Banalieva & Dhanaraj, 2019).

With regard to the limitations of growth, however, Arthur (2014) does not elaborate on the level of saturation and does not allude to the limitation of growth overall. Stoica et al. (2012) further support the concept of winner-taking-it-all markets, increasing returns, and lock-in markets in the age of digitalization. During the dotcom hype, a famous analysis of Schwartz and Moon (2000, 2001) revealed the implication of unlimited growth on valuations. The authors have chosen Amazon as a case study to demonstrate the impact of globally scalable platforms. Unparalleled growth patterns lead to sky-rocketing valuations which foster the school of thought to declare digital companies subject of a digital hype.

Overall, it can be stated that the topicality of growth is of major interest in the digital age and certainly deserves more detailed academic attention.

Therefore, it is the intention of this chapter to explore the relevance, function, and development of value creation of digital native and classic industrial companies with the application of the PVGO model in a straightforward fashion.

From the perspective of the empiric analysis, the aim is to identify the validity of hypothesis that the digital companies have created more value than their industrial peers. Furthermore, it is the ambition to explore if industrial companies exhibit a positive PVEA and a negative PVGO, as they offer value to their shareholders in the form of cash dividends and high earnings while facing challenges to sustain those in the future of the digital era. By contrast, digital players with negative earnings in form of PVEA and a promising outlook, leading to a higher PVGO, are expected to arise. Last but not least, the cluster analysis envisions to identify specific companies which exhibit "superpowers" in terms of increasing profitability and extraordinary growth opportunities.

The remainder of this chapter proceeds as follows: Section "Method and Data" explains the methodology and the data selection of the empiric analysis following

[1] The terms digitalization and digitization are considered as synonyms in this chapter.

thereafter. Section “Graphical Analysis” focuses on the results of the graphical analysis. Section “Cluster Analysis” presents results of the cluster analysis. The last subchapter relegates to the limitations of the analysis based on its scope and offers a summarizing conclusion.

Method and Data

The empirical analysis presented in this chapter is based on the PVGO concept explained in Brealey et al. (2010) and consists of two steps.

In a first step, the developments of the top ten outperforming companies are grouped into two subsets of digital natives and classic industrials. The comparison of both groups allows to explore differences on an intra- and intergroup level. Furthermore, considering the limitations of the presented empirical analysis and the need for further and more comprehensive empirical research, an interpretation is also offered here on whether PVGO could serve as a useful indicator to predict PVEA.

In a second step, the tool of pattern detection by bottom-up clustering serves to identify groups of the top performing value creating companies based on standard k-means algorithms, computed in the open-source machine learning software R and R-studio. In order to allow for a solid quality of the digitalized clustering, the scope of companies is extended to the most valuable 20 companies of the S&P 500. Note that only the results of the scatter plots from cluster analysis are depicted. A more detailed discussion on the results of the clustering in 2017 is presented in Balzer (2020a, 2020b).

The raw data set used for the empirical analysis presented in this chapter originates from Thomson Reuters Datastream. In order to ensure the consistency and comparability of the data, the analysis of the time series focuses on the years from 2007 onwards. In total, 497 companies of the S&P 500 were available to be selected for both steps of the following empirical analysis.

In the first step of the graphical analysis, there are two groups of the top ten most valuable companies which have been identified as extraordinary performers in terms of MVE and PVGO. On the one side, the digital native companies (or “digital natives”) are represented by Alphabet, Amazon, Apple, Facebook, and Microsoft. On the other side, top performers of the S&P 500 in 2017 (the group of the other multinational corporates or “classic industrials”) are Berkshire Hathaway, Exxon Mobil, Johnson & Johnson, JP Morgan Chase, and Procter & Gamble.

In the cluster analysis, the scope of companies is extended to the most valuable 20 companies of the S&P 500. This number of observations allows for a solid quality of the digitalized clustering, while sustaining a feasible graphical interpretation in the scatter plot charts. These are in alphabetical sequence: AIG, Alphabet A and C series, Amazon, Apple, AT&T, Bank of America, Berkshire Hathaway, Chevron, Citigroup, Exxon Mobil, General Electric, IBM, Intel, Johnson & Johnson, JP Morgan Chase, Microsoft, Pfizer, Procter & Gamble, and Walmart.

In order to analyse the value a company has generated and is expected to generate, the following Key Performance Indicators (KPI) expressing the definition of value in multiple forms were considered: Market Value of Equity (MVE, in USD million), Value per Share (SPRICE, in USD), Present Value of Existing Assets per Share (PVEA, in USD), Present Value of Growth Opportunities (PVGO, in USD), PVEA in relative terms (PVEA_REL, in %), PVGO in relative terms (PVGO_REL, in %), PVEA in terms of total equity (PVEA_TOTAL, in USD million), and PVGO in terms of total equity (PVGO_TOTAL, in USD million). According to Brealey et al. (2010) and Balzer (2020a, 2020b), the following applies:

$$\mathrm{SPRICE} = \mathrm{PVEA} + \mathrm{PVGO}$$

$$\mathrm{MVE} = \mathrm{PVEA\_TOTAL} + \mathrm{PVGO\_TOTAL}$$

$$\mathrm{PVEA\_REL} = \frac{\mathrm{PVEA}}{\mathrm{SPRICE}} = \frac{\mathrm{PVEA\_TOTAL}}{\mathrm{MVE}}$$

$$\mathrm{PVGO\_REL} = \frac{\mathrm{PVGO}}{\mathrm{SPRICE}} = \frac{\mathrm{PVGO\_TOTAL}}{\mathrm{MVE}}$$

Subsequently, the graphical analysis intends to retrace the concentration of profitability and value based on the PVGO concept, structured in form of the top-ranked companies of S&P 500 from July 20th, 2017, for each of the eight KPI variables.

The illustrations of the ten selected companies are depicted regarding their development of Share Price (SPRICE) and respective split in Present Value of Existing Assets (PVEA) versus Growth Opportunities (PVGO). As the share price is a result of the issued number of shares, the graphical analysis is extended by the overall view of the development of Market Value of Equity (MVE) and its corresponding split of PVEA_TOTAL and PVGO_TOTAL. In the presentation of the results, the focus of the KPIs is set on MVE, PVEA_TOTAL, and PVGO_TOTAL as the number of shares and stock splits could blur the direct comparison of value creation on a per share base, reflected in the KPI variables SPRICE, PVEA, and PVGO.

Consequently, the second step of the cluster analysis thereby focuses on the selection of the variables PVGO_TOTAL and PVEA_TOTAL of the top 20 most valuable companies for the years 2007, 2012, and 2017.

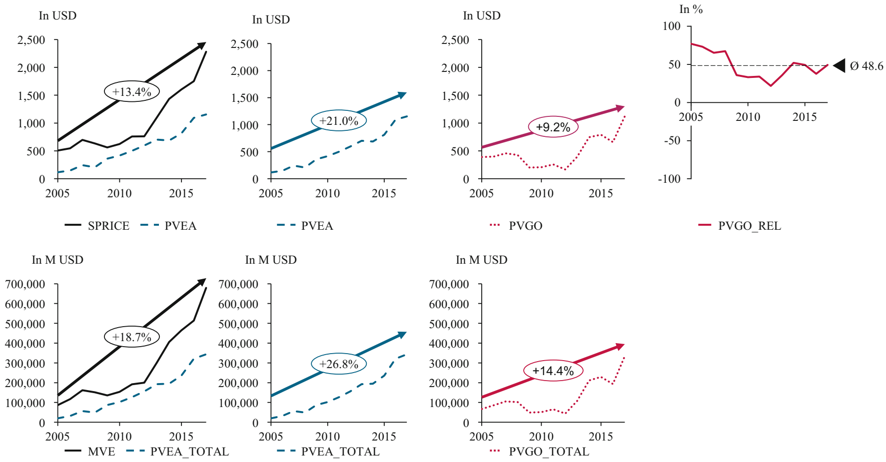

Fig. 9.1 Alphabet: top PVGO at levels of >50% and high PVEA (own representation)

Graphical Analysis

The Digital Natives

The analysed variables are taken from Google's Initial Public Offering (IPO) in 2005, hence the time horizon is shortened by three years compared to the other companies. For Alphabet, the PVEA and PVGO values indicate the same trends, whether they are observed on a per share base or for the whole company. While all variables are always positive (>0) and have double-digit Compounded Annual Growth Rates (CAGR), it can be stated that the high ratio of a PVGO_REL in 2005 was >75%, while in 2017, the PVGO_REL corresponded to ~50%. In the case of Alphabet, a strong growth of realized profitability is the baseline for the investors to continue assessing further growth opportunities, while over time, the PVGO grows slower than PVEA. Clearly, Alphabet's value is mainly driven from investors' future expectations based on its PVGO (see Fig. 9.1).

Taking the last 15 years as a time horizon of Amazon, all variables indicate a strong, exponential growth which is basically attributed to its PVGO value (see Fig. 9.2). Investors obviously categorize the financial realization of Amazon as yet to come and are willing to pay a significant premium with a PVGO_REL between 68% and 130%, with the highest average PVGO of 88%. In 2002 and 2014, the cash flow from existing assets was negative, hence investors valued the share and the negative PVEA, therefore the percentage of PVGO_REL was even greater than 100%.

