

Central Bank Digital Currencies, Crypto Currencies, and Anonymity: Economics and Experiments



By Emanuele Borgonovo, Stefano Caselli, Alessandra Cillo,
Donato Masciandaro and Giovanni Rabitti*

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With the development of new forms of money, as cryptocurrencies and central bank digital currencies, the attention paid to their role as a store of privacy is increasing. Two intertwined questions arise: Theoretically, which is the difference between privacy and anonymity? Empirically, is anonymity relevant in shaping the demand for these currencies? The results of laboratory experiments show that anonymity matters and increases the overall appeal of a medium of payment, and that this effect is stronger for risk-prone individuals.

* **Emanuele Borgonovo** and **Stefano Caselli**, Bocconi University; **Alessandra Cillo**, Bocconi University & SUERF Research Affiliate; **Donato Masciandaro**, Bocconi University and SUERF, corresponding author: donato.masciandaro@unibocconi.it; **Giovanni Rabitti**, Department of Actuarial Mathematics and Statistics, Maxwell Institute for Mathematical Sciences, Heriot-Watt University.

Privacy protection is an important issue in the information age (Acquisti et al. 2015). The particular relevance of this issue in the monetary field becomes evident if we observe three stylized facts. First, public paper currencies, most of which are in the form of large-denomination banknotes, are still appreciated for their resiliency and their anonymity. We have seen a rise in the circulation of paper currencies in both advanced and emerging economies (Berentsen and Schar 2018), with only Sweden and Norway as notable exceptions (Armeliu et al. 2020).

Second, the recent wave of innovation in private-payment systems has been characterized by the issuance of private digital currencies; in these payment architectures, cryptographic procedures are used to protect privacy (Schilling and Uhlig 2018, Halaburda et al. 2020, Auer and Tercero-Lucas 2021). A notable share of private digital currency users have expressed their appreciation for the anonymity associated with these systems (Bohme et al. 2015). Moreover, individuals interested in using cash for illegal reasons seem to view private digital currencies as close substitutes (Hendrickson et al. 2019).

Third, the issuance of a (public) central bank digital currency (CBDC) is an option that central bankers are carefully considering. Given that a hypothetical CBDC can be designed in different ways, and that money digitalization may lead to a process of unbundling and re-bundling the different properties of money (Brunnermeier et al. 2021), the level of privacy is a key issue in this debate, especially with respect to retail payments (De Lis and Urbiola 2020, Agur et al. 2021).

In a monetary transaction, full privacy protection coincides with anonymity. As such, a crucial question arises: Does privacy matter in shaping the demand for money? This question can be answered using laboratory experiments based on a novel methodology that combines standard techniques for eliciting individual preferences with some innovative aspects (Borgonovo et al. 2021). But preliminary it is necessary to discuss the difference between privacy and anonymity.

Money, Privacy and Anonymity

We start with the definitions of money and memory. Money is defined as a token that has a relatively stable value in terms of goods and services, and is used as a medium of exchange and a unit of account (Brunnermeier et al. 2021, Borio 2019). Moreover, it includes a transfer mechanism that allows for payment execution (Borio 2019). Memory is knowledge on the part of an agent of the histories of all agents with whom he or she (hereafter “she”) has had direct or indirect contact (Kocherlakota 1998, Bigoni et al. 2020). If these two definitions hold, money is equivalent to a primitive form of memory (Kocherlakota 1998).

If the value of money as a medium of exchange stems from its role as a memory technology, then the development of more technologically sophisticated account-based networks can generate doubt about the role of money as a store of information. In a sense, more developed memory technologies can reduce the value of money. However, somewhat paradoxically, money’s role as a record-keeping device creates its utility as a device for providing transaction privacy when individuals live in a world with imperfect and asymmetrical information (Kahn et al. 2005).

Therefore, it is not surprising that the economic literature has progressively highlighted that in an economy with less-than perfect information distribution, the value of money (all else equal) may be derived from the privacy protection that it confers (Kahn et al. 2005 and 2018).

Each medium of exchange is associated with a payment mechanism. In each payment mechanism, the number of individuals who can observe every transaction – directly or indirectly, immediately or after a while – can differ. In

some transactions (e.g., when using cash), the number of observers is minimized. With other payment mechanisms, transactions are observable not only to the parties involved but also to third parties. This possibility increases the more the payment mechanism is an account-based network (Hendrickson et al. 2019).

