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EXECUTIVE SUMMARY OF THE THESIS

Effects of Central Bank Digital Currency (CBDC) Introduction on Monetary Policy and Tax Evasion

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1. Introduction

The rapid evolution of financial technologies has spurred discussions and inquiries into the potential implementation of Central Bank Digital Currencies (CBDCs) worldwide. Within the Eurozone, the prospect of introducing a CBDC has ignited fervent debates and garnered considerable attention among policymakers, economists and financial institutions, with the European Central Bank (ECB) undergoing a thorough and detailed evaluation process aiming at the introduction of a Digital Euro. This thesis aims to provide a comprehensive assessment of the implications arising from the integration of a CBDC within the Eurozone's economic framework, particularly focusing on its impact on the function of the banking sector and the collection of sales taxes currently evaded. The advent of digital currencies, especially those backed by central banks, represents a transformative shift in traditional monetary systems: such innovation holds the promise in revolutionizing financial landscapes, potentially influencing economic policies, tax regimes and banking dynamics, as this work aims to study. This research in fact seeks to bridge the gap in understanding the consequences of the adoption of a Digital Euro

within the Eurozone. Emphasizing empirical methodologies and advanced economic modeling, this study delves into the interplay between CBDC introduction and key economic factors, particularly focusing on tax collection mechanisms. By leveraging an empirical simulation using historical data mainly gathered from Eurostat databases, this research endeavors to unravel the intricate relationship between CBDC implementation and tax revenues, shedding light on the potential of CBDCs to mitigate tax evasion effectively, while at the same time examining the impact on deposit dynamics and evaluating the concerns of disintermediation within the banking sector after the integration of a CBDC. The following sections delve deeper into the review of the existing literature, the methodology adopted (both the analytical model and the empirical analysis) and the conclusive insights derived from the thesis work.

2. Literature Review

The context of this literature review is rooted in the dynamic landscape of Central Bank Digital Currency (CBDC), a topic that has garnered significant attention in the field of finance and economics. In the past decade, CBDC has

emerged as a focal point for policymakers, researchers and central banks worldwide. The discussion surrounding CBDC has evolved from a theoretical concept to a tangible reality, with several countries actively exploring its implementation. This literature review aims to provide a comprehensive overview of the existing research on CBDC with a particular emphasis on its impact on tax evasion and fiscal budget dynamics. The inception of CBDC has been largely influenced by the digital transformation of the financial industry, the rising importance of cryptocurrencies and the need for central banks to maintain relevance in the modern monetary landscape. CBDC represents a form of digital currency issued and regulated by a central authority, typically a country's central bank. Unlike cryptocurrencies like Bitcoin, CBDC is backed by the full faith and credit of the issuing government.

The review of the existing literature was conducted grouping the main themes encompassed by the transversal topics analyzed in relation to CBDC and therefore is presented the same way. In particular, the analysis of the review will first go through the scientific works (papers, articles, essays etc.) dealing with the conceptual matter of CBDCs and other more general forms of digital currencies, before proceeding with the references focusing on the technology of the solutions designed and eventually implemented and the different architectures the CBDC can be structured upon, for what regards both payments and relations with the issuing institute (i.e. convertibility). From a more macroeconomic point of view the analysis will then go through the studies of the relations with and the effects on the money market and the monetary policy implementation, in particular for what regards all the mechanisms related to interest rate (and therefore the demand for money) and the monetary transmission mechanism adopted by the Central Bank for putting in place any monetary policy decision into the real economy. Finally there is a focus on regulatory issues and economic models addressing from an analytical side the effects of a CBDC introduction in real systems and on real phenomena, such as tax evasion or inflation, based on individual agents' choices. Overall, it can be seen that the motivation to adopt

CBDC for each country is different. It also appears that developing countries tend to speed up more vigorously in terms of researching, testing and implementation to obtain financial inclusion or cross-border payments, while more advanced economies are motivated to introduce CBDC to enhance domestic payments efficiency as well as financial stability. Therefore, it is likely that there would be no one-size-fits-all CBDC development: each country should have its own way of developing CBDC that is most suitable for its specific circumstances and requirements. However, the introduction of a CBDC can be risky for the economy in certain aspects: in particular, issuing CBDC may result in a banking sector instability, especially in times of crises, where businesses and households might switch deposits from their commercial bank accounts to their CBDC account with central banks, facilitating a bank run from bank deposits to the safe nest of the CBDC: as a result, the capability to supply credit of commercial banks would be substantially restricted. Weakening such a function from the banking industry and granting the public direct access to the central bank balance sheet may potentially lead to the less efficient allocation of credit in the economy due to the centralization of credit allocation under the control of central banks.