The variables on a per share and per company base indicate a similar growth pattern as Amazon's stock splits were executed shortly after their IPO in 1997 and before the observed time horizon of 2002.

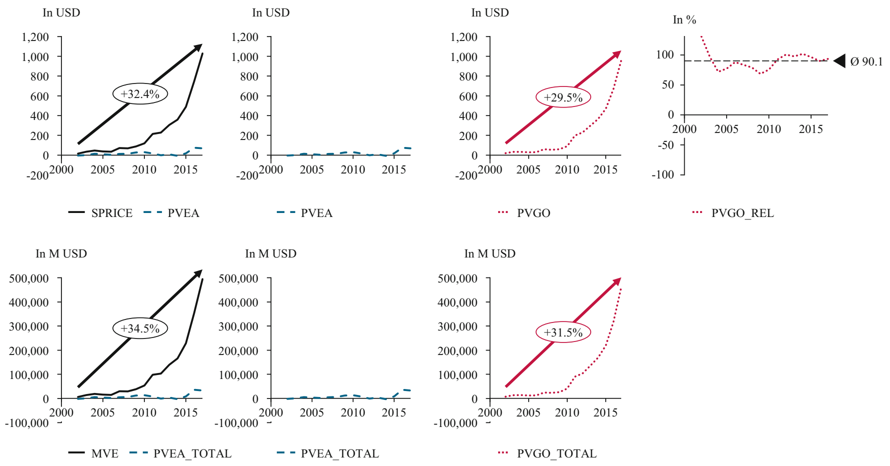

Fig. 9.2 Amazon: the golden future, top PVGO, low PVEA (own representation)

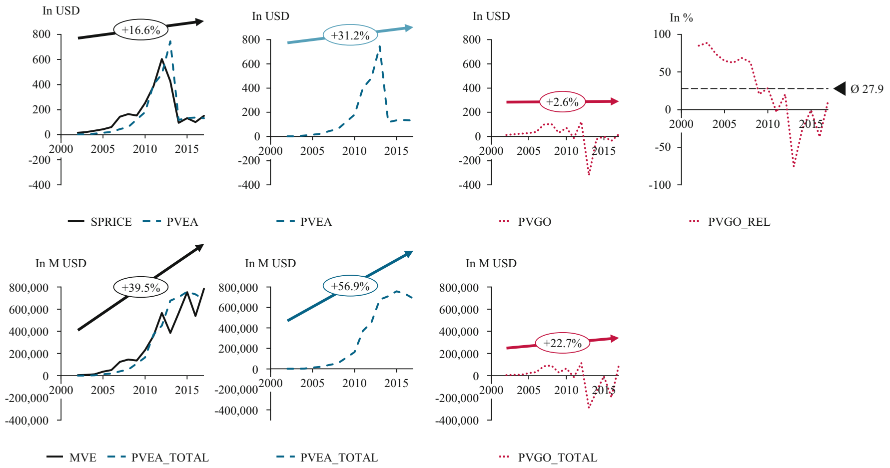

Fig. 9.3 Apple: curse of success, struggle to keep PVGO level (own representation)

The graphic illustration (see Fig. 9.3) of Apple's variable SPRICE in comparison to the total market value of equity (MVE) shows the 7:1 stock split in 2014. Consequently, the variables PVEA_TOTAL and PVGO_TOTAL show an interesting picture: While the overall market value of equity MVE has constantly risen with a CAGR (compound annual growth rate) of nearly 40% per year, PVEA has experienced exponential growth since 2007, particularly attributable to the introduction of the iPhone. The PVGO_TOTAL shows a unique alternation between positive and negative value between 2010 and 2017. This could be interpreted to the fact that

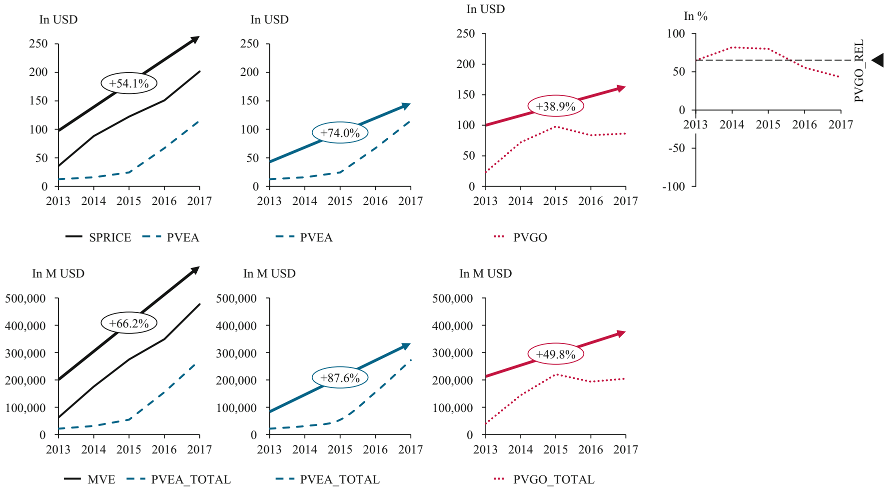

Fig. 9.4 Facebook: the youngster, all positive values (own representation)

the Apple's shares do not reflect the immense realized profits generated by the iPhone, outperforming the investors' expectations. However, the volatility also indicates the challenge which strong growth companies face: the "curse" of success to consistently outperform investors' expectations by a reiteration of a success story comparable to the launch of the iPhone. While the Apple valuation had nearly "sky-rocketed" until 2012, the volatility of the MVE and PVGO_TOTAL variable in the last five years shows the pressure on Apple to sustain its growth track record based on further bold strategic moves and a strong successor team of icon Steve Jobs.

It may be subject to discussion whether the limited amount of observations since 2013 suffice a profound analysis, yet it is agreed that Facebook is one of the most prominent "unicorns" with a digital platform needed to create networks using digital technologies. As the envisioned stock split from 2018 was cancelled, both types of variables, on a per share and per company base, can be applied for further analysis. While Facebook has created positive income (PVEA, PVEA_TOTAL > 0) since the IPO, thereby exhibiting exponential growth from 2015 to 2017, its PVGO of 2013–2015 can be interpreted as an early indicator of future PVEA and thereby confirm the theoretic concept of Brealey Myers Allen' PVGO approach: Today's PVGO corresponds to the expectation of tomorrow's PVEA. The slowing growth rate of PVGO rate shows that capital markets expect strong future incomes, but at a lower growth rate (see Fig. 9.4). The phenomenon can be drawn parallel to Apple's shares, where the pressure to sustain growth and profitability is the core strategic challenge of the management.

Apart from a 2:1 stock split in 2003, Microsoft's variables on per share and company level provide the same history: With growth rates of one-digit CAGR, the maturity of the company compared to Alphabet or Facebook is at a later stage (see Fig. 9.5). Yet, the turnaround of valuation of SPRICE, PVGO respective MVE, and

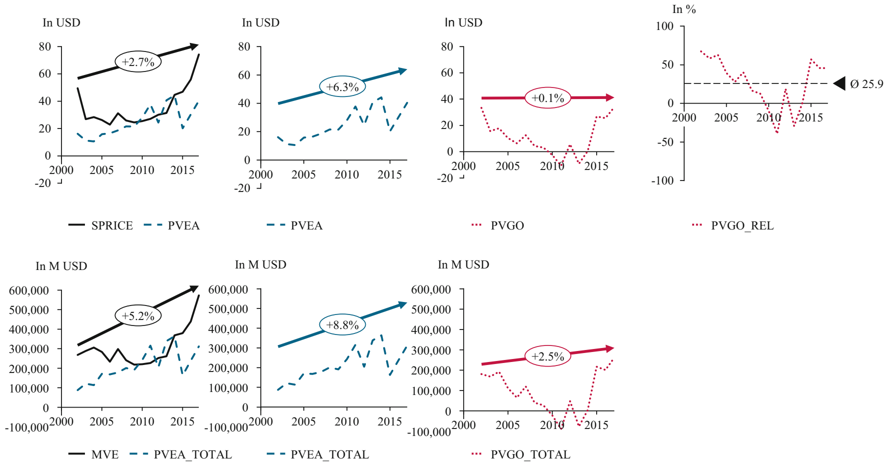

Fig. 9.5 Microsoft: weakest digital 1.0, still stronger than classic industrials (own representation)

PVGO_TOTAL with a U-shaped curve shows a parallel development of Microsoft's value according to its future perspective. With a CAGR PVEA_TOTAL growth rate of 8.84% per year, the company represents a relatively stable cash flow option for investors while its future growth opportunities are valued differently. Shareholder valuations have shown a mixed picture in the past years, with a more positive outlook in 2015–2017. Overall, the PVGO_REL of 26% on average with a remarkable volatility is at a different level than those of the other digital natives.

