“Tracing the invisible: How CBDCs can strengthen anti-money laundering in small open economies”

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TRACING THE INVISIBLE: HOW CBDCS CAN STRENGTHEN ANTI-MONEY LAUNDERING IN SMALL OPEN ECONOMIES

Abstract

Money laundering poses serious risks for small open economies by weakening financial stability and reducing trust in the financial system. This paper investigates how central bank digital currencies (CBDCs) can enhance the enforcement of anti-money laundering (AML) policies in these economies. We develop a simple macroeconomic model to examine the trade-offs between stronger financial control and household welfare when digital enforcement tools are introduced. A dynamic model is constructed in which a representative household chooses consumption, labor, and foreign savings under a capital account that allows illicit transfers. The government enforces AML rules by increasing detection probability through CBDC infrastructure. The model compares scenarios with and without CBDCs to assess changes in behavior, illegal outflows, and welfare outcomes. The findings show that CBDCs can reduce money laundering by making transactions more transparent and harder to hide. As detection becomes more likely, the household's incentive to move funds illegally declines, and the resulting loss of hidden income leads to slightly higher labor effort and lower consumption. The welfare effects depend on the balance between enforcement strength and households' need for economic flexibility. Policymakers in small open economies can use CBDCs to improve the integrity of financial flows, especially when evasion risks are high. However, effective CBDC design must consider the trade-off between tighter control and households' ability to manage their finances. This study provides one of the first theoretical frameworks showing how CBDCs reshape the interaction between financial transparency and household welfare in vulnerable economies.

Keywords central bank digital currencies, anti-money laundering, capital controls, transparency, households, enforcement

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INTRODUCTION

Money laundering poses serious challenges for many countries, particularly small open economies with limited monitoring capacity. Criminals often move large sums of money across borders using complex networks of shell companies, fake invoices, and untraceable cash transfers. These illegal flows can weaken financial systems, erode trust in banks, and reduce government tax revenues. Traditional anti-money laundering (AML) tools such as bank reporting requirements and international cooperation have helped, but they are often slow, incomplete, and easy to avoid (Benson et al., 2024). As financial systems become more digital and cross-border transactions increase in speed and volume, these older approaches are struggling to keep up. As digital currencies evolve, regulatory frameworks must adapt to new technological architectures that blur traditional distinctions between payment systems and monetary instruments (Schwarcz, 2022).

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Money laundering is not just a legal issue; it is a macroeconomic threat. According to a relatively old estimation by the International Monetary Fund (2001), money laundering accounts for approximately 2% to 5% of the global GDP, or roughly USD 800 billion to USD 2 trillion annually. In 2023, an estimated USD 3.1 trillion in illicit funds flowed through the global financial system, including activities such as drug trafficking, human trafficking, fraud, and terrorist financing (Nasdaq, 2024). These illicit flows have direct consequences for financial stability, particularly in small open economies that are highly exposed to capital volatility. When large amounts of money leave a country illegally, they can create exchange rate pressure, drain foreign reserves, weaken banks, and reduce public trust. In this context, strengthening AML enforcement is not only about catching criminals, it is also about protecting economic resilience.

Despite ongoing global efforts, AML enforcement remains persistently weak in many small open economies. Limited monitoring capacity, high exposure to illicit cross-border flows, and the increasing use of anonymous or hard-to-trace channels continue to undermine the effectiveness of traditional enforcement tools. This persistent gap highlights the need for new digital mechanisms that can enhance monitoring and make illicit transfers more difficult to hide.

Central bank digital currencies (CBDCs) offer one potential path forward. CBDCs are digital forms of national currency issued by central banks. The Bank for International Settlements (2021) notes that CBDCs represent a potential restructuring of the monetary system by combining sovereign backing with digital programmability. What makes them different from cash or regular bank transfers is that they can be designed to track transactions, link payments to verified identities, and include built-in rules to limit certain types of activity (Ozili, 2023; Shahen & Sharaf, 2025). This means that CBDCs could allow governments to see where money is going and quickly block suspicious transfers. As a result, CBDCs have the potential to become a powerful tool for fighting money laundering and illegal capital outflows (Dupuis et al., 2022). For small open economies in particular, the ability to reduce anonymous flows and enhance traceability could significantly strengthen enforcement capacity.

