FiDL Working Papers

Editor: Prof. Dr. Christoph J. Börner
Chair of Financial Services, Heinrich-Heine-University

Working Paper No. 2 (2018)

Coexistence of Cryptocurrencies and Central Bank Issued Fiat Currencies
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A Systematic Literature Review

Second, revised version
First version: December 2018

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ISSN 2625-7041 (online)
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Düsseldorf, Germany, May 2019

We gratefully appreciate any commentaries from participants of the 8th International Conference on Business, Economics, Management and Marketing on 6th-8th March 2019, held at University of Oxford, St Anne's College, United Kingdom and and of the UniCredit/HVB Doctoral Colloquium 2018, Siegen, Germany.

Abstract

Since the amount of simultaneously circulating cryptocurrencies is increasing rapidly worldwide, this study aims to question the effects on competition between privately issued cryptocurrencies and central bank issued fiat currencies by postulating a coexistence theory despite extreme scenarios. This systematic literature review provides a comprehensive, detailed overview and analysis of the relevant contributions on currency competition and coexistence and develops a theoretical framework of the main ideas and functions of cryptocurrencies as well as a brief summary of the currency approach. Furthermore, it categorises current findings in finance literature into major categories to introduce further research on coexistence. To proof a lack of research, we conducted a systematic literature review to outline previous research and highlight its gaps. We find that the literature reveals convergence towards the hypothesis of a lack of research in coexistence and competition concerning the inter-market situation of privately issued cryptocurrencies and central bank issued fiat currencies.

Keywords: *digital currency, cryptocurrency, bitcoin, fiat currency, currency coexistence, parallel currency, currency competition, literature review*

JEL Classification: E42, E51, G29

1 Introduction

1.1 Research Motivation

When F. A. Hayek introduced his ideas on domestic private currency competition in 1976, and M. Friedman presented his case study on the stone money in Micronesia in 1991, they could not anticipate that decades later their ideas of parallel circulating private currencies without physical exchange would come in a cryptographic code (Weber, 2014; Friedman, 1991; Hayek, 1976). Since the publication of Satoshi Nakamoto's white paper in 2008 and the introduction into circulation in 2009, *Bitcoin* was the first privately issued cryptographic currency starting the digital coming of age, followed by nowadays over 2100[1] cryptocurrencies with an actual market to study. With a daily increasing amount of issued currencies, cryptocurrencies are challenging the current monetary and payment system. A rising share in overall economic transactions and a huge media interest lead to a rapidly increasing attention for industry, the public at large as well as academia (Vigna and Casey, 2015; Frisby, 2014), with *Bitcoin* being the most prominent (Huberman et al., 2017). While technical as well as economic research find several answers on questions whether cryptocurrencies are either a disruptive innovation or just a speculative technology to fail, there are still fields of little academic research. Furthermore, the literature tends to be fragmented by disciplines. Studies related to finance, law (e.g. Plassaras, 2013; Grinberg, 2012) and computer science literature (e.g. Catalini and Gans, 2016; Böhme et al., 2015) are overlapping in several directions. Therefore, this review outlines several concepts in current cryptocurrency research with the aim to highlight a gap in financial literature.

Regardless of assuming cryptocurrencies to be a medium of exchange or a speculative asset, there are three different directions, in which cryptocurrencies are able to develop in the future. A lot of research in fields of disruption, which argues cryptocurrencies to replace existing payment systems, counters for fiat currencies to be the only legal tender and therefore cryptocurrencies to fail in the longrun. The question comes up if it is possible for currencies, not to crowd out one another, but to coexist as a parallel currency, which would postulate a third direction of causality. Since the corner solutions of disruption and failure are exhaustively investigated, we aim to strike a balance in examining

[1] Exact amount of cryptocurrencies: 2194; effective May 21, 2019 (https://coinmarketcap.com/).

the coexistence of privately issued cryptocurrencies and central bank issued fiat currencies. History has shown many examples of dual or multiple currency economies[2] and more recently they can be observed in emerging countries of e.g. Latin America. The case of cryptocurrencies differs as they claim to be international currencies, used for worldwide transactions. Moreover, the distribution process that is wider and more dispersed than before and the possibility of commiting devices through the protocols, make cryptocurrencies vary from former private currencies. Some do even claim *Bitcoin* to become a universal currency (Huberman, 2017; Ammous, 2015). Since there has been private currencies before and hence the competition or parallel usage of currencies has been investigated before, our analysis contributes in the way that we expect to have a coexistence between cryptocurrencies and fiat currencies and at the same time addressing the competition between privately and central bank issued currencies. The question that occurs is not only on the ability of cryptocurrencies to survive, but even to coexist with fiat currencies over time (Sauer, 2016; Rogojanu and Badea, 2015).

The current situation results in a competition of currencies, intra-market and inter-market, which would in correspondence to F. A. Hayek, be a benefit for the whole monetary economy (Hayek, 1976). This paper further elaborates on the theoretical grounding of choice in currency and currency competition (Camera et al., 2004; Hayek, 1976; Klein, 1974), coexistence theories (Bryant, 2005; Wallace, 1980) and the utility from the use of money (Farrell and Saloner, 1986) as well as network effects and switching costs (Luther, 2016a; Katz and Shapiro, 1985; McKinnon, 1963). Regarding the theoretical framework, a coexistence would therefore result in more valuable goods (here: money), free of choice to stop inflation and make constant average prices and diversification possible.

Since competing currencies are not new to scholars, most papers analyzing the cryptocurrency phenomenon have either been descriptive (Böhme et al., 2015) or have dealt with governance and regulatory concerns from a legal perspective (Chuen, 2015). An extensive amount of research covers the question whether cryptocurrencies, respectively *Bitcoin*, are a currency in means of payment and as a medium of exchange or rather a speculative asset (Beer and Weber, 2015) in context with classical portfolio theory. While current research lacks to find answers concerning a possible coexistence of

[2] For a detailed overview of the historical development of private currencies and dual or multiple currency regimes see Hong et al., 2018; Dowd and Hutchinson, 2015; Camera et al., 2004; Dowd, 1993.

cryptocurrency and fiat currency, we assume to have a lack of research for that specific topic. To identify a potential research gap we gently review published literature on the topics of currency competition and coexistence in the field of business research, especially financial economics. The focus lies on cryptocurrencies in a wider view by indicating that the money functions are fulfilled for cryptocurrencies in general and therefore reviewing literature from a currency perspective. What strikes out in either way is a focus on *Bitcoin.* With a dominance of over 55%[3], *Bitcoin* is the most prominent currency among available cryptocurrencies. Due to its popularity as well as its dominance, market capitalization and availability of data, it is also the most dominant in technical and economic research. Therefore, we further examined literature on *Bitcoin*, whilst we tried to isolate it to focus our study on privately issued cryptocurrencies in general.

Against this backdrop, we argue to conduct a reproduction on the coexistence of privately issued and central bank issued fiat currencies in the matter of cryptocurrencies in particular. Therefore, we examine the relevant literature on inter-market competition among currenices and investigate if and how the topic of simultaneously circulating currencies in means of a coexistence is considered in previous research. As this is not the first literature review to study private money, our emphasis is different from previous research in a matter of perspective as from the point of a parallel, coexisting currency (Pautasso, 2013). Respectively, we assume the parallel circulation and usage with a currency not backed by a commodity without any physically character. This systematic literature review aims to shed light on an important topic in the field of cryptocurrencies, which might give important implications for scholars as well as for practitioners in means of monetary policies, as this is the first attempt to review existing literature within this particular field of research.

1.2 Objective of the Paper

This paper aims to conduct a literature review of the current research within the field of financial economics. To identify the assumed gap in research literature, we will look at cryptocurrencies from a coexisting and parallel currency perspective. Therefore, we do not question whether cryptocurrencies are identified to be a financial asset or serve as a currency as prior research has shown evidence in each

[3] Exact *Bitcoin* dominance of 56.7% effective May 21, 2019 (https://www.coingecko.com/en/coins/bitcoin).

way (Smith and Kumar, 2018; Ammous, 2018; Yermack, 2015; Briére et al. 2015). Therefore, the three money functions are not considered and been assumed as given. Neither do we question the disruptive nor the failing character of the technology cryptocurrencies are based on. Previous research predicts a high dynamic for the underlying technology along with the whole field of academic research. Therefore and concerning its novelty, a brief overview into the direction of a parallel currency literature and recent developments is provided in this paper. We do not compare this to currency competition during the time of free banking for the reason that cryptocurrencies differ, as they are fully fiduciary, not directly related to credit and can also work as sophisticated, automatic escrow accounts.

This study delivers signification for both scholars and practitioners. For scholars in general as well as in the area of economic and monetary research, we seek to identify a novel field of research that focuses on the interaction of both fiat currency and cryptocurrency as well as a possible outcome or perfect equilibrium. As literature on cryptocurrencies tends to be fragemented by disciplines, working definitions of the key terms are provided for further research (Zorn and Campbell, 2006) in order to distinguish among different definitions and synonyms for virtual currencies. For practitioners, we show that there needs to be more sensitivity besides the corner solutions as it aims to motivate the development of the technology as well as the integration into the existing monetary system and to consider interaction effects of different systems instead of driving one another out and taking an isolated view.

Due to the conceptual framework of the literature search, the paper itself is organized by the identified concepts. The structure is composed as follows: After a brief definition of the key topics, Paragraph 2 embraces the theoretical background as well as the methodology. Section 3 analyses and synthesizes the main results of the research, whilst section 4 discusses the approach and different concepts of the literature reviewed. Paragraph 5 concludes.

1.3 Definitions

1.3.1 Fiat Currency

In terms of this study, we define fiat currencies, according to the European Central Bank, as any legal tender, issued and designated by a central authority of that people are willing to accept in exchange for goods and services because it is backed by regulation, and by cause of trust for this central authority

(European Central Bank, 2015). The most common form of currency backing is therefore at the sovereign state's government level.

While there are many different currencies worldwide, each currency is traditionally issued centralized by a single monopolist, the central bank, which is typically a government organization, following the objective of price stability. Private intermediaries can offer inside money, but in doing so are regulated and constrained by central banks or other bank regulators, and often need to obtain central bank money to do so (Schilling and Uhlig, 2018). To define fiat currencies for this study, we assume it to be a central bank issued and therefore regulation backed legal tender (in means of payment).