The Classic Industrials

Berkshire Hathaway, the prominent company driven by value investor Warren Buffett, invests in company portfolios and is thereby seen as a "trendsetter" for the capital markets (see Fig. 9.6). Shares which are bought by Berkshire Hathaway usually enjoy a trend of investors to follow, a phenomenon appointed to by Arthur (1996). Berkshire Hathaway has the highest absolute share price of its A-series stock to signal a high value and attractiveness. Its core dividend policy driven by Warren Buffett (Segal & Scott, 2021).

Due to the stock split of 10:1 into a B-series stock in 2009 to attract more capital, only the variables on the company base are relevant for the analysis: While the Market Value of Equity (MVE) shows a stable growth of ~10% CAGR, the PVGO_TOTAL variable exhibits a picture of volatility. The maximum PVGO_REL value remains >50%, which alludes to the fact that this company can be categorized as a "classic industrial". Berkshire's approach benefits from the growth of successful digital natives by acquiring shares, such as Apple and Amazon in 2019 (Hargrave,

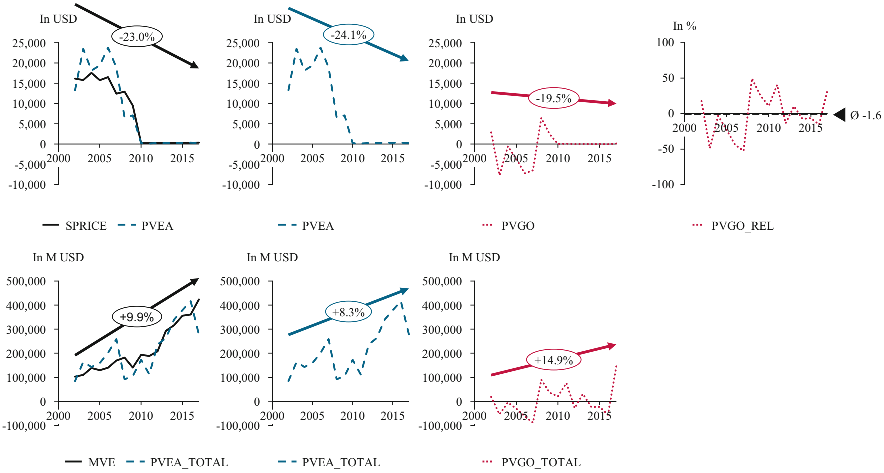

Fig. 9.6 Berkshire Hathaway: value driven by PVEA, the value company (own representation)

2021), and offers the risk mitigation of diversification as a cross-industry portfolio is held.

Exxon Mobil, one of the largest global oil corporates, represents a classic industrial company, which can be directly inferred from its one-digit growth in the analysed variables. A respective high correlation between the market valuation and the history of the oil price may be assumed, leading into a similar trend line for PVEA_TOTAL and MVE. The negative PVGO_TOTAL value in 2012 reflects the rather pessimistic level of expectation for oil companies to create future growth opportunities. With a 2.87% CAGR per year in Market Value of Equity (MVE), Exxon Mobil's valuation originates mainly on asset-intense investments in equipment and oil production (see Fig. 9.7).

Exhibiting one-digit growth rates since 2002 in the variables SPRICE, PVEA, MVE, and PVEA_TOTAL, Johnson & Johnson can be categorized as a corporate stemming its value mostly on monetization of its existing assets and cash flow. While its PVGO variables alternate between positive and negative value, Johnson & Johnson's share price contains a small ratio of PVGO overall (see Fig. 9.8). The share price is valued based on existing assets, as the similar graphs from MVE and PVEA_TOTAL suggest. This industrial classic faces the challenge of converting the value from the existing cash flow streams (PVEA) into value for its shareholders (SPRICE).

As the variables on a per share and per company base show similar trends and no stock split has been executed in the observed time horizon, JP Morgan Chase sources its value from existing assets rather than future growth opportunities (see Fig. 9.9). With the average PVGO >0, the company creates value for shareholders with a growth perspective, and yet those are minor compared to the digital natives. The double-digit CAGR per year growth rates of PVEA are higher than MVE and signal a stable and healthy cash flow situation without any extraordinary growth ambition.

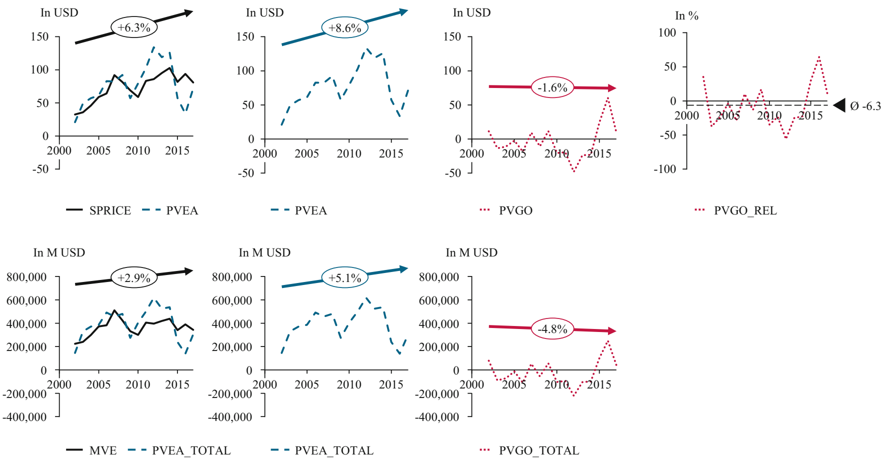

Fig. 9.7 Exxon Mobil: PVGO not relevant, PVEA > MVE (own representation)

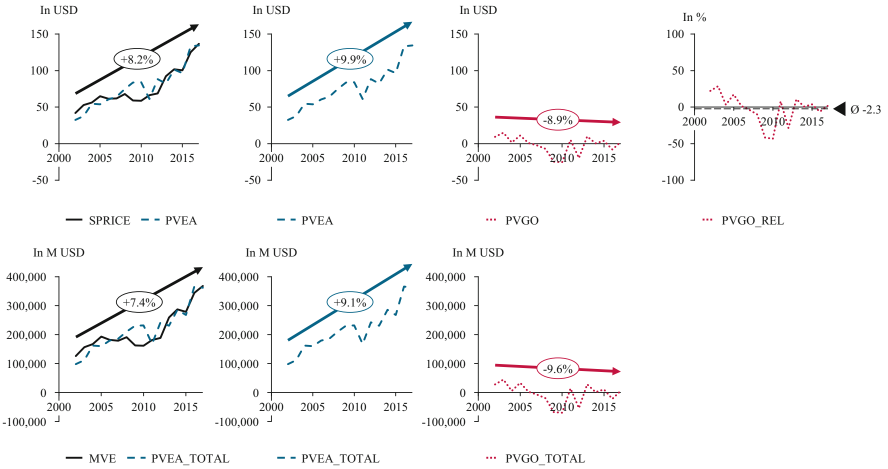

Fig. 9.8 Johnson & Johnson: driven by PVEA (own representation)

Besides the stock split of 2:1 in 2004, the graphical illustration (see Fig. 9.10) of Procter & Gamble indicates another PVEA-oriented stock, with a minor PVGO. The company experiences positive, but rather volatile PVEA values and is therefore assessed by the capital markets as a stable, but no-growth stock. This can be clearly seen in 2017, when the PVEA value is only partially transferred into the corresponding share price of the stock.

The results of the graphical analysis of the selected companies of both subsets, labelled as digital natives and classic industrials, can be summarized as follows:

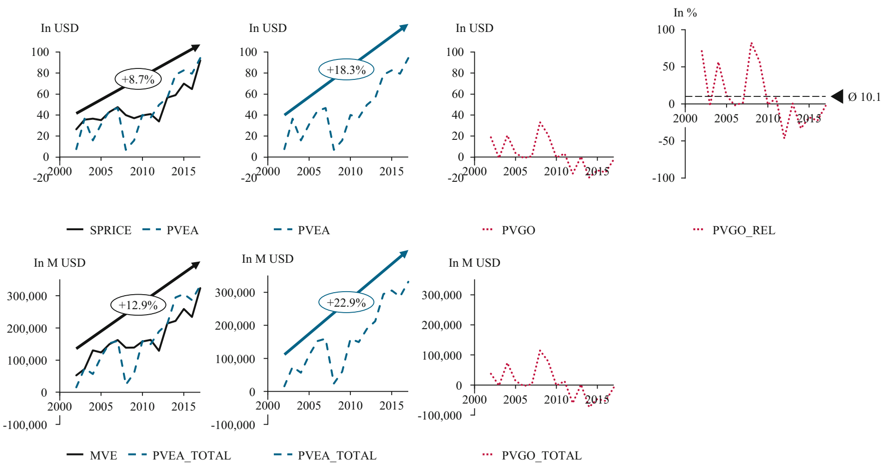

Fig. 9.9 JP Morgan Chase: PVEA equals MVE (own representation)

