Multi-Currency Settlement Token

DRAFT
February, 2023

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Abstract

This paper outlines a basic design setup for a multi-currency settlement token (MCST) and illustrates its use in bilateral and multilateral settlement problems. In a first step, the paper shows how a basic but general version of an MCST can be implemented through a linear combination of existing fiat-tracking digital assets. In a second step, the paper discusses extensions and design choices of the MCST setup.

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1 Introduction

Consider a simple bilateral settlement problem, in which party A in country A provides services to party B in country B and vice versa. At the end of a settlement period, parties net out their receivables and an invoice is issued for the settlement of the outstanding net balance. Let's say at the end of the settlement period party B owes party A an amount M.

The question may arise, in which currency amount M should be denominated. If both parties have a clear preference on a single currency (e.g. in the case of a single currency area) the question becomes trivial. If this is not the case, the choice of a settlement currency becomes non-trivial as it can have significant economic, financial, and political implications. In the literature, several factors that influence the choice of a settlement currency have been identified, including exchange rate stability, liquidity, transaction costs, and political considerations

- Exchange rate stability is a major concern for international trade and affects the choice of a settlement currency. A stable exchange rate reduces the risk of changes in the value of the settlement currency, which can affect the profitability of the trade. The choice of a currency with low volatility in exchange rates can help to mitigate this risk.
- Liquidity is another important factor that affects the choice of a settlement currency. A currency with high liquidity makes it easier for parties to transact and settle their outstanding balances. For this reason, major currencies such as the US dollar, euro, and yen are commonly used as settlement currencies.
- Transaction costs, including exchange costs and conversion fees, also play a role in the choice of a settlement currency. A currency with low transaction costs makes it easier and more cost-effective for parties to transact and settle their balances.
- Finally, political considerations, such as the level of trust in a government and the stability of its economy, can also influence the choice of a settlement currency. The reputation and stability of a government and its economy can affect the perception of the currency's stability and the level of trust that parties have in it as a settlement currency.

In conclusion, the choice of a settlement currency, even in a simple bilateral settlement setting, is a complex issue that involves a variety of economic, financial, and political factors. The choice of a currency depends on the specific needs and preferences of the parties involved.

If the parties agree on currency A, party B bears the full exchange rate risk. If they agree on currency B, it's party A that is at disadvantage. Economic theory suggests that the parties would agree on a currency that minimizes transaction costs and that maximizes joint surplus. This could be currency A, currency B, or a currency C that may be preferred by both for macroeconomic reasons (e.g. because of available market liquidity).

This paper introduces another option for the settlement parties to consider, namely a synthetic mixed-denomination currency that allows for an arbitrary distribution of exchange rate risk among an arbitrary number N of settlement parties and number M of currencies.We propose a technological implementation of this settlement currency using distributed ledger technology (DLT) and outline the design of a decentralized multi-currency settlement token (MCST) that serves as DLT-based representation of the settlement currency.

2 Basic setup

2.1 Issuance

Let an instance of the multi-currency settlement token MCST be minted by locking up a pre-defined linear combination of different fiat-tracking token assets ('stablecoins') in a smart contract[1]. Let $C = (c_1, c_2, \ldots, c_N)$ denote the set of stablecoins included in the MCST instance and let $W = (w_1, w_2, \ldots, w_N)$ denote the weights attached to each stablecoin in the MCST instance[2]. The minting process is then characterized by $MSCT = w_1c_1 + w_2c_2 + \ldots + w_Nc_N$ with $\sum w_n = 1$.

Example: Assuming there are two stablecoins available, cEUR and cUSD, and we are interested in a 50-50 EUR-USD MCST, the minting process would require locking up 0.5 cEUR and 0.5 cUSD.

2.2 Redemption

In the basic setup, the redemption process is the reverse of the issuance process, i.e. a user would send $MSCT_i$ to a smart contract and the contract would send the previously locked up combination of assets back to the sender address[3].

Example: Consider the EUR-USD MCST in the example above. Sending the MCST to the smart contract, would return 0.5 cEUR and 0.5 cUSD to the sender

2.3 Valuation

The value of MCST fluctuates and depends on the currency in which the value of MCST is supposed to be denominated[4]. Let $Pn = (p_{1n}, p_{2n}, \ldots, p_{Nn})$ denote the exchange rates from the perspective of currency n such $pnn = 1$ by design. The value of the $MSCT$ in currency n is then given by $V_n(MSCT) = p_{1n}w_1c_1 + p_{2n}w_2c_2 + \ldots + p_{Nn}w_Nc_N$.