1.3.2 Cryptocurrency

Following He et al. (2016), a clear differentiation between the definitions of money has to be given before investigating deeper in this research field. Digital currencies can be seen as a superior term of any value represented digitally (with no physical counterpart), which is denominated in legal tender (e.g. *PayPal*). Hence virtual currency represents a medium of exchange that operates like a currency in some environments, but does not have all the attributes of real currency, which points out the absence of legal tender status in any jurisdiction (Ammous, 2018; Dibrova, 2016). Moreover, cryptocurrencies are virtual currencies using cryptography to validate, which represent a decentralized, digital value, issued by private developers and denominated in their own unit of account (He et al., 2016). This means they have no central authority in control of monetary policy like the previous defined fiat currencies, but are convertible to real-world goods, services or money (Peters et al., 2015). Thus, they can be obtained, stored, accessed, and transacted electronically, and can be used for a variety of purposes, as long as the transacting parties agree to use them. For that reason, virtual currency is based on the idea of exchanging value without the approval of an institution (Maftei, 2014).

Bitcoin, as the most popular and cited cryptocurrency, is often used as a synonym, which is not adequate within this review. It can simply be described as a decentralized ledger of transactions. The role of the verifying third party, found in centralized systems, is played by the *Bitcoin* network participants, who contribute computational power and are rewarded in the form of new amounts of cryptocurrency (Peters et al., 2015). A detailed explanation of how digital currencies and the Blockchain,

especially of *Bitcoin* work, can be found in Böhme et al. (2015), Fry and Cheah (2015) and Nakamoto (2008), we therefore introduce cryptocurrencies only briefly by definition.

Though all definitions are used interchangeably in literature to some point, attention has to be paid to use it in the right way. Due to the fact of popularity and data availability, most research is on *Bitcoin.* This automatically implements a cryptocurrency, sometimes it is even used representative for cryptocurrencies in a generic manner. When comparing all these currencies, it is important to distinguish between *private digital currencies* and *digitization of state- issued currencies* (Gans and Halaburda, 2015). In means of this review, we cut out the state factor for digital currencies and define it as privately issued cryptocurrencies, offering direct peer-to-peer online payments via a Blockchain.

1.3.3 Intra-Market and Inter-Market Competition

Since the distinction between different types of currencies, even within one single type tends to be quiet unclear, the possible combinations for different competing markets get even more confusing. Therefore, a determination and defintition of the relevant markets for the study is given. While intra-market competition investigates the interactions between currencies of the same type, as in fiat currencies e.g. between Euro and US-Dollar or in cryptocurrencies between *Bitcoin* and *Ether*, inter-market competition involves different types of currencies, as between privately issued cryptocurrencies and central bank issued fiat currencies. This means for example between *Bitcoin* and Euro, as they differ extrinsically and intrinsically. Competition, either if intra- oder inter-market, also means that a currency can be exchanged for other currencies on an exchange rate, but this means that the issuer must support a competing currency (Østbye, 2017). This paper aims to examine the inter-market competition as assumption of a coexistence.

1.3.4 Coexistence and Parallel Currency

If more than one currency exists alongside, they do theoretically coexist. Coexistence in this context means that different kinds of money have their very own demand and therefore do not drive each other out but circulate parallel (Bryant, 2005). This, as a result of imperfect information, is possible for noninterest-bearing money and interest-bearing default-free securities as also of private notes and fiat money (Aiyagari et al., 1996). Theoretically, coexistence means that the counterparts exist

independently next to each other. Since it is hard to claim an independence between currencies, the termini of substitute, complementary and parallel currency have to be taken into account. While currency substitution means the use of a foreign currency instead of the domestic, a complementary, non-national currency therefore serves as a supplement or complement to national currencies (Costanza et al., 2003; Baliño et al., 1999). Furthermore, parallel currency is qualified as an additional source of money creation with its own independent monetary implications (Vaubel, 1990). In terms of coexistence, we therefore focused on definitions of parallel currencies and moreover complementary application. Hence, we define the coexistence as deposited in this review as a *parallel existence and interaction of inter-market competing currencies.*

2 Theoretical Background

2.1 Methodology

Since the amount of literature on cryptocurrencies within the field of technology is growing rapidly, this review claims the existence of significant gaps in current financial economic research. Most of the researchers try to answer questions about the existence as a currency or asset and argue from an investment theoretical point of view (Appendix A and B). Thus, this review tries to elaborate understanding for a novel perspective despite the corner solutions of being either a disruptive or a failing innovation. As this review only examines the economic factors and the financial approach of a competing cryptocurrency to fiat currencies, we do not emphasize ans search for technological aspects. Therefore, the systematic background of the Blockchain is disregarded.

A literature review, as subsumption of summaries, is essential for almost any research project (Fisch and Block, 2018). It serves as the means to reveal open research gaps and is part of a larger research endeavour (Ridley, 2012; vom Brocke et al., 2009). Furthermore, it can be conducive for gaining new as well as synthesizing existing research to support the identification of methodologies and concepts commonly used in a specified field (Hart, 2018). By identifying critical knowledge and concepts, it is conducted to uncover novel research areas and to motivate researchers to close this breach (Webster and Watson, 2002; Rowley, 2004).

Following the taxonomy of Cooper (1988) a literature review focuses on research outcomes with the goal to identify central issues in order to define the scope of the review. With a conceptual organisation and a neutral presentation, it aims to exhaustively cover the topic for specialised scholars and to identify a research gap (Rowley and Slack, 2004; vom Brocke et al., 2009). This also includes the development of keywords as well as the creation of definitions within the review process. We therefore follow the research and reviewing scheme of vom Brocke et al. (2009). Hence, we determine the scope and the topic conceptualization before a literature search is conducted. Thereupon we analyse and synthesize the identified contributions in order to identify a research gap.

2.2 Scope & Topic Conceptualization

The paper focuses on the general research contributions within the field of cryptocurrencies. The review is conducted and organized conceptually (Fisch and Block, 2018) to identify and integrate central issues (Cooper, 1988). The evaluation of the underlying concepts should guide the subsequent analysis (Fisch and Block, 2018) in order to identify gaps and to give incitements for further research. Although the framework is structured by concept, due to the novelty of the field of cryptocurrencies, we will also establish a general research baseline by a wider keyword-database search on *EconLit* as well as on *Google Scholar* to make sure to identify all the relevant research papers. Detected literature is structured by concepts, which determines the framework of the review. Focus lies in the economic use as a currency, while the approach as speculative asset as well as the disruptive characteristics, security aspects of technologies and especially the blockchain technology are excluded, as the literature tends to be fragmented by disciplines. Limitations have been made concerning the period of interest, which reaches from 2009 to the present of 2019, due to the first cryptocurrency *Bitcoin* has been introduced into circulation in 2009. Concurrently, we try to isolate *Bitcoin* as it is often used synonymous for cryptocurrencies. We also limited the review to English, peer-reviewed publications and working papers. Considering the peer-review and publishing process of academic journals, contributions with a working paper status older than four years (before mid 2015) have been excluded, as this would lower the academic level of the review

The major topic and therefore concept of the review is the coexistence of privately issued cryptocurrencies and central bank issued fiat currencies, which was previously defined as a *"[...] parallel existence and interaction of inter-market competing currencies"*. The review aims to examine how previous and current literature contemplates the possibility of coexistence. Papers that did merely attach the existence, coexistence or focussed on the failure of cryptocurrencies in general, especially compared to traditional central bank issued currencies, were not considered any further. To gather a deeper understanding of the competition concepts of currencies, contributions concerning the sub concept of intra-market competition have been considered as they mentioned a possible coexistence or did a pledge for the longterm existence of cryptocurrencies without being disruptive. The first selection based on abstracts and keywords assessed the relevance for the study. Respectively we have selected the keywords *Currency Coexistence, Currency Competition, Parallel Currency, Cryptocurrency* and *Digital Currency*.

2.3 Literature Search

The literature search was divided into the three main phases of keyword, database and backward/forward search. First, we searched generally for different concepts across various platforms to identify the major points and fields of research. We employed around 32 keywords to cover unrelated topics and to find new keywords (Galvan and Galvan, 2017). We reduced those to the 5 most important after we found saturation in the relevant areas and excluded unrelated concepts such as information technology related conceptualization (excluded in the scope before). The primary focus has been on the keywords *Currency Coexistence, Parallel Currency, Cryptocurrency* (as well as *Crypto AND Currency)* and *Digital Currency* (as well as *Digital AND Currency*). Since the keywords on coexistence did not reveal any relevant literature (Appendix A), we investigated for the subordinated topic of competition with the related keyword of *currency competiton* and *cryptocurrency competition*. Due to the fact that most of the research is on *Bitcoin*, and most researches use *Bitcoin* vicariously for Cryptocurrency, we

also conducted the same keyword search and added *Bitcoin*[4] to every single keyword as well as we searched for *Bitcoin* only (Appendix A).

In phase two, we conducted a database search based on the identified relevant keywords. First, we started out with a general database scan for a brief overview of existing literature. As we searched three different databases *NEXIS*, *wiso* and *EconLit*, we found either the exactly same results or less. Therefore, we focused our research on only one of the mentioned databases and selected *EconLit*, which is run by the *American Economic Association*. Since the service focuses on literature in the fields of economics and uses the JEL classification, we qualified it as the appropriate search engine. As it provides access to about 750 journals, it allows ensuring that all relevant sources are included in the database. This makes it possible to conduct a topic-based search instead of a journal-based search to gather a broader overview on relevant literature (vom Brocke et al., 2009; Webster and Watson, 2002). Although cryptocurrenices are a topic of interdisciplinary interest, we did exclude literature in related areas like computer science, psychology and operations research, since the research questition is only motivated economically. This again justifies the topic related search instead of the journal-based search. Finally, there is no sufficient reasoning for a journal based proceeding, it does not need any further justification for a topic-based search (vom Brocke et al., 2009; Jasperson et al., 2002).

Within the database search, we restricted our search by period of time, language and peer-reviewed journals and working papers (as of mid 2014 onwards). As they have typically been peer-refereed before publication, it is commonly recommended to focus on articles published in scholarly journals (Rowley and Slack, 2004) or proceedings of renowned conferences (Webster and Watson, 2002) as well as due to the dynamic and novel research field to review working papers. Since the quality of contributions in conference proceedings is usually considered lower and less mature than those in journals (Levy and Ellis, 2006), we argue to exclude those articles from our review. Furthermore, we excluded books and dissertations. The language of the articles was manifested to be English, as this is the academic language and the review attemps to reach out for international scholars. After the practical and methodological screening (Fisch and Block, 2018), the contributions identified (duplicates have

[4] A keyword search for *Ether* and *XRP* has also been implemented but did not reveal any results, which proves the hypothetical assumption about *Bitcoin.*

been removed)[5] have been scanned by abstract for relevance (Appendix B). We studied the remaining literature due to their concepts and selected 27[6] remaining articles that build the basis of the review (vom Brocke et al., 2009). Those have been mapped into a concept matrix according to Webster and Watson (2002), as shown in Appendix C, to identify the key concepts. Thus, this follows also the concept centric approach of the review, which provides the opportunity to uncover relevant search items (Rowley and Slack, 2004).

