How Tracking of Electronic Money might Improve Financial Market Crisis Intervention

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Technology has changed and will continue to change the financial system. This paper proposes a set of tools that can give control entities a more profound insight into the markets and enable them to react to crises more efficiently. The theoretical proposal presented in this paper is a control tool that has its foundation in digital currencies and enables central banks to trace some of their freshly issued money in order to understand the current market activities more profoundly. The second purpose of this basic tool is to enable further tools, which are based on the same technology. The tool that exemplifies the possibilities of the concept in this paper allows money to be targeted to a particular market sector or another market. This paper introduces this original, theoretical system and investigates its possible positive and negative impacts on the economy.

Introduction

Multiple causes lead to financial market crises, and the past has shown that it is particularly hard to keep the markets controlled in the end. Now, through the growth of shadow banking and through other continuous technological developments central banks are losing their formerly profound insight into the markets. Attempts to determine the markets schematically are already outdated, but they are still able to show the historical origins of the development (Pozsar et al. 2010).

This paper proposes a new, original and specialised form of electronic money, which is traceable through the markets, Monetary Tracking (MT). The objective of such money is to improve the understanding of systemic monetary flows. The objective is not to provoke a complete surveillance of the financial sector but to enable the detection of possible future issues through trade patterns. The second

objective of this tool is to enable the development of more advanced control and intervention tools.

The example used to exemplify the possibilities of the tool in this paper is Monetary Restricting (MR), which has the objective to improve the accuracy of market interventions, particularly in times of crisis. MR allows the central bank (CB) to restrict the use of specially determined money only for a particular market or section of the economy. One of the core ideas behind MR is to prevent the spread from the financial markets to the 'real economy.' Credit crunch and thus interrupted liquidity flows towards the 'real economy' in times of financial distress could be prevented or at least minimised with this technology.

The importance of this piece derives from the current developments within the financial markets. Shadow banking, digital currencies and distributed ledger-based systems are growing day by day, and the regulatory response is still only in its early development. The main intention of the paper is to create an awareness for the problems and to start a discussion about the possible solutions that technology is able to provide. These adaptations need to be discussed thoroughly before being introduced, which is why this very first proposal of such technology-based tools is limited to two basic tools. The two systems or adaptations of trackable money are introduced in this paper to provide an appropriate reaction to the technological developments and systemic changes in the financial markets. Even those two tools would require a monograph to cover all aspects with the thoroughness they deserve. Hence, the objective of the paper is to propose the systems and to start a discussion on all aspects of this particularly multi-layered issue. Monetary Tracking, as proposed in this paper, is not a way to prevent financial crises, but it is a tool that enables a continuing insight in, and hence an understanding of, the markets. The follow-up tools might be able to ease the effects of a crisis or prevent its spread or even its emergence, but that has to be the subject of future debate. This first introduction is only focused on starting a debate on tools based on similar technologies that allow an effective supervision and intervention in the constantly changing financial markets.

The concept might sound farfetched to some, but issues like these will and must occupy all scientists working on financial markets in the coming years and decades. The current Chief Economist of the Bank of England, Andrew Haldane, argued for an idealistically similar solution to MT: 'I have a dream. It is futuristic, but realistic. It involves a *Star Trek* chair and a bank of monitors. It would involve

tracking the global flow of funds in close to real time (from a *Star Trek* chair using a bank of monitors), in much the same way as happens with global weather systems and global internet traffic' (Haldane 2014).

The paper first shows the technological basis and origins of the concepts and provides a background for the adaptations that are proposed in sections three and four.

Digital Money

Only three kinds of money are important for this paper: Physical, electronic and digital money. However, to believe that these are all kinds of money in existence would be absurd, as money is disguised and created in many ways today.

Physical money is our everyday and official currency consisting of paper money and coins. We can touch it and transfer it from hand to hand. The definition of electronic money used here is very rudimentary, as it is just seen as the same thing as physical money, the only difference being that it is not tangible. Electronic money makes up for the biggest share of all issued money today. It is just the not printed version of physical money that is transferred electronically.

