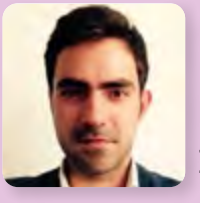
DEFINING RELEVANT MARKETS IN THE CRYPTO ECONOMY



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NERA Economic Consulting, Berlin, Germany. All remaining errors are our own. The opinions expressed herein do not necessarily reflect those of our employer. Besides both authors holding small portfolios with long positions in various cryptocurrencies, there are no conflicts of interest to declare.

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Defining Relevant Markets in the Crypto Economy

By Florian Deuflhard & C.-Philipp Heller

The regulation of cryptocurrencies and the application of antitrust law to cryptocurrencies is still in its infancy. As the definition of relevant markets may play a role both in antitrust law and other areas of the law, we discuss how existing methods to delineate relevant markets may be adapted to cryptocurrency market, in relation to consensus mechanisms, crypto exchanges, and transactional money.

01 INTRODUCTION

Since the creation of Bitcoin as the first cryptocurrency during the global financial crisis in 2009, an entire ecosystem has emerged.[2] Consequently, cryptocurrencies and other applications based on blockchain technology have received increasing attention from regulators. While issues of taxation and securities law have come under intense regulatory scrutiny, cryptocurrencies and related markets increasingly raise concerns from an antitrust and competition law perspective.[3] In the European Union, there are also plans to create an entirely new regulatory framework for cryptocurrencies.[4]

> *Since the creation of Bitcoin as the first cryptocurrency during the global financial crisis in 2009, an entire ecosystem has emerged*

An important dimension in the assessment of potential violations of antitrust and competition law and in the application of sector-specific regulation is the need to define the relevant market(s) in which firms compete.[5] This allows the calculation of meaningful market shares as well as an assessment of market power and relevant competitive forces.[6] For traditional markets, established methods to delineate relevant markets exist. Do these transfer to new forms of digital money and asset classes with specific features both from an economic and network security perspective or is an entirely new approach needed?

Economists typically define relevant markets using the hypothetical monopolist test ("HMT").[7] This identifies the relevant market as the smallest market worth monopolizing. A hypothetical monopolist on the relevant market would not be constrained in its price-setting by outside substitutes to a substantial degree. If some candidate market is not worth monopolizing, then the candidate market is typically expanded, and the process is repeated.[8]

To implement the HMT for traditional markets, it is tested whether a small, but significant non-transitory increase in the price relative to the competitive level on a candidate market would be profitable for a hypothetical monopolist (the "SSNIP" test). We will show that the HMT and the SSNIP test may - after some modifications - also be applied to

2 See Nakamoto (2008). Nakamoto, S. (2008). Bitcoin: A Peer-to-Peer Electronic Cash System. Retrieved from https://bitcoin.org/bitcoin.pdf. For an overview on Bitcoin, see Böhme *et al.* (2015) and Huberman *et al.* (2021). Böhme, R., Christin, N., Edelman, B., & Moore, T. (2015). Bitcoin: Economics, Technology, and Governance. *Journal of Economic Perspectives, 29*(2), 213-238; Huberman, G., Leshno, J. D., & Moallemi, C. (2021). Monopoly without a Monopolist: An Economic Analysis of the Bitcoin Payment System. *Review of Economic Studies, 88*(6), 3011-3040.

3 For some early analyses of cryptocurrencies and blockchain from an antitrust perspective, see Schrepel (2019a; 2019b; 2020a; 2020b), Schrepel and Buterin (2020), Deuflhard & Heller (2021) as well as Schrepel (2021). -143. Schrepel, T. (2019a). Collusion by Blockchain and Smart Contracts. *Harvard Journal of Law and Technology, 33*(1), 117-166; Schrepel, T. (2019b). Is Blockchain the Death of Antitrust Law? The Blockchain Antitrust Paradox. *Georgetown Law Technology Review, 3*(2), 281-338; Schrepel, T. (2020a). Libra: A Concentrate of 'Blockchain Antitrust'. *Michigan Law Review Online, 118*, 160-169; Schrepel, T. (2020b). The Theory of Granularity: A Path for Antitrust in Blockchain Ecosystems. *SSRN Working Paper*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3519032; Schrepel, T., & Buterin, V. (2020). Blockchain Code as Antitrust. *Berkeley Technology Law Journal.*; Deuflhard, F., & Heller, C.-P. (2021). Antitrust Economics of Cryptocurrency Mining. *SSRN Working Paper.* doi:http://dx.doi.org/10.2139/ssrn.3917012; Schrepel, T. (2021). *Blockchain + Antitrust: The Decentralization Formula.* Cheltenham, UK, and Northampton, MA, USA: Edward Elgar

4 See Proposal for a Regulation of the European Parliament and of the Council on Markets in Crypto-assets, and amending Directive (EU) 2019/1937.