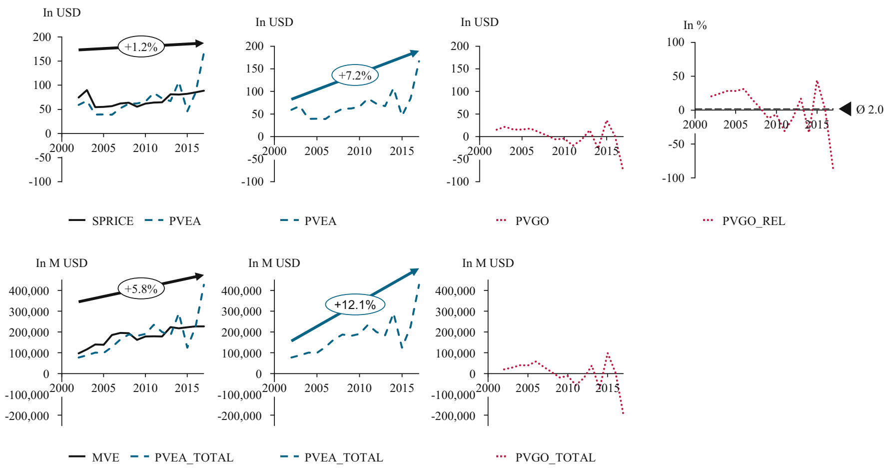

Fig. 9.10 Procter & Gamble: No PVGO, not able to transfer all PVEA into MVE (own representation)

While all companies demonstrate a growth of MVE between 2007 and 2017, the CAGR of MVE varies significantly, indicating a difference between the digital natives and industry classics. All digital natives enjoy a double-digit growth of MVE, which indicates a growth story supported by the capital markets. With nearly exponential growth, such as for Amazon, the valuation based on a solid rationale might be in question, however one can clearly conclude: The business models of digital players are valued with a significantly higher PVGO than the ones of their peers in the industry classics. The reasoning for the notion of growth of MVE stems from strong PVGOs, while PVEA seems to play a less significant role as opposed to the industrial classics. Interestingly, three out of the selected ten companies show high PVEA and PVGO similarly: Alphabet, Facebook, and Microsoft. Furthermore, investors anticipate Amazon to join those in future, which would classify as the GAFA (Google, Amazon, Facebook, Apple) group commonly referred to.

PVGO, calculated as a residual, can alter and show volatility in the short term. Yet, its strength as a proxy KPI for future growth grows in proportion to the length of the time horizon: Amazon, the most valued company in 2017, has reached its valuation on the pure “promise” of future profitability with PVEA levels manoeuvring at less than 10%. As PVGO $>$ MVE, Amazon sets an example by mastering its business model to the expectation of further dominance. The digital native companies experience a different level of capital market valuations (MVE) which lead to record high PVGO levels. Amazon’s share price contains an average 88% PVGO_REL and thereby exemplifies the valuations which are subject to the question of PVGO as intrinsic value or the reflection of a possible bubble.

Supporting the rationale, intrinsically justifiable valuation, the fact of negative PVEA is legitimately explained by investments in Research & Development and Management & Accounting and contributes to the overall storyline of Amazon. It can be inferred that the calculation of PVGO as an indicator of how firmly the capital markets are willing to finance the growth of digital natives dominates PVEA as a proxy for actual profitability.

Yet, the higher the PVGO of the more mature digital natives, the more the company faces the challenge of sustaining its growth levels. Apple sets the example to show how the curse of past outperformance poses a challenge to continuously outperforming in the capital markets.

PVEA, by contrast, seems to be strong for industry classics which can generate optimized cash flows in asset-intense industries. The industrial corporates present a solid, predictable storyline to their respective, conservative investors. The classic industry companies derive their value creation mainly from existing assets. If shareholders remain sceptical about future growth perspectives, they ignore the value of a dramatically negative PVGO to assess the company’s (MVE).

The KPI of PVGO seems to be a rather sensitive variable which may alternate significantly within a short time frame. PVGO can possibly be attributed to experiencing a “life cycle” parallel to the business life cycle. In addition, PVGO plays a more significant role in terms of value creation for younger tech companies. The higher the PVGO, the higher MVE.

The empirics support the assumption that the capital markets value today’s price based on future opportunities. In short: PVGO may serve as a valuable indicator, being future-oriented, while PVEA reflects realized cash flows from historic investment decisions. This key insight from the graphical analysis shows the importance of investigating the development of value creation along the dimension of time and thus serves as the point of departure for the second step of the adjacent cluster analysis.

Cluster Analysis

Starting with the scatter plot of 2007 in Fig. 9.11, the values of PVEA_TOTAL and PVGO_TOTAL range in a rather similar fashion. It is of little surprise that Berkshire Hathaway and Exxon Mobil indicate an observation of outliers. While this might be a temptation to exclude both companies at first, the consideration of the context proves relevant. In the case of Berkshire Hathaway, the share price has been famous for being extraordinarily high. With regard to Exxon Mobil, the peak of the oil prices in 2007 allowed for a peak in profitability levels, reflected in a record high PVEA value.

As a consequence, the oil giant benefits in terms of an increase of positive NPV (Net Present Value) project opportunities. As the data is sourced from the time before the financial crisis, Citigroup can be seen enjoying tremendously high levels of PVGO. Certainly, those valuations by the capital markets allude to the pre-existence of the global bubble in the financial markets rather than sustained cash and value flows.

The visualization of the results for 2012 (see Fig. 9.12) signals a slight trend in the clustering to differentiate between industrial and digital companies. This interpretation is further supported and strengthened later, in 2017 (see Fig. 9.13).

The contrast between the value of existing assets and growth assets is apparent. While Chevron and Exxon Mobil on the bottom right represent not only the oil industry but the industrial classics, the digital player Amazon is located on the top left. Hence, while the valuation of the oil giants is purely based on exploitation of value, Amazon explores its future value potential stemming from PVGO.

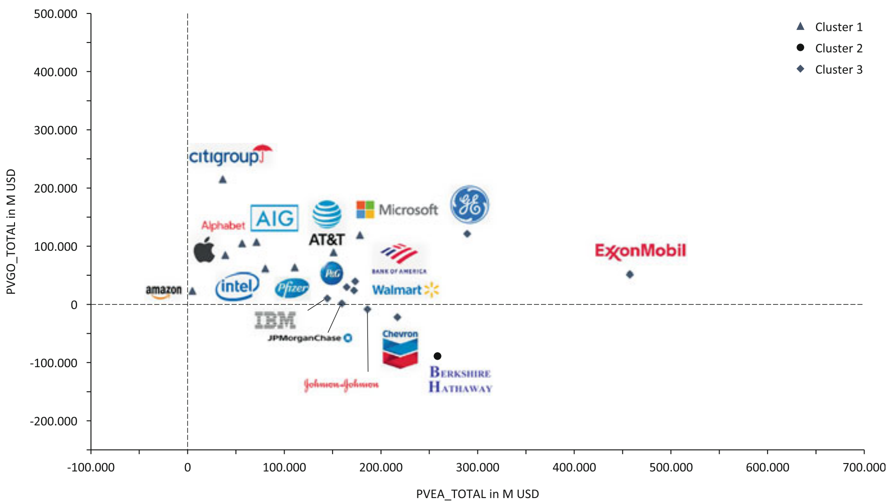

Fig. 9.11 Clustering of selected companies: PVEA_TOTAL and PVGO_TOTAL, 2007 (Balzer, 2020a, p. 69)

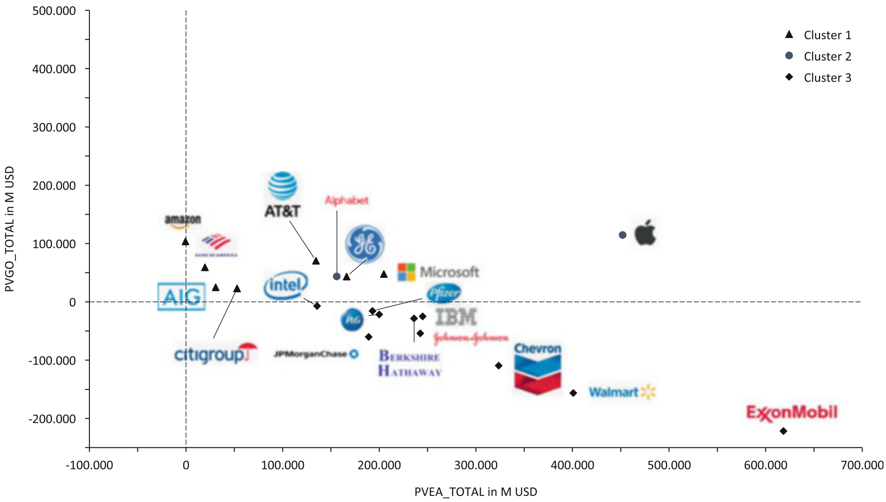

Fig. 9.12 Clustering of selected companies: PVEA_TOTAL and PVGO_TOTAL, 2012 (Balzer, 2020a, p. 70)