The last category is digital money, which is a broader variety of specially designed online currencies that are used in certain subcultural or market segments, like Bitcoin, BitMint or Digicash. They work like any 'normal' currency. The personal accounts in the respective currency are convertible into any or most official currencies, with a flexible exchange rate. The private issuer guarantees the accuracy of the currency. These currencies can be seen as nonofficial online substitutes for the official currencies, but up to this point, they play only a marginal role within our system and are not yet able to pose a threat to monetary stability. However, the volume and number of transactions has grown substantially over the last few years (Robleh et al. 2014a; 2014b; see https://blockchain.info/stats). The growth of digital currencies is exponential, but along with this growth, the number of problems increases as well. The velocity as well as the intensiveness of financial crises within digital currencies are increasing (CNBC 2017). The fact that central banks are already concerned about the possible threat shows their apprehension of possible future challenges. All over the world, numerous government entities have invested money and time into the creation and study of digital currencies. The Bank of England, for example, has established a team to investigate numerous research questions related to central bank-issued digital currencies, which would be a

public countermeasure to the currently leading privately owned digital currencies (Bank of England n. d.). Also the German central bank and the German stock exchange have joined together in an endeavour to create a blockchain-based settlement system for securities (Deutsche Börse 2016). These are just two of the multiple examples of the different and internationally distributed trials with digital currencies.

Some of the currently dominating privately issued digital currencies may play an increasingly important role in the future of our economy, but there is still a chance that they might vanish, as well. However, what they will definitely leave behind are some technological advancements like 'distributed ledgers,' based on blockchain technologies, which is a concept that is about to revolutionise the financial markets. A group of 40 major institutions have already formed a research network to develop the topic (see https://www.r3.com). The number of funding companies grew rapidly from 22 in 2015 (R3 2015), and as mentioned before, multiple other entities are also moving ahead with this technology. These ledgers enable a decentralised payment system without a central third party that secures the payments. The ledgers are based on advanced programming tools that enable a secured peer-to-peer transaction with the help of cryptography. Digital signatures, encryption and the presence of money ensure the authenticity of the authorship of a particular transition or message. The transaction can then be verified by any third party within the network, which means that a centralised ledger becomes obsolete (Robleh et al. 2014a; 2014b). This could mean that distributed ledgers might make obsolete the role of a clearinghouse, which is often held by the CB. However, CBS are not alone in being impacted by the fundamental market changes. The classical banking model will disappear over time, as digital banking and even more advanced systems than that are able to provide the services for the people in a more direct way (Lipton, Shrier, and Pentland 2016).

Monetary Tracking

Monetary tracking is money issued by the Central Bank that is traceable with the help of a mapping system and the technology deriving from the digital currencies. It is primarily an analysis tool that shows entities and at least an insight into trade flows, but its technology can also be the basis for numerous further developments. It is a concept focused on electronic money. The simplified explanation of the concept is that predefined electronic money is marked

with an individually identifiable key. The key or mark gets pinned on one electronic 'coin,' which can be pictured as the serial number on printed money, but that does not have to mean that one coin has to be one Euro or Dollar but might be one million Euro. The mark could then be dividable in order to minimise the required server space. The electronical mark would make the particular note traceable through a mapped system of companies and entities. Hence, the cb gets a notice of transition if a coin is transmitted from one entity to another. This would allow mapping the interactions when the master accounts are cleared at the end of each trading day. General tendencies and flow tendencies could be deducted. A limitation is of cause that most money used in the system is privately created money and not issued by the central bank, but models are able to respect this fact in the analytics of the system. MT is a highly automated system, as the marking, tracking and analysis of the movement is made automatically. MT does not require any changes, as the appearance of the electronic money remains the same. The only accountable change is that the money will need a little bit more disk space than before, but even this difference will not be significant, when a smart technical design is employed. The analysis output would not only allow more profound insight into the markets, but some important key indicators should also be made available publically. The rest of the database should be accessible for companies, central bankers and researchers with a particular research interest in order to improve the acceptance of the stakeholders.