5 For example, European fixed broadband regulation requires the delineation of relevant markets. See European Commission (2014). European Commission. (2014). *Commission Recommendation of 9 October 2014 on relevant product and service markets within the electronic communications sector susceptible to ex ante regulation in accordance with Directive 2002/21/EC of the European Parliament and of the Council.* Brussels: European Commission.

6 For an attempt to calculate market shares in the crypto economy, see Konstantinos & Carter (2020). Konstantinos, S., & Carter, N. (2020). The Size of the Crypto Economy: Calculating Market Shares of Cryptoassets, Exchanges and Mining Pools. *Journal of Competition Law & Economics, 16*(4), 511–551.

7 See Motta (2004), Chapter 3; Davis & Garcés (2010), Chapter 4. Motta, M. (2004). *Competition Policy.* Cambridge: Cambridge University Press; Davis, P., & Garcés, E. (2010). *Quantitative Techniques for Competition and Antitrust Analysis.* Princeton and Oxford: Princeton University Press.

8 A candidate market should probably include at least one of the products that are of interest to the analyst.

delineate relevant markets for cryptocurrencies and related markets.[9]

This article is organized as follows. In Section II, we apply existing tools for market definition to cryptocurrency mining (Section II.A) and validation (Section II.B). In Section III, we turn to the relevant markets for cryptocurrency exchanges. In Section IV, we discuss stablecoins and where they fit into relevant markets for money. In Section V, we conclude.

02
MARKETS FOR BLOCK VALIDATION

We now discuss in detail how the relevant markets are defined for proof of work ("PoW") and proof of stake ("PoS") consensus mechanism.[10] The markets for the two consensus mechanisms are likely separate. While PoS uses mainly holdings of cryptocurrency as an input, PoW relies on more specialized mining equipment and electricity.

A. Proof of Work

PoW is the consensus algorithm of the two of the most well-known cryptocurrencies, Bitcoin and Ethereum.[11] Under PoW, so-called miners, akin to miners for historic metal-based currencies, invest computing power to guess the solution of a cryptographic puzzle which wins the right to add a new block of transactions to the blockchain.[12]

Cryptocurrency miners do not set prices, although they respond to the expected and pre-determined mining reward. Directly applying the SSNIP test is thus not practical, since even a monopolistic cryptocurrency miner would not set the price of the mining reward. It is therefore necessary to modify the standard HMT/SSNIP test to consider how much computing power a miner allocates to a cryptocurrency's proof of work as measured by the hashrate.[13] For a hypothetical monopolist that is the only miner for one (or more) cryptocurrencies, one would then ask whether a reduction in the computing power by 5 to 10 percent is profitable.[14] If it is, then the initial cryptocurrency (or more) is the relevant market. If not, then additional cryptocurrencies need to be included in the relevant market.

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When applying the HMT, it is typically necessary to consider a price increase relative to a competitive benchmark case. To apply the HMT for cryptocurrency mining, one correspondingly needs a benchmark hashrate for the cryptocurrency (or cryptocurrencies) under consideration. Assuming that the observed cryptocurrency mining markets are competitive, one may thus assume that the observed hashrate corresponds to the competitive level. Applying the HMT then implies asking whether a reduction in this observed hashrate by 5 to 10 percent would be profitable to a hypothetical monopolist.

9 While Bitcoin and many other cryptocurrencies may have features of two-sided markets, this will not be the focus of our discussion. For an introduction to the literature on two-sided markets, see Rochet & Tirole (2006) and Rysman (2009): Rochet, J.-C., & Tirole, J. (2006). Two-Sided Markets: A Progress Report. *RAND Journal of Economics, 37*(3), 645-667; Rysman, M. (2009). The Economics of Two-Sided Markets. *Journal of Economic Perspectives, 23*(3), 125. For a discussion of market definition in two-sided markets, see Filistrucchi, Geradin, van Damme & Affeldt (2014). Filistrucchi, L., Geradin, D., van Damme, E., & Affeldt, P. (2014). Market Definition in Two-Sided Markets: Theory and Practice. *Journal of Competition Law and Economics, 10*(2), 293.