2.1. Design and Technology

It is crucial for central banks to have a proper design of CBDC that can balance different requirements across stakeholders such as privacy requirements for the users and reasonable levels of control over individual's account to combat financial crimes. In order to increase the adoption of CBDC among general public, it is suggested that significant benefits in the usage of CBDC such as ease of use, convenience, availability, and credibility should be considered [4].

2.2. Monetary Policy

The impact of CBDC on monetary policy largely depends on the system design for CBDC. For example, Davoodalhosseini [3] describes a system that can implement the CBDC in which a debit card system is owned and monitored by the central bank, although its operations can be outsourced to other third parties such as fintech companies provided their low operational costs.

Each individual can have an account with the central bank, which they can earn interest on top of utilizing these balances for buying necessities and services. The author argues that with such a system, the implementation of monetary policy becomes more transparent as it directly affects people's decisions to carry balances rather than through the financial system. Additionally, with the varying aggregate supply of CBDC, it is most likely that CBDC would lead to more effective quantitative easing. A classic limitation of monetary policy that has received significant discussion in the existing literature is the Zero Lower Bound (ZLB) constraint, where the interest rates are at zero and there is a need for further lowering interest rates, as the central bank cannot go below the ZLB [2]: in this context, some scholars say that CBDC would allow central banks to conduct a more effective monetary policy where CBDC would help central banks to impose charges on their digital currency, which evades the limitation of ZLB on the nominal interest rate [1]. Similarly, other scholars suggest that a CBDC could potentially make it easier to set a negative rate on central bank money and thus alleviate the lower bound on interest rates.

2.3. Economic Models on CBDC

My research aligns closely with prior studies, particularly those by Williamson [8] and Davoodalhosseini [3]. In Williamson's model, the implications of introducing a CBDC are explored, considering factors such as cash-related crimes and their reduction following CBDC adoption. This study suggests that CBDC can offer advantages, including a decrease in cash-related crimes and the optimization of the use of safe collateral. However, it also raises concerns about the payment of interest on CBDC and its potential impact on central bank independence. Similarly, Davoodalhosseini's model introduces a condition for optimal CBDC introduction. In our research, we build upon these insights by introducing a proportional sales tax specifically associated with CBDC, emphasizing the separate budget constraints of the central bank and the government, and introducing a remittance constraint on the central bank. My model further highlights CBDC's role as a means of exchange that discourages tax evasion as expressed also by Kwon et al. [5].

2.4. Current CBDC Projects

The comprehensive literature review not only delved into theoretical frameworks and academic works but also scrutinized ongoing CBDC initiatives worldwide, with particular emphasis of course on prominent developing projects like the Digital Euro (as all the empirical analysis is based in the Euro area) but also on actively working CBDCs like the eNaira in Nigeria, Sand Dollar in the Bahamas and the Digital Yuan in China. This focused analysis involved dissecting the design features, objectives and implications of these initiatives, drawing insights from policy documents, pilot studies, and analyses conducted by central banking authorities and regulatory bodies. By scrutinizing these live CBDC projects, the review aimed to glean practical insights into the potential operational modalities, technological architectures, regulatory frameworks and socioeconomic impacts, thereby enriching the discussion on the implementation and implications of CBDCs within the global financial landscape.

3. Research Framework

The first research goal centers around the assessment of the convenience of introducing CBDC. This involves a comprehensive analysis of the effects produced by the introduction of CBDC on the overall welfare of the economy. The inquiry extends to understanding how CBDC influences monetary policy, household behaviors, and market dynamics. Hence, the first research question: **RQ1** – *How does the introduction of CBDC impact tax evasion and fiscal budgets? Is it convenient to introduce a CBDC? What are the effects produced by the introduction of a CBDC on the overall welfare of the economy?*

The second research goal focuses on the influence of CBDC on the money market and the activities performed by commercial banks. This inquiry recognizes that the presence of CBDC may have implications for these crucial components of the financial landscape. Insights gained from previous discussions on CBDC's impact on the money market and commercial banks will guide this investigation: **RQ2** – *What are the broader implications of CBDC adoption on monetary policy and central bank*

independence? Does the presence of a CBDC influence the money market and the activities performed by Commercial Banks?