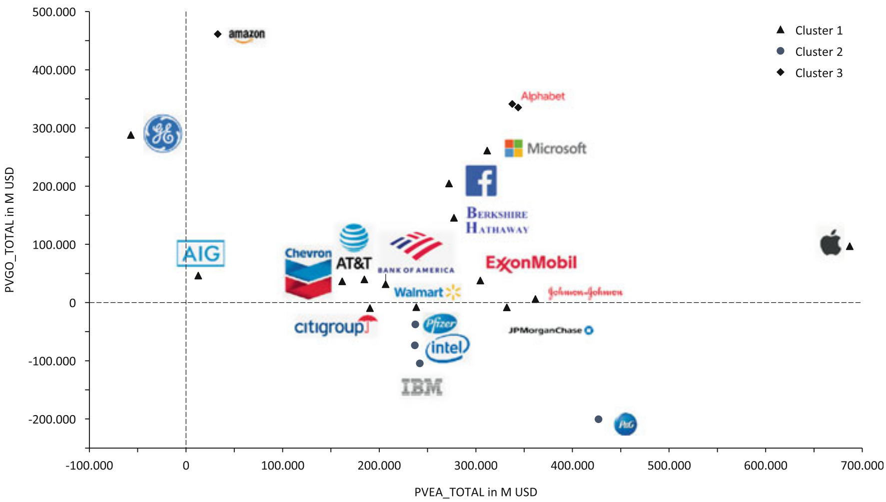

Fig. 9.13 Clustering of selected companies: PVEA_TOTAL and PVGO_TOTAL, 2017 (Balzer, 2020a, p. 71; Balzer, 2020b, p. 7)

Another example for the monetization of digitalization is the prominent case of Apple. The capital markets attribute an immense value of both, PVEA and PVGO, in 2012. Five years after having launched the revolutionary iPhone, Apple has successfully, globally scaled not only its products but also its ecosystem. Second, the unique personality of CEO (Chief Executive Officer) and ambitious visionary Steve Jobs is absorbed by investors, resulting in all-time high valuations of Apple.

The position of Apple therefore is of little surprise: Five years after the launch of the iPhone, the company enjoys scaling effects from global iPhone sales while offering a unique PVGO value.

The so-called superstar phenomenon (Rosen, 1981), which can be attributed to Steve Jobs, resembles a dominance of digital technology and innovation to spur future growth. As an important factor, however, these superstar companies enjoy a culmination of popularity decoupled from pure performance.

Finally, the scatter plot of clustering in 2017 draws the clearest picture. Fig. 9.13 emphasizes the "majority in the middle" (Cluster 1), a few "losing" companies (Cluster 2), and a concentration of value around the "winners" (Cluster 3). (Balzer, 2020a, 2020b). These findings support the fact that the few digital companies have started to dominate the acquisition of capital in the markets. In other words, the value creation of the digital players leads to a concentration of value (Balzer, 2020a, 2020b).

While the cluster analysis provides a static view of value patterns with regard to industrial and digital companies, the long-term development on a time scale is of greater interest. Due to this reason, the scatter plots from the years 2007, 2012, and 2017 are depicted.

It is noticeable that the quality of the clustering increases over time. In 2007, the value sources PVEA and PVGO of the companies were rather similar. They had rather small distances to each other; hence a clustering was not yet clearly visible. In general, the strength of the clustering stems from small distances within a cluster while longer distances can be observed between clusters.

As it can be inferred from Figs. 9.11, 9.12, and 9.13, the quality of the clustering enhances within the decade between 2007 and 2017. The set of companies can be distinguished and categorized in a clearer visual way, supporting the split of industrial and digital companies referred to earlier in this chapter.

In general, one can conclude from the visualized cluster analysis how the development of the digital companies has progressed over a longer time horizon: The growth and success of very few digital companies, commonly also referred to as unicorns, has accelerated at a different pace. One can subsume that digital pioneers have emerged as dominators.

Moreover, as a long-term trend, no company has remained in the same group for the past decade, hence there is a consequent fluctuation in terms of market valuations of equity. While the quality of the clusters increases in explanatory power, an even longer time horizon for further future analysis is advisable. Then, the riddle could be solved whether the trend of monetization of digital technologies is the emergence of the digital age superseding the industrial age or whether the current dynamics rather resemble a subjectively perceived hype.

Limitations and Conclusion

The presented analysis serves as a starting point for further research and therefore inhibits a set of limitations. Both elements of analysis offer a first impression on the different characteristics of value creation of digital players and classic industrials and the resulting interpretation is rooted in the classic basic concepts of PVGO. Definitively, a wider scope of research of financial academia to substantiate the topic requires further attention.

Furthermore, rational investment behaviour is consistently assumed in this chapter. Yet, the field of behavioural economics, which has gained a wide range of academic acceptance and relevance in today's VUCA world, has not been investigated. One example of further analysis could be attributed to irrational investment decisions, as capital market decision-makers influence other investment groups with their investment decisions. As complexity and fast-paced drive decisions taken by investors, the concentration of capital seems purely a natural consequence (Balzer, 2020b).

Second, the macroeconomic conditions of the last decade have not been analysed in further detail. While it is common knowledge that the global economy after the financial crisis has enjoyed growth at negative interest rates, financial institutions pursue riskier investments in digital natives to reap higher returns (Balzer, 2020b). Additionally, there has been little empiric study regarding the robustness of the selected digital natives in a financial crisis. Possibly, the demanded risk premiums of equity, taken for the CAPM model to evaluate PVEA, are rather small and might not adequately reflect their true intrinsic associated risk.

Third, a positive feedback loop (Arthur, 2014) can be observed, as the current success of the digital natives feeds their future success. The most cited phenomenon of the self-fulfilling prophecy may hold true for the raise of the unicorns. As the few companies enjoy a nearly unlimited access to capital, they can secure the exclusive right to pursue a new, wide range of growth opportunities. Even though the scope of this paper does not allow for following the value drivers of a call option in a more thorough manner, this subject clearly deserves further investigation.

In the first step of the graphic analysis, both groups of digital natives and industrial classics lead to the following conclusions: PVGO is hardly relevant for industrial companies. Following the notion of value, the classic industrials generate constant, stable, rather predictable cash flow streams. The opportunities in terms of the application of digital technologies to develop innovative business models are not a scalable option for, for example, oil corporates like Exxon Mobil. Even though those companies may optimize their resources further based on increased automation and data intelligence in the time of digitalization, the core of their business models remains. Nevertheless, the industrial business model allows for steady, predictable PVEA_TOTAL cash flow streams.

By contrast, the digital native players have shaped another system of generating cash flows from a different set of business models. As it can be seen, their relative percentage of PVGO (PVGO_REL) values of 40% and higher reflect the expectation level of the capital markets to generate immense cash flows in the future. The rise of PVGO_TOTAL values from 2007 to 2012 and finally 2017 is a clear sign of how compelling investors expect the respective market dominance of the digital players.

A key question arises to gain a profound understanding: Was today's success predictable? Has yesterday's PVGO transferred into today's PVEA and is therefore today's PVGO an indicator for tomorrow's PVEA? As the individual, qualitative analysis of the basic data with regard to PVGO_TOTAL and PVEA_TOTAL reveals, the simplistic use of PVGO as a proxy for future PVEA cannot be applied without individual context. However, the empiric evidence regarding whether today's PVGO truly reflects the realization of future profitability still invites for further academic research.

The visual interpretation of the cluster analysis allows for drawing the following conclusion: Expressed in market value of equity, a small number of digital companies have emerged to dominate the market within the last decade. These digital native companies from the Silicon Valley have achieved to concentrate an immense amount of capital. Furthermore, only very few players have the capability to generate market value of equity from both elements, existing asset as well as future growth opportunities. Based on the data set of nearly 500 companies, only about 1% have captured value and will be able to drive further growth. Those companies can be labelled as digital pioneers because of their ability to dominate global markets with business models rooted in digital platforms and excessive scaling.

The digital dominance signals a new era of business models which allow for these companies to obtain dominating market positions with perceiving an almost exclusive right to exercise real options in terms of projects. It can also be concluded that there is less change in valuation models of the capital market, but more change in business models' setups. The common approach to forecasting future cash flows remains valid.

As a summary, it can be claimed that the empiric aim of both elements of analysis has been achieved. The results support the hypothesis that digital native companies have created more value than their industrial peers between 2007 and 2017. Certainly, the aspect of digital platforms enabling global scaling based on networks might be one aspect. Nevertheless, the PVGO between future-oriented growth opportunities as option value quantifying the growth of digital companies truly translate into profitability still seeks empiric evidence.

While the foregoing analysis can be classified as a first academic, rudimentary attempt to support the superseding paradigms of the industrial and the digital world, a great avenue of further research is open to be discovered. Without a doubt, it is critical to substantiate the presented results by continuing the analysis in future. Therefore, this hint of evidence is at best minimal, but not yet satisfactory.

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Chapter 10
The Economic Impact of Open Data as Liquid Information for Unlocking Potential

Neele Hiemesch-Hartmann

Abstract The influence of digitalization is evident in public administrations. It is not a short-term fashion topic but a profound digital (and overdue) change process in public administrations. In addition to the digitalization of internal and external administrative procedures, the issue of "open data" is also on the political agenda. Data offers a variety of economic forms and therefore, new business models can arise based on new data. The economic impact of open data is rated as high internationally and nationally. This chapter aims to provide an overview of open data in Germany. That includes the data publication process and economic possibilities. Besides, significant challenges to unlocking the potential of data will be discussed. This chapter tries to explain and quantify this potential.