10 A consensus mechanism describes the process, in which validators or nodes (e.g., miners) jointly agree on the (ideally truthful) addition of new entries (e.g., transactions) to the existing blockchain.

11 At the time of this writing, the plans to switch Ethereum to a PoS consensus mechanism have not yet been implemented.

12 For a mathematical characterization of PoW, see Leshno & Strack (2020). Leshno, J. D., & Strack, P. (2020). Bitcoin: An Axiomatic Approach and an Impossibility Theorem. *AER: Insights, 2*(3), 269-286.

13 The hashrate measures the number of calculations or hashes executed by a network participant per second.

14 This crucially depends on entry of miners switching from other cryptocurrencies to the candidate market due to the increased attractiveness of mining in the latter. For more details on the use of the HMT to delineate relevant markets for cryptocurrency mining, see Deuflhard & Heller (2021).

Given that the hypothetical monopolist is the only miner of the cryptocurrency, reducing the hashrate reduces its cost for energy, which increases its profit. The reduction in hashrate would, however, make it more profitable for miners of other cryptocurrencies to switch their hashrate to the hypothetical monopolist's cryptocurrency. The outsiders have a greater incentive to do so because the monopolist's hashrate is reduced by 5-10 percent, which increases the outsiders' probability of successfully mining blocks of the cryptocurrency.

Whether this will also be profitable for the outside miners will then depend on how similar the proof of work puzzles used by the relevant cryptocurrencies are. If both use the same cryptographic hash function, it appears that miners with similar mining equipment for one cryptocurrency could easily switch to another cryptocurrency. Even if the cryptocurrencies do not use the same PoW puzzle, they might be similar enough that switching is still profitable for outsiders.

The relevant market will not only depend on the hash puzzle used by cryptocurrencies, but also on the available mining technologies. For Bitcoin, several phases of primary mining technologies can be identified.[15] In the beginning, bitcoins were be mined by practically anyone with a personal computer. As the price of Bitcoin rose, graphic cards became more suitable for solving mining puzzles and increasingly sophisticated sets of graphics cards were built to mine bitcoin. Today mining of many cryptocurrencies is done mainly with application-specific integrated circuits ("ASICs"). These specifically designed computer chips deliver optimal performance for solving cryptographic hash puzzles that make other methods uneconomical.[16]

The prices of the relevant cryptocurrencies are another aspect that will matter for assessing whether outsiders will switch after the hypothetical hashrate reduction of the hypothetical monopolist. The higher the price and the block reward of the cryptocurrency in the candidate market, the more likely other miners will switch to mining it after a hashrate reduction. The higher the prices of other cryptocurrencies, the less likely other miners will switch.

"The relevant market will not only depend on the hash puzzle used by cryptocurrencies, but also on the available mining technologies

B. Proof of Stake

PoS is an alternative consensus mechanism used by blockchain networks to achieve distributed consensus. Instead of miners investing energy to validate transactions, users lock up or "stake" part of their cryptocurrency holdings to become a validator in the network. They thereby risk losing part of their own cryptocurrency holdings, in the case of untruthful reporting, in exchange for a chance of getting to validate a new transaction and earning a reward.

The likelihood of earning a reward depends on the amount of crypto currency holdings and the length of time this amount is put at risk. Thus, more invested participants are more likely to earn a reward than relatively less invested participants. Participating validators are rewarded according to their relative staking amount. Becoming a validator typically requires a certain minimum stake in the underlying crypto currency.

Consensus is reached by other validators attesting whether the respective block has been validated accurately, thus ensuring the truthfulness of all validated blocks. In case validators report untruthfully, they can lose some of their stake as a result, a process called "slashing."[17] This constitutes an important pillar to incentivize staking parties to accurately validate transactions although no prior investment has been made as in the case of PoW.[18]

In the case of PoS, the HMT/SSNIP methodology needs to be adjusted again, since validators do not set the staking rewards themselves, but instead decide on how much of their crypto currency holdings to stake. For a hypo-

15 For an overview of the different mining technologies that were used over time, see Narayanan, Bonneau, Felten, Miller & Goldfeder (2016). Narayanan, A., Bonneau, J., Felten, E., Miller, A., & Goldfeder, S. (2016). *Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction.* Princeton and Oxford: Princeton University Press. For a general, but dated overview of semiconductors, see Turley (2002). Turley, J. (2002). *The Essential Guide to Semiconductors.* Pearson.