The purpose of this study is to develop a simple macroeconomic model that examines how CBDCs can strengthen AML enforcement by increasing detection probability and shaping household decisions related to consumption, labor, and illicit foreign savings.

1. THEORETICAL BASIS

Understanding the interaction between CBDCs, financial transparency, and AML enforcement requires drawing from several areas of economic and regulatory research. The literature covers CBDC design, illicit financial flows, open-economy capital movement, and household behavior under monitoring constraints. This section integrates these areas to provide the conceptual foundation for the model developed in the Results section.

Early CBDC research focused on payment efficiency, competition, and financial stability. Auer and Böhme (2020), Bindseil (2020), and Auer et al. (2022) highlight the technical design of CBDCs and their broader macro-financial implications, including their potential effects on monetary transmission and financial intermediation. Adrian and Mancini-Griffoli (2021) emphasize that CBDCs differ from private digital currencies in their regulatory alignment and policy integration. Ozili (2023) similarly argues that CBDCs introduce programmable compliance features that traditional electronic money does not provide.

Another body of literature examines illicit financial flows and the limits of traditional AML frameworks. Classic contributions by Reuter and Truman (2005) and Ferwerda (2009) show that criminals exploit anonymity, weak regulatory coordination, and gaps in cross-border enforcement. Barone and Masciandaro (2011) argue that money laundering distorts competition and reduces the efficiency of legitimate markets, while Unger et al. (2014) document the economic costs of weak AML

systems. Dupuis et al. (2022) link these insights directly to CBDCs, arguing that digital traceability and identity-linked transactions can significantly restrict laundering strategies.

Recent regulatory studies expand these insights by examining how AML obligations will operate within actual CBDC legal frameworks. Minto (2025) shows that the introduction of a digital euro raises new compliance challenges because current EU AML laws do not explicitly cover CBDCs. Minto's (2025) analysis highlights key gaps – particularly the unclear coordination between the AML Regulation and the proposed Digital Euro Regulation – and argues that AML effectiveness will depend heavily on how policymakers impose transaction limits and monitoring rules on both online and offline CBDC use. Similar regulatory concerns are raised by the Financial Intelligence Unit of Latvia (2023), which discusses AML/CFT implications related to privacy features and offline functionality in the context of the digital euro. Complementary technical work by Michalopoulos et al. (2024) explores compliance design options for offline CBDCs, emphasizing mechanisms to balance privacy and AML/CFT requirements. Complementing this regulatory perspective, Gaisina and Finger (2025) provide empirical evidence using global data from piloted and launched CBDCs. They find that countries with stronger CBDC development tend to have better AML performance, while higher cryptocurrency activity in CeFi and DeFi environments is associated with weaker AML outcomes. Their work suggests that well-designed CBDCs can offset some of the AML vulnerabilities created by cryptocurrencies, but only when embedded within a strong institutional and regulatory framework.

Research on digital enforcement tools adds another important dimension. Meiklejohn et al. (2013) show how blockchain-based systems allow authorities to follow illicit flows in decentralized networks. Kim et al. (2025) further propose AI-supported monitoring frameworks for enhancing AML detection in CBDC systems. Carstens (2021) argues that CBDCs can build regulatory compliance into the core payment infrastructure, reducing reliance on intermediary reporting. Kahn (2018) examines how digital payment systems reshape the trade-off between privacy and surveillance, showing that greater traceability strengthens enforcement but raises concerns about user autonomy. This balance is central to understanding how CBDCs may improve AML outcomes while affecting user welfare.

