Circular economy and central bank digital currency

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Abstract

The emergence of central bank digital currency (CBDC) provides an opportunity for central banks to make an important contribution to the transition to a circular economy. This paper examines the role of a central bank digital currency in the circular economy. Central banks can contribute to the transition to a circular economy in two ways: first, by making central bank digital currency accessible to circular businesses and other players in the circular economy sector; and second, by looking into how the design features of CBDC can support circular economy goals. On the role of CBDC in the circular economy, I argue that a central bank digital currency offers a better payment option for circular economy financial transactions; central bank digital currency can lead to greater financial inclusion for 'unbanked' informal workers in the circular economy; CBDC can create a gateway that allows a central bank to offer financial assistance to distressed circular businesses; using a central bank digital currency can reduce illicit activities in the circular economy; a central bank digital currency can be used to provide stimulus funding to support circular businesses during crises; and, a central bank digital currency can offer low transaction cost for circular economy financial transactions. The paper also shows the link between CBDC and the circular economy. It also offers a critical perspective on the link between CBDC and the circular economy.

Keywords: circular economy, central bank digital currency, circular finance, linear economy, resources, sustainability, central bank, CBDC design, blockchain, sustainable development, payment system, innovation.

I. Introduction

The circular economy is part of global efforts to achieve the sustainable development goals of the United Nations. The circular economy aims to preserve and maximize the value of materials until materials reach the end of its life (Blomsma and Tennant, 2020). In other words, the circular economy ensures that the value of materials is preserved for a long time. Corporations, such as the Ellen MacAuthur Foundation, the FinanCE Working Group, ING and RaboBank, have been at the forefront of the transition from a linear economy to a circular economy.

A central bank digital currency is the digital representation of paper money, and is a direct liability of the issuing central bank. Central bank digital currency, apart from being a money equivalent, can be designed to be used as a payment solution for most types of transactions. A central bank digital currency has many potential benefits, including, the potential to offer low transaction cost than that charged by financial institutions, it can increase cross-border remittances and increase financial inclusion (Ozili, 2022b). Given the enormous opportunity that central bank digital currency presents for businesses and projects in the circular economy, there is need for a discussion on how circular businesses can benefit from a central bank digital currency. Also, as central bank digital currency and circular economy concepts are growing in popularity among practitioners and policymakers, there is a need to examine the link between the two concepts.

Although the transition to a circular economy is expected to generate some environmental, economic and social benefits (Geissdoerfer et al, 2017), the transition to a circular economy cannot be fully achieved without substantial funding for circular businesses and circular projects (Ozili and Opene, 2021). And even when funding is fully available for circular economy projects and business activities, there is a need to develop innovative payment solutions that enables efficient allocation of funding to circular projects and activities. The current model of financing that puts banks and financial institutions at the epicenter of financial intermediation presents some challenges. The most significant of the challenges is the high transaction cost involved in investing and lending to circular businesses. An innovative solution that has emerged to reduce transaction cost for circular businesses is the central bank digital currency.

Previous studies have looked at how payment solutions can facilitate activities in various sectors of the circular economy. For instance, Kouhizadeh et al (2020) focused on blockchain payment, and argue that automatic agreements stored on the blockchain can be initiated using blockchain payment that help to reduce cost, reduce time and minimise communication problems in supply chains in the circular economy. Kouhizadeh and Sarkis (2018) show that blockchain-based smart contracts have a variety of applications in circular economy practices, for instance, it allows suppliers to pay for returned products through blockchain payment rather than allowing the buyer to dispose the product as waste when the buyer no longer need the purchased product. Pizzi et al (2022), focused on Fintech payment, and show that Fintech enterprises can provide customizable payment solutions that are suitable for circular business models. Other related studies include Upadhyay et al (2021), Böckel et al (2021), Blakstad and Allen (2018), etc. Despite these existing studies, the literature has not addressed how specific payment alternatives, such as a CBDC, can facilitate activities in the circular economy. The lack of previous studies in this area makes it difficult to gain a rigorous understanding of how CBDCs can facilitate growth in the circular economy, and how circular economy activities can reinforce the need for CBDCs. This paper addresses this issue by establishing a link between the circular economy and central bank digital currency. Establishing a link between the circular economy and CBDC is important because it can offer insights on how retail or wholesale CBDCs can be designed, and redesign, to support circular economy goals in the circular economy.

To date, the circular economy literature has not explored how innovative payment solutions, such as a central bank digital currency, can promote activities in the circular economy. This paper is the first to explore the potential role of a central bank digital currency in accelerating the transition to a circular economy. There is also a need to create a common understanding of the role of central bank digital currency in circular finance. Such understanding can stir up helpful debates in the literature, and can open up new opportunities for small businesses, large corporations and individuals that want access to finance to carry out circular economy activities.