16 Several cryptocurrencies using PoW, such as Ethereum and Litecoin, were designed to be resistant to ASICs by not using Bitcoin's PoW hash puzzle, thereby making switching more costly.

17 This mimics the PoW system, in which miners lose their invested computing power in case of inaccurate reporting of a transaction.

18 On the one hand, PoW offers some advantages compared to the PoW such as better energy efficiency, lower barriers to entry, and reduced hardware requirements. On the other hand, critics have described it as less secure than comparable PoW mechanisms. See for example Schwarz-Schilling et al. (2021). Schwarz-Schilling, C., Neu, J., Monnot, B., Asgaonkar, A., Tas, E. N., & Tse, D. (2021). Three Attacks on Proof-of-Stake Ethereum. arXiv.

thetical monopolist holding the entire stake of a crypto currency, one would then ask whether a reduction in the overall stake by 5 to 10 percent is profitable. If that is the case, the relevant cryptocurrency market has been found, if not other cryptocurrencies need to be included. Assuming as before that the cryptocurrency staking market is competitive, we can apply the potential 5 to 10 percent reduction directly to the overall observed staked crypto currency.

Given that the hypothetical monopolist is the only staking party for the cryptocurrency, reducing the staked amount reduces the opportunity costs of staking (e.g. using the staked amount of the crypto currency for transactions). The reduction in the overall amount of staked cryptocurrency would make it more profitable for outsiders to stake in that crypto currency. In contrast to PoW, this now potentially includes not only staking parties in other cryptocurrencies but also users holding the same cryptocurrency but using it for, e.g. transactions.

These outsiders now have a greater incentive to stake since a higher reward can be achieved with the same amount staked when entering the candidate market compared to the benchmark scenario. Whether this will also be profitable for the outside miners will then depend on how transferable the different technologies are between different crypto currencies staked or the different use cases. Depending on the nature of the PoS mechanism, different PoS blockchains might, for example, have substantially different technical requirements in terms of CPU.[19]

03
CRYPTO EXCHANGES

During the early phase of the development of Bitcoin, when mining on standard PCs was still viable, consumers could obtain Bitcoin by being active as a miner. Since the mining of the more popular cryptocurrencies now requires specialized mining equipment, obtaining them this way is no longer feasible. To obtain additional units of a cryptocurrency using PoS in any case requires the validators to already possess some of the cryptocurrency.

Nowadays, specialized cryptocurrency exchanges allow consumers to trade cryptocurrencies amongst each other or against fiat currencies. While crypto exchanges typically offer consumers to transfer the cryptocurrency to the consumer's own separate wallet, many consumers are happy to have the crypto exchange act as a custodian for their crypto holdings.[20]

Cryptocurrency exchanges can be categorized in three types. The first and most basic type allows the trading of a cryptocurrency, such as Bitcoin or Ether, for fiat currency, such as U.S. dollars or the Euro. A second type of exchanges offer to trade different pairs of cryptocurrencies since for some cryptocurrencies there are limits on the number of exchanges offering to trade them against fiat currencies. Often this involves the use of a stablecoin, such as Tether's USDT in place of a fiat currency.[21] While both types of these crypto exchanges are thus making transactions on the blockchains of various cryptocurrencies (on behalf of customers), they compete in the traditional world.

> ***During the early phase of the development of Bitcoin, when mining on standard PCs was still viable, consumers could obtain Bitcoin by being active as a miner***

Third, there are Decentralized Exchanges ("DEx").[22] These exchanges operate as smart contracts on top of an exist-

19 For example, to be a Solana validator, an Ethereum competitor using PoS, "[…] you need a computer with 12 CPU cores, 128 gigabytes of RAM, and 300Mbit/second upload speed (1 Gbit/second recommended)." This basically implies you need to be a datacenter operator to run a Solana validator. See https://docs.solana.com/de/running-validator/validator-reqs, last accessed January 4, 2022.