Studies on small open economies highlight how capital mobility amplifies vulnerabilities to illegal outflows. Obstfeld and Rogoff (1995, 1996), Edwards (2004), and Lane and Milesi-Ferretti (2007) show that even moderate capital flight can generate exchange rate pressure, weaken reserves, and undermine macroeconomic stability. Fernández-Villaverde et al. (2021) and Popescu (2022) extend these insights to CBDCs, arguing that digital cross-border payment channels can either increase or reduce outflows depending on system design and identity-verification requirements. These dynamics make enforcement challenges more severe for small open economies with limited institutional capacity.

Household behavior under monitoring also plays a central role. Deaton (1991) and Carroll (2001, 2006) show that households rely heavily on consumption smoothing and precautionary savings. When monitoring becomes tighter, hidden income channels shrink, which may increase labor effort or reduce welfare depending on enforcement intensity. Wang (2023) shows that CBDCs reduce anonymity and discourage illicit transfers, but their welfare effects depend on surveillance intensity and privacy expectations. Mahari et al. (2022) argue that CBDCs can be designed "AML-by-design," balancing traceability with economic flexibility.

Taken together, these areas of research highlight three key points that motivate the model that follows. First, CBDCs introduce new enforcement tools that can substantially reduce illicit financial flows. Second, small open economies are especially vulnerable to capital leakages that weaken financial stability. Third, households adjust their labor, savings, and consumption decisions in response to detection risk, creating trade-offs between enforcement effectiveness and economic welfare. These insights justify the need for a formal model examining how CBDCs reshape incentives and outcomes in environments with illicit capital outflows.

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2. RESULTS

This section develops a simple inter-temporal macroeconomic model to examine how CBDCs alter household decisions and strengthen AML enforcement. The model considers a representative household that chooses consumption, labor supply, legal foreign savings, and illicit foreign savings while facing the possibility of detection and punishment when laundering money. CBDCs influence outcomes through their effect on the detection probability, which rises when financial transactions become traceable and identity-linked.

The representative household maximizes lifetime utility over an infinite horizon:

$$\max_{\{C_t, L_t, B^f_{t+1}, \theta_t\}} \sum_{t=0}^{\infty} \beta^t \left(\ln C_t - \frac{\varnothing}{1+\eta} L_t^{1+\eta}\right). \quad (1)$$

Subject to the budget constraint:

$$C_t + B^f_{t+1} + \tau(\pi)\theta_t = w_t L_t + R_t B^f_t, \quad (2)$$

where $\beta^t \in (0,1)$ is the discount factor; C_t is consumption; L_t is labor supply, B^f_t denotes legal foreign asset holdings, and θ_t represents laundered funds abroad. The term $\tau(\pi)$ captures the expected penalty or cost for laundering, which depends on the detection probability π. The detection probability increases with CBDC-based enforcement, making illicit transfers more costly. The parameter $\varnothing > 0$ measures the disutility of labor; $\eta \geq 0$ is the inverse of the Frisch elasticity of labor supply; w_t is the wage rate; R_t is the gross return on legal foreign assets.

In this setup, households gain utility from consumption and dislike labor. They can choose to move funds illegally abroad (θ) but face a cost that rises with enforcement strength. We assume $\tau(\pi) = \alpha\pi$ where $\alpha > 0$ captures punishment severity and $\pi \in (0,1)$ reflects the detection probability, which is higher when CBDCs are in place.

To solve the household problem, consider the Lagrangian:

$$\mathcal{L} = \sum_{t=0}^{\infty} \beta^t \left[\ln C_t - \frac{\varnothing}{1+\eta} L_t^{1+\eta} + \lambda_t \left(w_t L_t + R_t B^f_t - C_t - B^f_{t+1} - \alpha\pi\theta_t\right)\right]. \quad (3)$$

The household chooses sequences $\{C_t, L_t, B^f_{t+1}, \theta_t\}$ to maximize its lifetime utility, taking wages, interest rates, and enforcement conditions as given. Differentiating the Lagrangian with respect to each choice variable gives the first-order conditions as follows:

(i) ***With respect to*** C_t

$$\frac{\partial \mathcal{L}}{\partial C_t} = \beta^t \left(\frac{1}{C_t} - \lambda_t\right) = 0 \Rightarrow \lambda_t = \frac{1}{C_t}, \quad (4)$$