The discussion in this paper contributes to the literature in the following ways. Firstly, the study contributes to the circular economy literature. Some studies in this literature include Andrews (2015), Kouhizadeh et al (2020), Geissdoerfer et al (2017), Schöggl et al (2020), etc. The present study contributes to the circular economy literature by showing that the presence of an effective payment alternative, such as a central bank digital currency, is crucial to support and accelerate the transition to a circular economy. Secondly, this study contributes to the literature that examine circular finance. Some studies in this literature include Dewick et al (2020), Aranda-Usón et al (2019), Ozili, (2021), etc. The present study contributes to the circular finance literature by showing that a central bank digital currency can act as a reliable low-cost payment solution to facilitate circular economy financial transactions. Thirdly, the discussion in the paper opens up new discussions about the role of central banks in the transition to a circular economy. Such discussions can offer ideas on how central banks can design, and redesign, the CBDC in ways that promote sustainable financing for circular economy projects and activities which are geared towards sustainable development.

Regarding methodology, I used desk research method to analyse available information that link central bank digital currency with the circular economy. The desk research method involves collecting and examining information that already exists in publicly available policy documents, practitioner white papers, media reports, academic journals, and use-case reports. The information obtained from these sources were used to establish a link between central bank digital currency and the circular economy.

The rest of the paper is structured as follows. The paper begins by presenting a conceptual background of the circular economy, circular finance and central bank digital currency in section 2. The paper then reviews studies on the link between innovative finance and the circular economy in section 3. Thereafter, the paper discusses the role of CBDC in the circular economy in section 4. The paper then shows the direct link between CBDC and the circular economy in section 5. Afterwards, the paper presents some critical perspective on the use and application of CBDC in the circular economy in section 6. Finally, the paper highlights the contribution of the study to existing knowledge in section 7.

2. Conceptual background

2.1. Circular economy

A circular economy is an economic system, or economic philosophy, that preserves the value of resources and raw materials by minimizing raw materials or resources waste, and promoting the reuse and recycling of resources and raw materials (Korhonen et al, 2018; Pomponi and Moncaster, 2017; and Ozili, 2021). Geissdoerfer et al (2017, p.7) define the circular economy as “a regenerative system in which resource input, waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops”.

The circular economy is based on three principles, which are (i) eliminating waste and pollution, (ii) recycling products and materials at their highest value, and (iii) regenerating nature (MacArthur, 2017). A circular economy decouples economic activity from the depletion of finite resources towards the preservation and regeneration of finite resources (Giampietro and Funtowicz, 2020), thereby generating positive benefits for business, people and the environment (MacArthur, 2017).

The circular economy needs to be distinguished from the linear economy. The linear economy operates a take–make–dispose model that degrades resources and generates unacceptable levels of waste (Sariatli, 2017). In the linear economy, raw materials are sourced, and then transformed into final products for use by consumers until they are finally discarded as waste and then destroyed (Esposito et al, 2018). In the linear economy, value is created by producing and selling as many products as possible (Gardetti, 2019). In contrast, the circular economy operates a reduce–reuse–recycle model that preserve resources, thereby protecting the environment (Kirchherr et al, 2017). In the circular economy, the value of resources and raw materials are preserved by minimizing raw materials or resources waste, and promoting the reuse and recycling of resources and raw materials (Heshmati, 2017).

The circular economy plays a significant role in the climate change mitigation agenda. It contributes to mitigating resource scarcity, resource waste and pollution, which together

helps to preserve the environment, and contribute to the climate change mitigation agenda.

2.2. Circular Finance

Finance is needed to accelerate the transition to a circular economy. Financial institutions need to allocate more capital to stimulate economic growth through the transition from a linear economy to a circular economy (UNEPFI, 2020). One way in which financial institutions can do this is by creating financial instruments that can be used to raise capital to fund circular economy projects and activities. Common terms used to describe financial instruments that are design for circular economy purposes are 'circular financing' or 'circular economy finance' (see, for example, Dewick et al, 2020; De La Cuesta-Gonzalez and Morales-García, 2021). Circular finance, or circular economy finance, refers to financial instruments where the funding raised (e.g. investments, loans or donations) will be exclusively used to finance or re-finance, in part or in full, new and/or existing eligible companies or projects in the circular economy (CEFG, 2018). Circular finance can also be viewed as any form of financial service or financial instrument that integrates circular economy factors into business and investment decisions in order to accelerate the transition to a circular economy as a basic cornerstone of sustainable development (PWC, 2021).[1] These definitions show that circular finance uses financial instruments to accelerate the transition to a circular economy.