A natural consequence arises from the association between privacy demand and personal information: if the demand for privacy relates to a set of private details about the individual, its maximum level coincides with a demand for anonymity (i.e., all details about the individual are hidden). In other words, it is impossible for all possible parties that are directly or indirectly involved in a monetary transaction to find any information on the individual after the deal goes through (Kahn 2018).

Two effects follow. On the one hand, anonymity in payments is a feature inherent to the use of well-defined public money, such as cash (Garratt and van Oordt 2021). Cash provides a greater degree of financial privacy than other payment technologies (Hendrickson et al. 2019). On the other hand, if anonymity (i.e., full privacy protection) is not available, any improvement in privacy protection leads to efficiency gains in the demand for money (Kahn et al. 2005). In fact, several cryptocurrencies are explicitly premised on the ability to facilitate quasi-anonymous transactions (Hendrickson et al. 2019).

Money Demand, Anonymity and Experiments

From a theoretical point of view, the experiments were based on a specification of the demand for money, in which a Medium of Exchange (MOP), as a unit of account, has three simultaneous economic functions. The first two are the MOP's standard functions as a medium of exchange and as a store of value – that is, the original Keynesian transaction and speculative motives (Baumol 1952; Santomero and Seater 1996). The third is the novel function of store of information and privacy protection (Kocherlakota 1998, Kahn et al. 2005).

The experiments used the definition of a safe MOP, which focuses on a MOP's liquidity properties (Greenwood et al. 2015). In parallel, the experiments evaluated the MOP's ability to preserve its expected value (Caballero et al. 2017), which is the second property of a currency. Holding a MOP implies an expected opportunity cost that can be calculated by comparing the total return associated with alternative MOPs.

Finally, a currency can offer privacy protection. There is evidence of a preference for anonymity in the financial field (Charness and Neugebauer 2019, Weber et al. 2018), yet individual preferences for the anonymity dimension in the demand for money have not been investigated in the literature, although Athey et al. (2018) analysed the more general preference for privacy. The experiments have been focused on full privacy (i.e., anonymity) and answers the question of whether anonymity in monetary transactions have any value in absolute and relative terms when compared with the other properties of money.

The experiments started with a descriptive analysis of the data and then continue with an inferential analysis. When presented with two MOPs differing only on the anonymity dimension, experiment subjects assigned to the anonymous MOP assigned a value, on average, 1.44% higher than the values assigned to the non-anonymous MOP. Thus, anonymity per se matters.

Furthermore, it has been tested whether the preference for anonymity was related to subjects' risk attitudes. In the experiments the subjects have been classified as risk averse/prone/neutral, if the risk premium was positive/negative/null for at least 50% of their choices. For the risk prone subjects, the increase was 30% greater than for risk-averse subjects. In other words, risk-prone subjects seem to assign more value to the property of money as a store of privacy. There are several possible interpretations for this result. For example, people may

not want others to know that they like risk. That is, as risk aversion is the social norm, risk-loving agents may have a greater desire for anonymity. Another possible interpretation is that risk-prone subjects are more prone to illegal deals and, therefore, they might like anonymity more.

Finally, the experiments provided an understanding of how much anonymity matters when compared to illiquidity risk and expected return. The first two attributes – illiquidity risk and expected return – tend to be more influential than anonymity, with expected return having a greater influence than illiquidity risk.

Among the anonymous MOPs, the trade-off between the two properties of liquidity and return was relatively high – to accept higher illiquidity risks, individuals require a more than proportional increase in the expected return.

These results can be interpreted as signalling that anonymous MOPs are considered attractive if they promise gains substantially greater than the associated risk. This can explain the initial interest in bitcoins, which initially had high returns that overwhelmed the associated illiquidity risk. It can also explain the appetite for new and emerging private digital currencies that can produce high returns despite the associated non-negligible illiquidity risk.

At the same time, consider a digital currency issued by an entity with a low illiquidity risk, such as a central bank. In this case, the denominator in the “return/illiquidity risk” ratio is small. Therefore, as soon as the return is not negligible, the ratio is high. For illustration purposes, consider a central bank digital currency. For such a MOP, the default probability is close to zero or even zero. If it is zero, then any return would make the “return/illiquidity risk” infinite. However, let us set the illiquidity risk at 10^{-5} per year. Then, a yearly return of 0.0001 would lead to a return/illiquidity risk of 10 – a region in which individuals would allocate a considerable amount of their capital to this MOP.