(ii) ***With respect to*** L_t

$$\frac{\partial \mathcal{L}}{\partial L_t} = \beta^t \left(-\varnothing L_t^{\eta} + \lambda_t w_t\right) = 0 \Rightarrow \varnothing L_t^{\eta} = \lambda_t w_t, \quad (5)$$

By substituting $\lambda_t = \frac{1}{C_t}$ we get $\varnothing L_t^{\eta} = \frac{w_t}{C_t}$,

(iii) ***With respect to*** B^f_{t+1}

$$\frac{\partial \mathcal{L}}{\partial B^f_{t+1}} = -\beta^t \lambda_t + \beta^{t+1} \lambda_{t+1} R_{t+1} = 0 \Rightarrow \lambda_t = \beta R_{t+1} \lambda_{t+1}, \quad (6)$$

By substituting

$\lambda_t = \frac{1}{C_t}$ we get $\frac{1}{C_t} = \beta R_{t+1} \frac{1}{C_t + 1}$,

(iv) ***With respect to*** θ_t

$$\frac{\partial \mathcal{L}}{\partial \theta_t} = -\beta^t \lambda_t \alpha \pi = 0, \quad (7)$$

where λ_t, α, π is the marginal benefit of laundering. This implies that laundering occurs only if its perceived benefit exceeds the expected penalty. Thus, laundering activity decreases monotonically in π.

CBDC-based enforcement enters through an increase in the detection probability. Under a traditional system with limited traceability, enforcement is characterized by a lower probability π_0. Under CBDCs, enhanced monitoring increases detection to π_1, where $\pi_1 > \pi_0$. This shift allows us to compare equilibrium outcomes under weak and strong enforcement.

A higher detection probability raises the expected cost of laundering, reducing optimal illicit transfers. Let θ^* denote the optimal amount laundered. The comparative static result follows immediately:

$$\frac{d\theta^*}{d\pi} < 0. \quad (8)$$

This result is fully consistent with Wang (2023), who shows that digital enforcement mechanisms embedded in CBDCs reduce incentives to hide income abroad.

Stronger enforcement also reduces disposable resources because illicit income becomes harder to conceal. As a result, consumption falls:

$$\frac{dC^*}{d\pi} < 0, \text{ while labor supply rises: } \frac{dL^*}{d\pi} > 0. \quad (9)$$

This reflects a classic enforcement–welfare trade-off where crime decreases, but households respond by supplying more labor and reducing consumption to offset lost hidden income. Similar dynamics appear in Tsang et al. (2023) and Soana and de Arruda (2024), who document that digital enforcement strengthens compliance but may reduce short-run household welfare.

Overall, the model shows that CBDCs increase enforcement effectiveness by raising detection probability and limiting opportunities for illicit financial flows. While the model is intentionally stylized, it still captures the essential trade-off between stronger enforcement and household welfare that arises when CBDC-based monitoring is introduced. However, these gains come with economic adjustments, as households compensate for reduced illegal income through higher labor effort and lower consumption.

3. DISCUSSION

The model shows that CBDCs strengthen AML enforcement by raising the probability of detection and increasing the expected cost of hiding funds abroad. This higher detection probability lowers the optimal amount of illicit foreign savings and reduces the overall scale of laundering in the economy. This result aligns with prior research showing that digital traceability reduces the scope for criminal adaptation (Dupuis et al., 2022) and makes it harder to exploit anonymous channels (Ferwerda, 2009; Reuter & Truman, 2005).

An important implication of the model is that enforcement gains come with economic adjustments. When illicit income becomes harder to hide, households experience a decline in disposable resources and compensate by supplying more labor and reducing consumption. This mirrors the consumption–labor trade-offs described in household behavior research (Carroll, 2001; Deaton, 1991) and aligns with the idea that hidden income channels support smoothing when formal mechanisms are limited.