For a better understanding of the system, a possible issuance of MT-marked money is exemplified here: The cb management decides to mark a certain percentage of newly issued money, which is then issued together with all the rest of the regularly issued money. The marked coins are issued randomly to the receivers of central bank cash. The movement of this money is then tracked through the financial system, until the money is either exchanged to another currency, withdrawn as printed money or paid back to the cb. The two first barriers are legal barriers for a first introduction and not necessarily technical issues. The documented movements of the 'marked coin' are saved within the cb and can then be analysed. The private banks handling money do not see which money is traced, but they have to provide the cb with a mapping system of their accounts in order for the cb to see where the coin moved.

The system introduced here is a first step that can trigger many follow-up innovations and developments, such as international coordination to keep money trackable across currency borders. MT could

become the basis for even more tools, if all electronic money was marked, i.e. all high-powered money and the bank reserves, as well. Such a universal system would enable a very detailed market analysis for all stakeholders of the financial markets, especially as this would include the money created within the system. However, these and many other possibilities for further developments have to be discussed in other papers, as the implications of all of these issues exceed the confines of this paper.

The advancements in cyber security, in particular those in digital signatures and public-key cryptography, as well as the advancements in digital currencies show that the system is feasible. The possibility for all parties involved to analyse the worldwide trading patterns opens new opportunities for strategic behaviour, but it prevents one entity from controlling the rest. Of course, the limits of the system have to be determined in order to prevent a totalitarian state. Clear restrictions have to be the core legal borders for MT and all of its tools, and they are crucial for its success. These will be evaluated in the last chapters of this paper.

Monetary Restricting

Monetary restricting is a freely chosen name for a monetary tool that builds on the technology used for MT. MR is one example of a tool based on the technology behind MT, but it does not need an introduced system of MT to function. MR is money issued by the central bank with a particular purpose or target area. The central bank is able to limit its usage to a market or region in order to fight monetary outflow or credit crunches in times of crises. MR works on the basis of marked money and is nothing else than the permission for the CB to assign some of the marked money to a specific use, area, partial market or purpose, for example the European or even the Greek real economy. Such a tool would be able to provide the so-called real economy indirectly with fresh credit even if the private banks are struggling with liquidity or asset difficulties. The central bank has hence not the power to finance a state with this tool, but it is only able to support a particular 'real economy,' market or region. The use of MR presented here, to prevent credit crunches is only an exemplified use of the tool, as other applications or political targets are imaginable, but it is a very rewarding example, as it shows the power, but also the problems, of the tool without being too controversial a topic. A brief discussion on credit crunches will follow after this part, and it will show the remaining reasoning behind the tool's design. MR can obviously be a very

controversial tool, which is why it needs to be restricted carefully. Unlike MT the money issued under MR needs to be easily identifiable for all stakeholders in order to enable the banks to deal with it appropriately.

MR distinguishes itself from direct governmental funding and selective credit controls, as the CB provides the money to the private banks, as always, through credit. The difference, if MR is implemented for a determined period, is that a certain share of the money is marked. The marked share of the issued money is determined in use by the CB. The size of the share cannot be influenced by the private banks. It is solely determined and implemented by the CB, which in the current example means that under MR the CB would dedicate a share of all money credited to private banks, in a particular period, to crediting the 'real economy.' The CB on the other hand does not have the ability to influence the private banks in the decision which company from the 'real economy' receives a credit and which does not. The share has to depend on the severity of the crisis, but it should always ensure the survival of the private banks. The banks and financial entities need to be able to rebuild their equity ratios and prevent their bad assets from impacting their entire company in times of crisis, especially if ratings are dropping and obligatory equity cushions have to grow exponentially (Beck 2012; Mizen 2008; Ioannidou 2012).