To make sure that no relevant literature is disregarded, we did a backward and forward search in phase three of our literature search process. We went backward by reviewing the bibliographies of the articles identified in the previous step to determine prior articles (Webster and Watson, 2002). Due to the fact, that the relevant period was determined very strictly to the time after Nakamoto's launching of the open source software for *Bitcoin*, the backward search did only reveal a single further contribution that has not been detected on *EconLit* before. The dynamic and the presence of the topic, as well as the fact that it might take some time to investigate a coexistence, might also be reasons for a forward search oriented outcome. To proof this and to show the impact of the papers we identified before, we conducted a forward search afterwards. We used *GoogleScholar* as search engine (esp. for forward search) to identify articles citing the key articles and determined which of these articles should be included in the review (Webster and Watson, 2002). An overview of the results is given in Appendix D. By gently removing speeches, books and presentations, which are included in its database, we examined 6 peer-reviewed relevant papers. The relevant articles identified in the backward and forward search were added to the concept matrix. The cited references show that the topic is highly relevant. An evaluation of the subjects has been made by limiting the amount of literature through out the whole process to only those articles relevant to the topic at hand (vom Brocke et al., 2009; Levy and Ellis, 2006; Torraco, 2005; Webster and Watson, 2002; Cooper, 1988). Although we reach theoretical saturation of the topic of coexistence and parallel currency theories, we cannot claim to do an exhaustive literature review due to the exclusion of interdisciplinary research.

[5] The results of the keyword search are stated in Appendix A, as representation of all first considered keywords.

[6] A first selection resulted in 26 but developed to 27 after a later backup scan. A revised version has been found (*marked in the concept matrix). Since the former version is published under a different title and thus still in circulation, we had to consider both articles.

That being said, certain fields of the concept matrix, which remain nearly 'blank' during the literature study, often highlight research areas that are significantly under-researched (vom Brocke et al., 2009). We retrieved 1416 total hits, which we broke down to 469 relevant articles after eliminating by language, period of time and journal. After a subsequent scan of abstracts, 188 articles remained to be studied further. Once duplicates have been removed, ultimately 33[7] research contributions overall were found in the databases to be reviewed. This selection led us to explore and examine our research question in the following.

For a sufficient literature review, the collected and identified literature has to be analysed and synthesized (Webster and Watson, 2002). We do so by evaluating the concept matrix and identifying subordinated categories of interest. After a critical analysis of existing literature the synthesis tries to reconceptualise the developed topics in order to provide a new approach of thinking about the subordinated topic and to uncover and manifest a research gap (Torraco, 2016). In accordance to the analysis and synthesis, a research agenda is formed within the last phase of the review, according to vom Brocke et al. (2009). The synthesis is supposed to result in a research agenda to structure the main findings on future research as well as to create a baseline for research in the economic field of cryptocurrencies. Hence, the literature review may be extended to some point.

3 Analysis and Synthesis

3.1 Overall Observations

We figure in our research, that due to the assumptions made before, the literature on cryptocurrencies and currency competition is very fragmented and on a high level of popularity. Instead of analysing every of the identified concepts, we try to categorize them, after sorting out the most common ones which are attached to the technical topics or major concepts of every research paper (Torraco, 2016). Therefore one or more concepts can be combined in a subordinate category to be identified, analysed and synthesized as stated by Webster and Watson (2002). Our study investigates three major concepts,

[7] We retrieved all articles on March 4, 2018 and double-checked the results in a backup scan for the revised version on April 23, 2019, to make sure that none significant contribution is missed out. This resulted in 4 more relevant contributions whilst we had to reject one former contribution due to a continuous working paper status before 2015. To ensure consistency within the survey period, the 5 main keywords remained the same.

of which the quantitative as well as the qualitative relevance is nearest to our subordinated research goal. Hence, those are chosen to be the center of the review in order to investigate the state of the art in cryptocurrency research and justify the conducted review (vom Brocke et al., 2009; Webster and Watson, 2002). Overall, 33 academic papers have been selected to be reviewed in the following of which at least two[8] seem to be developed versions of relating publications of the authors. However, since they are both published and under different titles, they are considered independently within our study.

In total, 28 concepts are identified in the overall literature search, as can be seen in the concept matrix (Appendix C), and mapped into 3 categories (Table 1) to be analysed in the following. Each of these concepts is represented 11 times in average while the average paper contains 9[9] concepts. The relevant literature consists primarily of topics related to the corner solutions. Even if a possible coexistence or parallel character is mentioned, most of the research finds a clear answer in the end, of the currencies, either fiat und crypto, of cutting each other out. Note that the study ignored all issues related to the concepts of assets and investment functions. In addition, there is a lot of research on the topics of E-Money, Mobile Money, Platform-based money (e.g. *Facebook*-Money) as well as concepts like Linden-Dollars. We have refrained from pursuing that here for concept-centric reasons.

Category	Concepts
Currency Approach	Bitcoin, Altcoin, Blockchain, Virtual Currency, Digital Currency, Cryptocurrency, Platform-Based Currency, Private Currency (not crypto), Currency, Usage/Adoption, Central Bank issued Cryptocurrency, Asset
Competition Approach	Disruption, Mining Competition, Intra-Market Competition, Inter-Market Competition, Coexistence, Failure/Bubble Overall, Failure/Bubble of Bitcoin, Efficient Market Hypothesis, Pricing, Privacy/Security, Intermediation
Coexistence and Parallel Currency	Coexistence, Parallel Currency, Emerging Markets, Niche, Exchange Rates, Central Bank issued Cryptocurrencies, Taxes and other Official Payments, Regulation, Blockchain

Table 1: Concept Categories

[8] Fernández-Villaverde and Sanches (2018) and Rogojanu and Badea (2015) as can be seen in the concept matrix in Appendix C.

[9] The exact value of the average amount of concepts represented is 11.5 and the concepts per paper is 9.76 as it can be seen in the sum calculation in the concept matrix in Appendix C.

While some of the concepts (e.g. digital currency, virtual currency) are related very strongly, we also ranged widely for other economic topics like *efficient market hypothesis* or *intermediation*. However, for presenting a clear and methodological proper review we categorized them to the common concepts of *currency approach, competition approach* and *coexistence & parallel currency* (perspective and functional approach). Thus, there is a wide range of definitions of usage of cryptocurrency interpretation; we also conducted the concepts of those different definitions and the *Bitcoin* approach, which was dominant.

3.2 Currency Approach

Despite the interdisciplinary fragmentation of the literature, it transpires that several notations for cryptocurrencies are used, which are hard to distinguish by different understandings of the currencies. For instance Fernández-Villaverde and Sanches (2017) and Fernández-Villaverde and Sanches (2018) define *Bitcoin* as privately issued fiat currency, which does not follow the definition of neither a cryptocurrency nor a fiat currency as previously determined for this study. Therefore, we control for the understanding of *cryptocurrencies* in general and identify that either adressing virtual, digital or cryptocurrencies, on the baseline they are closely related and do address an equal idea. Even *Bitcoin*, as stated before, is often used as a synonym for cryprocurrencies. For this reason, we do not separate the analysis by the definition and type of currency. Only for *Bitcoin*, a distinction is made, as in several articles, not the cryptocurrency in general is stated to fail or to not coexist, but the special technological system of *Bitcoin*, which is not supposed to work in the longrun.

Since we only searched for literature on the currency approach of cryptocurrencies, all of the 33 reviewed papers address the topic of usage, adoption and viability of a currency. Beer and Weber (2014), Carrick (2016) as well as Marimon et al. (2012) and Weber (2014) simultaneously address the asset concept, which we did not investigate any futher. Overall, the wording of cryptocurrencies (27) and digital currencies (16) is nearly used in the same way, while virtual currency is used in only 5 papers. The definition of virtual currencies used by Peters et al. (2015) implies a medium of exchange in an online virtual economy and typically used for virtual purchases while Sauer (2016) further states virtual currencies as money which does not exist in reality as a coin, bank note or bank deposit. Hong et al.

(2018) further state that digital currencies are internet-based media of exchange and include *Bitcoin*. Eight articles introduce the technique of the blockchain (as excluded in the review) before defining and analysing the currency component. What strikes attention is that more than three-quarters of the research is on *Bitcoin*. Some in focus, some in general as well as in focus, while only 4 of those mention the *Altcoins*. Gans and Halaburda (2015) defined *Bitcoin* as a fully convertible, purely digital currency which is not associated with a given platform. Suchlike definitions can be projected on cryptocurrencies in general. Other authors like Rahman (2018) do use the wording of digital currencies, but argue with the technology of *Bitcoin* without stating it in particular. Hence, we consider them in the review, although we try to isolate the research on *Bitcoin*. We also examine 5 papers which address only private currencies and not cryptocurrencies in particular. We consider them due to its possible projection on cryptocurrencies (Gans and Halaburda, 2015) and for the fact, that they do not exclude them since they do not address the technological component as a factor of possible competition or coexistence. As in means of our research question, we exclude research on the exclusive investigation of central bank issued cryptocurrencies, due to the fact that we consider the private issuance of cryptocurrencies for a possible coexistence. In our analysis, however, papers on central bank issued cryptocurrenies as a side topic or consequence are identified in seven of the reviewed articles (Fung et al., 2017; Garrat and Wallace, 2016; Raskin and Yermack, 2016).

3.3 Competition Approach

3.3.1 Intra-Market Competition

Since we postulated the connection of competition and coexistent prior in this study, the concept of competition is detected in 31 of the 33 reviewed articles and therefore approves our theroretical approach. We further distinguish between intra- and inter-market competitions to take a deeper look on both concepts. Literature on intra-market competition displays that for cryptocurrencies in general the market is very diffuse due to a dynamic and rapidly increasing amount of currencies. Since there are still nearly no restrictions to the private issuance of a cryptocurrency, there is no control over the market at all. Although the study focuses on the inter-market competition as required for a coexistence, we also

identify at least 10[10] articles concerning the intra-market competition. We consider them within the review because all of them argue for a purely private competition to fail which we presume to shed light on as well at this point. Fernández-Villaverde and Sanches (2017) as well as Fernández-Villaverde and Sanches (2018) argue that competition between privately issued fiat currencies, which they define for e.g. *Bitcoin* or *Ehter*, works only sometimes and partly. They construct a model, which is defined of two cryptocurrencies from our point of view. They show that in a competitive environment, the existence of a monetary equilibrium consistent with price stability crucially depends on the properties of the available technologies (Fernández-Villaverde and Sanches, 2017). Moreover, the study shows that a purely private monetary system does not provide the socially optimum quantity of money, although the equilibrium with stable prices pareto dominates all other equilibria[11] (Fernández-Villaverde and Sanches, 2017). As they introduce government to compete inter-market with private money in their model, they show that currency competition creates problems for monetary policy implementation. This will be considered further in the section of inter-market competition. At that point Rahman (2018) builds upon his study connected to Fernández-Villaverde and Sanches (2016) in exploring the consequences of digital and fiat currency competition on an optimal monetary policy according to the Friedman rule[12]. The author states first that a purely private arrangement of digital currencies will not deliver a socially efficient allocation (Rahman, 2018). Lastly Sanches (2015) ties on this opinion, when arguing that private money won't be able to compete due to the properties of endogenously determined limits when creating private money (cryptographical character absent). With an equilibrium analysis, the author assumes a collapse of the value and a decline in the demand for the money.