The model's result that tighter monitoring reduces laundering is directly in line with Wang (2023), who finds that lower anonymity in CBDC systems discourages illegal transfers. Similarly, Tsang et al. (2023) and Soana and de Arruda (2024) document that digital monitoring increases compliance but may place welfare pressure on individuals who lose access to informal financial pathways. The model in this paper shows that trade-off in which enforcement improves, but households respond by increasing labor effort and reducing consumption, creating short-run welfare costs.

For small open economies, the findings also reinforce long-standing concerns about capital mobility. The decline in illicit outflows under higher detection probability connects closely to the work of Obstfeld and Rogoff (1995, 1996) and Lane and Milesi-Ferretti (2007), who show how unregulated cross-border flows can weaken exchange-rate stability and drain foreign reserves. By constraining illegal transfers, CBDCs may help reduce these vulnerabilities. However, the model also indicates that enforcement cannot be evaluated purely by its success in reducing crime; it must also account for changes in household behavior and overall welfare.

Finally, the results emphasize that CBDC design plays a central role in determining the strength of AML outcomes. Higher traceability and programmable compliance enhance enforcement, as highlighted by Carstens (2021) and Mahari et al. (2022). But the model also shows that stronger surveillance increases the economic burden on households, supporting the argument that CBDC frameworks must

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balance enforcement capability with user privacy and financial flexibility (Kahn, 2018).

An additional implication of our findings concerns the practical implementation of AML rules within CBDC systems. While our model focuses on detection probability as a technological feature, real-world enforcement also depends on how legal frameworks operationalize monitoring. As Minto (2025) notes in the context of the proposed Digital Euro, AML effectiveness will ultimately depend on how policymakers design transaction limits, reporting obligations, and supervisory coordination mechanisms – especially for offline, cash-like CBDC functions. This suggests that enforcement strength is not determined by traceability alone, but by how legal institutions translate technological capacity into binding compliance structures. In other words, CBDCs increase potential detection, but regulatory calibration determines whether that potential is fully realized.

Similarly, Gaisina and Finger (2025) provide empirical evidence that well-designed CBDCs are associated with stronger AML performance across countries. Their results show that jurisdictions with higher cryptocurrency activity – especially in DeFi – tend to have weaker AML scores, while CBDCs with clear AML frameworks improve regulatory outcomes. This finding reinforces our model's prediction that digital identity and programmable compliance can materially reduce illicit flows in small open economies.

Overall, our results show that CBDCs can substantially strengthen AML enforcement in small open economies, but the gains in transparency come with economic trade-offs that policymakers must consider. Effective CBDC design requires balancing traceability, privacy, and financial flexibility to ensure that improved enforcement does not produce unintended welfare costs.

CONCLUSION

The purpose of this study was to examine how central bank digital currencies (CBDCs) can strengthen anti-money laundering (AML) enforcement in small open economies by increasing detection probability and shaping household decisions. Using a simple macroeconomic model, the paper analyzed how tighter monitoring affects laundering behavior, consumption, labor supply, and overall welfare.

The results show that higher detection probability reduces the incentive to move funds illegally abroad, leading to a clear decline in illicit foreign savings. At the same time, the reduction in hidden income forces households to adjust their economic behavior by supplying more labor and lowering consumption. This reveals an important trade-off where CBDCs make laundering more difficult, but stronger enforcement also restricts financial flexibility for households.

These findings suggest that CBDCs can play a meaningful role in improving financial transparency and reducing the macroeconomic risks associated with illicit capital outflows, especially in economies that lack strong monitoring institutions. However, the welfare implications depend on how CBDCs are designed. Systems that rely heavily on surveillance may achieve higher enforcement but also place greater pressure on households. Policymakers therefore need to balance enforcement strength with privacy and flexibility to avoid unintended welfare costs.

Future research could extend the model by incorporating heterogeneous households, cross-border CBDC interactions, or enforcement responses from financial intermediaries. Exploring these dimensions would help clarify how CBDCs reshape financial integrity and economic behavior in more complex and realistic settings.

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DECLARATIONS

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CONFLICT OF INTEREST STATEMENT

Author(s) reported no conflict of interest

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