The trick with the marked money is that the serial numbers in use are prohibited from being accounted for in equity ratios and asset coverage in general. This step circumvents the banks' own need for liquidity and forces the banks to rethink the possibility of distributing credit to the real economy. The private banks are thus still fully in charge, but some of the money they received from the CB is not usable for anything other than for the distribution to the real economy. Therefore, they only have the chance to either provide credit and gain a possible profit from it or leave the money in their accounts without doing anything with it. This also means that they are, as usual, stuck with the risk of an investment, so that MR does not help to keep unprofitable companies alive, but it prevents monetary outflow and many aspects that lead to a credit crunch, which helps to keep well performing companies from getting impacted by systemic financial struggles.

The technical side of the exemplified restricting goes along with the introduction of an easy categorisation process based on a traffic-light system. Trackable or marked money will be distributed to the market with the restriction that it can only be used for investments,

credits and any other form of monetary flow to the green and yellow traffic-light market sections.

The traffic-light system distributes all companies of one economy into different groups. All companies represented in the traffic system of one cb need to be part of the underlying common or national market. Foreign companies cannot be accounted for in one of the categories. A company's affiliation within a particular section is calculated by its main source of revenue. These affiliations must be proven, which can be done rather easily, as the private banks have profound insight into the company's situation in any case. The cb then only has to use a randomised sample to control these affiliations.

The green section comprises companies gaining less than five per cent from financial activities within a three-year averaged period. Companies in the yellow area are companies with averaged revenues of five per cent to less than 50% through financial activity over the last three years. All companies above this percentage are grouped together in the red section. In critical cases, the cb is supposed to investigate individually if the assignment to one of the groups is correct or not. To improve the success rate of mr all tendencies like the investment into letterbox companies or other circumvention mechanisms that private banks might want to employ should be penalised.

The groups of this provisional determination have been chosen because most small and medium-sized companies are in the green, but also in the yellow group, without direct access to cb money. These companies are impacted the quickest and hardest by credit crunches, as there is a reported tendency of financial institutions to prefer loans to larger companies in credit-crunch situations (Buera, Fattal Jaef, and Shin 2015). Additionally, these companies are statistically not as agile with their production factors as bigger companies, which leads to higher rates of laid-off employees among these companies in comparison to bigger or more established companies (Zhang, Yang, and Long 2014). This process, together with the reallocation and the contraction of investments leads to a macroeconomic recession (Buera, Fattal Jaef, and Shin 2015), which emphasises the importance of a working intervention tool. mr is intended to provide a first monetary policy tool that can help to impact credit crunches.

The objective of mr is thus to direct monetary flows towards a specific objective, in this case to the green and yellow areas of an economy. The purpose of this is to minimise the risk of credit crunches and thus to contain the spread of a financial crisis to the rest of the economy.

Credit Crunches and the Central Banks

Bernanke and Lown (1991) describe a credit crunch as an abnormally large decline in the credit supply for a given stage of the business cycle. Owens and Schreft (1995, 65) define the same 'as a period of sharply increased nonprice credit rationing.'

A credit crunch is thus a situation in which banks and other lenders retreat from lending and focus most of their resources on other activities with higher potential profits within the financial markets or in other regions of the world. The limited resources force the real economic market participants to reallocate their own resources, cut back investments and lay off employees. This circle can lead an economy into a deepening recession. Mishkin (2008, 67) outlines one possible scenario in his description of a feedback loop between lending and rising equity values: 'At some point, however, the bubble bursts. The collapse in asset prices then leads to a reversal of the feedback loop in which loans go sour, lenders cut back on credit supply, the demand for the assets declines further, and prices drop even more.'

On the other hand, a credit crunch is not necessarily a consequence of an economic downturn (Clair and Tucker 1993). It is important to know that lending does not only react to the creditworthiness of a project but also to the capacity of the bank's balance sheet and the capacity of off-balance sheet entities owned by the bank to compensate further risk, which leads to pro-cyclical behaviour. The last important issue that lending depends on is the soft factor of trust. If the companies distrust each other, lending decreases (The Committee on International Economic Policy and Reform 2012; Mizen 2008; Aliber and Kindleberger 2000).