Example: Consider the MCST in the example above and let the EUR/USD rate be equal to one. The EUR value of the MCST is then given by $V_{EUR} = 1EUR/EUR{*}0.5{*}1EUR{+}1EUR/USD{*}0.5{*}1USD = 1EUR$ and analogously for the USD value because of the price parity.
Assume now the EUR/USD rate decreases to 0.9 EUR per USD. The EUR value of the MCST is then $V_{EUR} = 1EUR/EUR * 0.5 * 1EUR + 0.9EUR/USD * 0.5 * 1USD = 0.5EUR + 0.45EUR = 0.95EUR$. Analogously, the USD value of the MCST is then $V_{USD} = \frac{1}{0.9}USD/EUR * 0.5 * 1EUR + 1USD/USD * 0.5 * 1USD = 0.56USD + 0.5USD = 1.06USD$.

Table 1: Summary of the value development of one MCST

MCST Value	EUR/USD = 1	EUR/USD = 2
in EUR	1	0.95
in USD	1	1.06

To illustrate the economic effects to the settlement parties we compare MCST settlement to scenarios, in which the parties would have settled either fully in EUR or fully in USD[5]. In this example, suppose the settlement currency is USD and the open amount to settle is 1 USD. We will first compare the MCST settlement from the perspective of a EUR-denominating party and then from a USD-denominating party.

[1] Stablecoins here refer to tokenized digital assets that track the value of a reference currency. There are various types of stabilizing mechanisms that involve different risk factors, which are not further analyzed in this paper. To achieve stability, the mechanisms typically involve collateral assets, such as bank credit ('fiat-backed stablecoin'), short-term market instruments, or other digital assets.

[2] When we talk about a set of stablecoins, we refer to one ERC-20 unit of a stablecoin implementation, e.g. one unit of USDC.

[3] An alternative issuance and redemption process is discussed further below.

[4] We abstract away from the de-pegging risk of particular stablecoin. It would be straightforward to extend the setup to take into account whether a particular stablecoin is on peg or not by also including the stablecoin's market price via oracle reports in the minting process.

[5] For a more formal analysis of mixed-currency risk properties, see e.g. Giudici, Leach, & Pagnottini (2022).

The maximum loss a EUR-denominating party could have incurred in this scenario is 0.1 EUR by converting EUR to USD at 1:1 rate instead of waiting for the rate to decrease to 0.9 EUR/USD. In comparison, the maximum loss with MCST settlement is 0.05 EUR by converting EUR to MCST at a 1:1 rate instead of waiting for the MCST value to decrease to 0.95 EUR. In this example, the maximum loss is therefore reduced by 50% through MCST settlement.

A USD-denominating party by definition does not bear any exchange rate risk if the settlement currency is USD. Under MCST settlement, however, the USD-denominating party bears the risk that the USD-to-MCST conversion takes place at a price of 1.06 USD instead of 1 USD, i.e. the maximum loss is 0.06 USD.

2.4 Conclusion

Unsurprisingly, MCST settlement therefore spreads the exchange rate risks across the parties involved. It reduces the risk for some parties and increases the risk for others. The extent is a design choice and depends on the composition and weights of constituent assets. As it allows for a broader set of risk outcomes compared to agreeing on a single currency setup (choosing a single currency could be considered as an edge case of the MCST), it might lead to economic efficiencies and increase gains from trade across the settlement parties involved.

3 Discussion and extensions

3.1 Composition and design choices

The basic setup above theoretically allows for an arbitrary linear combination of constituent stablecoins. Instead of a 50-50 EUR-USD MCST, it would also be possible to create a 20-40-40 YEN-EUR-USD token or a 43.38-29.31-12.28-7.59-7.44 USD-EUR-CNY-YEN-GBP token, a virtual replication of the IMF's SDR[6][7].

The composition of constituent assets and the selection of weights are design choices and should be carefully considered in the context of the envisaged use cases. Relevant aspects could be:

- *Availability of suitable stablecoins*: availability and reliability of stablecoin structures, regulatory compliance, market liquidity, as well as stablecoin-to-fiat conversion options (on- and off-ramp).
- *Currency needs among settlement parties*: distribution of currencies involved in the settlement process, as well as volume estimates per currency.
- *Risk preferences of settlement parties*: some parties might have third-party risk hedging arrangements in place that reduce the need of the MCSt. Similarly, parties might have a preference for one currency over the other for portfolio optimization reasons.

[6] See https://www.imf.org/en/Topics/special-drawing-right. The weights represent the IMF's reported weights for its 2022 review of the SDR's currency basket.

[7] The concept could also be extended to other currency designs, such as Mundell's 'stable world currency' for which weights were calculated in Hovanov, Kolari, & Sokolov (2004). Similarly, see proposals for settlement currencies with geographic focus (e.g. Pontines, 2015) or with purchase power adjustments(e.g. Ho, 2018).

3.2 Balanced vs. unbalanced issuance and redemption

The above basic setup assumes that issuance and redemption takes place in a 'balanced' way. Parties would only be able to mint a new MCST by providing the required combination of constituent currencies and they would get an analogous combination of currencies back when redeeming the MCST.