There is need for innovative circular economy financial instruments that are structured to reduce investment risk and increase risk-adjusted returns. These innovative financial instruments also need to be ring-fenced to ensure that the financial instruments are used only to finance specific circular economy projects and activities (CEFG, 2018). If the financial instruments are not ring-fenced, it means the financial instruments can be used to finance both circular and linear projects and activities (CEFG, 2018). Types of financing instruments that can be used to fund circular economy projects and activities include: own capital (e.g. personal savings of the entrepreneur and contributions received family members and friends); subsidies and grants; venture capital (e.g. capital provided by

[1] https://www.pwc.ch/en/insights/sustainability/circular-finance.html

angel investors); crowdfunding (e.g. funds contributed or donated by generous members of the public who support circular economy goals); and bank funding (e.g. loans provided by banks) (Wyman, 2017). Investors, banks and financial regulators can play a significant role in accelerating the transition to a circular economy by ensuring that there are abundant financing instruments to meet the financing needs of the circular economy.

2.3. Central bank digital currency (CBDC)

Central bank digital currency (CBDC) is a digital representation of paper money or physical money (Bordo and Levin, 2017; Ozili, 2022b). The origin of CBDC dates back to the 1980s when central banks permitted commercial banks to use digital money, and this led to a rise in digital money (Adrian and Mancini-Griffoli, 2019). Digital money at that time was depositors' account balances that are accessible using bank applications, mobile wallets or internet banking applications which today is known as mobile banking or internet banking (Adrian and Mancini-Griffoli, 2019). Two decades later, cryptocurrencies, also known as private digital currencies, emerged which allows people to hold large amounts of private digital currencies without needing an intermediary and without regulation. Examples of cryptocurrencies include bitcoin, ethereum, dogecoin, tether, etc (Náñez Alonso et al, 2021). Central banks observed that cryptocurrencies were becoming very popular and that a large number of people had embraced private digital currencies. It also led to concerns that people could abandon fiat paper money in favour of cryptocurrencies. This led central banks to look into the possibility of creating their own digital currencies, and to determine whether there is a strong case for creating a central bank digital currency (Barontini and Holden, 2019). As of 2021, six countries have fully launched a digital currency. They are the Bahamas, Saint Kitts and Nevis, Antigua and Barbuda, Saint Lucia, Nigeria, Grenada, Dominica, and Montserrat. Other countries have formally declared that they are conducting research into CBDC or plan to adopt a CBDC in the near future. These countries include Thailand, Ghana, United States, India, the UK, etc.

CBDC has specific features. The first and most important feature of a CBDC is that it is a fiat digital currency or a digital legal tender (Mancini-Griffoli et al, 2018). This means that the central bank digital currency is recognized by law. A CBDC is issued only by the

central bank and is a liability of the central bank (Ward and Rochemont, 2019). This means that the central bank is fully liable for any loss of CBDC arising from data breaches, privacy breaches and theft. A CBDC is designed to perform all the functions of paper money and can perform additional functions (Miedema et al, 2020). This means that the CBDC can be used as a medium of exchange, a store of value, a unit of account, and for settlement of debt. CBDC can be used by individuals, firms and governments to make micro and large payments (Ozili, 2022b). A CBDC is also designed to offer settlement finality for all transactions (Calle and Eidan, 2020). This means that a transfer of funds using CBDC is final, irrevocable and unconditional.

Here's how CBDCs work. A central bank can issue CBDC directly to the digital wallet of citizens (Ward and Rochemont, 2019), which is similar to how a government make stimulus payment directly into bank account of citizens. In this case, the central bank will credit the account of the receiver with specified units of CBDC in exchange for the paper money equivalent held in the receiver's bank account. The central bank can also issue CBDC to financial institutions for distribution. In this case, a person who has money in his or her bank account will notify the bank that he or she wants to convert a specified amount of deposit balances into CBDC units. This amount is then transferred to the CBDC account of the person. After conversion, the deposit balances in the CBDC account can then be used to make electronic payment. The person initiates an electronic payment transaction and selects the amount to be paid. The person approves the electronic payment by scanning his or her transaction QR code against the QR code of the seller (in the case of an account-based CBDC held in a digital wallet), or by validating the token of the seller before making payment (in the case of a token-based CBDC). Once this is done, value is transferred electronically.

While the design of a CBDC may vary across countries, one feature that is common to all CBDC is that a CBDC is usually designed to fit with the current payment system infrastructure. This ensures that CBDCs will work like a mobile wallet which most people are already familiar with.