The financial market has also proven itself to be able to absorb the greatest part of the issued money without preventing contagion at all, as observable in the problems following the sub-prime crisis (Mizen 2008; Ait-Sahalia et al. 2009). Models have estimated that financial shocks on leveraged sectors and the redistribution between these sectors accounted for approximately two-thirds of the output collapse in the time after the subprime crisis (Iacoviello 2015). In the case of the subprime crisis, the cycle of an increasing accumulation of problems, which is nothing else but a crisis, was also driven by the cross-market linkages and spread via liquidity channels (Allen and Gale 1999; Longstaff 2010). The habitual business-cycle movement does usually not cause a credit crunch. Usually the lending entities recover relatively quickly after a downturn. The actual causes for

credit crunches are multiple, like overestimation of risk, the necessity for banks to rebuild their equity base, capital adequacy ratios and misregulation (Clair and Tucker 1993; Zhang, Yang, and Long 2014). In conclusion: The credit crunch can be a result of the willingness to lend. The basis of this issue is trust, which is a big issue that MR cannot solve, but other than that monetary restricting is able to circumvent all of the described problems and should thus be able to help to stabilise the system.

Economic Impacts

The financial markets were able to partially outgrow the direct influence of the CB with the help of technological advancements. The outgrowing process can mainly be credited to the so-called shadow-banking sector. These unregulated parts of the financial markets are already responsible for a third of the market activity in finance, and the growth tendencies indicate that the market share of the shadow banking sector will continue to increase faster and faster over the next few years (European Central Bank 2014; Constâncio 2015a; Kregel 2010). The shadow-banking sector grew faster than its financial competitors did. The sector grew from 2003 to 2013 from 9 trillion Euro to 19 trillion euro. The volume of insurance companies and pension funds 'only' doubled from 4 trillion Euro to 8 trillion Euro within the same period. The banking sector residing in the Euro area, excluding monetary financial institutions, grew from 19 trillion Euro to 30 trillion Euro in the same period (European Central Bank 2014). Since mid-2012, the velocity of the growth of the highly diversified shadow-banking sector has even increased, as the assets of the shadow-banking sector already amounted to 23 trillion Euro in mid-2014. This means that such a development, if continued, will lead to a financial system within the entire Euro area in which the shadow banking system will be bigger than the regulated banking sector within five years as of 2015 (Constâncio 2015a).

These entities emerged through a market need for security and accountable promises that the central banks did not provide, while regulatory reforms were suspended. These markets developed an exceptional system of money creation that was, and for the most part still is, completely out of reach for any regulatory power (Gorton 2010; Kregel 2012).

The shadow banking activities go hand in hand with advanced technological products. These uncontrolled activities are highly profitable for the most part, but at the same time they are a source of systemic instability and a risk for the entire financial market (Ton-

veronachi 2015). The growth tendencies of the shadow-banking sector are not surprising, as the banking, system underlies a set of regulations and ratios, which do not apply to the shadow banking entities. Many vehicles of the shadow banking markets work with extremely high leverage ratios, which comes not only from the reuse, repackaging or re-pledging of collateral, but also from reusing or re-pledging securities to obtain new loans. This re-pledging process of using collateral multiple times leads to hidden leverage and a multiplying effect (Kalinowski 2012). This cyclical behaviour leads to the conclusion that the vehicles of the shadow banking sector and their asset managers are crucial suppliers of collateral and at the same time important demanders of 'safe, short-term, liquid instruments, or non-deposit money-claims' (Singh and Pozsar 2011, 3–4). This means that the continuously growing shadow banking sector has created a well performing, 'self-refuelling' circle of money creation, which works in multiple layers so that the description above is only a short cut-out of the entirety of the process. Kalinowski (2012, 6) explained the reason for the cycle with these words: 'For assets managers, it is cheaper to obtain liquidity in this manner than borrowing in the old-fashioned way. For commercial banks, securitization offers substantially higher profits than traditional lending.'