Introduction

In 2013, the G8 countries established the Open Data Charter. The Open Data Charter already has 74 governments and 55 organizations that support the Open Data Charter as members. The basis of the charter is formed by the six principles and guidelines for the implementation of open data decisions, which have been defined by international states and experts. These six principles are: Open by default (1), timely and comprehensive (2), accessible and usable (3), comparable and interoperable (4), for improved governance and citizen engagement (5), and for inclusive development and innovation (6) (Open Data Charter, 2021). These six principles are an obligation for members at a national level and must be heeded. The high number of members within just a few years and the extensive principles imposed by the Open Data Charter are strong indicators of the great importance of open data in political understanding (Dapp et al., 2016; Open Data Charter, 2021).

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The Online Access Act for Germany came into force in August of 2017. It obliges the federal, state, and local authorities to offer all administrative services in Germany digitally via administrative portals by the end of 2022 and to link them via a portal network (Bundesregierung, 2017). The consequence is that digitalization is changing the role of data, which is no longer a waste product of the economic or administrative activity, but a strategic resource and basis for new digital services (Schieferdecker et al., 2018). Open data, therefore, has enormous economic potential.

This chapter includes the following issues. Section “Definitions” answers the questions “What is open data?” and “Who are the users of open data?” by defining open data and explaining the different user groups. Section “Open Data in Germany” clarifies the status quo of open data in Germany. Section “Publishing Open Data” presents an optimal data publishing process. The economic aspects of open data are presented in section “Economic Impact of Open Data” which answers the questions “How does open data create added value?” and “What are the economic effects of open data?” as well as “How great is the added value of open data?”. Section “Challenges to Unlocking the Potential of Open Data” discusses the existing challenges to unlocking the economic potential of open data. Finally, section “Conclusion” offers a summary and conclusion.

Definitions

What Is Open Data?

First, open data or open government data (these terms are often used similarly) must be defined. Pure data are a just sequence of characters. Those characters can only be used to a limited level without syntax. A syntax or a format defines numbers and characters into data. Data becomes information by using a context and making interpretations (semantics) possible. Those data can clarify relationships, make interactions visible, and allow for knowledge to be created (Dapp et al., 2016). This turns simple data into the raw material for information and knowledge generation (European Commission, 2020).

Lucke (2012) defines Open Data as “all datasets that are made freely accessible for the interest of the public society without any restriction for free use.” In conclusion, only data that can be used without any restriction are open data. The unrestricted use of open data does not exclude anyone. Public institutions, private companies, and private individuals can use those data equally. The user can achieve added value in the social or economic and ecological way. Providers for open data are only public institutions (European Commission, 2020). Examples of open data can be geodata, data on metropolises and rural regions, social data, data of traffic statistics, legal data, administration data, statistics, research data, scientific publications, or cultural data (Preische, 2014).

Open data standards and rules are defined by the Sunlight Foundation (2010): Completeness, primary sources, currency, easy access, machine readability, non-discrimination, use of open standards, licensing, durability, and usage costs (Sunlight Foundation, 2010). These ten principles aim to ensure that data can be reused in a user-friendly way. The principles do not stand side by side. Depending on the use case, principles have a stronger or lower effect. However, regardless of the application, certain principles have a bigger catalytic effect than others. Machine readability makes automatic processing possible and is one of the important principles with strong effects for further use. The principle of licensing can also enormously increase user-friendliness through legal freedom and clear conditions of use. Additionally, low or zero costs are a strong guarantee for user-friendliness (Preische, 2014).

Who Are the Users of Open Data?

The users of open data are heterogeneous. On the one hand, the public administration uses data by itself to optimize internal processes. On the other hand, politics (at all levels) benefit from open data by data-based politics (Schweigel et al., 2020). Other users for open data are civil societies (e.g., the publication of election data, possibilities for public participation, or infrastructure data on the region), data journalists (e.g., municipal budgets), NGOs (e.g., environmental data), or data experts. Open data serves the interest of civil societies in public data. Besides, open data enables science and research organizations to access data faster and more extensively (Dapp et al., 2016; Smith & Sandberg, 2018). Another interest group for open data is the economy itself. For example, startups create new data-based business ideas by newly linked data to form a new business model. Additionally, location decisions for new business opportunities are based on open data. Companies make long-term decisions with data on the workforce market, tax issues, or transport and mobility connections in a region. The investigation has an impact on location decisions for or against a location or area (McKinsey Global Institute, 2013).

Open Data in Germany

Open data in a broader perspective means a fundamental cultural change in administrations from a culture of official secrecy to a culture of openness and transparency. In this context, the term "data" is no longer about making documents available but about data as characters that can be further processed by a machine. Data consist of texts that can be understood by humans but not by machines. Open data is the other way around; they should not be understood directly by people but by machines (Klenk et al., 2020). Open data is currently taking place in portal solutions at both the federal, state, and municipal levels. In addition to the federal administration itself, companies such as Deutsche Bahn are also active and provide extensive data sets. At the state level, the situation is heterogeneous. The city-states as well as Rhineland-Palatinate and North Rhine-Westphalia are in the lead. Other federal states, on the other hand, have a lot of catching up to do. Even less than one percent of German cities and municipalities are active in opening up their databases (Schweigel et al., 2020). Urban spaces have already implemented diverse and successful open data projects. Only 90 of the 10,795 municipalities have open data portals in Germany. So far, there have been few municipalities in rural areas. The municipalities that provide data count 43% in large cities. But only five counties and only 30 smaller parishes operate open data projects (Bürger & Hoch, 2020).

Different EU programs and national projects relate to the development and change of infrastructures from analogy to a smart city or community. All programs try to keep many data with a cross-domain relationship. The data are grouped separately in varied portals. With this interaction between open data portals, they hold the opportunity to simulate and forecast better. The basic idea is to provide public data for communities (like companies, citizens, developers, data journalists, etc.) to develop applications and services that support the local economy. It is about the control and optimization of urban mobility and local public transport, energy issues, climate and environment, citizen participation, increasing transparency, tourism, and several other areas of applications and scenarios. These are based on the published data in urban spaces with innovative ideas. In addition to the provision of open, static data, the basic idea is also increasingly about using sensor data in the smart city or community, for example as a part of an Internet of Things platform. The data available to the municipality is expanded (almost) in real-time using communication technologies with sensor data and large data streams (big data). This variety of data feeds special urban services and applications that can also be made available in real time to a broad smart city or community or only to certain actors. The services and applications themselves are diverse, based on a wide variety of data, and serve to comprehensively develop and optimize the smart community through innovative concepts and business models (Schieferdecker et al., 2018).

Open data is a new phenomenon. Concerning the developing speed of legal norms, open data is in a pioneer stage. The regulatory framework of open data and the publication of municipal data is extremely complex and fragmented. Individual specifications are even in (possible) conflict with one another. For municipalities, the legal situation is often difficult to overlook. A uniform, a clear legal framework, is urgently needed. Due to a lack of legal clarity, much more practical questions have taken effect. In this respect, the current data issues are more likely to be resolved via factual-technical than legal access (Voigt et al., 2020).

Publishing Open Data

Municipalities provide social benefits and educational opportunities, day-care places, and transportation infrastructure, offer sport and leisure activities, and take care of building and residents' registration. The list could go on and on. The underlying message is clear: The municipal administration is responsible for a wide range of essential public services. To meet the increasing requirements because of lacking capacities and resources, the effective use of data for effective control is becoming increasingly important. Exploiting the full potential of data, however, poses various challenges for administrations. This applies in particular to the municipal administrations, which are only just beginning to build up the necessary capacities for data-based control (Tuncer et al., 2020).

An internal administration process (see Fig. 10.1) of open data can ideally be defined by five process steps, namely identification, selection, publication, editing, and use (Klenk et al., 2020).

Step 1: Identification

First, it is to clarify which databases are present in an administration and at which point. Not all data sets can be published ad hoc. A prioritization of publishing data is necessary. For this purpose, comparisons with other administrations can be helpful. High-demand data sets will be classified and prioritized. In addition to the comparison, stakeholders must become involved. Open data users have individual requirements for open data.

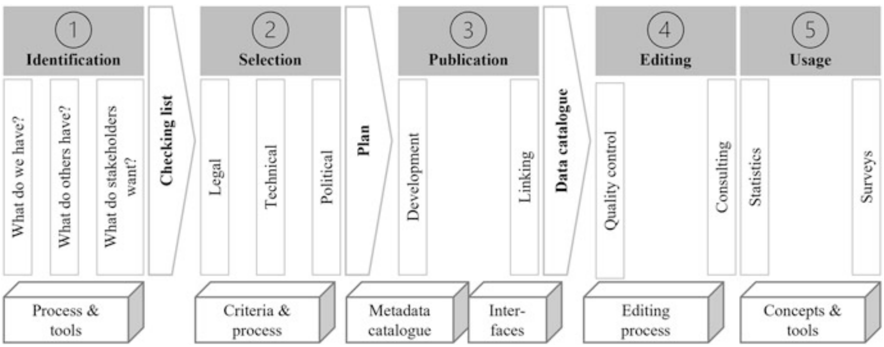

Fig. 10.1 Internal administration process of providing open data (Klenk et al., 2020)

Step 2: Selection

Based on the requirements and comparative data, data sets must be selected. Selection means that publication represents a reasonable effort from a legal, technical, and political perspective.