White (2015) and Luther (2016b) both describe the intra-market competition as the competition faced between *Bitcoin* and *Altcoins*. White (2015) compares it to giant nonprofit organizations to compete with smaller, as they still try to gather a market position. The Author further states to have competition within the *Altcoin* market but in the longrun not between *Altcoins* and *Bitcoin*, as *Bitcoin* in the medium of exchange for *Altcoins* into fiat money and vice versa (White, 2015). Luther addresses a

[10] Of those 10 articles, only two have been on intra-market only and did not mention an inter-market competition explicitly.
[11] In which the value of private money declines over time.
[12] The Friedman rule implies a standard deflationary policy where the nominal interest rate is zero, thus the opportunity costs of holding money (privately) should equal the social costs of creating additional fiat money.

possible first-mover advantage of *Bitcoin* which might be overcome by a second mover advantage of *Altcoins* in the longrun and therefore remain existing in the monetary system (Luther 2016b). Interactions between different currencies, especially in the case of private issuance, are also dependent on trust (Dowd and Hutchinson, 2015; Marimon et al. 2012). This component is studied further by Marimon et al. (2012) who qualify money as an experience good, modeled in a Bertrand competition with trust. They find that for efficiency purposes, trust is the main provider while competition does not play a role anyway. They also modeled this for competing fiat currencies, which is analysed in a later section. The dynamic surrounding and the competition between the cryptocurrencies themselves are often argued by the different technological approaches and argue that technology drives the bad one out (Raskin, 2016). Since cryptocurrencies differ by technological aspects and purposes, another possibility would be intra-market competition with completely equal cryptocurrencies. Researchers such as Garratt and Wallace (2016) who modeled the case of competing *Bitcoin* clones back this. They find in their theoretical model that the amount of equilibria is huge due to a random process of sharing demand and crowding each other out in a vicious circle. He claims for a competition to work if not trying to create perfect substitutes.

As we consider also the *Bitcoin* market in our keyword and database scan, we also detect a special form of competition only the *Bitcoin* market is facing, the competition among miners. We review at least two relevant contributions (Dowd and Hutchinson, 2015; White, 2015) on the existing competition among the miners of *Bitcoin*, who validate transaction blocks. As this topic is specially related to *Bitcoin*, either for the art of competition or its technical approach, we have refrained from pursuing that here. Also from an economical point of view it is unsuitable in the longrun due to economies of scale in the mining industry (Dowd and Hutchinson, 2015).

3.3.2 Inter-Market Competition

All the articles, despite Dowd and Hutchinson (2015) and White (2015), manage to transfer the results and findings on intra-market competition to the inter-market and compare or model it with central bank issued, sovereign fiat monies. We identify different resulting concepts. Either they follow the concept of a real competition between fiat currency and privately issued fiat currency in their pure

construction, or they model a central bank issued cryptocurrency as an additional form of competition, both will be analysed in the following.

When introducing private currencies to the monetary system ruled by central banks, several interactions are possible. First of all, Fernández-Villaverde and Sanches (2018) and Ferndández-Villaverde and Sanches (2017) as mentioned in the section of the intra-market before, develop their model by introducing government competing with private cryptocurrencies. For a socially efficient allocation, an alternative monetary policy rule is characterized for the government to provide the good money and support exchange in the economy (Fernández-Villaverde and Sanches, 2018; Ferndández-Villaverde and Sanches, 2017). They show that through the created competition problems for monetary policy implementation occur, when a money-growth rule is indicated. It would therefore be impossible to implement an allocation for the real return on money equaling the rate of time preference. Fernández-Villaverde (2018) follows that by stating a perfect competition, which might discipline the government into complementing better monetary policies. Building upon that, Rahman (2018) tries to draw conclusions from the competition of digital and fiat currency competition by modeling an optimal monetary policy according to the Friedman rule as mentioned before. The author argues that due to the profit-maximizing incentive of the miners and therefore a diminished money supply, a socially efficient allocation with a deflationary policy is only possible, if government drives out the digital currencies (Rahman, 2018). This assumes that there is acutally inter-market competition, but not socially efficient. In addition, Garrat and Wallace (2016) expand their model of *Bitcoin* clones by the introduction of a central bank issued, sovereign currency (Fedcoin) which in the end of the analysis, drives the private money out. The authors argue that under a fixed exchange rate the private supplier would have incentives to continually increase supply leading to an infinite price level. So, in fact, the Fedcoin proposal is really more about an alternative "form" of sovereign currency than a competing, private outside money (Garratt and Wallace, 2016).

On the other hand, Hendrickson et al. (2016) argue for a competition that will not crowd out the private money, but the fiat currency. The authors state that if *Bitcoin* is strictly preferred (exogenous) by some agents and the official currency is refused, the government needs to control a sufficient size of the economy. In a Keynesian money market model, Sauer (2016) also showed the crowding out effect

on national currency in a first attempt. Central banks adapt their money supply to the reduced demand, thus the overall money supply shrinks (Sauer, 2016). A competition situation in which *Bitcoin* is driving out fiat currency as a store of value is also possible for Hong et al. (2018). They argue a dual currency regime due to the decentralization of digital currency and the absence of sovereign authorities as insurance is a barrier for digital currencies to become a store of value but that its use as a medium of exchange will dominate (Hong et al., 2018). Further, the model is extended to a triple currency regime with private-issued digital currency, central-bank issued digital currency and fiat currency. This idea of a cryptocurrency issued by a central bank and not privately is conducted by several other authors (Nelson, 2018; Berentsen and Schär, 2018; Fung et al., 2017; Raskin and Yermack, 2016). Raskin and Yermack (2016) mention the issuance of a sovereign digital currency to remove the need for the public to keep deposits in fractional reserve commercial banks. This could lead to a serious de-funding of the commercial banking sector as this could have spillover effects into credit creation and monetary policy (Raskin and Yermack, 2016). This would result in omnipotent *uber-banks*. They could commit to an algorithmic rate of money creation and control it precisely via interest on customer deposits. This interest rate could be negative. Alternatively, the central bank could retain discretion to adjust the money supply on a tactical basis as part of a stabilization policy (Raskin and Yermack, 2016). Berentsen and Schär (2018) find that Central Banks should issue electronic money but not cryptocurrencies. Stating that a reliable government or central bank does not have any incentive and therefore welfare maximizing functions to issue a cryptographic based currency, the operational risk would be too high. They rather argue to have different institutions issuing different kinds of currency for differing demands. Borgonovo et al. (2019) refer to that in investigating the privacy component of cryptocurrencies as a third money function. In an experiment, they find that anonymity matters and therefore with taking a higher risk the affinity to use a cryptocurrency. Therefore there will not be a crowding our but a competition for different kinds of demand.

Since cryptocurrencies are not the first private monies to compete with fiat currencies, there are several authors, who investigate and compare the actual competition szenario with historical competition within in the currency market. Fung et al. (2017) do so by drawing lessons for digital currencies based on the evidence from Canada and the United States with bank notes and government issued notes. Digital

currencies likely will be counterfeited, will not be inflationary and will not be safe and a uniform currency without government intervention. However, since problems like transport of exchange or counterfeiting still differ from how the cryptocurrencies work, the comparison is not conducted very convincing in the end. Hence, they argue that a central bank can always get its digital currency into circulation, but its digital currency will not necessarily drive out existing private digital currencies (Fung et al., 2017). Gans and Halaburda (2015), who take a deeper look on platform-based currencies (e.g. *Facebook* Credits, *Amazon* Coins), draw another comparable analogy. The authors show that if the platforms were to allow for the reverse exchange of earned credits into state-issued currency, it would decrease platform usage which can be related to economic research on private digital currencies and digitized money transfer systems (Gans and Halaburda, 2015). Fernández-Villaverde (2018) finally finds comparisons for the theories of Hayek and Friedman.

Another fraction of researchers proposes that there is or will be competition in the currency market, but that *Bitcoin* will not dominate it in particular. Scholars such as Dowd and Hutchinson (2015), Peters et al. (2015) and Weber (2014) argue especially *Bitcoin* to be the point of failure but that lessons might be drawn to make other cryptocurrencies able to compete. Main reasons here belong to a predominantly technical failure and in means of money functions (Luther, 2016a; Dowd and Hutchinson, 2015; Weber, 2014). Berentsen and Schär (2018) and Raskin and Yermack (2016) mention conclusively that if given a free choice in competition situations, agents will possibly tend to use a neutral currency between the dominating. This encourages the statement of a competition with fiat currency, despite *Bitcoin*.

3.4 Coexistence & Parallel Currency

Since we analysed the research articles on inter-market competition, it became apparent that not every inter-market competition implies a coexistence or parallel currency. Most of the previously presented results address the corner solutions of extreme scenarios. Hence, we present the relevant research on the topics of competition, without considering a coexistence in detail. Despite the authors who claim a winner or loser in the subordinate market for currencies, Sauer (2016) as mentioned before, models a Keynesian national money market equilibrium as a combination of nationally-issued fiat

currency and globally-issued virtual currency (Sauer, 2016). This article states the potential of virtual currencies to become parallel currencies to national, for central banks no longer being the only issuer of money in means of payment. One of the most important conclusions is that central banks may lose money supply control and therefore one of the main instruments at their disposal to regulate inflation or maintain price stability (Sauer, 2016). Nair and Cachanosky (2017) stick to that with stating, that the use of a new currency can be done without stopping to use the incumbent currency when a network size is small.

The possibility of a new type of dual currency is also introduced by Hong et al. (2018). The author mentions the coexistence of a digital currency with no intrinsic value and a government-issued fiat currency to a threshold that equates the demand between the currencies. Dual currency regimes are often observed in emerging economies with dollarization. In some developing countries, foreign currency is officially used as a substitute for the domestic and it is often not easy to incentivize the market participants to hold the former currency. Therefore, an economy is referred to as a "partially dollarized economy" where the foreign currency is demanded as a medium of exchange as well as a store of value. The indicated, commonly known as transaction dollarization or currency substitution, is introduced by Hong et al. (2018) who bring up the topic of dollarization as a possible scenario for cryptocurrencies (and alternative currencies in general) to emerge in a dual currency regime. This goes alongside with observations in emerging economies with hyperinflation. The previously defined currency subsitution cannot be qualified as a coexistence since it crowds out the former domestic currencies (Luther, 2016a). According to that, Nelson (2018) postulates that cryptocurrencies dor or will coexist especially in countries where there is less confidence in the domestic currency or where individuals to not have financial access.