For this paper, the shadow banking tendencies mean that the central bank is continuously losing control over the monetary system and thus over the outcome of its own policies, especially if distributed ledgers and digital currencies continue their growth and destroy another part of the insight on the markets that the CB currently still has. The less the controlling entities are able to keep a profound insight on the markets, the less effectively they are able to work. MT is a first step on the side of monetary policy; the issues of financial regulation remain unresolved, but monetary tracking can make market estimations more realistic and meaningful. Already in the first stage, it is able to shed light on the interaction patterns within the shadow banking markets, and with that, it could deliver possible arguments for more precise financial-market regulations. In more developed stages MT is actually able to depict the monetary flows with precision, and even the issue of private-entity money creation is not a problem as described above, but MT is no miraculous tool either, as it can only engage one side of the problem.

The ECB is very open-minded with regard to modern tools, which are able to improve the performance of the CB in any way. Vítor Constâncio put it thus: 'The monetary policy experience of the past seven years is reviewed. In pursuit of its objectives, the ECB has been very

flexible in adjusting and expanding its toolkit' (Constâncio 2015b, 1). The ECB Banking Structure Report 2014 states: 'This increased divergence of financial cycles in boom periods calls for differentiated and well-targeted policy responses that are properly tailored to individual jurisdictions in order to address specific emerging risks in those countries' (European Central Bank 2014, 50–51). This clearly shows the ECB's determination to adopt new and technically adequate tools for more precise monetary activity, which is why this proposal should be considered to be one alternative.

Limitations and Research Outlook

All tracking tendencies are always two-sided, and one should understand both the positive and the negative sides, the misuse and trade of private data and the improved online-surfing experience. The same is true for the data generated through MT. So tracking of numerous activities on- and off-line is very famously in use and leads to the creation of billions of electronic portraits. The question remains why central banks should not be enabled to create rough 'electronic portraits' of the financial entities within their area of influence to improve the systemic stability. These data sets could be used to identify possible contagion risks, credit crunches and other eruptions within the monetary flows, which could then trigger more efficient reaction tools.

Another problematic side of such a tool is the possibility for private companies or hacker groups to build a subsystem with available private datasets, which has to be prevented, as this could trigger a race-to-the-bottom situation in which all companies compete on such analysis systems without helping anyone, while incentivising gaming behaviour. The system is only beneficiary for the society if either all stakeholders or only the public control has access to the produced data or a share of the data. Of course, the micro data from within the companies has to be protected from the private users in order to prevent espionage.

MT allows generating data in a quantity and quality that has never existed before, which enables an understanding of the current situation of the markets with much more profundity. This capacity of analysing monetary flows within the financial system can improve crisis prevention and reaction mechanisms, especially if private and public entities join their analytic tools to stabilise the system.

Cybersecurity generally is a crucial topic for this system, but also in general is it a field of growing importance for our society. Different financial market entities have already repeatedly been targets of

cyber-attacks (cpss-iosco 2011). Cybersecurity and cyberterrorism are two important issues that will take up more space in the future. International treaties and co-joined international working groups on cyber security between different big international players emphasise this fact (Williams 2015; The Associated Press 2014; Zhernov 2014). The security of the systems thus has to be up to the highest standards. Otherwise, the trust that the system tries to improve would vanish and reverse quite quickly.

A particularly beautiful aspect of mt is that it is a monetary policy tool. The cb can introduce it without needing the consensus of governments on how to restrict or control the shadow banking sectors. mt can be introduced by the cb in a trial run and could be perfected over time with ever-growing trial rounds before thinking about a complete systemic introduction.

Conclusion

A much more profound analysis of the consequences will be required in order to develop the concept further. This introductory paper was only able to touch upon many issues and hence further papers regarding the numerous critical aspects are needed for a further development of the tools. Monetary Tracking and especially Monetary Restricting are controversial technologies, but they might be less controversial than the long-term effects of some monetary policies that are in place at the moment.

mt is a technology-based analysis tool that enables an insight into the markets, but it is also the technological basis for much more profound tools. Monetary Restricting, one of many possible tools based on the same technology, is able to tackle some issues that financial market crises create. The tool helps to contain the crisis within the market it originated from.

This paper is too short, of course, to mention all aspects in necessary depth, but it is a contribution to the discussion on how to deal with the upcoming technological changes that will impact the financial system profoundly.

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