3. Literature Review

3.1. CBDC Literature

Central bank digital currency is a recent innovation, and is becoming a hot topic in mainstream public discourse and in the academic literature. Calle and Eidan (2020) show that the reason for issuing and using a central bank digital currency will differ widely depending on the particular central bank and the existing payment systems in each country. They show that central banks' motivation for issuing a retail CBDC is to increase seigniorage income, support monetary policy, link payments to identity, enable participation in a tokenized financial ecosystem, foster competition within the private sector, provide a cash alternative, or to generally modernize the payment system. Ozili (2022a) shows that another reason why central banks issue a central bank digital currency is to promote financial inclusion by digitizing value chains, offering low transaction cost, and being able to have CBDC holdings without needing a bank account. Ponce (2020) shows that a central bank digital currency serves as an alternative tool to help central banks improve efficiency, resilience and security in retail payments and to preserve financial stability. Huynh et al (2020) suggest that CBDC should be an easy-to-use, low-cost, and secure payment method to ensure full consumer adoption and merchant acceptance. Khiaonarong and Humphrey (2019) argue that the level and trend in cash use in a country will influence the demand for central bank digital currency, and the demand for digital currency may be low in countries where there is high preference for cash substitutes such as cards, electronic money, mobile phone payments.

Several studies have called for caution when using CBDCs. For example, Mancini-Griffoli et al (2018) show that the impact of CBDC will depend on its design. They suggest that central banks need to consider their specific country circumstances when designing and adopting CBDC while paying careful attention to the risks of CBDC. Barontini and Holden (2019) argue that central banks will move at different speeds in adopting a CBDC due to differences in technical capabilities, and central banks should apply a great deal of caution in adopting a CBDC. They further suggest that a central bank should collaborate with other central banks to develop a robust and effective CBDC. Williamson (2021)

argues that CBDC tends to encourage banking panics, even though banking panics are less disruptive with central bank digital currency than with physical currency. Ozili (2022b) shows that there is a need to: (i) determine the optimal CBDC design that meets all competing objectives, (ii) determine the effect of CBDC on the cost of credit, (iii) the effect of CBDC on financial stability, and (iv) find a balance between limiting the CBDC holdings of users and allowing users to hold unlimited units of CBDC. Arner et al (2020) suggest that most central banks should focus on transforming their existing payment systems rather than on rolling out a central bank digital currency. Davoodalhosseini (2021) shows that having both cash and a CBDC available to people at the same time may result in lower welfare than in the cases where only cash or only a CBDC is available. They suggest that it is better to have only one available option at a time either cash or CBDC.

3.2. Circular economy literature

Several studies identify some benefits and challenges of a circular economy. Stahel (2016) suggests that the circular economy can reduce resource waste by encouraging the re-use and recycling of materials to save resources, energy and create local jobs. Brydges (2021) shows that the circular economy will lead to a more efficient, closed-loop economy. Salmenperä et al (2021) investigate the application of the circular economy in the waste management industry. They show that a circular economy approach to waste management will promote the retention of material value through waste recycling, better sharing of waste-related data, greater dialogue and cooperation between key players, and harmonisation of regulations and their interpretations. Chen et al (2021) examine the application of circular economy in the textiles industry. They were concerned about the rate at which textile waste end up in landfills. They suggest ways in which circular economy can change this trend such as by creating renewable raw materials sources, rethinking production, maximizing the use and reuse of textile products, adopting reproduction and recycling strategies, redistributing textiles to new and parallel markets, and improvising means to extend the textiles lifetime. Geng et al (2019) suggest ways in which policymakers can globalize the circular economy. Some of the suggested ideas include (i) setting up a global database that capture the link between resource use and resource waste, (ii) fostering knowledge sharing about the circular economy, (iii)

encouraging international collaboration to promote large-scale experimentation of a circular economy model, (iv) developing standards for performance measurement, reporting and accounting in the circular economy, and (v) formulating and enforcing regulation of the circular economy on a global scale. Notwithstanding, Chhimwal et al (2021), Pincelli et al (2021) and Droege et al (2021) identify some challenges in implementing a circular economy model. The challenges include non-compliance with environmental laws, revenue generation problems, difficulty in attracting investors, technological limitations, lack of policy support, the high cost involved in the circular economy transition, and low demand for refurbished and reused products.