However, in some circumstances, we might also talk about a complementary currency to argue for a coexistence. The concept is focused by Gawthorpe (2017). Carrick (2016) and several other scholars, who refer to that by characterizing *Bitcoin*, as a symbol for cryptocurrencies in general, as a complementary currency, especially in emerging markets (Nelson, 2018; Gawthorpe, 2017; Carrick, 2016; Hendrickson et al. 2016). The author compares the relative *Bitcoin* price to the relative prices of major currencies and additionally to other emerging market currencies. Since the analysis shows a

negative correlation, he postulates that *Bitcoin* can be a complement to other currencies, not a substitute. Countries with weak economic circumstances tend to adopt a new form of currency more than those economically powerful. Thus inflation rate is an important factor for currency choice (Nelson, 2018; Fernández-Villaverde, 2018; Gawthorpe, 2017). The main hypothesis of the model of Gawthorpe (2017) is lower inflation rate in the scenario of currency competition. A resulting effect would be a more stable currency offered by central banks and therefore a parallel existence. This idea is also investigated according to the Friedman rule of a standard deflationary policy by Rahman (2018) who build up his results in the work of Fernández-Villaverde and Sanches (2016) as examined before (Rahman, 2018). Also do Nelson (2018), Schilling and Uhlig (2018), Raskin and Yermack (2016) and Rogojanu and Badea (2015) and Rogojanu and Badea (2014) in stating that a simultaneously use of digital and fiat currencies is possible, but do not determine to that and remain in a grey area (Rogojanu and Badea, 2015). The presence of cryptocurrencies may pressure central banks in a competition situation especially during periods when central banks are perceived as weak or unworthy, and therefore allow a parallel usage (Nelson, 2018). According to Nelson (2018), a total conversion into cryptocurrencies is not possible due to its fixed supply, which is exogenous to the demand. Also does Fernández-Villaverde (2018) in stating that cryptocurrencies will not provide optimal amounts of money or seliver price stability but improving the current means of payments in disciplining central banks. Hence, they will coexist in a way. Fung et al. (2017) reveal to that in postulating, that one currency cannot further exist without the other and that therefore cryptocurrencies and fiat currencies will be uniform. Additionaly, Szetela et al. (2016) conduct a GARCH model before, to investigate the relationship between the exchange rate for *Bitcoin* to the leading currencies such as Dollar, Euro, British Pound, Chinese Yuan and Polish Zloty. They identify that *Bitcoin* is independent from the influence of all of analyzed currencies. However, *Bitcoin's* conditional variance is influenced by the logarithmic rate of return of the leading fiat currencies (despite Zloty) (Szetela et al., 2016). According to that, Seetharaman et al. (2017) show in a partial least square model that *Bitcoin* is even influencing the future of US-Dollar, as representative for a sovereign world currency, positively. Under circumstances of a possible coexistence in means of parallel circulation, Peters et al. (2015) argue further that cryptocurrencies in general can be prefered over fiat currencies for purposes of security or privacy features. Sauer (2016) finally elaborates

her findings on the Keynesian model to the concept of a parallel currency for developing countries and therefore emerging markets (Sauer, 2016).

We also see notions in the research that argue for cryptocurrencies to be niche currencies in means of a medium of exchange. On the one hand, this refers to the emerging markets hypothesis, on the other hand, even when working only in niches, a parallel run is implemented. Hence, the papers on niches are investigated herein. The concept of a niche product for emerging markets evolved by Luther (2016a) and Luther (2016b) who imputes users to switch to cryptocurrencies for the purpose of completing transactions which would have been impossible before (Luther, 2016b). The author even postulates cryptocurrencies to be more than a niche money in countries with especially weak incumbent currencies (Nelson, 2018). This refers back to the concept of dollarization, which we examined before. Likewise, Hendrickson et al. (2016), Beer and Weber (2015), Peters et al. (2015) and Weber (2014) cover the concept of a complementary currency in niches, not only for emerging markets. They argue with anonymity, small-denomination online payments and lower costs (Beer and Weber, 2015). Peters et al. (2015) address the particular niches of online gaming, social communities and internet currencies in general (Peters et al., 2015). Even the positive impact on product innovation and the complex dynamics of the payment market is addressed within (Weber, 2014). At the same time, the author precludes that only cryptocurrencies survive as a medium of exchange due to internal problems and a following collapse of the system. So all the argumentation on niche products and emerging markets might as well implement a parallel usage of currencies. Hendrickson et al. (2016), who classify a higher preference for *Bitcoin* in countries with higher levels of technology and access to the internet, but also having a weak currency, present a converse solution. They find mutiltiple monetary equilibria of coexistence in their study (Hendrickson et al., 2016). Lastly concerning a simultaneous use, the concept of complementary currencies is mentioned as there are scholars, who claim cryptocurrencies for everything but the legal and official payments like for instance taxes (Peters et al., 2015; Beer and Weber 2015). Also they refer to the point of niche money and define cryptocurrencies as a medium of exchange for the black market (Beer and Weber, 2015). For this reason, they state to have a hierachy where fiat currency is at the top, as long as taxes and legal payments have to be made. Hence, the notion emerges

that this is the reason why cryptocurrencies will never be a disruptive innovation or dominate an incumbent money in any case.

A further concept we identify by the topic of coexistence within the currency market is the idea of conjuctions of cryptocurrencies and fiat currencies, beyond the concept of central bank issued cryptocurrencies. Carrick (2016) addresses the high effectiveness of transactions with *Bitcoin* and thus of a parallel usage of cryptocurrencies and fiat currencies beyond the function in emerging markets. Unfortunately, he does not suggest in detail how this would work out. Conley (2017) on the other hand, introduces the idea of CryptoBucks (a cryptocurrency backed 100 % by Dollars) to solve the problem of volatility and offer various levels of privacy and anonymity depending on how the system is implemented. Especially in case of international transactions, and to reduce transactions costs, it is introduced as an adequate solution. Luther (2016b) further introduces a combination of mobile payment systems[13] and cryptocurrencies to be transferred more simply.

As we have analysed for the concept of competition before, there are also notions that address coexistence for cryptocurrencies and fiat currencies but not for *Bitcoin* and fiat currencies in particular. Compared to the gold standard, a *Bitcoin* standard is possible to coexist with federal currencies, but not supposed to last long, because central banks and the government will take actions to prevent it. Further Weber (2016) suggests that there will be a switch to one of the various other cryptocurrencies or technical innovation coming soon to overcome the weak points of *Bitcoin* and thus coexist as a medium of exchange. Along with that, Seetharaman et al. (2017) argue that *Bitcoin* will not be the coexisting cryptocurrency in the longrun due to regulatory hurdles, even if it affects world currencies positively as mentioned before. Another underlying cryptocurrency with regulatory backing will develop to do so (Seetharaman et al., 2017).

4 Discussion

In this research paper, we explore the current literature of currency coexistence within the field of cryptocurrencies. We identify that the literary contributions are highly fragmented within different

[13] The author compares it to Vodafone's m-pesa system as it is used in Kenya (Luther, 2016b, p. 402).

disciplinces as well as within the disciplines (in means of definition). When examining the category of currency approach, we found different concepts and definitions regarding the virtual or cryptocurrency character[14], although we investigated exclusively for the currency perspective. Whereas we exclude technological research, it still remains a huge extent in different economic fields of research. Hence, we categorize the detected concepts into categories to provide an overview. As we do not detect any scientific work on a purely coexistence level of fiat money and cryptocurrency as an alternative to the corner solutions of crowding out eachother, we extend our review to the component of currency competition as a molding of coexistence. It comes as a subordinate topic when investigating opportunities and risks or when predicting the future performance of cryptocurrencies. Neither one of the articles focuses on the coexistence, on a parallel currency nor is a possibility hardly mentioned. Despite the topic of competition, it also strikes attention that due to the novelty of the research field, articles on cryptocurrencies try to address as much concepts and topics as possible. They all give (or at least try to give) a large overview of the topic instead of focussing one special topic extensive. However, this would increase the niveau of research and its output substantially.

By analysing the previously reviewed research, we find that even if competition among cryptocurrencies and fiat currencies or the parallel usage of both currencies is mentioned, it is never in the focus of research neither for *Bitcoin* nor for cryptocurrencies in general. There is indeed work, looking at the interactions of privately issued cryptocurrencies and central bank issued fiat currencies (Hong et al., 2018; Seetharaman et al., 2017; Sauer, 2016; Szetela et al., 2011). But they all lack in several points, since they only investigate for emerging markets (Carrick, 2016) or on the focus of *Bitcoin* (Seetharaman et al., 2017; Hendrickson et al., 2016; Carrick, 2016; Rogojanu and Badea, 2014). Therefore, the review process of several articles could be described more like a “read between the lines” than a straight analysis. There is also a lack in empirical foundation, if a coexistence is addressed in the articles. Most of the contributions aim to succeed theoretically, but remain in a hypothetical grey zone, where everything is possible under theoretical and uncertain circumstances. Only Borgonovo et al. (2019) aim in conducting an experiment to observe actual behaviour within the choice of currency.

[14] As can be seen in the concept matrix in Appendix C.

The research on intra-market competition also draws conclusions for inter-market competition and thus for a possible parallel usage of the currencies, but it remains a minor topic within the different contributions (Fernández-Villaverde, 2018; Fernández-Villaverde and Sanches, 2018; Fernández-Villaverde and Snaches, 2017; Dowd and Hutchinson, 2015). Therefore, even though we detect research on the developed research questions, we hardly find answers that really address the topic. It is more like an interpretation of a research outcome, which we conclude to be a parallel currency or coexistence. Our study cannot state, whether a coexistence is predicted or not in general because we only investigate for this detailed research question. However, what is catching attention is that of the 33 relevant and reviewed papers, only 15 mentioned the concept of coexistence and only 10 the one of parallel currency[15]. As the amount of research on the topic of cryptocurrency is growing very fast, it catches our attention that most of the research on competition and parallel currency is rather old, that even if a right topic was addressed, it may not be state of the art anymore.

Another point that occurs is that while cryptocurrencies are said to be the world currencies, international with no boundaries, there is no research looking at cryptocurrencies from a macro perspective. We rather find research from a micro perspective for the countries of Canada (Fung et al., 2017; Weber, 2016) or the United States of America (Seetharaman et al., 2018). Research that points out to implement a central bank issued cryptocurrency as a form of conjunction, it does not address the private character of cryptocurrencies as stated before and which in combination with a central bank issued fiat currency is the major topic of this literature review.