Step 3: Publication

The selected data must then be technically prepared in a third step (e.g., compatible with other interfaces) and then published afterwards.

Step 4: Editing

The data quality must be checked overtime in the fourth step. At this stage, data changes and updates become necessary. Also, a contact person should be designated. Much of the data is not self-explanatory, so there may be a need for clarification.

Step 5: Usage

It would be advisable to get an impression of the users from an administrative perspective. For this purpose, usage statistics should be evaluated so that high-demand data records are identified and give implications for future data selections.

This idealized publication process is not typically in practice when data is being published. Problems often arise in the form of a lack of personnel, a lack of technological know-how, a lack of data awareness, and legal reservations about open data. Larger municipalities in cities are less affected by these problems when trying to change their systems to follow the German government's digitalization mandate. At the same time, however, for many smaller municipalities, it is hard to implement open data projects due to the given problems.

Economic Impact of Open Data

Open data as a public good has specific economic characteristics and special conditions. First, data are subject to the principle of "zero marginal costs." That means marginal costs for the publication of another data set are almost zero. Another characteristic is the lack of competition in the data. Actor A and actor B work with the same data at the same time without any rivalries on the user market. The free use of data also includes a copy of the data. In the case of non-open data, tight copyright licenses prevent further reproductions. Another economic characteristic is the fact that nobody can be excluded from a data offer. It is also not possible to exclude one actor from another. If open data are published, there is no possibility for withdrawing any of the data. Another economic characteristic are the positive network externalities: the more users, the greater the benefits of open data (Dapp et al., 2016). Selling data for profit is only possible in a strongly limited way because many legal regulations intervene in the pricing of data (Lindman et al., 2015; Viana et al., 2019).

How Does Open Data Create Added Value?

User groups have already been identified in the context of open data. They can be summarized as the economy, public administration, science, civil society, and NGOs. These user groups can unfold the economic potential and added value for open data. Interactions between user groups work in an isolated and/or interrelated way. Value creation is not necessarily understood in Porter's sense of the value chain, but rather as a value network. Added value on open data is based on three stages: data collection (1), data processing and provision (2), and data use (3). In addition to these three stages, the user groups operate in a network logic (see Fig. 10.2) (Graudenz et al., 2009; Preische, 2014).

(A) Public administrations collect raw data as a byproduct of the day-to-day activities. Not only public administration collects raw data, but also third parties (ordered by public administrations) collect raw data, for example private meteorological stations. This initial step includes administrative costs, on the one hand, and makes a considerable contribution to value creation on the other. The administrative costs include a wide range of expenses for the administration itself. The provision costs for user groups outside the administration are defined as additional costs (Graudenz et al., 2009). Data acquisition is the cornerstone for value creation. This cornerstone includes data collection, filtering the data, and cleaning it before open data is available for any user group (Cavanillas, 2015).

(B) Open data gets processed by the economy, public administrations, science, civil societies, and NGOs (Graudenz et al., 2009). Data processing includes exploring, transforming, and modeling data to highlight relevant data and to synthesize and extract useful and hidden information with high potential from a social or economic point of view (Cavanillas, 2015). After this process, curated databases are available as an app or as a retrievable database (e.g., via a website) (Graudenz et al., 2009).

(C) This data process stage is an iterative cycle. For example, weather data from meteorology can be further used and processed by NGOs. Public administration receives data from a scientific study about the traffic situation in the local area.

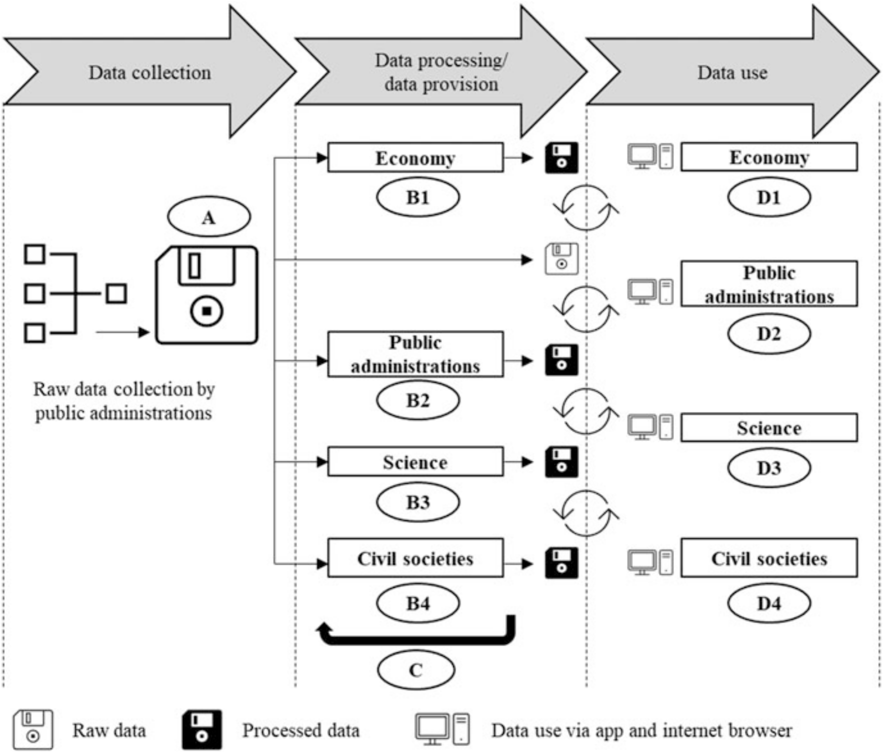

Fig. 10.2 Open data and added value (Graudenz et al., 2009)

These data are useful for decision-making processes in a traffic management system (Graudenz et al., 2009).

(D) At the stage of using data, open data are usable in many ways for all user groups. Examples would be public transit apps for citizens, companies using data for new business models, public administrations working with data from other administrations, or science using open data for further research.

A clear distinction between (D), (B), and (C) is not possible. Using data automatically creates new data (Graudenz et al., 2009). In a strictly interpreted economic view, points (B1) and (C) (if there is a commercial enterprise) and in part (D1) add value (Graudenz et al., 2009). These points show direct economic benefits, with the term "benefit" referring to a correlation and causality between the introduction of open data and output (Dapp et al., 2016). Using open data improves competitiveness by reducing costs, increasing added value, or determining other parameters that can be measured (Cavanillas, 2015). From a moderate perspective and an economic point of view, points (A), in parts (B2), (B3), (B4), and possibly also (D2) and (D3) are value creation steps. These benefits show indirect effects.

Between the publication of data and its effects, the correlation is solely argumentative (Dapp et al., 2016). From a broad perspective, the point (D4) is a value creation step if resources are conserved. In this case, a positive economic effect (welfare effect) would be visible if there was a visible resource-saving outcome, for example faster locomotion in traffic (Graudenz et al., 2009). There is no correlation between data and their direct or indirect impact. Potential relationships between these two interactions become visible by their common positive assumption of the welfare effect (Dapp et al., 2016; Miehler, 1998).

The following two practical examples (A and B) help to gain a better understanding of open data and the resulting added value.

Example A: Wasserkarte.info
With the uncomplicated recording of water extraction points, wasserkarte.info offers fire departments a simple tool for preparing for operations. The members of the fire brigade always know where which water supply point is and whether it is available. This increases safety for the citizens that are affected in emergency situations. Thanks to the shared use of wasserkarte.info by fire brigades, municipalities, and water suppliers, the data entered are accessible to everyone involved. That saves time and money when recording and maintaining water supply points. The information is accessible in the form of data sheets or in the app (wasserkarte.info, 2021).

Example B: Townfolio
The founders of the start-up "Townfolio" used open data to start a business model. The background of this business model was that companies would often turn to public institutions for market information. This search for robust and valid numbers is time-consuming. Additionally, the founders identified two main problems: On the one hand, founder pioneers have a high lack of in-depth knowledge about access to robust and valid public data sources and, on the other hand, this target group has a difficult time making a sound assessment of the data for the anticipated business model. To break through this problem, the founders developed a service platform to make real-time city data more accessible. "Townfolio" offers automated acquisition, visualization, and updating of millions of data points on its service platform. In this way, users can view and automatically compare hundreds of records from 38,000 parishes in Canada and the USA (Government Canada, 2020).

Both examples show two similar points. The first point is that both business models do not come from Germany. The second point includes that the place of value creation does not necessarily have to be the geographical place of the data origin. That makes the determination of economic effects extremely difficult.

What Are the Economic Effects of Open Data?

The three stages of introduction, growth, and pay-off describe the economic effects of open data. At the first stage, there is the opening of data sets and the submission of these, mostly based on marginal costs by a public institution (Preische, 2014).