20 This may be due to steep learning costs involved in setting up one's own crypto wallet. A crypto wallet allows users to store cryptocurrency directly without using an exchange. It is well-documented that even in traditional financial markets, differences in financial literacy can affect consumers' market behavior and outcomes. See Deuflhard, Georgarakos & Inderst (2019). Deuflhard, F., Georgarakos, D., & Inderst, R. (2019). Financial literacy and savings account returns. *Journal of the European Economic Association, 17*(1), 131-164.

21 Stablecoins are cryptocurrencies pegged to a cryptocurrency, fiat money, or to exchange-traded commodities. We define stablecoins more precisely in Section IV.

22 Decentralized exchanges are also referred to as automated market makers. A market maker is someone who provides liquidity to market participants wishing to buy or sell a security or currency by either directly quoting bid and ask prices for the security/currency or submitting limit orders on an exchange's market.

ing blockchain, such as Ethereum.[23] As running a DEx essentially only requires the code for a related smart contract as well as the provision of some liquidity, which may also be provided by disparate holders of the relevant pairs of cryptocurrencies, entry into the DEx market is fairly easy.[24] A DEx is fully decentralized and allow consumers full control over their funds.

So far, we are not aware of any antitrust authority having defined the relevant market(s) for crypto exchanges. We will nevertheless attempt to provide initial thoughts on what will likely be key issues to consider in defining relevant market(s). Before doing so, we note however that there may also be complementarities among the various crypto exchanges. Instead of exchanging a fiat currency for a cryptocurrency directly, the same consumer might first exchange the fiat currency for yet another cryptocurrency, only for her to later exchange that other cryptocurrency for the initially desired cryptocurrency. As such, a crypto exchange that offers fiat-to-crypto trades would be complementary to a crypto exchange that only offered crypto-to-crypto trades.

When defining relevant markets for crypto exchanges, one natural question to ask is whether separate markets should be defined for separate pairs of fiat and cryptocurrencies. Should there be, for example, separate markets for exchanging U.S. dollars into Bitcoin and Euros into Ethereum, or should these markets be aggregated into one? While we do not wish and indeed cannot provide a definite answer to this question, especially since the rapid developments in this industry likely will require adjustments to the definition of the relevant market, we provide some first rough indications on how this question might be addressed.

As usual, the basis for discussing the definition of the relevant market is the hypothetical monopolist test. Would a monopoly provider of trading a given fiat currency and cryptocurrency be able to profitably raise its transaction fee by 5-10 percent above the competitive benchmark level?[25]

To fix ideas, we consider the market for buying Ether using U.S. dollars ("USD"). From the point of view of a consumer, trading different pairs is not a substitute since the consumer may not have the relevant fiat currency or have no desire to purchase another cryptocurrency. It may, however, be possible for the consumer to replicate as USD-ETH transaction by first using U.S.˙ dollars to buy a different cryptocurrency, for example a stablecoin such as USDT, and then engaging in a second transaction with the target cryptocurrency, namely Ether. Depending on the fees charged for these other transactions and depending on how many consumers have access to this type of arbitrage trade, the hypothetical monopolist may see a decline in its transaction volume following its hypothetical price increase making it unprofitable.

Another possibility is that the hypothetical monopolist's price increase might induce other crypto exchanges offering trades in different currency pairs to enter the market for trading USD-ETH. Whether this will be profitable for the other crypto exchanges will depend on how similar the target cryptocurrency is to those cryptocurrencies already being offered. As most crypto exchanges do in fact offer trading in multiple fiat and cryptocurrency pairs, such countervailing entry may need to be considered when defining the relevant market.

04
STABLECOINS AND MONEY

In economics, money typically has three functions: medium of exchange, store of value and unit of account.[26] Cryptocurrencies compete among each other and with traditional money as a medium of exchange and as a store of value used by consumers. While the earliest cryptocurrency Bitcoin was initially intended to have both functions, the large volatility of its price relative to the U.S. dollar has limited its appeal for the use as a medium of exchange in mainstream transactions. As a result of the large volatility of most cryptocurrencies relative to the U.S. dollar, the cryptocurrency community has attempted to create so-called stablecoins. These are explicitly intended to simply be digital versions of existing fiat currencies backed by some form of collateral.