The third research goal delves into the relationship between CBDC and tax evasion. This inquiry seeks to identify any effects on tax evasion and understand how these effects correlate with the design of CBDC and regulatory parameters. The exploration is informed by insights gained from previous discussions on CBDC effects on tax evasion: **RQ3** – *How does the introduction of CBDC correct distortions induced by tax evasion? Are there any effects on tax evasion? How are they correlated with the design of the CBDC and regulatory parameters?*

3.1. Methodology

The previous research questions have been tackled through three different steps: at first an extensive analysis of the literature has been conducted through database selection and keywords filtering at first, then a citation analysis to uncover the most relevant works related to the topics of interest and then a thematic classification which is also highlighted in Section 2. Then, the development of an analytical model was carried out, as it serves as a crucial component of this research: aiming to analytically substantiate the derived results pertaining to the effects of CBDC on tax evasion, monetary policy and its potential impact on Eurosystem countries, the analytical model is structured to assess the intricate relationships outlined in the research questions and hypotheses, providing a theoretical foundation for the subsequent empirical analysis. The analytical model's validity and applicability are enhanced through the integration of real-world data, specifically tailored to Eurosystem countries. This involves the utilization of relevant datasets mainly provided by Eurostat, the ECB itself or some other Central Banks belonging to the Eurosystem. The integration of real-world data was conducted through a scenario modeling first (by varying the values of the key parameters involved) and then accompanied by a sensitivity analysis to assess the robustness of the model and the variation in outcomes under different assumptions.

4. Analytical Model

The model is based on and encompasses characteristics from multiple frameworks, especially those by Lagos and Wright [6] and Williamson [7]. Time is discrete and continues from zero to infinity. There are five types of agents: a continuum of households, a continuum of firms (with imperfect competition), N commercial banks, the Government and the Central Bank. The discount factor from the current period to the next one is $\beta \in (0, 1)$. In each period t , agents interact sequentially in two stages, say day and night: a Walrasian centralized market (CM) at day and a frictional decentralized market (DM) at night. Therefore, since the centralized market precedes the decentralized market and vice versa, every period t begins with activities carried out in the CM and ends with activities carried out in the DM. The CM is where monetary policy by the Central Bank is implemented and where money market and labor market take place. In the CM households also rebalance their portfolio to enter the DM: there the goods market takes place, while also taxation and fiscal policy are carried out by the Government and all financial repayments (capital and interest) are completed before going into the next period. Firms only produce one perishable good in quantity q , traded in the DM, and aim at maximizing the profit obtained from sales to households, reinvesting all that amount into the economy. Households, who have infinite life, want to consume but cannot produce q and therefore have to obtain it in the DM. Households' utility u from consumption q can be properly represented by a generic isoelastic utility function $u(q)$ in the form.

$$u(q) := \frac{q^{1-\sigma} - 1}{1 - \sigma}$$

where σ is a constant assuming positive values for risk-averse agents and that is not empirically valuable in the model. Such function is in fact characterized by $u'(0) = \infty$, $u'(q) > 0$ and $u''(q) < 0$, which are important in the model to identify households' dominant strategies over consumption and portfolio rebalance. Banks engage only in purely financial transactions. The Government and the Central Bank cooperate but are mutually independent, and their interactions with private agents are different: indeed the Central Bank, in the stationary

economy, only interacts with commercial banks, which therefore have the crucial role to transmit the monetary policy put in place by the Central Bank to the real economy. Please consider that for the sake of simplicity each type of agent is collectively considered as a sole unitary agent in terms of quantities of goods produced or traded and in terms of currency held or exchanged.

The model is constructed based on two different economies, a transitory economy characterized by the introduction of the CBDC by the Central Bank and a stationary economy which represents the status achieved once the CBDC is completely integrated into the economic mechanisms. The equilibrium of these two economies (represented in formulas by 0 and 1 indexes) is built upon the concurrent solutions of the households' problem

$$U_H(\Delta_t) = \sum_{t=0}^{\infty} \beta^t (u(q_t) + G_t(\Delta_t) - h)$$

(where q is the consumed quantity of goods, G is the public expenditure by the Government, h is the labor provided by households and Δ is the vector of portfolio rebalances for cash, CBDC and deposits) and of the firms' problem

$$V_F(\mathbf{T}_t, \mathbf{L}_t) = \sum_{t=1}^{\infty} \beta^t F_t^*(\mathbf{T}_t, \mathbf{L}_t)$$

(where \mathbf{T} and \mathbf{L} are the vectors of tax payment and loan repayment in cash, CBDC and deposits). Both problems have been provided an analytical solution based upon two different hypothesis: one solution is given when $\varepsilon_e < \varepsilon_d$ (i.e. the CBDC technology and design allow for lower tax evasion rate than current digital payment instruments) and the other one is given when $\varepsilon_e > \varepsilon_d$ (i.e. the CBDC technology and design allow for higher tax evasion rate than current digital payment instruments).