3.3. Literature on the relationship between circular economy and financing options

A number of studies explore the financing options that are available for growing the circular economy. For instance, Dewick et al (2020) suggest that a major shift in private and public investment is needed to forge a transition to a circular economy. Sepetis (2022) calls for collaboration between the public and private sector for change towards sustainable finance and a shift towards circular business models. Sepetis also suggests that environmental, social and governance (ESG) risk should be incorporated into circular economy financing models. Meanwhile, Hassan et al (2020) suggest that non-interest financial instruments can offer sufficient funding for the transition from the linear economy to the circular economy.

Empirical studies such as Demirel and Danisman (2019) examine the impact of available external funding for circular economy activities on the growth of European small and medium scale enterprises (SMEs). They find that equity finance, particularly venture capital investments, contribute positively to the growth of European SMEs. Aranda-Usón et al (2019), in an analysis of Spanish companies, find that the availability of funds, the quality of firms' financial resources and the availability of public subsidies have a positive effect in stimulating the implementation of circular economy initiatives.

Other studies explore the role of banks and other financial institutions in the circular economy. For instance, Goovaerts and Verbeek (2018) suggest that financial institutions can contribute to the circular economy transition in two ways: first, by providing appropriate financial and legal advice; and second, by looking at their own business

models and risk assessment frameworks to better balance linear and circular risks. Ozili and Opene (2021) identify the role of banks in the circular economy. They suggest that banks should: develop a common understanding of the circular economy; issue widely accepted and recognized guidelines on circular economy finance; adapt existing finance models to fit into a circular economy model; offer credit lines to circular businesses; create a green bank; train bank staff; promote a strong culture of waste reduction and material re-use; ensure that the board risk committee is competent in circular risk management and control. Also, Ozili (2021) shows that the circular economy offers some benefits to banks such as greater loan diversification opportunities, increased lending to circular clients in the recycling sector, and promoting responsible and sustainable banking. Some benefits to non-bank financial institutions include greater sustainability-adjusted return on investment for investment companies, greater funding to microfinance institutions; and more opportunities for collaborative funding to circular businesses (Ozili, 2021).

4. Role of CBDC in the circular economy

4.1. CBDC offers a better payment option for investing in the circular economy

Circular investors can pay for their investment using CBDC. Payments made using CBDC are low-cost, fast, flexible, safe and secure (Shkliar, 2020). They also provide a level of convenience that is not obtainable with credit cards, debit cards or bank transfer payment alternatives (Usher et al, 2021). Investors and donors will be able to use central bank digital currency as a means of payment (Maniff and Wong, 2020), and to transfer funds directly to circular businesses and projects, thereby bypassing financial institutions and the associated high transaction cost. Recently, the assets in public equity funds dedicated to the circular economy grew from US$300 million in 2019 to almost US$9.5 billion by November 2021.[2] Using CBDC to accelerate circular investment can further increase the amount of public equity funds invested in the circular economy by reducing investment fees and transaction cost.

[2] Ellen MacArthur Foundation https://ellenmacarthurfoundation.org/topics/finance/overview

4.2. CBDC can increase financial inclusion for circular economy workers

Many informal employees or local waste pickers working for circular businesses are often paid in cash (Wiener et al, 2019), either because they do not own a formal bank account or for some other reasons. This situation is common in developing countries and in poor countries, and it presents a major hindrance to financial inclusion for informal workers working for circular businesses especially in developing and poor countries. A central bank digital currency can change this trend by giving employers an option to pay the wages of informal workers into their account-based CBDC wallet if informal workers do not have a formal bank account. This means that informal workers can be financially-included in the formal financial system through owning a CBDC wallet even though they do not have a formal bank account, thereby, increasing financial inclusion (Ozili, 2022a). For example, employers in the circular economy can pay the wages of informal workers into their CBDC wallets if informal workers are having difficulties in meeting the burdensome documentation required to open a formal account in a bank.

4.3. CBDC creates a gateway that allow a central bank to offer financial assistance to distressed circular businesses

CBDC can be used as a means to make welfare and stimulus payments to distressed firms (Williamson, 2019). Using central bank digital currency to facilitate circular economy transactions can establish a direct connection between circular economy players and the central bank. The advantage is that it makes it easier for the central bank to give loans directly to circular economy businesses, thereby eliminating third-party risks. Also, the direct connection created between the central bank and circular businesses, when the latter use CBDC can provide an opportunity for distressed circular businesses to approach the central bank for financial assistance (e.g. a distress relief loan), thereby allowing circular businesses to avoid the high interest rate they will incur if they sought financial assistance from traditional lending institutions. Although central bank's loan support and financial assistance to circular businesses may appear to be a less compelling case for why CBDC is important to circular businesses, it is important to understand that circular businesses operating in a high interest rate environment may experience difficulty in obtaining low-interest loan for traditional financial institutions, and

this could affect their survival in the short-term. Such circular businesses may have no choice but to approach the central bank for financial assistance since most central banks are allowed to lend to non-banks under exigent circumstances. The central bank will find it easier to transfer CBDC-based digital loans to circular businesses than to issue loans in the form of cash to circular businesses. Notwithstanding, there is no guarantee that central banks will lend directly to non-banks or offer financial assistance to circular businesses just because circular businesses use CBDC in their business activities.