What definitely strikes out are the purposes of coexisting currencies, if covered in research. Reasons for a coexistence like a niche or emerging markets as well as crisistroke and hyperinflationary countries, but also the reasons for central bank issued fiat currencies to remain due to legal and taxational reasons (Berentsen and Schär, 2018; Beer and Weber, 2015; Peters et al., 2015). What is missing in all the articles is a focus on the topic and an interpretation and analysis of possible interactions in both ways. The only work on that by Seetharaman et al. (2018) investigates the interactioneffect of *Bitcoin* on US-Dollar, but not on cryptocurrencies in general or the effect of the US-Dollar on *Bitcoin* or cryptocurrencies. Despite all the interaction effects, what is also missing is a current state of the art

[15] As can be seen in the table of total hits in Appendix A and the concept-matrix in Appendix C.

anaylsis since right now, cryptocurrencies and fiat currencies are circulating parallel in our monetary system.

Finally, only one article really attaches the related topic to show how important it might be to investigate the coexistence. Hong et al. (2018) show that the demand between fiat currencies and digital currencies (here in means of *Bitcoin*) will emerge establishing a coexistence. Borgonovo et al. (2019), Nelson (2018) as well as Berentsen and Schär (2018) stick to that in a way as they postulate that different currencies aim to satisfy different kinds of demand. For this reason, there will be both cryptocurrencies and fiat currencies be circulating but there won't be a need for a central bank issued cryptocurrency. One could go further and do that in a next step, especially for cryptocurrencies, since there is a lack of research.

5 Conclusion

Privately issued cryptocurrencies and central bank issued fiat currencies do, as a matter of fact, interact if they circulate (currently) simultaneously in a monetary system. The literature reveals convergence towards the hypothesis of a lack of research in coexistence and competition theory concerning the inter-market situation of privately issued cryptocurrencies and central bank issued fiat currencies. Since researchers typically build on what has been developed before, attention should be paid to research questions despite the corner solutions of disruption or failure of a system or whether if cryptocurrencies are rather speculative assets than real currencies in means of the money functions.

Therefore, in this literature review, we examine the previous research on the topic of private issued cryptocurrencies as coexisting with fiat currencies. We limit our review to business research in means of a financial economic perspective and therefore exclude technical (i.e. Blockchain) as well as legal contributions. A possible consequence by reviewing the results of our work would be to also consider the idea of central bank issued cryptocurrencies, which we first excluded for a clear distinction of private and central bank issued currencies for parallel usage. However, little academic research looks closer on the existence, interaction and consequences as well as on a possible set up of coexisting private cryptocurrencies and central bank issued fiat currencies. The reviewed literature presents a short overview of either only the *Bitcoin* perspective or the intra-market situation. But the reviewed articles

also provide evidence and mention that there is a lack of research and economic knowledge as well as a field of interest for the topic (Gans and Halaburda, 2015; Carrick, 2016; Hong et al., 2018).

To conclude this, future research should try to reach out for several points. First, a distinction between *Bitcoin* and cryptocurrencies in general has to be made. What catches the readers' attention especially on the theoretical baseline is the isolation of *Bitcoin* and the lack of clean definitions. Some articles do not even provide any definitions despite for *Bitcoin* and/or Blockchain. Many articles use cryptocurrencies, digital currencies, virtual currencies and *Bitcoin* in the same way and mix them interchangeably up all the time. Future research has to cover that as well as it is important for practicioners to distinguish in that point and think outside of the box. It would also be useful, not to concentrate only on *Bitcoin* but to implement a generic theory about the interaction of fiat currency and cryptocurrency. Attention has to be paid to innovation to create the perfect cryptocurrency to compete and exist in a parallel way with fiat currency. There should further be commitment towards an isolation of *Bitcoin* from all the other currencies to create a unique definition as well as a clear understanding of what both currencies do and do not do for each other. Also what has been excluded in this review is the option of a conjuction currency of a central bank issued cryptocurrency as introduced by Bordo and Levin (2017). What we first excluded for a clear distinction of private money and sovereign money should be investigated in further research for a parallel usage. Attention has to be paid beyond the boundaries of emerging markets, as the investigations of prior research seem to be confinded to that solution of coexistence. What strikes out is a missing change of perspectives when investigating a possible coexistence of privately issued cryptocurrencies and central bank issued fiat currencies. The perspective of usage and adoption by "users" and their behavioral intention might have a major impact on the possibility simulataneously circulating currencies. The identified research, expect for one contribution, only investigates the effects and influences the monetary system. A consumer perspective and behaviour is totally disregarded among the theoretical investigations of the monetary system. Therefore, future research should cover that field of possible determinants of coexistence.

This review could also be extended to the technological component, as a distinction of the different forms of currencies did not result inconsistent. Due to all the research investigating mainly *Bitcoin*, the vulnerability of the technological system behind and its threats are mentioned as major point

of failure. Therefore, when examining the ability to coexist, the technological aspect of work has possibility to be considered for economic reasons of interaction. Since the construction of cryptocurrencies is very different, it is not easy to compare it to a fiat currency, which is, despite some little differences, generally the same overall. Likewise, the purpose of the cryptocurrencies has to be considered in the future, since many coins are created only for investment reasons and not to be an actual currency and therefore do not aim to coexist with fiat currencies or even compete. Limitations through regulation have been made and therefore been isolated. As long as there is no regulation on the issuance of cryptocurrency, there is no impact of the coexistence despite that it makes it possible at all. However, for the time when a regulatory hurdle is evolving, this review needs to be rereviewed under regulatory aspects.

Nevertheless, the growing amount of research makes it possible to build upon the boundaries of this review. As there is already research in means of parallel or coexisting currency, there is no available research or data in particular of a dual or multiple currency scenario for privately issued cryptocurrencies. It might not only be important for scholars, but also for central banks to observe the growing influence and to be aware of their development of supply. Likewise, the government and other authorities need empirical evidence on possible opportunities to control inflation or to react to a changing monetary policy.

6 Bibliography

Aiyagari, S. Rao; Wallace, Neil; Wright, Randall (1996): Coexistence of money and interest-bearing securities. In: *Journal of Monetary Economics* 37 (3), p. 397–419.

Ammous, Saifedean (2015): Economics beyond Financial Intermediation. Digital Currencies' Possibilitities for Growth, Poverty Alleviation, and international Development. In: *Journal of Private Enterprise* 30 (3), p. 19-50.

Ammous, Saifedean (2018): Can cryptocurrencies fulfil the functions of money? In: *The Quarterly Review of Economics and Finance* 70, p. 38-51.

Baliño, Tomas J. T.; Bennett, Adam; Borensztein, Eduardo (1999): Monetary policy in dollarized economies: *International Monetary Fund.*

Beer, Christian; Weber, Beat (2015): Bitcoin–the promise and limits of private innovation in monetary and payment systems. In: *Monetary Policy & The Economy*, Q4/14, p. 53-66.

Berentsen, Aleksander; Schär, Fabian (2018): The Case for Central Bank Electronic Money and the Non-case for Central Bank Cryptocurrencies. In: *Federal Bank of St. Louis REVIEW* 100 (2), p. 97-106.

Borgonovo, Emanuele; Caselli, Stefano; Cillo, Alessandra; Masciandaro, Donato; Rabitti, Giovanni (2019): Privacy and Money: It Matters. In: *BAFFI CAREFIN Working Paper Series*, WP N. 108.

Böhme, Rainer; Christin, Nicolas; Edelman, Benjamin; Moore, Tyler (2015): Bitcoin. Economics, technology, and governance. In: *The Journal of Economic Perspectives* 29 (2), p. 213–238.

Bordo, Michael D.; Levin, Andrew T. (2017): Central bank digital currency and the future of monetary policy. National Bureau of Economic Research; NBER Working Papers: 23711.

Briére, Marie; Oosterlinck, Kim; Szafarz, Ariane (2015): Virtual currency, tangible return - Portfolio diversification with Bitcoin. In: *Journal of Asset Management* 16 (6), p. 365-373.

Bryant, John (2005): Fiat Money and Coordination. A" Perverse" Coexistence of Private Notes and Fiat Money. In: *Eastern Economic Journal* 31 (3), p. 377–381.

Camera, Gabriele; Craig, Ben; Waller, Christopher J. (2004): Currency competition in a fundamental model of money. In: *Journal of International Economics* 64 (2), p. 521–544.

Carrick, Jon (2016): Bitcoin as a Complement to Emerging Market Currencies. In: *Emerging Markets Finance and Trade* 52 (10), p. 2321–2334.

Catalini, Christian; Gans, Joshua S. (2016): Some simple economics of the blockchain. National Bureau of Economic Research, NBER Working Papers: 22952.

Cooper, Harris M. (1988): Organizing knowledge syntheses. A taxonomy of literature reviews. In: *Knowledge in Society* 1 (1), p. 104-126.

Costanza, Robert; Farley, J.; Flomenhoft, G.; Blake, J.; Chappelle, D.; Chiota, M. et al. (2003): Complementary currencies as a method to improve local sustainable economic welfare. In: *Ecological economics.*

Dibrova, Alina (2016): Virtual Currency. New Step in Monetary Development. In: *Procedia-Social and Behavioral Sciences* 229, p. 42–49.

Dowd, Kevin (1993): Currency competition, network externalities and switching costs. Towards an alternative view of optimum currency areas. In: *The Economic Journal* 103 (420), p. 1180-1189.

Dowd, Kevin; Hutchinson, Martin (2015): Bitcoin will bite the dust. In: *Cato Journal* 35, p. 357-382.

European Central Bank (2015): Virtual currency schemes-A further analysis. In: Frankfurt am Main, February.

Farrell, Joseph; Saloner, Garth (1986): Installed base and compatibility. Innovation, product preannouncements, and predation. In: *The American economic review*, p. 940–955.

Fernández-Villaverde, Jesús; Sanches, Daniel R. (2017): Can Currency Competition Work? National Bureau of Economic Research, Inc, NBER Working Papers: 22157.

Fernández-Villaverde, Jesús; Sanches, Daniel R. (2018): On the Economics of Digital Currencies. Federal Reserve Bank of Philadelphia, Working Papers: WP 18-07.

Fernández-Villaverde, Jesús (2018): Cryptocurrencies: A Crash Course in Digital Monetary Economics. In: *The Australian Economic Review* 51 (4), p. 514-526.

Fisch, Christian; Block, Joern (2018): Six tips for your (systematic) literature review in business and management research. In: *Management Review Quarterly* 68 (2), p. 103–106.

Friedman, Milton (1991): The island of stone money: Hoover Institution, Stanford University.

Frisby, Dominic (2014): Bitcoin. The future of money? Random House.

Galvan, Jose L.; Galvan, Melisa C. (2017): Writing literature reviews. A guide for students of the social and behavioral sciences: Routledge.

Gans, Joshua S.; Halaburda, Hanna (2015): Some economics of private digital currency. In: *Economic Analysis of the Digital Economy: University of Chicago Press*, p. 257–276.