5. Results and Discussion

The introduction of a CBDC like the Digital Euro has a huge impact on tax evasion, particularly among those countries suffering from structural inefficiencies in collecting taxes and/or with inefficiently competitive markets (i.e. with high average mark-ups). That means preventing a sensible quota of prices paid up by house-

holds to get out of the economic system, cannibalized by firms enlarging their profits (since we assumed no capital accumulation by firms and no investments in production), and instead allowing it to be englobed by the Government through taxes and then spent to provide households with necessary services carried out as public expenditure. In this case the overall welfare of the economy can be considered of course through the public expenditure by the Government but also adding the value of extra deposits held at the commercial banks, which of course represent a portion of the overall wealth of the system. In fact, as we will deepen discussing about the answer to the next research question, banks' liquidity got larger in every country, thus allowing for more credit availability and sweeping any potential risk of credit crunch.

Country	Taxes	Deposits
AUT	+3.06%	+67.11%
BEL	+4.36%	+69.24%
CYP	+0.00%	+56.54%
EST	+0.00%	+47.85%
FIN	+0.00%	+35.36%
FRA	+7.06%	+52.04%
GER	+8.47%	+75.77%
GRE	+24.48%	+58.44%
IRE	+7.00%	+59.24%
ITA	+38.30%	+92.07%
LAT	+5.89%	+58.20%
LIT	+17.36%	+60.17%
LUX	+2.95%	+54.15%
MAL	+61.26%	+96.08%
NED	+1.01%	+44.59%
POR	+10.00%	+71.49%
SLK	+27.40%	+74.08%
SLV	+4.24%	+60.24%
SPA	+8.59%	+65.62%

Table 1: Results in Eurozone Countries

The introduction of a Central Bank Digital Currency has the potential to increase banks' deposits and mitigate the risk of credit rationing and restrictive policies within the financial system. By facilitating the flow of funds and enhancing liquidity, CBDC adoption can lead to a surge in deposits at commercial banks. This influx of deposits provides banks with a more substantial pool of funds, reducing the likelihood of credit rationing where borrow-

ers are unable to access necessary financing. Moreover, the increased liquidity resulting from CBDC usage could alleviate constraints that might prompt banks to implement restrictive lending policies, allowing for more accessible credit and stimulating economic activity. Overall, the introduction of CBDCs has the capacity to amplify banks' deposits and contribute to a more robust financial environment by potentially averting credit rationing and restrictive lending practices. It is therefore possible to say that on one hand the Central Bank has lower probabilities to be required for an intervention supporting financial market institutions in a liquidity restriction scenario, on the other hand it also allows to keep monetary growth stable without the necessity for the regulatory authority to take in place extraordinary measures to further stimulate the economy.

Introducing a CBDC drastically reduces tax evasion especially in those countries with structural issues in tax compliance like Italy, Malta or Greece. It has been shown through the model that the parameters affecting more this result are the competitiveness of the internal market, the amount of POS accepting only cash as mean of payment, the tax evasion rates for both cash and deposits and of course the overall tax rate on sales: the higher these amounts, the larger will be the effect of introducing a CBDC, which instead has little to no impact on countries with tax collection systems already efficient, like Finland or the Netherlands. The research reveals that the introduction of a CBDC could significantly improve welfare in an economy constrained by remittances. In such economies, where sales tax creates a distortion between tax-evaded and tax-paid transactions, a CBDC with a positive interest rate eliminates this disparity, aligning marginal utilities and adhering to the Ramsey principle of optimal taxation.

6. Conclusions

This comprehensive study investigates the implications of CBDCs on an economy with cash-based tax evasion and delves into crucial aspects regarding their impact on welfare, monetary policy, banking intermediation, implementation

strategies and future considerations. The dissertation gets to the conclusion, after a thorough literature review and the application of real-world data into an analytic model specifically built up according to the main relevant work previously conducted through such methodology, that introducing a CBDC in the Eurozone would produce a decrease in tax evasion (and therefore an increase in collected taxes and Government's balance) in each of the 19 countries analyzed. That achievement would be confirmed only under some specific conditions applied to the eventual Digital Euro: in particular, the crucial parameter that would be required to stick to some strict constraint is the interest rate on the possession of CBDC (in the model noted as i_e), which, also considering the prominent intention by the European Central Bank to issue a *cash-like* CBDC, should forcibly be equal to zero.

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