4.4. Reducing illicit activity in the circular economy

Cash is a very appealing instrument for money laundering, tax evasion, payment fraud, illegal diversion of funds and other criminal activities (Riccardi and Levi, 2018). Such risks can be avoided or reduced when circular economy financial transactions are made using central bank digital currency rather than cash. The advantage of central bank digital currency is that a central bank digital currency is deployed on a permissioned distributed ledger technology or blockchain (Kumar, 2021), and all transactions can be traced to the unique ID of the sender and recipient of funds (Oh and Zhang, 2020; Laboure et al, 2021). Therefore, using a central bank digital currency can make it very difficult to carryout illicit activity in the circular economy. This can help to reduce criminal activities and other risks associated with cash-based transactions in the circular economy. A real-life example that comes to mind is a criminal case reported in China in November 2021.[3] A criminal (name withheld) was arrested by Police in China for scamming over 300,000 yuan ($47,000) from a victim (name withheld) using China's central bank digital currency – the digital yuan. The criminal allegedly called the victim, and impersonated police to obtain the victim's personal information including the ID number, bank account details and a photo of the victim's face. The criminal then registered a digital yuan e-wallet for the victim and transferred the money from the victim's bank account, before transferring it again to the criminal's own e-wallet. The police traced the transaction and identified the criminal as the owner of the receiving CBDC e-wallet. The criminal was arrested and admitted to being involved in money laundering through the digital yuan. This real-life example shows how easy it is to link CBDC transactions to the unique ID of the sender and receiver,

[3] https://www.bloomberg.com/news/articles/2021-11-17/chinese-police-makes-arrest-over-digital-yuan-scam

thereby making it easy to detect illicit activities using a CBDC. This advantage of CBDC can be extended to the circular economy as CBDC can help to detect financial fraud and reduce illicit criminal activity in the circular economy.

4.5. CBDC can help circular businesses cope with crises

Circular businesses may be affected by crises that lead to significant loss of revenue or income (Giudice et al, 2020). Such crises can make it difficult for circular businesses to pay employee wages and salaries. With CBDC, the government can intervene by providing stimulus funding to support circular economy businesses. The government can do this by making CBDC payments into the wallet-based account or token-based account of circular businesses to support circular economy businesses that are affected by the crisis. It can also help businesses to cope with the negative effects of the crisis such as a pandemic, economic recession or financial crisis.

4.6. CBDC can offer low transaction cost for circular economy financial transactions

CBDC can offer low transaction cost (Mancini-Griffoli et al, 2018). The benefit to circular businesses is that it will become cheaper to receive circular economy donations, funding and investments from generous donors and investors in other countries. The low transaction cost of CBDC payments will make cross-border financial transactions cheaper (Auer et al, 2021). A central bank digital currency will also be beneficial to circular economy businesses that pay a high transaction fee to move cash to different locations to pay informal workers their wages. CBDC can reduce cost for merchants and consumers in the circular economy, making it a cheaper alternative to bank notes, cheques, debit and credit cards, and online transfers because the central bank may charge a very low transaction cost to process CBDC payments. Reducing transaction cost is a strong argument for adopting CBDC. For example, a 2021 JPMorgan report[4] shows that global corporations pay $120 billion in transaction cost through intermediary networks each year. Using CBDC to make payments can save global corporations an estimated £100 billion in transaction cost. Also, during the 2020 COVID-19 pandemic in

[4] https://www.jpmorgan.com/news/jpmorgan-central-bank-digital-currency-report

the United States, there were arguments that circular economy entrepreneurs could have received their paycheck protection program (PPP)[5] check in the form of CBDC (digital dollar) payments if the U.S. government had adopted a digital dollar at the time. This would have reduced the cost incurred by the government in making PPP check payments to circular entrepreneurs and to everyone else.