Garratt, Rodney; Wallace, Neil (2016): Bitcoin 1, Bitcoin 2. An experiment in privately issued outside monies. UC Santa Barbara Working Papers [online]: *https://escholarship.org/uc/item/91c7x1js*

Gawthorpe, Kateřina (2017): Competition of Currencies. An Alternative to Legal Tender. In: *Prague Economic Papers 2017* (2), p. 198–212.

Grinberg, Reuben (2012): Bitcoin. An innovative alternative digital currency. In: *Hastings Sci. & Tech. LJ* 4, p. 159-208.

Hart, Chris (2018): Doing a Literature Review. Releasing the Research Imagination: Sage.

Hayek, Friedrich August von (1976): Denationalisation of Money. An Analysis of the Theory and Practice of Current Currencies: Institute of economic affairs.

He, Dong; Habermeier, Karl Friedrich; Leckow, Ross B.; Haksar, Vikram; Almeida, Yasmin; Kashima, Mikari et al. (2016): Virtual currencies and beyond. Initial considerations. International Monetary Fund.

Hendrickson, Joshua R.; Hogan, Thomas L.; Luther, William J. (2016): The political economy of bitcoin. In: *Economic Inquiry* 54 (2), p. 925–939.

Hong, KiHoon; Park, Kyounghoon; Yu, Jongmin (2018): Crowding Out in a Dual Currency Regime? Digital versus Fiat Currency. In: *Emerging Markets Finance and Trade* (just-accepted).

Huberman, Gur; Leshno, Jacob D.; Moallemi, Ciamac C. (2017): Monopoly without a monopolist. An economic analysis of the bitcoin payment system. Bank of Finland Research Duscussion Papers, No. 27 (2017).

Jasperson, Jon Sean; Carte, Traci A.; Saunders, Carol S.; Butler, Brian S.; Croes, Henry J. P.; Zheng, Weijun (2002): Power and information technology research. A metatriangulation review. In: *MIS Quarterly 26* (4), p. 397–459.

Katz, Michael L.; Shapiro, Carl (1985): Network externalities, competition, and compatibility. In: *The American economic review* 75 (3), p. 424–440.

Levy, Yair; Ellis, Timothy J. (2006): A systems approach to conduct an effective literature review in support of information systems research. In: *Informing Science* 9 (2006), p. 181-211.

Luther, William J. (2016a): Cryptocurrencies, Network Effects and Switching Costs. In: *Contemporary Economic Policy* 34 (3), p. 553-571.

Luther, William J. (2016 b): Bitcoin and the Future of Digital Payments. In: *Independent Review* 20 (3), p. 397–404.

Maftei, Loredana (2014): Bitcoin-Between Legal and Informal. In: *CES Working Papers* 6 (3), p. 53-59.

McKinnon, Ronald I. (1963): Optimum currency areas. In: *The American economic review* 53 (4), p. 717–725.

Nair, Malavika; Cachanosky, Nicolás (2017): Bitcoin and entrepreneurship. Breaking the network effect. In: *The Review of Austrian Economics* 30 (3), p. 263–275.

Nakamoto, Satoshi: Bitcoin. A peer-to-peer electronic cash system, Oct. 2008 [online]: URL http://www. bitcoin.org/bitcoin.pdf.

Nelson, Bill: Financial stability and monetary policy issues associsted with digital currencies. In: *Journal of Economics and Business* 100 (2018), p. 76-78.

Østbye, Peder (2017): The Adequacy of Competition Policy for Cryptocurrency Markets. [online]: *https://dx.doi.org/10.2139/ssrn.302573.2.*

Pautasso, Marco (2013): Ten Simple Rules for Writing a Literature Review. In: *PLOS Computational Biology* 9 (7).

Peters, Gareth; Panayi, Efstathios; Chapelle, Ariane (2015): Trends in cryptocurrencies and blockchain technologies. A monetary theory and regulation perspective. Cornell University Library; arXiv preprint [online]: https://arxiv.org/abs/1508.04364.

Plassaras, Nicholas A. (2013): Regulating digital currencies. Bringing Bitcoin within the reach of IMF. In: *Chicago Journal of International Law*. 14, p. 377-407.

Rahman, Adib J. (2018): Deflationary Policy under Digital and Fiat Currency Competition. In: *Research in Economics*, p. 171-180.

Raskin, Max; Yermack, David (2016): Digital currencies, decentralized ledgers, and the future of central banking. National Bureau of Economic Research, NBER Working Papers: 22238.

Ridley, Diana (2012): The literature review. A step-by-step guide for students: Sage.

Rogojanu, Angela; Badea, Liana (2014): The issue of competing currencies. Case Study - Bitcoin. In: *Theoretical & Applied Economics* 21(1), p. 103-114.

Rogojanu, Angela; Badea, Liana (2015): The issue of" true" money in front of the BitCoin's offensive. In: Theoretical & Applied Economics 22 (2), p. 77-90.

Rowley, Jennifer; Slack, Frances (2004): Conducting a literature review. In: *Management research news* 27 (6), p. 31–39.

Sauer, Beate (2016): Virtual currencies, the money market, and monetary policy. In: *International Advances in Economic Research* 22 (2), p. 117–130.

Schilling, Linda; Uhlig, Harald (2018): Some Simple Bitcoin Economics. National Bureau of Economic Research, NBER Working Papers: 24483.

Seetharaman, A.; Saravanan, A. S.; Patwa, Nitin; Mehta, Jigar (2017): Impact of Bitcoin as a World Currency. In: *Accounting and Finance Research* 6 (2), p. 230-246.

Smith, Christie; Kumar, Aaron (2018): Crypto-currencies - an introduction to not-so-funny moneys. In: *Journal of Economic Surveys* 32 (5), p. 1531-1559.

Torraco, Richard J. (2016): Writing Integrative Literature Reviews: Using the Past and Present to Explore the Future. In: *Human Resource Development Review* 15 (4), p. 404–428.

Vaubel, Roland (1990): Currency competition and European monetary integration. In: *The Economic Journal* 100 (402), p. 936–946.

Vigna, Paul; Casey, Michael J. (2015): Cryptocurrency. How Bitcoin and Cybermoney Are Overturning the World Economic Order: Random House.

vom Brocke et al. (Hg.) (2009): Reconstructing the giant. On the importance of rigour in documenting the literature search process. *ECIS 2009 Proceedings*, Paper 161.

Weber, Beat (2014): Bitcoin and the legitimacy crisis of money. In: *Cambridge Journal of Economic*s 40 (1), p. 17–41.

Weber, Warren E. (2016): A Bitcoin standard. Lessons from the gold standard. Bank of Canada Staff Working Paper: 2016-14.

Webster, Jane; Watson, Richard T. (2002): Analyzing the Past to Prepare for the Future. Writing a Literature Review. In: *MIS Quarterly* 26 (2), p. xiii–xxiii.

White, Lawrence H. (2015): The market for cryptocurrencies. In: *Cato Journal* 35, p. 383-402.

Yermack, David (2015): Is Bitcoin a real currency? An economic appraisal. In: *Handbook of Digital Currency*, Academic Press; p. 31-43.

Zorn, Ted; Campbell, Nittaya (2006): Improving the writing of literature reviews through a literature integration exercise. In: *Business Communication Quarterly* 69 (2), p. 172–183.

7 Appendix

A Keyword Search Results

Keyword	Total Hits	Period of Time	Academic Journals and Working Paper	Reviewed
Adoption Bitcoin	2	2016-2017	2	-
Bitcoin	**205**	**2013-2018**	**184**	**14**
Bitcoin Effect GDP	11	2014-2017	8	-
Bitcoin Exchange	21	2013-2017	17	-
Bitcoin Fail	1	2016	1	-
Bitcoin Fiat Curreny	4	2016	4	-
Bitcoin Future	5	2016	1	-
Bitcoin + $	113	2013-2018	97	-
Bitcoin + €	113	2013-2018	97	-
Currency Coexistence	**3**	**2009-2015**	**3**	**0**
Coexistence Money	10	2010-2013	9	-
Complementary Currency	25	2009-2018	22	-
Creation of Digital Money	135	2009-2018	106	-
Creation of Money	205	2009-2018	174	-
Cryptocurrencies; Crypto AND Currency	**109**	**2014-2018**	**97**	**6**
Currency Competition	**69**	**2009-2018**	**62**	**6**
Cryptocurrency Competition	**7**	**2014-2016**	**7**	**0**
Digital Bubble	3	2011-2016	3	-
Digital Currency; Digital AND Currency	**83**	**2009-2018**	**76**	**5**
Digital Currency Adoption	1	2014	1	-
Digital Currency Transaction	1	2017	3	-
Ether	2	2016-2017	2	-
Fiat Currency	51	2009-2018	45	-
Initial Coin Offering	4	2014-2017	3	-
Lite Coin	1	2017	1	-
Money Disruption	7	2010-2015	5	-
Money Future	86	2009-2018	67	-
Money Innovation	62	2009-2018	52	-
Network Effects of Money	5	2015-2018	4	-
Parallel Currency	25	2015-2018	21	-
Usage of Money	16	2015-2018	16	-
Virtual Currency	31	2010-2018	30	-
XRP	0	-	0	-
Total Hits on all Keywords	**1416**		**1220**	**31***
Total Relevant Hits	**469**			
Total after abstract Scan	**188**			
Reviewed	**33**			

*double counting keywords

B Relevance after Abstract Scan

Total Relevance after Abstract Scan	∑ 188
Asset	8
Currency	24
Competition	33
Intra-Market (only)	10
Inter-Market	**9**
Failure	16
Disruption	9
General Information/Other	79