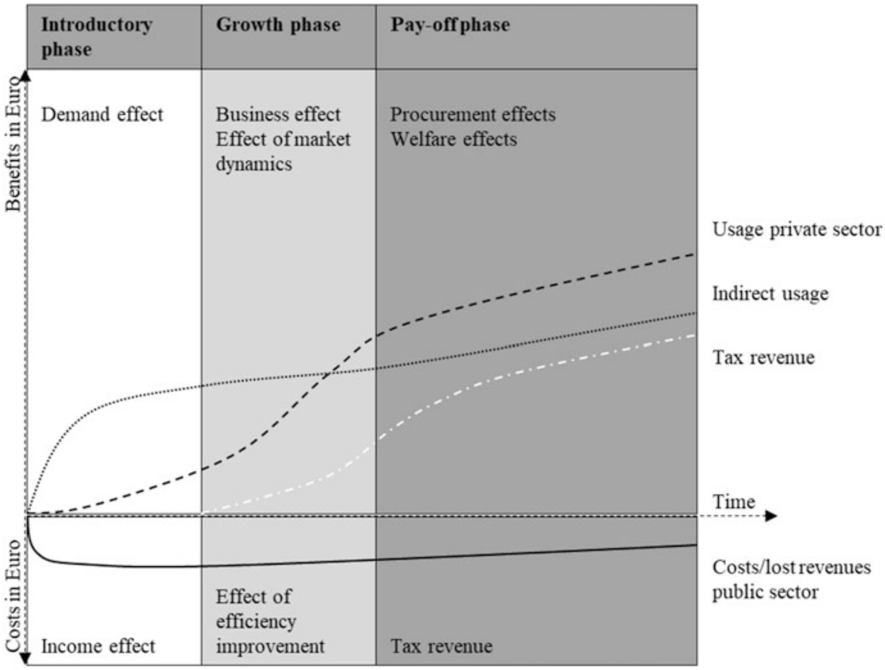

Fig. 10.3 Economic effects of open data (Preische, 2014)

Fig. 10.3 shows the three stages of economic effect. A specific time course (in years or decades) is not evident.

In the introductory phase, the demand for data increases with the absence of a fee. The acquisition costs reduce the attractiveness of increasing data for the user groups with a demand effect. On the supplier side (public institution), negative income effects arise. These income effects develop from the loss of income from data sales. At the same time, the increased demand from user groups can lead to an increase in costs (Preische, 2014).

The growth phase follows the introductory phase. Three effects become visible: the business effect for the user groups (1), the effect of market dynamics (2), and the supplier-side effect of improving efficiency (3). The business effect for the user groups (1) shows the form of larger sales quantities. Also, lower prices without any loss of profit become visible. At the same time, transaction costs fall. An effect of the market dynamics (2) arises from the fact that the entry barriers have fallen by reduced costs. At the same time, established market participants offer incentives for further market participants through profitable results. More competitors are pushing into the market and putting well-established market participants under pressure. The established market participants can only escape this pressure from new competitions by innovations. If there is no response like innovation, they are likely to exit the market. The provider-side improvement in efficiency (3) arises from falling transaction costs and saved resources. Certain cost-intensive administrative structures from the introductory phase are gradually being dismantled (Preische, 2014).

The pay-off phase follows the growth phase. The tax revenues generated by the public institutions using open data exceed the costs incurred for establishing and operating data portals. The lost income by free data gets amortized by the tax revenue or exceeds it. Furthermore, the market dynamics lead to economic growth and the creation of new jobs, so that an employment effect arises. There are also welfare effects. These effects create indirect benefits for citizens that cannot be directly measured in monetary terms (Preische, 2014).

The sum of the effects shows the added value of open data. It becomes clear that economic effects are not easy to classify as they often do not occur directly but indirectly.

How Great Is the Added Value of Open Data?

The value creation potential of open data reports in different studies with divergent numbers. Values between €12.1 billion and €131 billion in value creation potential are calculated for Germany over the next ten years. In the case of geodata, there are direct growth and value creation effects. It can be empirically proven that many mobile applications have only become possible because of location-related data. Those applications generate sales that are, in turn, VAT deductible. That means that open data in the form of geospatial data contrasts with direct sales (Klenk et al., 2020). The Konrad-Adenauer-Stiftung has developed a formula to determine the benefits (B) of open data (Dapp et al., 2016):

$$B = I\lambda 1 \times \lambda 2 \times \lambda 3 \times \varepsilon$$

B = Benefit; I = Income/costs; $\lambda 1$ = Cost multiplier; $\lambda 2$ = Benefit multiplier (direct); $\lambda 3$ = Benefit multiplier (indirect); ε = Elasticity.

Due to the early phase of open data, there is little or no data on the economic impact. Calculations that try to quantify the economic effect are only of limited informative value. Those calculations work with many assumptions and thereby reduce the informative quality. The costs for open data cannot yet be determined. Direct and indirect economic effects can currently only be estimated. That makes a cost–benefit calculation very imprecise at this point. Comparisons from abroad are only possible to a limited extent because different countries make different political decisions. That makes the comparison with Germany exceedingly difficult.

Challenges to Unlocking the Potential of Open Data

The idealized publication process in administrations of open data and a lived data culture contrast with the diametrical picture that is currently in practice. Diverse challenges are emerging. Those challenges must be solved to increase and unlock the economic potential of open data. The study by Tuncer et al. (2020) examines the challenges of public administrations. To this end, 19 expert interviews were conducted with municipal decision-makers. The results consist of five possible solutions to meet the current challenges in data use in municipal administration. These are presented below.

Challenge 1: Missing Holistic Data Strategies in the Administrations

There are hardly any data synergies in the administrations. Data are often collected multiple times because they are relevant in different departments. Synergies rarely exist here. It is also becoming apparent that there are heterogeneous degrees of digitalization in the administrative departments. While individual departments work fully digitally, data is recorded and processed manually in other departments. The result is data silos in separate areas. Single departments provide solutions for these challenges. All these solution approaches are to be assessed qualitatively, as the narrow understanding in the broad administrations only allows for single solutions which do not provide any assertiveness. The background to these diverse problems is the lack of holistic data strategies with uniform standards for the publication of data in administrations.

Challenge 2: Build Data Literacy in Administrations

Competencies in data analysis, collection, processing, and interpretation must be built within the personnel level of any administration to exploit the potential of open data. Most of the training offers by public bodies address the error-free application of legislation. The trainings' focus is therefore not on data analysis. Training courses can prepare administrative employees for their future tasks and sensitize them to the potential added value of open data. External service providers are currently being used to analyze internal administrative issues and the resulting political effects. To use databases systematically and efficiently, internal data competence is needed. Further training can build up data competence in an administration.

Challenge 3: Technically Improve Data Transfer

Different tasks arise within the administrations, which have varied solutions from municipality to municipality. These solutions contain various data formats: standardized, partially standardized, or open procedures. As a result, the fragmented technical process landscape makes the internal and external exchange of data more difficult. This means that analyzing data across several municipalities is impossible. Uniform data structures and specialist procedures could help here. Public IT service providers could provide technical support.

Challenge 4: Exchange of Municipalities

Administrations are self-sufficient in many areas and have a constituent agenda. The municipalities act within a local radius. Synergy effects can arise from exchanging solution ideas with other administrations. They may have similar problems and already have a solution. By exchanging transmitted solutions from other municipalities, synergies for data solutions arise.

Challenge 5: Strengthening Competencies in Data Protection and Security

The collection, storage, processing, and publication of data go hand in hand with a diverse interweaving of legal regulations. That means that there is high legal uncertainty in administrative practices. True to the motto: “Better nothing than wrong,” a lot of data are not even published because those who are responsible are legally uncertain. Privacy concerns nip any form of data publication in the bud. In general, there is a lack of in-depth knowledge on how to avoid data protection conflicts. Clarification and updating of data protection and data security are required here and certification of providers and data products can also help.

Conclusion

The digitalization of German administrations and municipalities was and still is overdue. In the past, many administrative services, communication between the authorities, and internal and external processes ran analogously. In the past, for many civil services, communication between the administrations and internal and external processes still ran analogously. That has created enormous inefficiencies.

Digitalization offers a solution for improving internal and external processes. The road to complete digital management is still long, but the first steps have been taken.

A byproduct of digitalization is the topic of open data. The data silos of the authorities can have a high economic added value. However, the silos' data only develop their power when they are getting published across the board. Uniform standards are necessary for intelligently linked data. The data must also be consistent and valid. Besides, data must be easily accessible and easy to understand. Economic added value can only arise based on a robust data structure.

Data-driven innovations create new business models and processes become more effective and efficient. Civil societies and businesses have a right to these data innovations, as they were collected by public authorities and thus financed by taxpayers' money.

But what expectations can users of open data have for the future? The ambitious goal to digitalize all internal and external processes of the administration until 2022 will be hard to complete. However, with the digitalization strategy, a large pool of data will be available in Germany for the first time. Examples from abroad show that diverse new business models can arise from those data. These examples show intelligent traffic systems, links between geodata and environmental data, traffic or infrastructure data, and promising business models. There will also be efficiency effects in public administrations. Besides, data-based political decisions (at all levels) are possible. Time will tell how quickly and comprehensively the scenarios emerge.

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