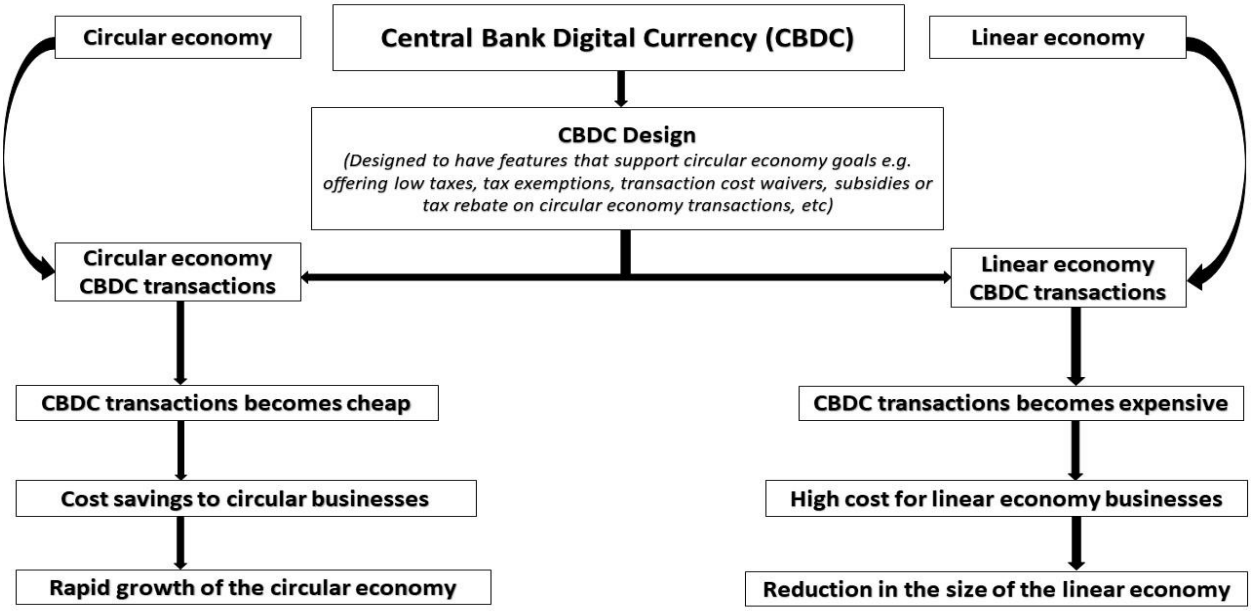
5. Direct link between circular economy and CBDC

The direct link between CBDC and the circular economy depends on the CBDC design, and the effect on circular economy transactions. Generally, a CBDC is usually designed to meet specific goals such as payment efficiency, financial stability or financial inclusion (Agur et al, 2022; Allen et al, 2020, Ozili, 2022b). This means that the unique nature of a CBDC depends on the design of the CBDC and the goal the central bank wants to achieve by adopting a CBDC. A CBDC that is designed to support circular economy goals will have design features that encourage the use of CBDC for circular economy financial transactions. For example, a CBDC can be designed to offer a transaction cost waiver for transactions that are channeled to waste reduction activities or waste re-use activities. A CBDC can also be designed to have features that give tax rebates for transactions that are channeled to waste reduction activities or waste re-use activities. A CBDC can also be designed to exempt circular economy transactions from being taxed so as to encourage more circular businesses to use CBDC. This type of specially-designed CBDC will offer huge incentives to circular businesses, it can lead to cost savings, and can help to grow the circular economy industry. A CBDC that is designed to promote circular economy goals will also have technical features that restrict the use of CBDC for linear economy transactions. Such CBDC can be designed to impose high taxes for linear economy transactions, thereby, inhibiting growth in the linear economy. This means that a CBDC can be designed to have features that support circular economy goals while

[5] The Paycheck Protection Program (PPP) is a $953-billion business loan program established by the United States federal government in 2020 through the Coronavirus Aid, Relief, and Economic Security Act (CARES Act). It was established to help certain businesses, self-employed workers, sole proprietors, certain nonprofit organizations, and tribal businesses to continue paying their workers.

discouraging growth in the linear economy. In sum, a direct link between CBDC and the circular economy can be established only if a CBDC is designed to incorporate features that support circular economy goals while discouraging growth in the linear economy. Figure 1 below shows the direct link between CBDC and circular economy.