While this 'balanced' approach guarantees that the MCST is always fully collateralized and redeemable ('one apple in, one apple out'), it might put a high administrative burden on the settlement parties. First, parties would need to handle multiple currencies in parallel. Second, parties may not be able to on- or off-ramp some of its constituent stablecoins using local fiat currencies (if necessary).[8]

From the perspective of the parties involved, it would therefore be preferable to be able to issue MCST with local currency only and, similarly, to redeem MCST for local currency only. While in a more developed MCST market environment, this might be provided through secondary markets, we will discuss below how such a mechanism could be implemented on the MCST token level.

First, it is important to notice that allowing 'unbalanced' issuance and redemption may change the collateral composition of the MCST. The collateral system would no longer work on a 'one apple in, one apple out' basis but rather on a 'one apple in, one orange out' basis. This is problematic because it changes the MCST composition away from its target composition, which in turn has effects on the MCST's risk properties. An 'unbalanced' issuance and redemption model must therefore be accompanied by adequate collateral rebalancing measures, which are discussed further below.

3.3 Collateral rebalancing

It should first be noted that this paper assumes that the MCST token setup is implemented in a fully decentralized way through smart contracts that do not require any input or intervention from intermediaries. This also means that the collateral assets are custodied by a smart contract and that any collateral management is performed in a decentralized way. We will outline two approaches (indirect and direct) to decentralized collateral rebalancing.

Indirect collateral rebalancing

The indirect approach relies on routing incoming and outgoing token transfers through an exchange wherever necessary to guarantee a balanced collateral position on a MCST level but provide the user with an experience of an "unbalanced' issuance and redemption process[9].
This approach therefore relies on available and liquid exchange markets that allow for smart contract interaction[10]. This would increase transaction costs (swap fees and potentially additional gas fees) but may provide users with higher utility value.

Example: Consider the 50-50 USD-EUR MCST example from above. Assume the user wants to issue and redeem MCST only with a EUR-stablecoin, cEUR. Further assume a 1:1 EUR/USD exchange rate and abstract away from any swap and transaction fees. Issuing one MCST would then cost the user 1 EUR, of which 0.5 EUR are deposited directly into the MCST, while another 0.5 EUR are exchanged for 0.5 USD before depositing into the MCST. When redeeming the MCST, the contract would release 0.5 EUR and 0.5 USD but before sending the currency value to the user, the contract would swap the 0.5 USD for 0.5 EUR and send 1 EUR in total back to the user.

[8] Up until today, it is fairly uncommon for stablecoins to be redeemable in currencies other than the currency they are supposed to track. As an example, a Euro-tracking stablecoin cEUR is likely listed with a cEUR-EUR pair on an exchange. This secondary market price (cEUR in EUR) is typically referred to when the 'peg' of a particular stablecoin is discussed. But it is far less likely to see a direct listing of a EUR-stablecoin with a non-EUR currency pair. Similarly, redemption with the primary issuer typically only takes place in the currency that the stablecoin is tracking.

[9] The process is indirect because the MCST collateral is never actually out of balance. From a contract perspective, all incoming and outgoing transfers are always balanced.

[10] Most decentralized exchanges (DEXs) provide this functionality natively.

Direct collateral rebalancing

The direct approach relies on incentivizing currency deposits and withdrawals depending on the actual collateral composition compared to its target composition. The incentive system works in a way that the collateral composition is self-correcting over time, as it incentivizes (disincentivizes) deposits (withdrawals) of currencies that are underrepresented (and analogously for currencies that are overrepresented).

These rebalancing transactions can be performed either by the settlement parties directly or by third-party actors in case of a permissionless environment. The cost function could be dynamic and costs could increase over-proportionally the farther away a collateral position is from its target weight to make it increasingly harder to trade the collateral system away from its target rates. It might also be necessary to implement limits on unbalanced withdrawals and deposits to limit the overall extent of collateral imbalances and to guarantee a minimum level of balanced collateral.

Example: Suppose the target composition of EUR-USD MCST is 50-50 but the actual composition is 60-40. The contract would then charge a higher fee for additional USD withdrawals than for EUR withdrawals and would charge a lower fee for USD deposits than for EUR deposits. This encourages settlement parties (or third-party market participants) to rebalance the collateral system towards its target composition.

4 Conslusion

The Multi-Currency Settlement Token (MCST) presents a transformative approach to international settlements by integrating distributed ledger technology with a diverse basket of stablecoins. This innovation addresses key issues in cross-border transactions, such as exchange rate volatility, transaction costs, and currency preferences. MCST's design offers a balanced risk distribution and increased economic efficiency, making it a significant step forward in the realm of global trade.
While MCST's flexibility and decentralized nature are promising, challenges in stablecoin selection, regulatory compliance, and technical implementation must be carefully navigated. Effective management of these issues is crucial for ensuring the stability and reliability of the MCST system. In summary, MCST stands as a pioneering solution in international settlements, poised to enhance stability and fairness in global financial interactions. Its success hinges on continued research and collaborative efforts to harness its full potential.