Stablecoins should allow consumers a relatively fast transaction throughput and lower fees for small and large pay-

23 A smart contract is a computer program that is automatically executed on a blockchain.

24 As a result, even large DEx', such as Uniswap (V3) and PancakeSwap (V2), have only a small share of the transaction volume. See https://coinmarketcap.com/rankings/exchanges/dex/, last accessed January 3, 2022.

25 Since the fees for trading currencies is often expressed in percentages of the transaction amount, it may be necessary to adapt the benchmark for what constitutes a SSNIP.

26 For a modern discussion of money's role as a medium of exchange, see Kiyotaki & Wright (1989; 1993). Kiyotaki, N., & Wright, R. (1989). On Money as a Medium of Exchange. *Journal of Political Economy, 97*(4), 927-954. Kiyotaki, N., & Wright, R. (1993). A Search-Theoretic Approach to Monetary Economics. *American Economic Review, 83*(1), 63-77.

ments on a national and international level compared to the traditional financial system without the volatility of traditional cryptocurrencies. Consumers can then send and receive stablecoin payments between themselves with no centralized third-party. We distinguish three types of stablecoins depending on the type of collateral used.

First, fiat-backed stablecoins are issued by a centralized entity that collects a specific amount of fiat currency or a fiat currency portfolio, most commonly the U.S. Dollar, and then issues a redeemable stablecoin token backed 1-for-1 by the collected fiat currency.[27] Thus, in principle, every digital U.S. Dollar entering the crypto economy should be accompanied by one physical U.S. Dollar serving as collateral. Fiat collateralization typically happens off the blockchain, thus relying significantly on trust in the centralized entity. One problem is that these stable coins are often relatively centralized since the emitting party holds the fiat currency backing the stablecoin. Moreover, stablecoin accounts can be frozen by the centralized emitting party.[28]

Second, cryptocurrency-backed stablecoins are conceptually similar but are backed by a cryptocurrency or a cryptocurrency portfolio instead of fiat money. One major difference, however, is that the collateralization typically happens in a more decentralized way on the blockchain using smart contracts. Additional features may be implemented into the smart contract to promote price stability, which may, however, introduce additional technical risks that may be exploited.

Last, algorithmic stablecoins are not backed by any collateral. Similar to traditional monetary supply steered by central banks, the underlying protocol works as the central bank by adjusting the supply in reaction to deflationary or inflationary tendencies. The specific rules for such actions are typically defined within a smart contract. One advantage compared to more centralized models is that algorithmic stablecoins rely on transparent and auditable code which can enhance trust in the stablecoin itself.

While still in exploration phase, related central bank digital currencies ("CBDCs") are digital counterparts of fiat currency issued by central banks with similar features as stable coins. Since those are issued by the same authority determining the monetary policy of traditional fiat money, CBDCs are not strictly speaking stablecoins. They are, however, different from traditional central bank money in that CBDCs combine two formerly distinct features of banking, namely the banknote in the form of a token and a bank account in the form of ledger entries in accounts.

This could allow central banks to participate more directly in the creation of money which so far is largely left to private institutions.[29]

Although we are not aware of competition authorities examining the issue of the relevant market for money, central banks use a variety of definitions of money. The European Central Bank, for example, defines the monetary aggregate M1 to be the sum of currency in circulation and overnight deposits.[30] The larger aggregate M2 includes M1, but adds deposits with an agreed maturity of up to two years and deposits redeemable at notice of up to three months.

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What makes these monetary aggregates problematic is that the simple addition of the constituent quantities implicitly takes the various types of deposits to be perfect substitutes from the perspective of consumers. This is unlikely to be correct. While cash may be convenient for paying smaller sums at the point of sale, bank transfers from a customer's bank account may be more convenient for larger purchases. To better consider the imperfect substitutability of monetary assets, the use of Divisia indices has been proposed. These differ from simple sum monetary aggregates in that they take account of differences in the monetary assets' relative prices in a way that is consistent

27 The claim of 1-for-1 backing by fiat currency has often been controversial. For example, Tether, issuer of the one of the largest stablecoins, was fined for claiming it had a 1-for-1 backing of its stablecoin, although this was not the case. See https://www.bloomberg.com/news/articles/2021-10-15/tether-bitfinex-to-pay-fines-totaling-42-5-million-cftc-says, last accessed January 4, 2022.

28 For example, the most popular stablecoin to date has frozen over 500 addresses. Source: Bitquery, last accessed November 8, 2021.