Figure 1: Direct link between circular economy and CBDC



Source: Constructed by Author

6. Critical perspective on CBDC for the circular economy

Although a CBDC present new opportunities for growth in the circular economy (Engert and Fung, 2017), there are potential impediments to using CBDC in the circular economy. The first impediment is that individual preference and choice will play a significant role in determining whether CBDC will be fully embraced by circular workers, circular entrepreneurs, circular investors and circular corporations (Huynh et al, 2020). Individuals and businesses involved in circular economy activities will have many payment options available to them, e.g. physical cash, credit card, CBDC, cryptocurrency, debit card, etc., They will prefer one payment option over the other, and these preferences will reveal the extent to which individuals and businesses embrace CBDC in their circular economy

activities. For instance, informal workers may refuse to receive wages in the form of CBDC payment. Another example is that circular businesses may prefer to accept bank transfer payment rather than CBDC payment. The implication is that if circular entrepreneurs, circular merchants and circular corporations do not fully embrace CBDC, the value of CBDC in the circular economy will decline. Another potential impediment lies in the design of a CBDC. Central banks may not take into account circular economy goals when designing a CBDC especially when they have more important statutory priorities. Central banks tend to give more priority to price stability and financial stability goals when designing a CBDC (Agur et al, 2022; Allen et al, 2020), and may not be interested in incorporating circular economy considerations in the CBDC design. Another potential impediment is that economic agents in the circular economy may not understand how a CBDC works, and as a result, they may prefer to continue using the existing payment channels they are familiar with. Others may avoid CBDCs because they want their circular economy transactions to be completely anonymous since the government actively monitors CBDC transactions but cannot closely monitor cash transactions. Another potential impediment is that there may be digital connectivity problems when using CBDC as a means of payment for circular economy transactions (Lee, 2018). This can limit the usefulness of CBDC for circular economy transactions especially in developing and poor countries where high cost of digital connectivity is a major problem. Another potential impediment is the lack of awareness about CBDC. Circular entrepreneurs and businesses may not be aware about the benefits of CBDC, and this can be attributed to poor publicity, poor awareness and low sensitization about the benefits of CBDC in promoting business activities in the circular economy (Söilen and Benhayoun, 2022). Another potential impediment is the cost of converting paper currency to CBDC, and the cost of converting CBDC back to paper currency. The cost of converting paper currency to CBDC and the cost of converting central bank digital currency back to paper currency may be substantial to individuals and small businesses involved in circular economy activities, and this can discourage them from using CBDC. Finally, the above mentioned impediments suggest that there is a need to proceed with caution in using CBDC to accelerate the transition to a circular economy. Central banks need to find a way to ensure that CBDC design

supports circular economy goals without sacrificing price stability, monetary stability and financial stability goals of the central bank.

7. Contribution to existing knowledge

The discussions in this paper contribute to the literature that examine the role of finance in accelerating the transition to a circular economy (see, for example, Dewick et al, 2020; Ling-hua, 2007; Aranda-Usón et al, 2019, etc.). These studies show that the finance industry can provide financial resources to accelerate the transition to a circular economy (Dewick et al, 2020). Ling-hua (2007) shows that abundant financial resources are needed to develop the circular economy, while other studies, such as Aranda-Usón et al (2019), show that the availability of funds, the quality of a firm's own financial resources, and public subsidies can stimulate circular economy initiatives in the finance industry. These three studies show that financial resources are needed to accelerate the transition to a circular economy. The findings of the present study support the previous literature, and also extends the literature by showing how innovative payment channels, such as a CBDC, can be used to channel financial resources to the circular economy such as the recycling sector. Also, the findings of the present study extend the literature by showing that CBDC can increase access to finance for circular economy activities, thereby accelerating the transition to a circular economy. The findings of this paper also extend existing knowledge by being the first study to examine how CBDC can accelerate the transition to a circular economy.

8. Conclusion

This paper analyzed the role of a central bank digital currency in the circular economy. In the paper, I argued that a central bank digital currency offers a better payment option for circular economy transactions; central bank digital currency can increase financial inclusion for unbanked informal workers in the circular economy; CBDC creates a gateway that allows a central bank to offer financial assistance to distressed circular

businesses; using a central bank digital currency can help to reduce illicit activity in the circular economy; a central bank digital currency can be used to provide stimulus funding to support circular businesses during crises; and, a central bank digital currency can offer low transaction cost for circular economy financial transactions.

The implication of the findings of this paper is that the current discussions about circular finance should also include discussions about the opportunities that a central bank digital currency present for the circular economy as well as the benefits of using a central bank digital currency to accelerate the transition to a circular economy. This can open up an opportunity for policy makers, such as central banks, to support the circular economy agenda. However, it is yet to be seen whether central banks will play a significant role in supporting the transition to a circular economy other than offering its central bank digital currency as an alternative payment solution, and given their other statutory priorities. Finally, a central bank digital currency is not the only existing innovative payment alternative that can support the circular economy transition. It is one of many payments alternative such as crypto currency, bitcoins, stable-coins, etc. As a result, there will be debates about whether the circular economy should embrace CBDC or a better blockchain-based alternative. Future studies can explore the role of other payment alternative in accelerating the transition to a circular economy.

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