C Concept Matrix

Researchers	Name of Paper	Date	Year	Journal	Search Engine	Search Metric	Theories used	Empirical Methodology	Kewords	Concept	Bitcoin	Altcoin	Blockchain	Virtual Currency	Digital Currency	Cryptocurrency	Private Currency (not CC)	Currency	Asset	Usage/Adoption	Disruption	Failing/Bubble Overall	Failure / Bubble of Bitcoin	Mining Competition	Intra Market Competition	Inter Market Competition	Coexistence	Parallel Currency	Emerging Markets	Niche	Central Bank Issued Cryptocurrency	Efficient Market Hypothesis	Exchange Rates	Pricing	Privacy/Security	Taxes and other Official Payments	Regulation	Intermediation	ref
Beer/Weber	Bitcoin - The Promise and Limits of Private Innovation in Monetary and Payment Systems	4th Quarter	2014	Monetary Policy and the Economy	EconLit	Overall	-	-	Bitcoin		x				x	x		x	x	x			x			x			x	x			x		x	x	x	x	15
Berentsen/Schär	The Case für Central Bank Electronic Money and the Non-Case for Central Bank Cryptocurrencies	2nd Quarter	2018	Federal Reserve Bank of St. Louis REVIEW	EconLit	Overall, revised	-	-	Bitcoin		x					x		x		x						x		x			x							x	9
Borgonovo/Caselli/Cillo/Mascandaro/Rabitti	Privacy and Money: It matters	February	2019	BAFFI CAREFIN Working Paper Series	Google Scholar	Forward, revised	Demand for Money (Keynes), Relevance of Privay (Friedman)	laboratory experiment	-					x	x	x		x		x						x	(x)	(x)			x				x			x	11
Canfick, J.	Bitcoin as a Complement to Emerging Market Currencies	-	2016	Emerging Markets Finance & Trade	EconLit	Overall	-	Regression Analysis	Bitcoin, Digital Currency, Cryptocurrency		x					x		x	x	x						x	x		x	x				x			x		11
Conley, J. P.	Blockchain Cryptocurrency Backed with Full Faith and Credit	6th June	2017	Vanderbilt University Department of Economics Working Paper Series	EconLit	Overall	-	-	Cryptocurrency				x			x		x									x						x		x			x	7
Dowd/Hutchinson	Bitcoin Will Bite The Dust.	Summer	2015	Cato Journal	EconLit	Overall	-	-	Bitcoin		x		x			x		x					x	x	x									x	x		x		10
Fernández-Villaverde, J.	Cryptocurrencies: A Crash Course in Digital Monetary Economics	-	2018	The Australian Economic Review	EconLit	Overall, revised	-	-	Cryptocurrency		x				x	x		x		x					x	x	x	x			x				x				11
Fernández-Villaverde/Sanches	Can Currency Competition Work?	29th January	2017	National Bureau of Economic Research, Working Papers	EconLit	Overall	Lagos-Wright Environment	-	Cryptocurrency, Curency Competition		x	x				x		x					(x)		x	x	x					x							9
Fernández-Villaverde/Sanches	On the Economics of Digital Currencies*	Februarry	2018	National Bureau of Economic Research, Working Papers	EconLit	Overall	Lagos-Wright Environment	-	Cryptocurrency, Curency Competition		x	x				x		x					(x)		x	x	x					x							9
Fung/Hendry/Weber	Canadian Bank Notes and Dominion Notes: Lessons for Digital Currencies	-	2017	Bank of Canada Staff Working Papers	EconLit	Overall	-	-	Digital Currency						x		x	x		x						x	x				x				x		x	x	10
Gans/Halaburda	Some Economics of Private Digital Currency	April	2015	National Bureau of Economic Research, Working Papers	EconLit	Overall	-	-	Digital Currency						x		x	x		x						x		x							x		x		8
Garratt/Wallace	Bitcoin 1, Bitcoin 2, ...: An experiment in privately issued outside monies	1st October	2016	UC Santa Barbara Departmental Working Papers	EconLit	Overall	-	-	Bitcoin		x					x		x			x	x			x	x					x		x		x				10
Gawthorpe, K.	Competition of Currencies an Alternative to Legal Tender	-	2017	Prague Economic Papers	EconLit	Overall	money utility function	-	Currency Competition								x	x		x						x			x			x							6
Hendrickson/Hogan/Luther	The political Economy of Bitcoin	April	2016	Economic Inquiry	EconLit	Overall	consumption preferences	-	Bitcoin		x					x		x		x						x	x		x	x		x			x		x		11
Hong/Park/Yu	Crowding Out in a Dual Currency Regime? Digital versus Fiat Currency	-	2018	Emerging Markets Finance and Trade	Google Scholar	Forward	Dual Currency Regime Model	-	-		x				x	x		x		x						x	x					x	x	x					10
Luther, W. J. (a)	Cryptocurrencies, Network Effects and Switching Costs	July	2016	Contemporary Economic Policy	EconLit	Overall	Efficient Market Hypothesis, Network Effects	-	Cryptocurrency, Currency Competition		x					x		x		x			x			x						x							7
Luther, W. J. (b)	Bitcoin and the Future of Digital Payments	Winter	2016	Independent Review	EconLit	Overall	-	-	Bitcoin, Currency Competition		x	x	x		x	x		x		x					x	x	x		x	x					x		x	x	15
Maimon/Nicolini/Teles	Money is an experience good: competition and trust in the private provision of money	23rd Oct.	2012	Journal of Monetary Economics	EconLit	Overall	Bertrand Competiton		Currency Competition								x	x	x						x	x	x												6
Nair/Cachanosky	Bitcoin and entrepreneurship: breaking the network effect	18th July	2016	Review of Austrian Economics	EconLit	Overall	Network Effects	-	Bitcoin		x				x	x		x		x						x									x		x		8
Nelson, B.	Financial stability and monetary policy issues associated with digital currencies	18th June	2018	Journal of Economics and Business	EconLit	Overall, revised	-	-	Digital Currency		x		x		x	x		x		x						x	x	x			x		x	x		x			13
Peters/Panayi/Chapelle	Trends in Cryptocurrencies and Blockchain Technologies. A monetary Theory and Regulation Perspective.	19th August	2015	Journal od Financial Perspectives	EconLit	Overall	-	-	Cryptocurrency		x		x	x	x	x		x		x						x			x	x					x	x	x		13
Rahman, A. J.	Deflationary Policy under digital and fiat currency competition	16th April	2018	Reaearch in Economics	Google Scholar	Forward	Friedman Rule	-	-					x	x	x		x		x					x	x	x		x				x						10
Raskin/Yermack	Digital Currencies, Decentralized Ledgers, and the Future of Central Banking	-	2016	National Bureau of Economic Research, Working Papers	EconLit	Overall	-	-	Bitcoin, Digital Currency		(x)		x		x	x		x		x					x	x		x			x				x		x	x	13
Rogojanu/Badea	The issue of competing currencies. Case study - Bitcoin	-	2014	Theoretical and Applied Economics	EconLit	Overall	-	-	Bitcoin, Digital Currencies		x		x		x	x		x		x						x									x		x		9
Rogojanu/Badea	The issue of "true" money in front of the BitCoin's offensive**	Summer	2015	Theoretical and Applied Economics	EconLit	Overall	SWOT Analyse/Hayek	-	Bitcoin, Bitcoin		x		x		x	x		x		x						x		x							x		x		10
Sanches, D.	On the inherent instability of private money	12th February	2015	Review of Economic Dynamics	EconLit	Overall	Equilibrium Analysis	-	Currency Competition								x	x								x		x									x	x	7
Sauer, B.	Virtual Currencies, the Money Market, and Monetary Policy	26th April	2016	International Atlantic Economic Society	EconLit	Overall	Money Market Theory	-	Bitcoin, Cryptocurrency		x			x	x	x		x		x	x					x	x	x					x		x		x		13
Schilling/Uhlig	Some Simple Bitcoin Economics	April	2018	National Bureau of Economic Research, Working Papers	Google Scholar	Forward	Exchange Rate Indeterminancy	-	-		x					x		x										x					x	x					6
Seetharaman et al.	Impact of Bitcoin as a World Currency	May	2017	Accounting and Finance Research	Google Scholar	Forward	-	partial least squares structural equation model (PLS-SEM)	-		x			x	x	x		x		x			x			x									x		x		10
Szetela/Mentel/Gedek	Dependency Analysis between Bitcoin and Selected Global Currencies	December	2011	Dynamic Econometric Models	Google Scholar	Backward	Vector auto-regressive Models	ARMA model, GARCH model	Bitcoin		x							x								x							x						4
Weber, B.	Bitcoin and the legitimacy crisis of money	December	2014	Cambridge Journal of Economics	EconLit	Overall	-	-	Bitcoin, Digital Currency		x					x		x	(x)	x			(x)			x			x	x				x	x			x	12
Weber, W. E.	A Bitcoin standard. Lessons from the gold standard.	March	2016	Bank of Canada Staff Working Paper	EconLit	Overall	The Gold Standard	-	Bitcoin		x					x		x		x						x	x						x	x			x		9
White, L. H.	The market for Cryptocurrencies	Spring/Summer	2015	Cato Journal	EconLit	Overall	-	-	Cryptocurrency		x	x				x		x		x			x	x	x									x		x			10
											25	4	8	5	16	27	5	33	4	25	2	1	8	2	10	29	15	10	8	6	7	6	11	7	20	3	16	9	11.5 9.8

* This article was first found as "Can currency competition work?" as a former version of the working paper. In a later backup scan of the data, the new version under a different name was found. A forward/backward search was also conducted but did not deliver any new results.

** This article is a later version of the first, but both published and circulating independently.

D Backward/Forward Matrix

Article	Article references*	Article citations**	Period covered	Relevant backward search reviews (new***/existing)		Relevant forward search reviews (new***/existing)	
Beer/Weber (2014)	39	14	1993-2018	-	2	-	1
Berentsen/Schär (2018)	11	27	1993-2018	-	-	-	1
Carrick, J. (2016)	48	23	1982-2018	-	1	-	-
Conley, J. P. (2017)	2	0	2017	-	-	-	-
Dowd/Hutchinson (2015)	16	23	1976-2018	1	-	-	2
Fernández-Villaverde (2018)	46	3	1945-2019	-	2	1	-
Fernández-Villaverde/Sanches (2016)	36	31	1969-2018	-	1	4	2
Fernández-Villaverde/Sanches (2018)	18	2	1969-2018	-	1	-	-
Fung/Hendry/Weber (2017)	24	6	1897-2018	-	-	-	1
Gans/Halaburda (2015)	9	52	1974-2018	-	-	1	1
Garratt/Wallace (2016)	15	9	1959-2018	-	1	-	1
Gawthorpe, K. (2017)	40	0	1896-2015	1	-	-	-
Hendrickson/Hogan/Luther (2016)	29	49	1993-2018	-	3	-	4
Luther, W. J. (2016a)	44	77	1985-2018	-	2	-	4
Luther, W. J. (2016b)	18	29	2008-2018	-	3	-	1
Marimon/Nicolini/Teles (2012)	37	19	1971-2018	-	-	-	-
Nair/Cachanosky (2017)	28	6	1892-2018	-	4	-	1
Nelson, B. (2018)	8	2	2000-2018	-	-	-	-
Peters/Panayi/Chapelle (2015)	39	37	1924-2018	-	-	-	-
Raskin/Yermack (2016)	26	50	1912-2018	-	-	-	-
Rogojanu/Badea (2014)	17	67	2006-2018	-	-	-	3
Rogojanu/Badea (2015)	27	4	1892-2017	1	1	-	1
Sanches, D. (2016)	35	14	1959-2018	-	-	-	1
Sauer, B. (2016)	21	11	1977-2018	-	2	-	-
Weber, B. (2014)	91	45	1892-2018	-	-	1	1
Weber, W. E. (2016)	27	14	1879-2018	-	-	-	1
White, L. H. (2015)	36	57	1960-2018	-	3	1	5

* articles in the bibliograph
** articles citing the original
*** not found in EconLit, possible double counting in matrix