29 See Bank for International Settlements (2018). Bank for International Settlements. (2018). Central bank digital currencies. *Working paper.*

30 See https://www.ecb.europa.eu/stats/money_credit_banking/monetary_aggregates/html/index.en.html, last accessed January 3, 2022.

with economic theory.[31]

To calculate an appropriate Divisia monetary aggregate it is also necessary to first determine the type of monetary assets to be included in the aggregation procedure. While Divisia monetary indices can be computed analogously to simple sum monetary aggregates, such as M1 and M2, the selection of monetary assets into these aggregates is based primarily on a consideration of the ease of converting the asset into funds that may be used for transaction. While there is therefore some flavor of the arguments behind the HMT in the construction of these monetary aggregates based on closeness of substitution, there may be other considerations, such as the ease of using different types of monetary assets for different types of transactions. For example, using cash and debit cards will typically be the preferred payment method at the point-of-sale, whereas bank transfers are likely more common for paying for larger durable consumer goods.

Introducing stablecoins into the appropriate definition of monetary aggregates raises further questions. While in principle stablecoins are easily and quickly convertible into other monetary assets, their use by businesses for accepting payments still remains limited, compared to alternative such as cash and debit cards. Including them in narrow definitions of money, such as M1, would therefore appear to be premature.

To calculate an appropriate Divisia monetary aggregate it is also necessary to first determine the type of monetary assets to be included in the aggregation procedure

For fully fiat-backed stablecoins it may also be argued that these should not change the overall monetary aggregate. While the stablecoins themselves may, provided they are sufficiently substitutable with other types of money, count as an increase in the money supply, the simultaneous "locking up" of the currency backing the stablecoin would serve to reduce the overall money supply. For stablecoins that are only fractionally backed by fiat money, the stablecoin may contribute towards an increase of the money supply, akin to how fractional reserve banking serves to increase the money supply. In that sense fractionally fiat-backed stablecoins may share some similarities to deposit-taking financial institutions and may be vulnerable to something akin to bank runs.

This might justify regulating fractionally backed stablecoins through measures such as an insurance fund, akin to the U.S. Federal Deposit Insurance Corporation ("FDIC)."

As the value of all stablecoins referencing a particular fiat currency should, in principle, correspond 1-to-1 to the value of the underlying fiat currency, applying a SSNIP test to delineate markets may again not be straightforward. This would, of course, also be the case when applying the SSNIP test to more traditional monetary assets.

As the literature on Divisia monetary indices makes clear, different monetary assets are associated with different relative prices.[32] The price of a monetary asset in that literature refers to the difference between a benchmark rate of return and the rate of return offered by the monetary assets. The rate of return for a monetary asset may also include fees and other costs imposed on users when holding it. For stablecoins these costs may be the fees charged by crypto exchanges for buying and selling the stablecoin.

Once it is understood that the relative rate of return on stablecoins (and other monetary assets) is the relevant price variable – rather than the exchange rate between stablecoins and the reference currency – applying the SSNIP test should again be feasible conceptually. Of course, obtaining the necessary data may still be a challenge, so that approximate approaches may have to be relied upon.

05
CONCLUSIONS

We discuss how to adjust the well-known hypothetical monopolist test ("HMT") used to define relevant markets relating to cryptocurrencies. The adjusted tools may be

31 For an overview, see Barnett, Fisher & Serletis (1992). Barnett, W. A., Fisher, D., & Serletis, A. (1992). Consumer Theory and the Demand for Money. *Journal of Economic Literature*, 2086-2119. For recent evidence on the benefits of Divisia monetary aggregates, see Belongia & Ireland (2019). Belongia, M. T., & Ireland, P. N. (2019). The demand for Divisia Money: Theory and evidence. *Journal of Macroeconomics, 61*, 103-128.

32 See Barnett, Fisher & Serletis (1992). Barnett, W. A., Fisher, D., & Serletis, A. (1992). Consumer Theory and the Demand for Money. *Journal of Economic Literature*, 2086-2119.

helpful to determine relevant markets for blockchain consensus mechanisms, crypto exchanges as well as stablecoins and other monetary assets. Based on the definition of relevant markets, appropriate regulations may then be considered.

> *As the literature on Divisia monetary indices makes clear, different monetary assets are associated with different relative prices*

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