Lessons from Experiments

The experimental results show that: 1) anonymity matters; 2) the opportunity cost is the more relevant property of money; 3) a combination of the three properties of money is likely to increase interest in a medium of exchange; 4) risk-prone individuals like anonymity even more and 5) given the level of anonymity, the trade-off between illiquidity risk and return is relatively high. In other words, to accept higher illiquidity risks, individuals require a more than proportional increase in the expected return.

Given that the experiments confirm that anonymity matters, two considerations follow. On the one hand, cash can maintain its appeal as an anonymous MOP. On the other hand, the more other MOPs can be trusted to offer anonymity while balancing illiquidity risk and expected return, the more likely the crowding out of cash becomes.

Finally, policy implications emerge for MOP suppliers, such as banks, central bankers and private firms. As MOPs, bank currencies could be challenged by a lack of anonymity and by low expected returns, features that make private digital currencies more attractive. Similarly, the success of a private digital currency will depend on its ability to decrease the illiquidity risk and increase the expected return while credibly guaranteeing anonymity. A central bank digital currency is unique feature because it is an electronic MOP as well as a public currency. The experiments shows that its attractiveness depends on how it is designed in terms of the level of privacy and interest-bearing mechanisms. In principle, the illiquidity risk of a central bank digital currency is low. At the same time, it seems unlikely that individuals will view it as offering the same anonymity as cash. The experimental results show that offering a yield could help increase its appeal. ■

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About the authors

Emanuele Borgonovo is Full Professor at the Department of Decision Sciences of Bocconi University, and director of the Bachelor in Economics, Management and Computer Science at Bocconi University. He is the current President of the Decision Analysis Society of INFORMS and member of the Scientific Committee of the Fondazione Silvio Tronchetti Provera. He is co-editor-in-chief of the *European Journal of Operational Research*, and advisor of the Springer International Series in Management Science and Operations Research. He is the recipient of several National and International Awards and has published over 100 papers in scientific international journals. His research interests concern Sensitivity Analysis, Decision Analysis and Machine Learning. He is author of the book: "Sensitivity Analysis: An Introduction for the Management Scientist", <http://www.springer.com/gp/book/9783319522579> and of "Quando ai managers danno i numeri", EGEA.

Stefano Caselli, Ph.D in Financial Economics at University of Siena, is Full Professor of Finance, Algebris Chair in Long-Term Investment and Vice-Rector for International Affairs, at Bocconi University where he is also member of the board of SDA Bocconi School Management. Furthermore, he is member of the management board of CEMS (Community of European Management School) whereas he chairs the Quality Assurance Committee. He is member of the Advisory Board of the School in Transnational Governance at European University Institute in Florence and of the International Advisory Board of Stockholm School of Economics. He is member of the Steering Committee of CIVICA, The European University of Social Sciences (www.civica.eu), where Bocconi University is a member. His work has covered four main topics: investment banking, private equity and venture capital, corporate governance and risk management in banking sector, financial regulation and supervision. He is Columnist in the main Italian newspaper *Corriere della Sera* for "L'Economia".

Alessandra Cillo is Adjunct Professor in Decision Sciences at Bocconi University. She was Assistant Professor (2009-2018) in Decision Sciences at Bocconi University and in Managerial Decision Sciences at IESE Business School, Barcelona (2007-2009). She is Affiliate at Iger, Research Fellow at Baffi Carefin, and SDA Bocconi Fellow at Management Science Laboratory SDA Bocconi. She holds a Ph.D. in Management in Decision Sciences, Insead (2007) and an M.Sc. (2004) at Insead. Her research interests are behavioral models of decision under risk: Theory and experiments, Multiattribute utility, Risk-Value modeling and stochastic dominance, Value of information and importance measures.

Donato Masciandaro, born in Italy in 1961, from 2010 is Full Professor of Economics and Director of the BAFFI CAREFIN Centre for Applied Research on International Markets, Banking, Finance and Regulation. From 2005 he holds the Chair in Economics of Financial Regulation, at Bocconi University. From 2013 he is Head of the Department of Economics; he was already Department Head from 2008 to 2010. He is member of the Council and Honorary Treasurer of SUERF - The European Money and Finance Forum. He served as Visiting Scholar at the IMF (International Monetary Fund), as well as Consultant at the Inter-American Development Bank and the United Nations. He is Associated Editor of the *Journal of Financial Stability*. His main research interests are in Financial Regulation and Supervision: a) General Issues; b) Illegal Financial Markets; c) Central Banking.

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SUERF Secretariat
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Otto-Wagner-Platz 3
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